

# Program of the Seventy-Second Annual Meeting of the American Association of Physical Anthropologists

to be held at  
**The Tempe Mission Palms Hotel**  
Tempe, Arizona  
April 23 to April 26, 2003

## **AAPA Scientific Program Committee:**

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and many other student volunteers

## Message from the Program Committee Chair

The 2003 AAPA meeting, our seventy-second annual meeting, will be held at the Tempe Mission Palms Hotel in Tempe, Arizona. There will be 682 podium and poster presentations in 55 sessions, with a total of almost 1,300 authors participating. These numbers mark our largest meeting ever. The program includes nine podium symposia and three poster symposia on a variety of topics: 3D methods, atelines, baboon life history, behavior genetics, biomedical anthropology, dental variation, hominid environments, primate conservation, primate zoonoses, teaching physical anthropology, tooth chemistry. The program also includes the First Annual Wiley-Liss Symposium; this year's topic is the evolution of the genus *Homo* in Europe, and features talks by four distinguished colleagues from Europe.

As in past years, this year's meetings reflect the international nature of our meetings. Roughly 20 percent of the senior authors live outside the United States, representing 27 nations. Large numbers of senior authors live in the United Kingdom, Austria, Canada, and Germany, with substantial numbers also from Japan, South Africa, Italy, and France.

This is the second year that we have used an online registration system for payment of registration fees and submission of abstracts. Although we are still working out the bugs, we expect that the membership will continue to reap the benefits of electronic submission, particularly eliminating the tedious process of abstract preparation on the "blue box" forms of the past. As was the case for the past two years, we have put together a searchable on-line database of the abstracts in this issue, available at the AAPA web site: [www.physanth.org](http://www.physanth.org). By entering key terms, you can explore the contents of the entire meeting supplement to find presentations on topics of special interest to you. The search engine allows you to

obtain abstracts and determine when and where specific posters and papers will be presented.

As in the past, we will meet in conjunction with a number of affiliated groups including the American Association of Anthropological Genetics, the American Dermatoglyphics Association, the Dental Anthropology Association, the Human Biology Association, the Paleoanthropology Society, the Paleopathology Association, and the Primate Biology and Behavior Interest Group. As is our practice, the Paleoanthropology Society meets with us in alternate years (other years they meet with the Society for American Archaeology). This year, the Paleoanthropology Society has its meeting on Tuesday, April 22, and Wednesday, April 23. The Paleopathology Association also has its meeting on these days. As the second year of a two-year trial, the Human Biology Association will meet at the same time as the AAPA, having its sessions on Saturday, April 26 and Sunday, April 27.

The following pages provide a map of the Tempe Mission Palms Hotel; a summary table of conference events; a daily conference schedule, including meetings of affiliated associations, editorial boards, workshops, and various business meetings; a detailed listing of AAPA poster and podium sessions; the abstracts of the presentations; and an index of the authors showing the session numbers of their presentations.

AAPA activities commence on Wednesday evening, April 23, with a panel discussion organized by our Career Development Committee on "Non-Traditional Careers," featuring Kathleen Gordon, Alan Ryan, Linda Smith, Linda Valleroy, and Robert Walker, and moderated by Heather Edgar. This event will be followed by our annual reception. Poster and podium sessions begin Thursday morning and continue through Saturday afternoon. The plenary session,

held on Thursday evening, is a panel discussion on “Can Biological Anthropology and Cultural Anthropology Coexist?” featuring Jim Calcagno, Matt Cartmill, Ralph Holloway, Fran Mascia-Lees, and Jon Marks, with myself as moderator. Our annual luncheon on Friday features Charles Merbs speaking on “Paleopathology in the Days of the Arizona Territory, Today, and Beyond.” Our annual business meeting is on Friday evening. On Saturday evening, we will have our Student Awards Reception, which will be held at the Anthropology Building at Arizona State University, only several blocks from the Tempe Mission Palms Hotel.

The AAPA Program, Local Arrangements, and Executive Committees cordially invite you to our seventy-second annual meeting. We look forward to seeing you in Tempe.

*John H. Relethford*

*AAPA Vice President and  
Program Committee Chair*

## Contents

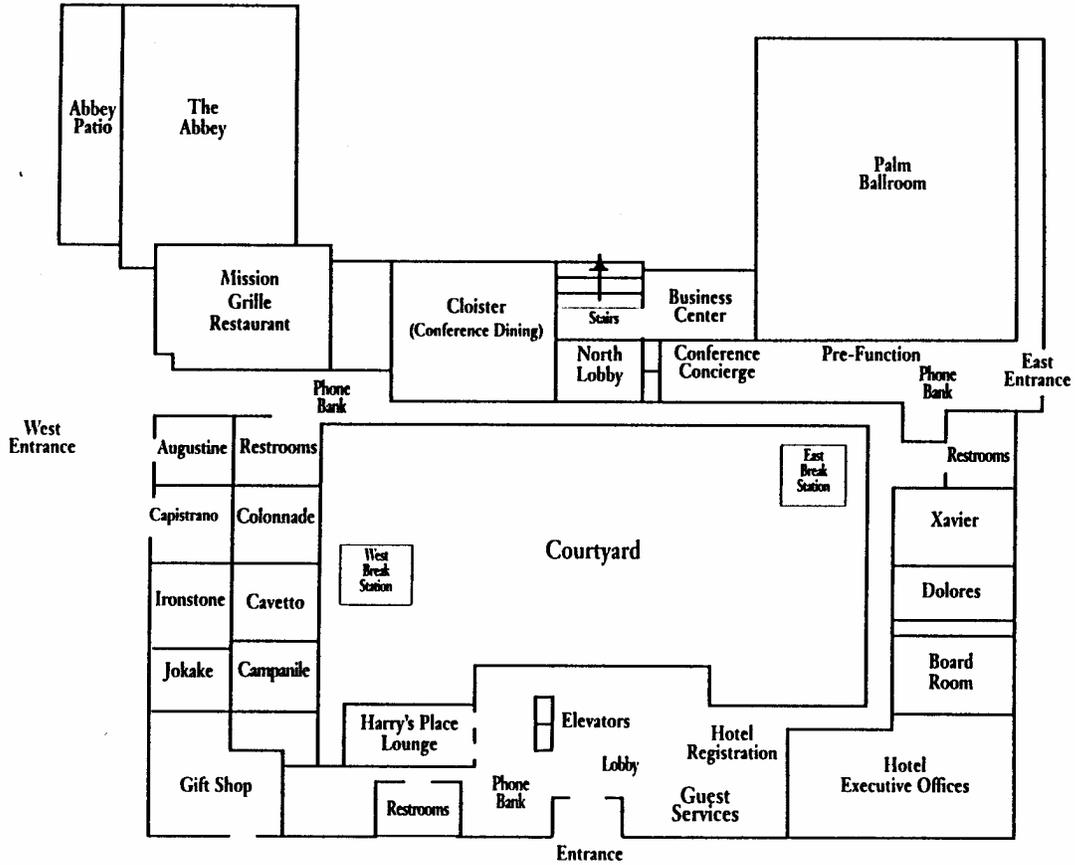
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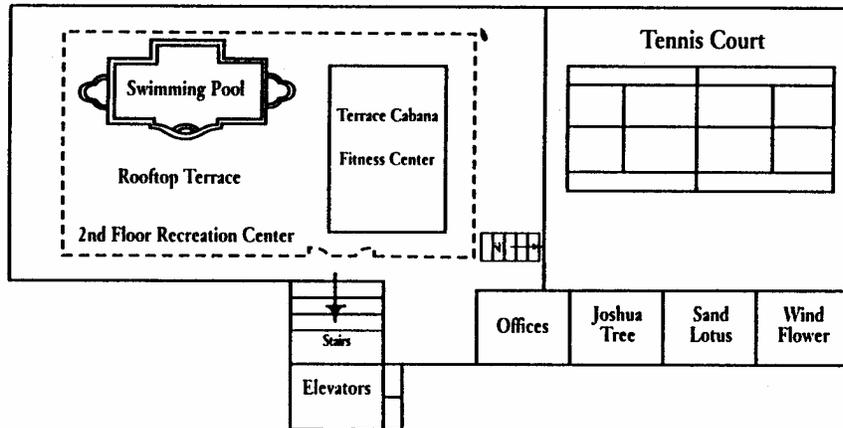
On the cover: Late Pliocene exposures in the Middle Ledi research area, set among diverse hominid localities near the Awash River in northern Ethiopia. Image courtesy of Charles Lockwood.

# Tempe Mission Palms Hotel

## 1st Floor



## 2nd Floor



# The Conference at a Glance

(Note: The Palm Ballroom is configured differently depending on day and event)

	Tue Morning	Tue Afternoon	Tue Evening	Wed Morning	Wed Afternoon	Wed Evening
<b>Xavier</b>			PPA Poster set-up, 6 – 7 pm	PPA Poster Session	PPA Poster Session	
<b>Dolores</b>			PPA Poster set-up, 6 – 7 pm	PPA Poster Session	PPA Poster Session	
<b>Palm C</b>	PPA Workshop	PPA Podium Session		PPA Podium Session	PPA Podium Session	AAPA reception & Cash Bar, 8-11pm
<b>Palm F</b>	PPA Workshop					
<b>Palm AD</b>	PS Podium Session	PS Podium Session		PS Podium Session	PS Podium Session	
<b>Abbey</b>						Career Dev. Panel: Nontraditional Careers 6:30-7:45pm
<b>Palm Ballroom Foyer</b>	PPA Registration 8 am - 6 pm PS Registration 8 am - 6 pm			PPA Registration AAPA Registration, 1-8 pm		
<b>Joshua Tree</b>	Slide preview, press	Slide preview, press	Slide preview, press	Slide preview, press	Slide preview, press	Slide preview, press
<b>Sand Lotus</b>					AJPA Editorial Board lunch, noon-2 pm	
<b>Wind Flower</b>						
<b>Board Room</b>				AAPA Exec. Comm Meeting. 8 am – 5 pm		Human Biology Editorial Board Dinner, 6 - 8 pm
<b>Board Room anteroom</b>	LAC, 7 am – 10 pm daily	LAC	LAC	LAC	LAC	LAC
<b>Poolside Terrace</b>			PPA Cocktails			

**Monday:** PPA Association Registration, 5:00-7:00 pm, *Palm Ballroom Foyer*

**Saturday:** AAPA Student Awards Reception, 6-7:30pm, *ASU Anthropology Building* (maps at Registration)

**Sunday:** HBA Registration, Podium & Posters Sessions *Palm Ballroom Foyer, Palm AD, Xavier, Dolores*, 8 am to noon

## Key to acronyms:

- AAAG** American Association of Anthropological Genetics
- AAPA** American Association of Physical Anthropologists
- ADA** American Dermatoglyphics Association
- AJHB** American Journal of Human Biology
- AJPA** American Journal of Physical Anthropology
- DAA** Dental Anthropology Association
- HBA** Human Biology Association
- LAC** Local Arrangements Committee
- PPA** Paleopathology Association
- PS** Paleoanthropology Society

## The Conference at a Glance (continued)

	Thurs Morning	Thurs Afternoon	Thurs Evening	Fri Morning
<b>Xavier</b>	Session 1. Human Biol I. Posters, 8:30 am - noon	Session 11. Primate Behav. II Posters, 1:30 – 5 pm		Session 20. Primate Behav. III Posters, 8:30 am - noon
<b>Dolores</b>	Session 2. Genetics I Posters, 8:30 am - noon	Session 12. Dental Anth. I Posters, 1:30 - 5 pm		Session 21. Poster Symposium: Variation in Dentition of <i>Homo</i> , 8:30 - noon
<b>Colonnade</b>	Session 3. Genetics II Posters, 8:30 am - noon	Session 13. Dental Anth. II Posters, 1:30 – 5 pm		Session 22. Primate Evol. I Posters, 8:30 - noon
<b>Cavetto</b>	Session 4. Hominid Evol. I. Posters, 8:30 am - noon	Session 14. Primate Biol. II Posters, 1:30 – 5 pm		Session 23. Primate Evol. II Posters, 8:30- noon
<b>Campanile</b>	Session 5. Hominid Evol. II Posters, 8:30 am - noon	Session 15. Primate Biol. III Posters, 1:30 – 5 pm		Session 24. Primate Evol. III Posters, 8:30- noon
<b>Palm ABC</b>	Session 6. Wiley-Liss Symposium: Genus <i>Homo</i> , 8 –10 am; Session 7. Paleopath. I, 10:15-noon	Session 16. Symposium: Teaching Phys. Anth., 1 – 5 pm	AAPA Plenary Session, 6 – 7:30 pm	Session 25. Hominid Evol. III, 8 am - noon
<b>Palm DE</b>	Session 8. Primate Behav. I, 8 am - noon	Session 17. Skeletal Biol. II, 1 – 5 pm		Session 26. Primate Biol IV, 8 am - noon
<b>Palm F</b>	Session 9. Primate Biol. I, 8 am - noon	Session 18. Genetics III, 1 – 5 pm		Session 27. Symposium: Behavior Genetics, 8:30 – noon
<b>Abbey</b>	Session 10. Skeletal Biol. I, 8 am - noon	Session 19. Symposium: Hominid Environments, 1-5pm		Session 28. Human Biol. II, 8 am - noon
<b>Palm Ball-room Foyer</b>	AAPA Registration, starts at 7:30 am	AAPA Registration, to 5 pm		AAPA Registration, starts at 8 am HBA Registration
<b>Augustine, Capistrano, Ironstone</b>	AAPA Book Exhibitors	AAPA Book Exhibitors		AAPA Book Exhibitors
<b>Jokake</b>	Interviews	Interviews	Primate Biol. & Behav. Group, 7:30-8:30 pm	Interviews
<b>Joshua Tree</b>	Slide preview, press	Slide preview, press	Slide preview, press	Slide preview, press
<b>Sand Lotus</b>			DAA Business Meeting, 7:30-8:30 pm	<i>AJHB</i> Editorial Board Breakfast 7:30 – 9 am
<b>Wind Flower</b>			AAAG Business Meeting, 7:30-8:30 pm	
<b>Board Room</b>			HBA Exec. Comm., 6-10 pm	
<b>Board Room anteroom</b>	LAC	LAC	LAC	LAC
<b>Cloisters</b>				
<b>Poolside Terrace</b>			Wiley-Liss Reception 8:30 – 10:30 pm	

*For a schedule of all conference events, see page 8.  
For a detailed listing of individual AAPA poster and podium presentations, see page 16.*

	<b>Fri Afternoon</b>	<b>Fri Evening</b>	<b>Sat Morning</b>	<b>Sat Afternoon</b>
<b>Xavier</b>	HBA Posters		Session 38. Skeletal Biol. III Posters, 8:30 am - noon	Session 47. Skeletal Biol. V Posters, 1:30 – 5 pm
<b>Dolores</b>	Session 29. Poster Symposium: Tooth Chemistry, 2:30 – 6 pm		Session 39. Skeletal Biol. IV Posters, 8:30 am - noon	Session 48. Skeletal Biol. VI Posters, 1:30 – 5 pm
<b>Colonnade</b>	Session 30. Forensic Anth. Posters, 2:30 – 6 pm		Session 40. Poster Symposium: Atelines, 8:30 am - noon	Session 49. Primate Biol. V Posters, 1:30 – 5 pm
<b>Cavetto</b>	Session 31. Paleopath. II Posters, 2:30 – 6 pm		Session 41. Hominid Evol. V Posters, 8:30 - noon	Session 50. Primate Biol. VI Posters, 1:30 – 5 pm
<b>Campanile</b>	Session 32. Paleopath. III Posters, 2:30 – 6 pm		Session 42. Hominid Evol. VI Posters, 8:30 - noon	Session 50. Primate Biol. VII Posters, 1:30 – 5 pm
<b>Palm ABC</b>	Session 33. Symposium in Honor of F. Johnston: Biomedical Anth., 2 – 6:15 pm	AAPA Business Meeting, 8 – 11 pm	Session 43. Hominid Evol. VII, 8 am - noon	Session 52. Hominid Evol. VIII, 1 – 5 pm
<b>Palm DE</b>	Session 34. Symposium: Conservation, 2 – 4:15pm; Session 35. Dental III, 4:45 – 6:15 pm		Session 44. Symposium: 3D Approaches in PA, 8 am - noon	Session 53. Human Biol. III, 1 – 5 pm
<b>Palm F</b>	Session 36. Genetics IV, 2 – 6 pm		Session 45. Primate Evol IV, 8 am - noon	Session 54. Symposium: Primate Zoonoses, 1 – 4 pm
<b>Abbey</b>	Session 37. Hominid Evol. IV, 2 – 6 pm		Session 46. Primate Behavior IV, 8 am - noon	Session 55. Symposium: Baboon Life History, Reprod. & Fitness 1 – 4:45 pm
<b>Palm Ballroom Foyer</b>	AAPA Registration, to 5 pm HBA Registration		AAPA Registration 8 am – 1 pm HBA Registration	
<b>Augustine, Capistrano, Ironstone</b>	AAPA Book Exhibitors		AAPA Book Exhibitors	
<b>Jokake</b>	Interviews	ADA Business Meeting, 6 – 7 pm	Interviews	Interviews
<b>Joshua Tree</b>	Slide preview, press	Slide preview, press	Slide preview, press	Slide preview, press
<b>Sand Lotus</b>				
<b>Wind Flower</b>				
<b>Board Room</b>				
<b>Board Room anteroom</b>	LAC	LAC	LAC	LAC
<b>Cloisters</b>	AAPA Annual Luncheon, noon – 2 pm; HBA Podium Sessions	HBA Reception	HBA Podium Session	HBA Luncheon, Podium Session & Business meeting
<b>Poolside Terrace</b>				

## Conference Schedule

*For a schedule of individual AAPA poster and podium presentations, see page 16.*

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### Monday, April 21, 2003

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#### Paleopathology Association

5:00 pm – 7:00 pm      Registration. *Palm Ballroom Foyer.*

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### Tuesday, April 22, 2003

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#### Paleopathology Association

8:00 am – 6:00 pm      Registration. *Palm Ballroom Foyer.*

8:00 am – 6:00 pm      Workshops, Scientific Sessions. *Palm C & F.*

6:00 pm – 7:30 pm      Cocktails. *Poolside Terrace.*

#### Paleoanthropology Society

8:00 am – 6:00 pm      Registration. *Palm Ballroom Foyer.*

8:00 am – 6:00 pm      Scientific Sessions. *Palm AD.*

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### Wednesday, April 23, 2003

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#### Paleopathology Association

8:00 am – 6:00 pm      Registration. *Palm Ballroom Foyer.*

8:00 am – 6:00 pm      Scientific Sessions. *Palm CF.*

8:00 am – 6:00 pm      Poster Sessions. *Xavier, Dolores.*

#### Paleoanthropology Society

8:00 am – 6:00 pm      Scientific Sessions. *Palm AD.*

#### American Association of Physical Anthropologists

1:00 pm – 8:00 pm      Registration. *Palm Ballroom Foyer.*

8:00 am – 5:00 pm      Executive Committee Meeting. *Board Room.*

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**Wednesday, April 23, 2003 (continued)**


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- 12:00 pm – 2:00 pm *American Journal of Physical Anthropology* Editorial Board Luncheon. *Sand Lotus*.
- 6:30 pm – 7:45 pm Career Development Committee Panel: “Nontraditional Careers.” *Abbey*.
- 8:00 pm – 11:00 pm Reception & Cash Bar. *Palm Ballroom*.

**Human Biology (Journal)**

- 6:00 pm – 8:00 pm *Human Biology* Editorial Board Dinner. *Board Room*.

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**Thursday, April 24, 2003**


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**American Association of Physical Anthropologists**

- 7:30 am – 5:00 pm Registration. *Palm Ballroom Foyer*.
- 8:30 am – 12:00 pm **Session 1. Human Biology I: Adaptation/ Demography/ Variation.** Contributed Posters. *Xavier*.
- 8:30 am – 12:00 pm **Session 2. Genetics I: Genetic Variation in Primates and Modern Humans.** Contributed Posters. *Dolores*.
- 8:30 am – 12:00 pm **Session 3. Genetics II: Ancient and Contemporary DNA Studies with Primates and Modern Humans.** Contributed Posters. *Colonnade*.
- 8:30 am – 12:00 pm **Session 4. Hominid Evolution I: Australopithecines.** Contributed Posters. *Cavetto*.
- 8:30 am – 12:00 pm **Session 5. Hominid Evolution II: Australopithecine and Primate Locomotion.** Contributed Posters. *Campanile*.
- 8:00 am – 10:00 am **Session 6. The Origin and Evolution of the Genus *Homo* in Europe: Perspectives from the Continent.** First Annual Wiley-Liss Symposium. *Palm ABC*.
- 10:15 am – 12:00 pm **Session 7: Paleopathology I: Paleopathology from Past to Present.** Contributed Papers. *Palm ABC*.
- 8:00 am – 12:00 pm **Session 8. Primate Behavior I: Ecology.** Contributed Papers. *Palm DE*.

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**Thursday, April 24, 2003 (continued)**


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- 8:00 am – 12:00 pm    **Session 9. Primate Biology I: Functional Morphology.**  
Contributed Papers. *Palm F.*
- 8:00 am – 12:00 pm    **Session 10. Skeletal Biology I: Bioarchaeology and Biological Variation.** Contributed Papers. *Abbey.*
- 1:30 pm – 5:00 pm    **Session 11. Primate Behavior II: Ecology and Behavior.**  
Contributed Posters. *Xavier.*
- 1:30 pm – 5:00 pm    **Session 12. Dental Anthropology I: Health, Hypoplasia, and Wear.** Contributed Posters. *Dolores.*
- 1:30 pm – 5:00 pm    **Session 13. Dental Anthropology II: Morphology, Modification, and Methods.** Contributed Posters.  
*Colonnade.*
- 1:30 pm – 5:00 pm    **Session 14. Primate Biology II: Comparative Anatomy.**  
Contributed Posters. *Cavetto.*
- 1:30 pm – 5:00 pm    **Session 15. Primate Biology III: Morphometrics .**  
Contributed Posters. *Campanile.*
- 1:00 pm – 5:00 pm    **Session 16. Teaching Physical Anthropology: Strategies for Dealing with Controversial Topics.** Symposium. *Palm ABC.*
- 1:00 pm – 5:00 pm    **Session 17. Skeletal Biology II: Diet and Biomechanics.**  
Contributed Papers. *Palm DE.*
- 1:00 pm – 5:00 pm    **Session 18. Genetics III: Molecular Genetic Variation in Modern Human Populations.** Contributed Papers. *Palm F.*
- 1:00 pm – 5:00 pm    **Session 19. Hominid Environments and Paleoecology in the East African Pliocene: An Assessment of the Faunal Evidence.** Symposium. *Abbey.*
- 6:00 pm – 7:30 pm    Plenary Session. *Palm Ballroom.*  
Panel: “Can Biological Anthropology and Cultural Anthropology Coexist?” Panelists: James Calcagno, Matt Cartmill, Ralph Holloway, Frances Mascia-Lees, Jon Marks.  
Moderator: John Relethford.
- 8:30 pm – 10:30 pm    Wiley-Liss Reception. *Poolside Terrace.*

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**Thursday, April 24, 2003 (continued)**


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**Dental Anthropology Association**

7:30 pm – 8:30 pm Business Meeting. *Sand Lotus*.

**Primate Biology & Behavior Interest Group**

7:30 pm – 8:30 pm Business Meeting. *Jokake*.

**American Association of Anthropological Genetics**

7:30 pm – 8:30 pm Business Meeting. *Wind Flower*.

**Human Biology Association**

6:00 pm – 10:00 pm Executive Committee Meeting. *Board Room*.

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**Friday, April 25, 2003**


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**American Association of Physical Anthropologists**

8:00 am – 5:00 pm Registration. *Palm Ballroom Foyer*.

8:30 am – 12:00 pm **Session 20. Primate Behavior III: Biology, Ecology, and Behavior.** Contributed Posters. *Xavier*.

8:30 am – 12:00 pm **Session 21. Morphometric Variation in the Dentition of *Homo sapiens*.** Poster Symposium. *Dolores*.

8:30 am – 12:00 pm **Session 22. Primate Evolution I: Fossils and Phylogenies.** Contributed Posters. *Colonnade*.

8:30 am – 12:00 pm **Session 23. Primate Evolution II: Communities, Biogeography, and Ecomorphology.** Contributed Posters. *Cavetto*.

8:30 am – 12:00 pm **Session 24. Primate Evolution III: Dental Development and Variation.** Contributed Posters. *Campanile*.

8:00 am – 12:00 pm **Session 25. Hominid Evolution III: Middle and Late Pleistocene Evolution.** Contributed Papers. *Palm ABC*.

8:00 am – 12:00 pm **Session 26. Primate Biology IV: Sexual Dimorphism/ Locomotion.** Contributed Papers. *Palm DE*.

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**Friday, April 25, 2003 (continued)**


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- 8:30 am – 12:00 pm    **Session 27. The Genetic Basis of Neurobehavioral Phenotypes: Methods, Applications and Controversies.** Symposium. *Palm F.*
- 8:00 am – 12:00 pm    **Session 28. Human Biology II: Health and Disease.** Contributed Papers. *Abbey.*
- 12:00 pm – 2:00 pm    AAPA Luncheon. *Cloisters.*  
Speaker: Charles Merbs. "Paleopathology in the Days of the Arizona Territory, Today, and Beyond."
- 2:30 pm – 6:00 pm    **Session 29. Tooth Chemistry: New Challenges, New Horizons.** Poster Symposium. *Dolores.*
- 2:30 pm – 6:00 pm    **Session 30. Forensic Anthropology.** Contributed Posters. *Colonnade.*
- 2:30 pm – 6:00 pm    **Session 31. Paleopathology II: Trauma and Infection in Past Populations.** Contributed Posters. *Cavetto.*
- 2:30 pm – 6:00 pm    **Session 32. Paleopathology III: Nutritional Status, Growth, and Metabolism.** Contributed Posters. *Campanile.*
- 2:00 pm – 6:15 pm    **Session 33. Recent Developments and Applications of Biomedical Anthropology In and Out of Academia: A Symposium in Honor of Francis E. Johnston.** Symposium. *Palm ABC.*
- 2:00 pm – 4:15 pm    **Session 34. Techniques, Applications, and Action: Moving Beyond the Call for Conservation.** Symposium. *Palm DE.*
- 4:45 pm – 6:15 pm    **Session 35. Dental Anthropology III: Methods and Variation.** Contributed Papers. *Palm DE.*
- 2:00 pm – 6:00 pm    **Session 36. Genetics IV: Molecular Genetics of Non-Human Primates.** Contributed Papers. *Palm F.*
- 2:00 pm – 6:00 pm    **Session 37. Hominid Evolution IV: Modern Human Origins.** Contributed Papers. *Abbey.*
- 8:00 pm – 11:00 pm    Annual Business Meeting. *Palm ABC.*

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**Friday, April 25, 2003 (continued)**


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**American Dermatoglyphics Association**

6:00 pm – 7:00 pm Business Meeting. *Jokake*.

**Human Biology Association**

8:00 am – 6:00 pm Registration. *Palm Ballroom Foyer*.

7:30 am – 9:00 am *American Journal of Human Biology* Editorial Board Breakfast. *Sand Lotus*.

2:30 pm – 5:30 pm Poster Session. *Xavier*.

2:30 pm – 5:30 pm Scientific Session. *Cloisters*.

6:30 pm – 9:30 pm Reception. *Cloisters*.

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**Saturday, April 26, 2003**


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**American Association of Physical Anthropologists**

8:00 am – 1:00 pm Registration. *Palm Ballroom Foyer*.

8:30 am – 12:00 pm **Session 38. Skeletal Biology III: Bioarchaeology.** Contributed Posters. *Xavier*.

8:30 am – 12:00 pm **Session 39. Skeletal Biology IV: Growth and Demography.** Contributed Posters. *Dolores*.

8:30 am – 12:00 pm **Session 40. The Atelines: Contemporary Issues in Behavior, Ecology and Evolution.** Poster Symposium. *Colonnade*.

8:30 am – 12:00 pm **Session 41. Hominid Evolution V: Archaeological and Taphonomic Issues of Hominid Sites.** Contributed Posters. *Cavetto*.

8:30 am – 12:00 pm **Session 42. Hominid Evolution VI: Pleistocene Evolution.** Contributed Posters. *Campanile*.

8:00 am – 12:00 pm **Session 43. Hominid Evolution VII: Miocene and Pliocene Evolution.** Contributed Papers. *Palm ABC*.

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**Saturday, April 26, 2003 (continued)**


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- 8:00 am – 12:00 pm **Session 44. 3D Approaches to Research in Physical Anthropology.** Symposium. *Palm DE.*
- 8:00 am – 12:00 pm **Session 45. Primate Evolution IV: Form and Function.** Contributed Papers. *Palm F.*
- 8:00 am – 12:00 pm **Session 46. Primate Behavior IV: Inter- and Intra-Specific Behavior.** Contributed Papers. *Abbey.*
- 1:30 pm – 5:00 pm **Session 47. Skeletal Biology V: Biomechanics.** Contributed Posters. *Xavier.*
- 1:30 pm – 5:00 pm **Session 48. Skeletal Biology VI: Bone Chemistry and Morphology.** Contributed Posters. *Dolores.*
- 1:30 pm – 5:00 pm **Session 49. Primate Biology V: Ontogeny, Hormones, and Life History.** Contributed Posters. *Colonnade.*
- 1:30 pm – 5:00 pm **Session 50. Primate Biology VI: Adaptation and Evolution.** Contributed Posters. *Cavetto.*
- 1:30 pm – 5:00 pm **Session 51. Primate Biology VII: Brains/Allometry.** Contributed Posters. *Campanile.*
- 1:00 pm – 5:00 pm **Session 52. Hominid Evolution VIII: Early Hominid Evolution.** Contributed Papers. *Palm ABC.*
- 1:00 pm – 5:00 pm **Session 53. Human Biology III: Reproduction/Demography/Variation.** Contributed Papers. *Palm DE.*
- 1:00 pm – 4:00 pm **Session 54. Ecology and Primate Zoonoses: Evolutionary, Environmental and Cultural Factors Associated with Emerging Infectious Diseases, Cross-species Transmission, and Nonhuman Primate Conservation.** Symposium. *Palm F.*
- 1:00 pm – 4:45 pm **Session 55. Life History, Reproductive Strategies, and Fitness in Baboons.** Symposium. *Abbey.*
- 6:00 pm – 7:30 pm Student Awards Reception and Cash Bar. *Arizona State University Anthropology Building* (maps available at registration).

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**Saturday, April 26, 2003 (continued)**

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**Human Biology Association**

8:00 am – 5:00 pm      Registration. *Palm Ballroom Foyer.*

8:00 am – 7:00 pm      Plenary Sessions, HBA Luncheon, Pearl Lecture, Business Meeting. *Cloisters.*

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**Sunday, April 27, 2003**

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**Human Biology Association**

8:00 am – 12:00 pm      Registration. *Palm Ballroom Foyer.*

8:00 am – 12:00 pm      Scientific Session. *Palm AD.*

8:00 am – 12:00 pm      Poster Session. *Xavier, Dolores, Colonnade.*

# AAPA Poster and Podium Presentation Schedule

*For a schedule of all conference events, see page 8.*

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## Thursday Morning – April 24, 2003

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**Session 1. Human Biology I: Adaptation/ Demography/Variation.** Contributed Posters. *Xavier.*  
Chair: A.T. STEEGMAN, JR., University of Buffalo.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors of even-numbered posters present for questions.
10:30 am – 12:00 pm	Authors of odd-numbered posters present for questions.
12:00 – 12:30 pm	Poster take-down.

1. Differential foraging strategies and diets of Hadza men and women. A.N. CRITTENDEN, M. RICHARDSON, M.J. SCHOENINGER, H.T. BUNN, T.R. PICKERING.
2. A preliminary investigation of wildlife, domestic and human use of the Sinya mine water pools, Tanzania. P. NYSTROM, P.C. ASHMORE.
3. Climate, racial category and body proportions in the U.S. A.T. STEEGMANN, JR.
4. Geographical distribution of hot flash frequencies: considering climatic influences. L. LEIDY SIEVERT, E.K. FLANAGAN.
5. The evolution of lactase persistence in African populations. K.B. POWELL, H., S.A. TISHKOFF.
6. Preliminary studies of the demography and genetics of the Boruca of Costa Rica. J.H. MIELKE, O.E. QUIROS, R.J. MITCHELL.
7. Twinning in relation to fertility and other reproductive outcomes in Blackfoot women. S.L. JOHNSTON.
8. STDs in prehistory: Why they mattered. R.L. PENNINGTON.
9. The 1737 matlazahuatl epidemic in Mixquiahuala and Tecpatepec, Mexico. A. CHRISTENSEN.
10. The influence of substrate on the skeletal structure of the human foot on Mangaia, Cook Islands. N.L. GRIFFIN, S.C. ANTÓN.
11. Prediction of the development of jaws in patients with complete unilateral cleft of the lip and palate. J. VELEMINSKA, Z. MÜLLEROVA.
12. Ancient antibiotics: Tetracycline in human and animal bone from the Dakhleh Oasis, Egypt. C.M. MAGGIANO, T. DUPRAS, J. BIGGERSTAFF.
13. Mycenaean mega-bones: A study of excessively thick cortical bone from Late Bronze Age Central Greece. C.A. IEZZI.
14. Human skeletal trauma patterns in a contemporary sample from Athens, Greece: Results from a pilot study. S.M. ABEL, A.B. FALSETTI, S.K. MANOLIS.
15. A cross-cultural study of consanguinity dispensations. L. MADRIGAL, B. WARE.
16. Dental morphology of subadult teeth from the Byzantine St. Stephen's Monastery, Jerusalem. J.C. SCHWEBACH, A. HOLDEN, J. ULLINGER, S.G. SHERIDAN.
17. Surnames analyses of two ancient Italian populations in the XIX century: Alia (Sicily) and Civitella del Tronto (Abruzzo). S. TULUMELLO, R. BIGAZZI, B. CHIARELLI, E. LUCCHETTI, S. DE IASIO.
18. Anthropology during National Socialism times: projects done in the Anthropologische Abteilung, Natural History Museum Vienna, 1938-1945. M. TESCHLER-NICOLA, K. STUHLPFARRER, M. BERNER, V. PAWLOWSKY, C. SPRING.
19. Declining fitness of race in the *American Journal of Physical Anthropology*: 1918-1996. L. LIEBERMAN.

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**Thursday Morning – April 24, 2003 (continued)**


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**Session 2. Genetics I: Genetic Variation in Primates and Modern Humans.** Contributed Posters.  
*Dolores.*

Chair: D.A. MERRIWETHER, University of Michigan.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors of even-numbered posters present for questions.
10:30 am – 12:00 pm	Authors of odd-numbered posters present for questions.
12:00 – 12:30 pm	Poster take-down.

1. Genetic history of hunting and gathering populations of Tanzania. H.M. MORTENSEN, M.K. GONDER, J. HIRBO, K. POWELL, A. KNIGHT, J. MOUNTAIN, S.A. TISHKOFF.
2. Complete mitochondrial genome sequencing of Tanzanians: Implications for the origin of modern humans. A.A. DE SOUSA, M.K. GONDER, K. SYLVESTER, C. OBELE, S.A. TISHKOFF.
3. mtDNA analysis does not detect Asian lineages in Cameroon. V. COIA, G. DESTRO-BISOL, I. BOSCHI, F. VERGINELLI, G. SPEDINI, F. CRUCIANI, D. COMAS, F. CALAFELL.
4. Dynamics of molecular genetic diversity in the East Midlands, England. S. MASTANA, P. GILL, D. LEE, A. PACYNKO, P.P. SINGH, M. SINGH.
5. The appearance and dispersion of the first farmers in Europe. R. PINHASI.
6. Relationships of Slovak Roma populations assessed from finger ridge counts. K.E. WEISENSEE, R.L. JANTZ, S. OUSLEY, D. SIVAKOVA.
7. Skin pigmentation and admixture in five populations with Native American ancestry. E.J. PARRA, L.G. MOORE, T.D. BRUTSAERT, G. GUTIERREZ, J.R. FERNANDEZ, R.F. HAMMAN, C. BONILLA, S.M. DIOS, M.D. SHRIVER.
8. Rapid deployment of the five founding Amerind mtDNA haplogroups via coastal and riverine colonization. A.G. FIX.
9. Test for selection on ALDH2 in a Southeast Asian population. R.S. MALHI, K. HUNLEY, J.C. LONG.
10. Mitochondrial DNA variation in Afghanistan. D.A. MERRIWETHER.
11. A pilot study of Y chromosome analysis on Melanesian populations. L.B. SCHEINFELDT, J.G. LORENZ, R. ROBLEDO, A. MERRIWETHER, G. KOKI, C. MGONE, J.S. FRIEDLAENDER.
12. JC virus genotypes in Papua New Guinea. J.M. CZARNECKI, J.S. FRIEDLAENDER, C.S. MGONE, G. KOKI, G.L. STONER.
13. Patterns of mitochondrial variation in Melanesia and implications for the settling of the Pacific. L.L. SMITH, D. A. MERRIWETHER.
14. A quantitative test of natural selection under changing environmental conditions. E.A. CARSON.
15. Comparison of methods for estimation of individual ancestry. C.L. PFAFF, J.S. BARNHOLTZ-SLOAN, J.C. LONG.
16. ALFRED - the ALlele FREquency Database - an update. K.K. KIDD, H. RAJEEVAN, M.V. OSIER, K. CHEUNG, H. DENG, L. DRUSKIN, R. HEINZEN, J.R. KIDD, S. STEIN, A.J. PAKSTIS.
17. Genotype-by-age effects on bone mineral density in the spine and forelimb in baboons: Possible implications of mechanical usage. L.M. HAVILL, M.C. MAHANEY, L. ALMASY, J. ROGERS.

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**Thursday Morning – April 24, 2003 (continued)**


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**Session 3. Genetics II: Ancient and Contemporary DNA Studies with Primates and Modern Humans.** Contributed Posters. *Colonnade*.

Chair: L.E. BAKER, Baylor University.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors of even-numbered posters present for questions.
10:30 am – 12:00 pm	Authors of odd-numbered posters present for questions.
12:00 – 12:30 pm	Poster take-down.

1. Tackling (some of) the vagaries of ancient DNA Work. B.M. KEMP, D.G. SMITH.
2. Analysis of base misincorporations in ancient and modern mtDNA. J.A. ESHLEMAN, R.S. MALHI, F.A. KAESTLE, D.G. SMITH.
3. Amish cemeteries have a patrilineal genetic spatial pattern: Implications for ancient DNA analyses. B.M. USHER, J.D. WEETS, A. HEIMROTH, E. ELLIOTT.
4. Mitochondrial DNA sequence analysis of the Holmes-Vardeman-Stephenson Cemetery. L.E. BAKER, S.M. PHILLIPS, K.J. MATTESON.
5. Genetic relationships among the prehistoric Adena and Hopewell. D.A. (WEISS) BOLNICK.
6. Mitochondrial DNA variation at a Late Woodland Michigan site. K.S. GRENNAN, D.A. MERRIWETHER.
7. Preliminary molecular analyses of individuals from a single multiple burial at the Neolithic Boisman II site of the Russian Far East. K.A. HORSBURGH.
8. Ancient DNA study of the San-Pau-Chu site, Tainan, Taiwan. H-M. LIN, A.C. STONE.
9. The commensal model continues - *Rattus exulans* mtDNA variation from Island Southeast Asia through to Polynesia. E.A. MATISOO-SMITH, J.H. ROBINS.
10. An optimized panel of microsatellites for fecal DNA studies of wild baboons: Preliminary analyses of genetic variation among Gombe baboons. A. VINSON, C. PACKER, J. ROGERS.
11. Molecular systematics of lemurs. J. PASTORINI, R.D. MARTIN.

**Session 4. Hominid Evolution I: Australopithecines.** Contributed Posters. *Cavetto*.

Chair: F.L. WILLIAMS, Georgia State University.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors of even-numbered posters present for questions.
10:30 am – 12:00 pm	Authors of odd-numbered posters present for questions.
12:00 – 12:30 pm	Poster take-down.

1. New perspectives on the hominin elbow joint. A. GALLAGHER, M.M. GUNTHER.
2. Broca's Area homologue in great apes: Implications for language evolution? D.C. BROADFIELD, C. SHERWOOD, P.R. HOF, R.L. HOLLOWAY.
3. The supralaryngeal vocal tract (SVL) as an exaptation. T. ESTENSON.
4. Mandibular corpora of *Australopithecus afarensis* and *Australopithecus africanus*: 3-D modeling and measurements. L.V. PYNE.
5. The anterior pillar of *Australopithecus africanus* - A mechanical support? G. NIEGL, F.K. FUSS, G.W. WEBER, H. SEIDLER.
6. Skull Reference Models (SRM) and the ontogeny of *A. africanus*. G.W. WEBER, P. GUNZ, P. MITTEROECKER, F.J. THACKERAY, F.L. BOOKSTEIN.

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**Thursday Morning – April 24, 2003 (continued)**


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7. *Australopithecus* or *Paranthropus*: "Robust" australopithecine taxonomy based on analogy. P.J. MACALUSO, JR.
8. New *Australopithecus boisei* specimens from the Kaitio Member, Nachukui Formation, Kenya. S. PRAT.
9. Facial-masticatory ontogeny in *Australopithecus* and *Pan*. F.L. WILLIAMS.
10. Climatological differences in areas inhabited by African ape taxa and Plio-Pleistocene hominoid/hominid fossil ecology and systematics. E. STINER, E. SARMIENTO.

**Session 5. Hominid Evolution II: Australopithecine and Primate Locomotion.** Contributed Posters. *Campanile*.

Chair: B.G. RICHMOND, George Washington University.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors of even-numbered posters present for questions.
10:30 am – 12:00 pm	Authors of odd-numbered posters present for questions.
12:00 – 12:30 pm	Poster take-down.

1. Aping the ape: Force plate patterns associated with bipedal posture and gait. T.M. GREINER, K.A. BALL, S.P. WOODWARD.
2. Early hominin locomotion and the ontogeny of phalangeal curvature in primates. B.G. RICHMOND.
3. Terrestrial walking versus climbing in bonobos (*Pan paniscus*): Position of the centre of mass and consequences for the locomotor behavior. K. SCHOONAERT, K. D'AOÛT, P. AERTS.
4. Quantitative analysis of femoral neck shape and loading environment in robust australopithecines. K.L. LEWTON, G.G. ECK, P.A. KRAMER.
5. Asymmetrical aspects of bipedal and quadrupedal walking in bonobos (*Pan paniscus*). K. D'AOÛT, E. VEREECKE, K. SCHOONAERT, P. AERTS.
6. The utility of the lateral meniscal notch in distinguishing taxa of early hominins. T.W. HOLLIDAY, J. DUGAN.
7. Dynamics of foot use during bipedal and quadrupedal walking in *Pan troglodytes*. R.E. WUNDERLICH.
8. Morphological variation of the lumbar vertebrae of *A. africanus*: Implications for locomotor differences between small and large individuals. N.L. BARRICKMAN.
9. Climbing behavior and locomotor energetics in wild chimpanzees: Implications for hominin locomotor evolution. H. PONTZER.

**Session 6. The Origin and Evolution of the Genus *Homo* in Europe: Perspectives from the Continent.** First Annual Wiley-Liss Symposium. *Palm ABC*.

Organizers: F.H. SMITH, Loyola University, and G. BRÄUER, University of Hamburg.

Chair: F.H. SMITH.

In recent years, new fossil discoveries, new dates from critical sites and specimens, and studies of ancient DNA and stable isotopes have had major impacts on perspectives on human evolution in Europe. This symposium brings together four of continental Europe's most prominent scholars of human evolution, all of whom have been actively involved in shaping these new perspectives. This symposium provides the opportunity to hear about the newest evidence from European researchers directly. Topics will range from the earliest paleontological evidence for the habitation of Europe, through the emergence and evolution of the Neandertals, to the initial appearance of modern people on the continent.

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|---------|---|
| 8:00 am | Early <i>Homo</i> remains from Georgia (Southern Caucasus). D. LORDKIPANIDZE. |
| 8:15 am | Discussion.   |

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**Thursday Morning – April 24, 2003 (continued)**


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- 8:30 am Europeans at the Early-to-Middle Pleistocene boundary and their role in assembling a scenario for the subsequent evolution of the Genus *Homo*. G. MANZI.
- 8:45 am Discussion.
- 9:00 am Neandertals in Europe: The weight of climate. J-J. HUBLIN.
- 9:15 am Discussion.
- 9:30 am The Neandertal-modern transition: Models, gene flow and the fossil evidence. G. BRÄUER.
- 9:45 am Discussion.

**Session 7. Paleopathology I: Paleopathology from Past to Present. Contributed Papers. Palm ABC.**

Chair: R.P. MENSFORTH, Cleveland State University.

- 10:15 am Franchthi Cave, Greece: The human population from the Upper Paleolithic to the final Neolithic Age. A. PAPATHANASIOU.
- 10:30 am Surviving scarcity - Remarks on the physical anthropology of a Neolithic population from the Oman Peninsula. H. KIESEWETTER.
- 10:45 am Traumatic injuries in archaic populations: An example from Mulberry Creek, Alabama. B.M. SHIELDS.
- 11:00 am The interrelationship of status and health in the Tellico Reservoir: A biocultural analysis. T.K. BETSINGER.
- 11:15 am Learning from the ancestors: The value of skeletal study. K.J. REINHARD, D. HASTINGS.
- 11:30 am Lives forgotten: Morbidity and mortality in the late 19th century Colorado Insane Asylum. A.L. MAGENNIS.
- 11:45 am Bone pathologies and anomalies: A view from American war dead. G.E. BERG, H.D. DOCKALL.

**Session 8. Primate Behavior I: Ecology. Contributed Papers. Palm DE.**

Chair: A. NEKARIS, Oxford Brookes University.

- 8:00 am Food selection by mantled howling monkeys (*Alouatta palliata*) in a shade coffee plantation: Resource abundance and nutrient content. K.A. WILLIAMS-GUILLEN, C.M. MCCANN, E.S. DIERENFELD.
- 8:15 am An examination of the increased annual range of a Tana River crested mangabey (*Cercocebus galeritus*) group. J. WIECZKOWSKI.
- 8:30 am Social organization and ecology of Mentawai leaf monkeys. S. SANGCHANTR.
- 8:45 am Sociality and infectious disease in wild primate populations. C.L. NUNN, S.M. ALTIZER.
- 9:00 am Effect of fruit scarcity on use of memory. E.P. CUNNINGHAM, C.H. JANSON.
- 9:15 am The win-stay rule in within-patch foraging decisions in free-ranging titi monkeys (*Callicebus cupreus cupreus*) and tamarins (*Saguinus imperator imperator* and *S. fuscicollis weddellii*). J.C. BICCA-MARQUES.
- 9:30 am Evidence for computational spatial memory in wild capuchin monkeys (*Cebus capucinus*). P.A. GARBER, E. BROWN.
- 9:45 am Break
- 10:00 am Ecological partitioning in Tai Forest guenons: *Cercopithecus campbelli*, *C. petaurista* and *C. Diana*. P.J. BUZZARD.
- 10:15 am Do wild chimpanzees and gorillas compete for food? C.B. STANFORD, J.B. NKURUNUNGI.

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**Thursday Morning – April 24, 2003 (continued)**


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- 10:30 am With whom, when, and why: Primate polyspecific associations at Ngogo, Kibale National Park, Uganda. S. TEELLEN.
- 10:45 am Communities of frugivores: The relative role of anthropoids in seed dispersal. J.E. LAMBERT.
- 11:00 am Predation risk and habitat structure affect habitat preference and vertical use of space by wild patas monkeys (*Erythrocebus patas*). K.L. ENSTAM, L.A. ISBELL.
- 11:15 am Rates of predation by diurnal raptors on the lemur community of Ranomafana National Park, Madagascar. S.M. KARPANTY.
- 11:30 am Primate social systems and predation risk: Factors influencing prey selection by crowned eagles in Tai National Park, Côte d'Ivoire. S.M. SHULTZ, W.S. MCGRAW, R. NOË.
- 11:45 am Ecological influences on chimpanzee hunting. R.W. WRANGHAM.

**Session 9. Primate Biology I: Functional Morphology. Contributed Papers. Palm F.**

Chair: A. TAYLOR, Duke University.

- 8:00 am Facial expression musculature in *Otolemur* with a comparison to the Lemuroids. A.M. BURROWS, T.D. SMITH.
- 8:15 am Ghosts of the past: Temporal muscles, fasciae and bones in some primates. C.E. OXNARD, R. WEALTHALL.
- 8:30 am Muscle function and temporomandibular joint loading in humans. M.A. SPENCER, D.E. SHERWOOD.
- 8:45 am Functional shape variation in the cercopithecine masticatory complex. M. SINGLETON.
- 9:00 am Functional interpretations of jaw shapes: Beware of morphometricians bearing geometric means. C.J. VINYARD.
- 9:15 am Kinematics and EMG activation of head-neck muscles during locomotion in *Erythrocebus patas*. J.S. SIPLA, C.F. ROSS, S.G. LARSON.
- 9:30 am Mechanical properties of molar enamel in *Homo sapiens* and *Alouatta palliata*. M.F. TEAFORD, M. WEINER, L. DARNELL, T.P. WEIHS.
- 9:45 am Mineral density patterns in femora and humeri of African pongids. K.J. CARLSON.
- 10:00 am Break
- 10:15 am Assessment of trabecular architecture parameters of catarrhine calcanei using high resolution MicroCT scanning. M. MAGA, J. KAPPELMAN.
- 10:30 am Evaluation of the functional adaptation of femoral trabecular bone in *Galago* and *Loris* using micromechanical finite element models. T.M. RYAN, B. VAN RIETBERGEN.
- 10:45 am Patterns of variation of the internal architecture of the primate proximal femur. T.B. VIOLA, L. BONDIOLI, M. NAKATSUKASA, R. MACCHIARELLI.
- 11:00 am The pitheciine postcranium: Functional morphology and phylogeny of *Pithecia pithecia*, *P. monachus*, and *Chiropotes satanas*. S.E. WALKER, L.C. DAVIS, S.M. FORD.
- 11:15 am Fiber architecture in primate limb muscles with new data for triceps surae in *Eulemur fulvus*. F. ANAPOL.
- 11:30 am An investigation of scaling relationships in sensory and masticatory systems of New World primates. M.N. COLEMAN.
- 11:45 am The critical function of the "robust" jaws of tufted capuchins. B.W. WRIGHT.

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**Thursday Morning – April 24, 2003 (continued)**


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**Session 10. Skeletal Biology I: Bioarchaeology and Biological Variation.** Contributed Papers. *Abbey.*

Chair: M.J. SCHOENINGER, University of California at San Diego.

- 8:00 am Digastric groove morphology: A potential new criterion for sex diagnosis. T.R. PETERSEN.
- 8:15 am A blind test of the auricular surface aging technique on a known age and sex skeletal collection. S.H. GARST.
- 8:30 am The meaning of impacts in several skeletal samples. C.M. PIJOAN, J. MANSILLA.
- 8:45 am Are Harris lines an indicator of stress? A comparison between Harris lines and enamel hypoplasia. M.P. ALFONSO, J.L. THOMPSON, V.G. STANDEN.
- 9:00 am Old versus new: Interpretation of flint toolmarks on skeletal material from West Tump Long Barrow, Gloucestershire, England. M.J. SMITH.
- 9:15 am The bioarchaeological evidence for intra-site class differences in the Roman Near East. M.A. PERRY.
- 9:30 am Warriors of the clouds? Inferences and interpretations of trauma from Chachapoyas, Perú. K.C. NYSTROM, J.W. VERANO.
- 9:45 am Break
- 10:00 am Bioarchaeological analysis of Wari trophy heads from Conchopata, Peru. T.A. TUNG.
- 10:15 am Variation in limb proportions in pre-contact human skeletons from different altitudes in the Andes. K.J. WEINSTEIN.
- 10:30 am The sutura frontalis and frontofacial growth in Pleistocene to recent *Homo*. G.D. RICHARDS, S. NABIPOUR, L. COBAIN.
- 10:45 am Morphological variation in the metatarsus of modern and ancient Holocene people from South Africa. B. ZIPFEL, R. KIDD, L.R. BERGER.
- 11:00 am New World Paleoindians in craniometric perspective: New looks at old faces. N. SEGUCHI, A.R. NELSON, C.L. BRACE.
- 11:15 am Cranial variation in a Bronze Age skeletal series from Cyprus: A study of population dynamics in the eastern Mediterranean. P.H. MOORE-JANSEN, N.K. HARPER.
- 11:30 am Regional variation in late 19th and early 20th century anatomical collections. M.K. SPRADLEY, K.E. WEISENSEE, R.L. JANTZ.
- 11:45 am Why has skeletal biology remained typological? G. ARMELAGOS, D. VAN GERVEN.

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**Thursday Afternoon – April 24, 2003**


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**Session 11. Primate Behavior II: Ecology and Behavior.** Contributed Posters. *Xavier.*

Chair: D.J. OVERDORFF, University of Texas.

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|----------------|---|
| 1:00 – 1:30 pm | Poster set-up.  |
| 1:30 – 3:00 pm | Authors of even-numbered posters present for questions. |
| 3:30 – 5:00 pm | Authors of odd-numbered posters present for questions.  |
| 5:00 – 5:30 pm | Poster take-down.                                       |

1. Coprophagy indicates stress in lowland gorillas (*Gorilla gorilla*). M. FARALDO, L.L. TAYLOR.
2. Population density and home range size of *Indri indri* in the Betampona Reserve, Madagascar. K.D. GLASSCOCK, A. BRITT.

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**Thursday Afternoon – April 24, 2003 (continued)**


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3. A preliminary study of travel routes and spatial mapping in mantled howler monkeys (*Alouatta palliata*). P.E. JELINEK, P.A. GARBER, M.F. BEZANSON, A. DELUYCKER, T. O'MARA.
4. Variation in the diet of *Cercopithecus ascanius* monkeys in Kibale National Park, Uganda: Influence of habitat, sex, and age. B.N. TORGRIMSON.
5. The influence of patch entry order on feeding priority in three prosimian primates in southeastern Madagascar. D.J. OVERDORFF, E.M. ERHART, T. MUTSCHLER.
6. Social organization of wild groups of *Callimico goeldii* in northwestern Bolivia. L.M. PORTER.
7. Preliminary report on the natural history of brown titi monkeys (*Callicebus brunneus*) at the Los Amigos Research Station, Madre de Dios, Peru. J.M. LAWRENCE.
8. Potential patterns of male mate competition among wild ring-tailed lemurs, *Lemur catta*. M.L. SAUTHER, L. GOULD.
9. Dispersal, philopatry, or something in-between? Behavioral patterns and dominance relationships amongst males in a population of semi-free ranging long-tailed macaques (*Macaca fascicularis*) at the Padangtegal Wanara Wana in Ubud, Bali, Indonesia. J.E. LOUDON, A. FUENTES, A.T. ROMPIS.
10. Acquisition of social ranks of females in one group of Taiwanese macaques (*Macaca cyclopis*) at Fushan Experimental Forest, Taiwan. H-H. SU.
11. Predator experiments on spectral tarsier infants. S.L. GURSKY.
12. Does hearing play a role in insect predation? An assessment of the relationship between external ear morphology and foraging behavior in nocturnal prosimians. A.K. PALMER, M.N. MUCHLINSKI.
13. Does topography affect the foraging effort of mountain gorillas in Bwindi Impenetrable National Park, Uganda? M.L. GOLDSMITH, H. MOLES.
14. A preliminary survey and GIS analysis of ring-tailed lemur habitat use in and around Beza-Mahafaly Reserve, Madagascar. D.C. WHITELOW, M.L. SAUTHER.
15. Ecogeography of primates in Guyana: Species-area relationships and ecological specialization. S.M. LEHMAN.
16. Genetic population structure in a wild lemur population, the white sifaka (*Propithecus verreauxi verreauxi*): 1992-2001. R.R. LAWLER, A.F. RICHARD, M.A. RILEY.
17. Forest degradation and demographic changes in *Ateles geoffroyi* at Estación Biológica La Suerte, Costa Rica. T. O'MARA.
18. Natural and anthropogenic influences on lemur population structure in southeastern Madagascar. S.E. JOHNSON, M.T. IRWIN, P.C. WRIGHT, S. ARRIGO-NELSON, C. GRASSI, K.E. SAMONDS, T.M. SMITH.

**Session 12. Dental Anthropology I: Health, Hypoplasia, and Wear. Contributed Posters.**

*Dolores.*

Chair: E.A. NEWELL, Elizabethtown College.

1:00 – 1:30 pm	Poster set-up.
1:30 – 3:00 pm	Authors of even-numbered posters present for questions.
3:30 – 5:00 pm	Authors of odd-numbered posters present for questions.
5:00 – 5:30 pm	Poster take-down.

1. Inter-tooth distribution of linear enamel hypoplasia in non-human primates. E.A. NEWELL.
2. The timing of linear enamel hypoplasia in the bonobo, *Pan paniscus*. S.A. TSUKAMOTO, M.F. SKINNER.
3. An unusual hypoplastic defect of the maxillary lateral incisors in great apes. D.L. HANNIBAL.
4. Complementary approaches toward evaluating dental health in skeletal samples: New recommendations to existing standards. A. WASHBURN, M.B. GOLDBERG.

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**Thursday Afternoon – April 24, 2003 (continued)**


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5. Dental health in North America. C.D. FOOCE, P.W. SCIULLI.
6. Numerical dental anomalies among the early inhabitants of the Northwest Coast. A.J. CURTIN.
7. Dental asymmetry among the Oraibi Hopi population: Evidence for decreases in stress among young males. M.A. EVERETT.
8. Dental disease: the root of all evil? Skeletal analysis of the relationship between periodontal and systemic disease. A.M. RUNYAN, D.R. HUNT.
9. Living conditions at the time of the Roman Emperors: Centralization of power and its effect on populations. A. COPPA, C. SIGNORETTI, R. RAMPA, M. LUCCI, R. VARGIU, A. CUCINA.
10. Regional variation in dental attrition rates of Chalcolithic Populations in Israel. N. LEV-TOV, P. SMITH.
11. Dental wear patterns of hunter-gatherer and agriculturists: The impact of behavioural changes accompanying this transition. C. DETER.
12. Diet in pre-contact Central California explored through dental microwear and stable isotope analyses. K.D. GORDON, M.J. SCHOENINGER, K.E. SEARS.
13. A comparison of microwear analysis and stable carbon isotope ratios to reconstruct Fremont subsistence. M.A. HATCH, S.A. NOVAK.
14. Dental microwear of Ms of Japanese monkeys. T. HOJO.

**Session 13. Dental Anthropology II: Morphology, Modification, and Methods.** Contributed Posters. *Colonnade*.

Chair: S.E. BAILEY, The George Washington University.

1:00 – 1:30 pm	Poster set-up.
1:30 – 3:00 pm	Authors of even-numbered posters present for questions.
3:30 – 5:00 pm	Authors of odd-numbered posters present for questions.
5:00 – 5:30 pm	Poster take-down.

1. Quantitative analysis of mandibular P4 shape in Neandertals and anatomically modern humans. S.E. BAILEY.
2. Looking at the small picture: Using cranial and dental nonmetric traits to determine the origins and sources of admixture for the Caddo, a frontier Mississippian culture. C. LEE.
3. Cementum annulations and age estimation in an early Holocene population. G.M. ROBBINS.
4. Occlusal molar borings in Native American dentitions. J.C. SEIDEL.
5. Tooth modification from the Neolithic to the Iron Age in Southeast Asia. K.M. DOMETT, N. TAYLES.
6. Space available in the mandible does not influence times of molar initiation. J.C. BOUGHNER, M.C. DEAN, P. O'HIGGINS.
7. Tooth root morphology and masticatory muscle force pattern in humans and nonhuman primates. K. KUPCZIK, F. SPOOR, M.C. DEAN.
8. Patterns of correlation among morphological traits in the deciduous and permanent dentitions of juveniles. M. DANFORTH, K. JACOBI.
9. Sectional survey series: A new maxillary and mandibular radiographic technique. M.B. GOLDBERG.

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**Thursday Afternoon – April 24, 2003 (continued)**


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**Session 14. Primate Biology II: Comparative Anatomy.** Contributed Posters. *Cavetto*.

Chair: M. YOUNG OWL, California State University, Long Beach.

1:00 – 1:30 pm	Poster set-up.
1:30 – 3:00 pm	Authors of even-numbered posters present for questions.
3:30 – 5:00 pm	Authors of odd-numbered posters present for questions.
5:00 – 5:30 pm	Poster take-down.

1. Subspecific variation in the crania of *Cebus capucinus*. T.J. MASTERSON.
2. Comparative postcranial morphology of the marmosets. L.C. DAVIS, S.M. FORD.
3. Modules and locomotion in the evolution of the anthropoid hand. M.S. SELBY, P. RENO, R. MEINDL, M. SERRAT, C.O. LOVEJOY.
4. The comparative morphology of the oblique cord in non-human anthropoid primates. B.A. PATEL.
5. Foot kinematics of *Hylobates lar*, *Ateles geoffroyi*, and *Macaca fuscata* during locomotion on arboreal and terrestrial substrates. E. HIRASAKI, H. KUMAKURA.
6. Locomotor adaptations reflected in contrasting muscle proportions in gorillas and orangutans. R.K. MCFARLAND, A.L. ZIHLMAN.
7. Survey of mucosal distribution in the small intestine of the primate genus *Macaca*. E.L. CRUZ, H. COLYER, L. ALLEN, L.L. MAI, M. YOUNG OWL.
8. Measurement of mucosa in the human small intestine. M. YOUNG OWL, R. LEAL, L.L. MAI.
9. Occlusal shape changes with wear: A comparison of chimpanzee and gorilla molars. F. M'KIRERA, P.S. UNGAR.
10. Dental topographic analysis of molar wear in *Alouatta palliata*. J.C. DENNIS, P.S. UNGAR, M.F. TEAFORD, K.E. GLANDER.
11. Using fish to test the expensive-tissue hypothesis. J.A. KAUFMAN.

**Session 15. Primate Biology III: Morphometrics.** Contributed Posters. *Campanile*.

Chair: S.M. HENS, California State University, Sacramento.

1:00 – 1:30 pm	Poster set-up.
1:30 – 3:00 pm	Authors of even-numbered posters present for questions.
3:30 – 5:00 pm	Authors of odd-numbered posters present for questions.
5:00 – 5:30 pm	Poster take-down.

1. Morphometric analysis of *Cercopithecus solatus*. U. CHALLA, W.S. MCGRAW, J.M. PLAVCAN.
2. Sexual dimorphism in the face and palate of the orang-utan. S.M. HENS.
3. An assessment of hylobatid monomorphism using geometric morphometrics. S.E. HAGELL, K.P. MCNULTY.
4. Dental variability in Peruvian tamarins (*Saguinus mystax*). M.A. TORNOW, S.M. FORD, P.A. GARBER.
5. Skeletal variation in adult chimpanzees of the Tai Forest compared to other *Pan troglodyes*: A preliminary report. A.L. ZIHLMAN, C. BOESCH.
6. An estimation of the heritability of cranial nonmetric traits in a tamarin sample (*Saguinus oedipus*). K.M. JEMMOTT, A.B. FALSETTI.
7. 3D Data Acquisition using Tuned-Aperture Computed Tomography, TACT(r). N.I. LINNENBRÜGGER, D.E. SLICE, R. WEBBER.

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**Thursday Afternoon – April 24, 2003 (continued)**


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8. Precision in 3-D landmark data collection for geometric morphometrics. K.L. BAAB, N.C. TING, T.D. CAPELLINI, S.E. HAGELL, E.E. DELSON.
9. The analysis of shape sequences. D.E. SLICE.

**Session 16. Teaching Physical Anthropology: Strategies for Dealing with Controversial Topics. Symposium. *Palm ABC*.**

Organizer and Chair: M.K. NICKELS, Illinois State University.

This symposium will examine various pedagogical strategies and methods useful for dealing with controversial topics in physical anthropology courses. Introductory courses are especially susceptible to student misunderstandings, misconceptions, and even antagonistic responses to several topics typically included in such courses. These include the nature and extent of human racial variation, the use of human bones in research, and various aspects of the scientific investigation of human origins and evolution. The intent of the symposium is not only to have the presenters provide their point of view, but to encourage audience response and interaction in order to enhance the pedagogical nature of the session. Sponsored by the AAPA Education Committee.

- 1:00 pm Using history to explore controversial topics in physical anthropology courses. M.K. NICKELS.
- 1:15 pm Getting beyond the warm fuzzies: Teaching the real reasons why there are no biological human races and why it's so important. M.A. PARK.
- 1:30 pm Bones and burials: Issues and strategies for teaching about issues related to human skeletal remains. N.E. TATAREK.
- 1:45 pm Discussion.
- 2:00 pm Evolution vs./and creation: Do students have to choose? B.H. O'CONNELL.
- 2:15 pm Addressing student misconceptions about human evolution. D.L. CUNNINGHAM, D.J. WESCOTT.
- 2:30 pm Using physical anthropology to diffuse the controversy over the teaching of human origins in middle school. P.C. ASHMORE.
- 2:45 pm Discussion.
- 3:00 pm Break
- 3:15 pm Changing student perceptions about human variation in an honors college program. D.L. HART, P.C. ASHMORE.
- 3:30 pm Connecting anthropology to the real world: Strategies for maximizing student understanding of human variation and minimizing racism in international experiential learning courses. L.A. WINKLER.
- 3:45 pm Discussion.
- 4:00 pm Extended discussion (1 hour).

**Session 17. Skeletal Biology II: Diet and Biomechanics. Contributed Papers. *Palm DE*.**

Chair: R.E. WUNDERLICH, James Madison University.

- 1:00 pm Influence of trophic level on bone oxygen isotope ratios. S.H. AMBROSE.
- 1:15 pm Investigation of stable Sr isotope ratios in prehistoric human bones and teeth using laser ablation ICP-MS. T. PROHASKA, C. LATKOCZY, G. SCHULTHEIS, M. TESCHLER-NICOLA, G.
- 1:30 pm Nutritional assessment based on  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  analyses of weanling, subadult and adult remains from Sudanese Nubia. B.L. TURNER, J.L. EDWARDS, J.D. KINGSTON, D.P. VAN GERVEN, T. NEPSTAD-THORNBERRY.
- 1:45 pm Skeletal indicators of diet at Piedras Negras, Guatemala: An isotopic and osteological analysis. C.J. YODER, M.S. PARKS, A.K. SCHERER, L.E. WRIGHT.

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**Thursday Afternoon – April 24, 2003 (continued)**


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- 2:00 pm Intra-site variation at the middle valley site of Estuquiña in southern Peru: Isotopic evidence. P.D. TOMCZAK.
- 2:15 pm Biological pattern changes in a French medieval population: Implications to reconstruct health status and dietary behaviour. E. HERRSCHER, F. VALENTIN, H. BOCHERENS, R. COLARDELLE.
- 2:30 pm A pilot study to assess paleodietary change in northeast Thailand using stable isotopic analysis. C.A. KING.
- 2:45 pm Break
- 3:00 pm Strain gradients in the colobine mandibular symphysis: Assessment of the reliability of morphometric proxies for biomechanical strength and rigidity. W.S. MCGRAW, J.L. HOTZMAN, D.J. DAEGLING.
- 3:15 pm Bone density differences in iliac crest samples from a modern and an archaeological Peruvian population. H.L. RAMSAY, S.D. STOUT, J.E. BUIKSTRA.
- 3:30 pm Asymmetry in the humeri of tennis players: 'Wolff's Law' or not? J.C. OHMAN, C.O. LOVEJOY.
- 3:45 pm Asymmetry, developmental instability and non-directional growth constraints in the human skull. V.B. DELEON.
- 4:00 pm Modeling and remodeling responses to normal loading in the human lower limb. M.S. DRAPEAU, M. STREETER.
- 4:15 pm Occupational activity level in relation to bone strength. M. MONDRAGÓN, O.M. PEARSON.
- 4:30 pm Postcranial reflections of climatic adaptation and habitual activity in Tierra del Fuego. O.M. PEARSON, M. MILLONES.
- 4:45 pm The pattern of robusticity among early Bronze Age groups of Central Europe: Sex differences. V. SLÁDEK, M. BERNER, R. SAILER.

**Session 18. Genetics III: Molecular Genetic Variation in Human Populations. Contributed Papers. Palm F.**

Chair: K.M. WEISS, Pennsylvania State University.

- 1:00 pm Malarial selection and the Dogon: Patterns of DNA sequence variation at the  $\beta$ -globin locus. E.T. WOOD, M.M. PILKINGTON, Z. MOBASHER, A. BINGHAM, B. STASSMAN, M.F. HAMMER.
- 1:15 pm Evidence of differential evolution of male and female lineages in African hunter-gatherers and food producers. G. DESTRO-BISOL, V. COIA, F. DONATI, C. BATTAGGIA, G. SPEDINI, B. ARREDI, A. CAGLIÀ, C. CAPELLI, C. TYLER-SMITH.
- 1:30 pm The genetic history of linguistically diverse Tanzanian populations: A multilocus analysis. S.A. TISHKOFF, M.K. GONDER, J. HIRBO, H. MORTENSEN, K. POWELL, A. KNIGHT, J. MOUNTAIN.
- 1:45 pm Sampling bias and the cytochrome oxidase III locus of mitochondrial DNA. M.M. PILKINGTON, J.A. WILDER, Z. MOBASHER, B. STRASSMAN, J. FRIEDLAENDER, M.F. HAMMER.
- 2:00 pm Evidence of founder effects in North Atlantic island populations. C.R. TILLQUIST, E. ARNASON, H. SIGURGISLASON, M.F. HAMMER.
- 2:15 pm APOE distribution in world populations with new data from the Indian sub-continent and the British populations. P. P. SINGH, M. SINGH, P. GILL, S. MASTANA.
- 2:30 pm Y-chromosome evidence on the origins of the Balinese and the "Indianization" of Bali. T.M. KARAFET, J.S. LANSING, A.J. REDD, S. SURATA, J. GULICK, M.F. HAMMER.
- 2:45 pm mtDNA variation in Central Siberians identifies West Eurasian and East Asian components of their gene pool. T.G. SCHURR, R.I. SUKERNIK, Y.B. STARIKOVSKAYA, D.C. WALLACE.
- 3:00 pm Break
- 3:15 pm Native American Y chromosomes and the peopling of the Americas. S.L. ZEGURA, M.F. HAMMER, T.M. KARAFET.

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**Thursday Afternoon – April 24, 2003 (continued)**


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- 3:30 pm Variation in the vitamin D receptor and NRAMP1 Loci in Ache and Ava of Paraguay: Implications for host susceptibility to tuberculosis. A.K. WILBUR, J.R. FEURSTEIN, A.M. HURTADO, K.R. HILL, A.C. STONE.
- 3:45 pm Allelic variation at alcohol metabolism genes and alcohol dependence in an American Indian population. C.J. MULLIGAN, M.V. OSIER, N. SAMBUUGHIN, R.A. KITTLES, D. GOLDMAN, J.C. LONG.
- 4:00 pm The origin of Mayans according to HLA genes and the uniqueness of Amerindians. A. ARNAIZ-VILLENA.
- 4:15 pm Skin pigmentation, biogeographical ancestry and admixture mapping. M.D. SHRIVER, E.J. PARRA, P. MCKEIGUE, R. KITTLES.
- 4:30 pm Analysis of DNA sequences under unequal evolutionary rates. J.C. LONG, K. HUNLEY, R.A. KITTLES.
- 4:45 pm Global population relationships based upon multiple haplotype loci. J.R. KIDD, A.J. PAKSTIS, K.K. KIDD.

**Session 19. Hominid Environments and Paleoecology in the East African Pliocene: An Assessment of the Faunal Evidence. Symposium. Abbey.**

Organizers and Chairs: R. BOBE, Smithsonian Institution, Z. ALEMSEGED, Institute of Human Origins, Arizona State University, and A.K. BEHRENSMEYER, Smithsonian Institution.

The study of hominid adaptation and evolution is intricately tied to our understanding of the environments in which humans evolved. Although many types of data are used in the reconstruction of past environments, vertebrate faunas provide one of the main lines of evidence. This symposium provides an overview of the key issues and baseline data used in the study of faunal change and hominid paleoecology for the East African Pliocene.

- 1:00 pm Key issues in the analysis of faunal changes across the East African Pliocene. A.K. BEHRENSMEYER, Z. ALEMSEGED, R. BOBE.
- 1:15 pm Faunal comparison between the Middle Ledi and Hadar hominin sites, Ethiopia: Time, landscape, and depositional environment. K.E. REED, C.A. LOCKWOOD, J.R. ARROWSMITH.
- 1:30 pm A comparative approach to faunal analysis in the Hadar and Turkana regions. R. BOBE, A.K. BEHRENSMEYER, G.G. ECK, L. LEAKEY.
- 1:45 pm Recent research on the evolution of Late Neogene African mammals, with emphasis on Pliocene Bovidae. E.S. VRBA.
- 2:00 pm Comparison of the Pliocene and Pleistocene cercopithecoid faunas from the Afar and Turkana Basins. S.R. FROST.
- 2:15 pm Hominid environments and faunal change in the lower Omo valley: A comparison of the French and American databases. Z. ALEMSEGED, R. BOBE, D. GERAADS.
- 2:30 pm Kanapoi: Fauna and paleoenvironments. J.M. HARRIS, M.G. LEAKEY.
- 2:45 pm Break
- 3:00 pm Late Pliocene climatic change and faunas in the Tugen Hills, Kenya. A. HILL, J. KINGSTON, A. DEINO, L. BISHOP, R. FISHER, J. ROSSIE.
- 3:15 pm The palaeoanthropological interpretation of Plio-Pleistocene locality of Gatarakwa, Central Kenya and its significance in understanding hominid evolution. N.R. MALIT, J.E. NGALLA, F.M. KIRERA.
- 3:30 pm The paleoenvironmental setting of hominin activities at Kanjera South, western Kenya. L.C. BISHOP, T.W. PLUMMER, J. FERRARO, P.W. DITCHFIELD, F. HERTEL, J.D. KINGSTON, D. BRAUN, J. HICKS, R.B. POTTS.
- 3:45 pm Faunal differences in the sequence at Laetoli: Implications for taphonomy and paleoecology. D.F. SU, T. HARRISON.

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**Thursday Afternoon – April 24, 2003 (continued)**


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- 4:00 pm Laetoli Pliocene environments revisited: Stratigraphic and taphonomic context of Upper Laetoli Bed Fauna at Localities 8 and 9. C.M. MUSIBA, C.C. MAGORI, S. BRANTING, F. NDUNGURU, S. KILLINDO, D.M.K. KAMAMBA, R.H. TUTTLE.
- 4:15 pm Ecological trends in the distribution of micromammals recovered from owl pellets in northern Tanzania: Using modern systems to calibrate paleoenvironmental analyses. D.N. REED.
- 4:30 pm Fauna, taphonomy and ecology of the Plio-Pleistocene Chiwondo Beds, Northern Malawi. O. SANDROCK, O. KULLMER, F. SCHRENK, Y.M. JUWAYEYI, T.G. BROMAGE.
- 4:45 pm Discussion: R. POTTS.

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**Friday Morning – April 25, 2003**


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**Session 20. Primate Behavior III: Biology, Ecology, and Behavior.** Contributed Posters. *Xavier*. Chair: M.S. GERALD, Cayo Santiago Caribbean Primate Research Center and University of Puerto Rico.

- 8:00 – 8:30 am Poster set-up.  
 8:30 – 10:00 am Authors of even-numbered posters present for questions.  
 10:30 am – 12:00 pm Authors of odd-numbered posters present for questions.  
 12:00 – 12:30 pm Poster take-down.

1. Friendly faces and sexy behinds: Variable signal content contained in female rhesus macaque facial and sexual skin coloration. M.S. GERALD, K.M. TREIER, H. LYONS.
2. Copulatory plug displacement: further evidence for sperm competition in *Lemur catta*. J.A. PARGA.
3. Genito-genital rubbing as a female bonding strategy in a group of captive chimpanzees (*Pan troglodytes*). S.F. ANESTIS.
4. Cranial sexual dimorphism, allometry and mating systems among hominoids. M. BERNHARD, K. SCHAEFER, P. GUNZ, P. MITTEROECKER, H. PROSSINGER, F.L. BOOKSTEIN, H. SEIDLER.
5. A comparison of substrate use among infant and adult red-shanked douc langurs, Delacour's langurs, and Hatinh langurs at the Cuc Phuong Endangered Primate Rescue Center, Vietnam. C.C. WORKMAN, H.H. COVERT.
6. The relationship between sexual dimorphism and male-female dietary niche separation in haplorhine primates. J.M. KAMILAR.
7. Patterns of positional behavior in juvenile and adult white-faced capuchins (*Cebus capucinus*). M.F. BEZANSON.
8. A comparison of limb preference in captive bonobos, chimpanzees, lowland gorillas and orang utans. R.M. HARRISON.
9. Body size, limb proportions, and positional behavior during ontogeny in captive chimpanzees (*Pan troglodytes*). M.L. SCHWANDT, M.W. MARZKE.
10. Differences in patterns of locomotor behavior and habitat use in adult and juvenile *Cebus apella* and *Cebus olivaceus*. K.A. WRIGHT.
11. Are juveniles at greater risk than adults? Preliminary data on ecological risk aversion in two species of neotropical monkeys (*Cebus albifrons* and *Saimiri boliviensis*) in Peru. L.R. BIDNER.
12. Noninvasive assessments of stress in male sifaka (*Propithecus verreauxi*). D.K. BROCKMAN, K. MELTZ, P.L. WHITTEN.
13. Development of human hand preference in the first year of life: The role of maternal influence. L.L. FIELDS, L.E. DIAZ.
14. Throwing behavior and the mass distribution of rock selection in tufted capuchin monkeys (*Cebus apella*). G.C. WESTERGAARD, A. CLEVELAND, A.M. ROCCA, E.L. WENDT, M.J. BROWN.

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**Friday Morning – April 25, 2003 (continued)**


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15. Late Holocene archaeological remains from chimpanzee and human sites in the rainforests of Cote d'Ivoire. J. MERCADER, M. PANGER, L. SCOTT-CUMMINGS, C. BOESCH.
16. Chimpanzee ant-dipping tools from West Cameroon: Geographical variation. E.J. INGMANSON.
17. The Chimpanzee Cultures Website: An online tool for research and teaching. L.F. MARCHANT, W.C. MCGREW, S. SMART, A. WHITEN.

**Session 21. Morphometric Variation in the Dentition of *Homo sapiens*. Poster Symposium. Dolores.**

Organizers and Chairs: H. EDGAR, College of Wooster, and L. LEASE, Ohio State University.

This symposium will bring together international experts on contemporary dental variation, with an emphasis on interpopulation comparisons. The intent of the symposium is to assess and characterize the state of dental anthropology with regard to the types of data and analytic methods used to assess interpopulation variation. This symposium is also intended to highlight the several recent advances in the anthropological use of dental data, as well as to foster communication between the participants and other members of the association. Sponsored by the Dental Anthropology Association.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors present for questions.
10:00 – 10:30 am	Discussion: S. HILLSON, G.R. SCOTT.
12:00 – 12:30 pm	Poster take-down.

1. Dental morphometric variation and human sex chromosome complement. L. ALVESALO.
2. Worldwide variation in tooth formation and eruption. H.M. LIVERSIDGE.
3. Ancestry determination using mesiodistal measurements of deciduous teeth. L.R. LEASE.
4. A comparison of morphological traits in deciduous and permanent dentitions. J.M. ULLINGER.
5. Mass migrations or mere movement of morphemes? A dental morphology investigation of post-Neolithic south Asian population history. B.E. HEMPHILL.
6. Dental morphometrics of Early Holocene India: A comparison of Indus and Ganga Valley samples. J.R. LUKACS.
7. Dental anthropology of the Prehispanic Canarian islandscape: L.S. OWENS.
8. Dental morphometry and indicators of developmental stress in precontact and contact Maya populations from Yucatan. A. CUCINA, V. TIESLER BLOS.
9. Where's the variation? Variance components in the permanent dentition. E.F. HARRIS.
10. Prediction of social race category using characteristics of dental morphology. H.J.H. EDGAR.
11. Ancient teeth and modern humans: Additional dental evidence for an African origin of *Homo sapiens*. J.D. IRISH, D. GUATELLI-STEINBERG.
12. Metric and nonmetric dental variations of major human populations in the world. T. HANIHARA, T. HIGA, H. ISHIDA.

**Session 22. Primate Evolution I: Fossils and Phylogenies. Contributed Posters. Colonnade.**  
 Chair: M.T. SILCOX, University of Winnipeg.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors of even-numbered posters present for questions.
10:30 am – 12:00 pm	Authors of odd-numbered posters present for questions.
12:00 – 12:30 pm	Poster take-down.

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**Friday Morning – April 25, 2003 (continued)**


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1. New discoveries on the middle ear anatomy of the Paromomyidae (Mammalia, Primates) from ultra high resolution X-ray computed tomography. M.T. SILCOX.
2. New *Loveina sheai* (Primates: Omomyidae) and implications for washakiin relationships. P.A. HOLROYD.
3. Comparative cranial anatomy and cladistic analysis of Paleocene primate *Carpolestes simpsoni* using ultra high resolution X-ray computed tomography. J.I. BLOCH, M.T. SILCOX.
4. Computer tomographic analysis of growth and development in juvenile adapiform primates from the Eocene of North America. R.T. HOGG, J.P. ALEXANDER, B.N. DELMAN, S. MARQUEZ.
5. An analysis of loridid phylogeny using morphological and molecular data. J.C. MASTERS, N. ANTHONY, A. MITCHELL.
6. Cranial evidence for the timing of the platyrrhine-catarrhine divergence. R.F. KAY, T.R.T. MITCHELL.
7. Nasal and paranasal anatomy of Oligocene and Miocene catarrhines. J.B. ROSSIE.
8. Phylogenetic implications of Miocene hominoid premaxilla length, with special reference to *Dryopithecus* from Rudabánya. M.L. MCCROSSIN.
9. Functional morphology of the *Nacholapithecus* forelimb long bones. T. TAKANO, M. NAKATSUKASA, Y. KUNIMATSU, Y. NAKANO, H. ISHIDA.
10. Morphology of the axial skeleton of *Nacholapithecus* from the Middle Miocene of Kenya. M. NAKATSUKASA, Y. KUNIMATSU, Y. NAKANO, H. ISHIDA.
11. Morphometric variation in African ape lumbar vertebrae. S.E. INOUYE, Z.B. NYE, A.M. HITZ.

**Session 23. Primate Evolution II: Communities, Biogeography, and Ecomorphology.**  
 Contributed Posters. *Cavetto*.

Chair: G.F. GUNNELL, University of Michigan.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors of even-numbered posters present for questions.
10:30 am – 12:00 pm	Authors of odd-numbered posters present for questions.
12:00 – 12:30 pm	Poster take-down.

1. Community ecology of the Middle Miocene primates of La Venta, Columbia: The relationship between divergence time and ecological diversity. B.C. WHEELER.
2. Reconstructing and comparing primate communities from the Eocene of North America and Europe. C.C. GILBERT.
3. Community perspectives on fossil cercopithecoids from the Hadar locality, Afar Region, Ethiopia. A.L. RECTOR.
4. Primate ecomorphospace: Anthropeidea and the African-Asian origin paradox. G.F. GUNNELL, R.L. CIOCHON.
5. Paleobiogeography, taphonomy, and the origin of the African hominoid clade. S.M. COTE.
6. Mind the Gap. Reconstructing the lemuriform colonization of Madagascar using insights from geophysics and the comparative method. M.J. DE WIT, J.C. MASTERS, B.G. LOVEGROVE.
7. Felsőtárkány, a middle Miocene catarrhine locality in central Hungary. L. KORDOS, D.R. BEGUN.
8. New aotine fossil from the middle Miocene of La Venta, Colombia. M. TAKAI, T. SETOGUCHI, N. SHIGEHARA.
9. New primate fossils from northern Vietnam. H.H. COVERT, T. DZANH.
10. Knuckle-walking anteaters? Testing the hypothesis of adaptation for purported knuckle-walking features using a non-primate model. C.M. ORR.
11. Environmental change and the evolution of gibbons. N.G. JABLONSKI, W.Y. BROCKELMAN.

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**Friday Morning – April 25, 2003 (continued)**


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**Session 24. Primate Evolution III: Dental Development and Variation.** Contributed Posters.  
*Campanile.*

Chair: L.J. HLUSKO, University of Illinois.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors of even-numbered posters present for questions.
10:30 am – 12:00 pm	Authors of odd-numbered posters present for questions.
12:00 – 12:30 pm	Poster take-down.

1. Dental development in *Anapithecus*. C. DEAN.
2. Molar crown formation in Miocene hominoids: A preliminary synthesis. T.M. SMITH, M.C. DEAN, J. KELLEY, L.B. MARTIN, D.J. REID, G.T. SCHWARTZ.
3. Topographic variation of the enamel thickness in the human anterior deciduous dentition. A. MAZURIER, L. BONDIOLI, S. CAROPRESO, R. MACCHIARELLI.
4. The relationship between size and shape in baboon molars. L.J. HLUSKO, M. MAAS.
5. A new morphometric approach to inferring diet from hominoid incisors and canines using Analytical Comparison of Digitized Curvatures (ACDC). A.S. DEANE, E.P. KREMER, D.R. BEGUN.
6. A morphological comparison of incisor variation in extant apes, *Kenyanthropus africanus*, and *K. wickeri*. C.A. DAVIS.
7. Assessment of upper premolar morphological traits as reliable phylogenetic indicators. L.C. BLUNDELL.
8. Geographic variation in gorillas: *graueri* and *beringei* are dentally similar. V.C. PILBROW.
9. What were the “monkey lemurs” of Madagascar up to? L.R. GODFREY, G.M. SEMPREBON, G.T. SCHWARTZ, D.A. BURNEY, W.L. JUNGERS, E. FLANAGAN, S.J. KING.

**Session 25. Hominid Evolution III: Middle and Late Pleistocene Evolution.** Contributed Papers.  
*Palm ABC.*

Chair: J.C.M. AHERN, University of Wyoming.

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| 8:00 am  | Speciosity in the early <i>Homo</i> lineage: Too many, too few, or just about right? G.C. CONROY.   |
| 8:15 am  | Limb proportions of <i>Homo habilis</i> reviewed. M. HAEUSLER, H.M. MCHENRY.  |
| 8:30 am  | A re-examination of purported “ <i>Meganthropus</i> ” cranial fragments. A.C. DURBAND.  |
| 8:45 am  | 3D morphometric study of the temporomandibular joint and its implication on species recognition in <i>Homo erectus</i> . A. BARASH, Y.Z. RAK.   |
| 9:00 am  | The relationship of skeletal and dental ages, with implications for the adolescent growth of KNM-WT 15000. S.L. SMITH.  |
| 9:15 am  | Behavioural differences in the early to mid-Pleistocene: Were African and Asian <i>Homo erectus</i> really that different? D.E. HOPWOOD.  |
| 9:30 am  | The browridge: Pleistocene body armor? J. HAWKS.  |
| 9:45 am  | Testing hypotheses of demes within <i>Homo erectus</i> using parsimony analysis. W.H. GILBERT.  |
| 10:00 am | Break   |
| 10:15 am | Faunal taphonomy and biostratigraphy at Ngandong, Java, Indonesia and its implications for the late survival of <i>Homo erectus</i> . M.C. WESTAWAY, T. JACOB, F. AZIZ, H. OTSUKA, H. BABA. |
| 10:30 am | What lies beneath? Testing the taxonomic validity of <i>Homo heidelbergensis</i> using endocranial morphology. L. DEFELICE.   |

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**Friday Morning – April 25, 2003 (continued)**


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- 10:45 am The Omo 1 partial skeleton from the Kibish Formation. J.G. FLEAGLE, Z. ASSEFA, F. BROWN, C.S. FEIBEL, I. MCDOUGALL, J.J.SHEA.
- 11:00 am The Dali cranium in the context of human evolution in China. J.H. KIDDER, A.C. DURBAND.
- 11:15 am Sharing commonly available foods in human evolution. A. GALLOWAY, M.E. MORBECK.
- 11:30 am Brain disorders in human evolution. D.P. BUXHOEVEDEN.
- 11:45 am Completing fossil *Homo* crania by statistical and geometrical estimation methods. P. GUNZ, P. MITTEROECKER, F.L. BOOKSTEIN, G.W. WEBER.

**Session 26. Primate Biology IV: Sexual Dimorphism/Locomotion. Contributed Papers. Palm DE.**

Chair: F. ANAPOL, University of Wisconsin, Milwaukee.

- 8:00 am Tri-nucleotide CAG repeat number in the androgen receptor gene as a mechanism for inter-specific variation of sexual dimorphism in primates. D. WALRATH, P. BINGHAM.
- 8:15 am Sexual dimorphism in the vomeronasal organ of *Otolemur*. T.D. SMITH, K.L. SHIMP, A.M. BURROWS, M.A. SMITH, K.P. BHATNAGAR.
- 8:30 am Cranial base sexual dimorphism: Size and shape and their taxonomic significance. L. NEVELL, B. WOOD, S. LUBOGA.
- 8:45 am Group size, sex ratios, and the contribution of male and female canine size to dimorphism. J.M. PLAVCAN.
- 9:00 am Comparison of patterns of shape dimorphism with interspecific scaling trends in the elbow and knee of cercopithecoids. M.R. LAGUE.
- 9:15 am Morphological differentiation among great ape subspecies, as indicated by geometric morphometric analysis of temporal bones. C.A. LOCKWOOD, W.H. KIMBEL, J.M. LYNCH.
- 9:30 am On morphological variation. M.J. RAVOSA, B.T. SHEA.
- 9:45 am Break
- 10:00 am Patterns of mandibular variation in *Pan* and *Gorilla*. A.B. TAYLOR, C.P. GROVES.
- 10:15 am Developmental anomalies in the dentition of a large sample of mouse lemurs (*Microcebus*) from Amboasary, Madagascar. F.P. CUOZZO.
- 10:30 am Locomotor modes of primates at moderate speeds. I. The implications of the amble and the canter for primate locomotor evolution. D. SCHMITT, P. LEMELIN, J. HANNA.
- 10:45 am Locomotor modes of primates at moderate speeds. II. Analysis of support patterns. M. CARTMILL.
- 11:00 am Locomotor development and the uniqueness of primate quadrupedalism. L.J. SHAPIRO, D.A. RAICHLIN.
- 11:15 am Habitat effects on positional behavior and fine branch use in red-tailed monkeys (*Cercopithecus ascianus*) and grey-cheeked mangabeys (*Lophocebus albigena*) in the Kibale Forest, Uganda. G.P. ARONSEN.
- 11:30 am The effect of body mass variation on the locomotor dynamics of *Cheirogaleus medius*: A natural experiment. P. LEMELIN, D. SCHMITT.
- 11:45 am How does branch stability affect prosimian arboreal quadrupedalism? N.J. STEVENS.

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**Friday Morning – April 25, 2003 (continued)**


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**Session 27. The Genetic Basis of Neurobehavioral Phenotypes: Methods, Applications and Controversies.** Symposium. *Palm F.*

Organizer and Chair: J.C. STEVENSON, Western Washington University.

Major advances in biometrics and molecular techniques have provided new insights into how genes may be translated into behavior. The messy complexity of this dynamic presents significant challenges but there are many successes. The goal here is to present various approaches to, and domains of, behavioral genetic research. Sponsored by the American Association of Anthropological Genetics.

- 8:30 am Introduction: challenges in behavioral genetics. J.C. STEVENSON, J.W. GILGER, E.R. MAHONEY.
- 8:45 am Twin research findings and methods and their implications for human behavioral development. N.L. SEGAL.
- 9:00 am Microsatellite polymorphisms: Relevance to issues in anthropology. D. E. COMINGS.
- 9:15 am Quantitative trait locus mapping in psychiatric/behavioral genetics: The state-of-the-science. J. BLANGERO.
- 9:30 am Genetics of sexual development. E. VILAIN.
- 9:45 am Gene-physical activity interactions on cardiovascular and type 2 diabetes risk factors. T. RANKINEN.
- 10:00 am Break
- 10:15 am Genetic effects on brain neurotransmitter function and mood. F.A. MORENO, D.C. ROWE, B. KAISER, D. CHASE, T. MICHAELS, J. GELERNTER, P.L.DELGADO.
- 10:30 am Phenotypic associations of the alcohol and aldehyde dehydrogenase genes in ethnic groups. T.L. WALL.
- 10:45 am Genetic etiology of autism endophenotypes. M. ALARCON, R.M. CANTOR, D.H. GESCHWIND.
- 11:00 am Genetic contributions to neurological and behavioral traits. K.M. WEISS, J. NOEBELS, D. BURGESS.
- 11:15 am Gene-culture co-evolution: The dopamine D4 receptor and other polymorphisms that may reflect social evolution. H. HARPENDING.
- 11:30 am Behaviorally evolutionarily stable strategies and genetic polymorphisms at loci affecting behavior in humans. G.M. COCHRAN.
- 11:45 am Discussion: M.H. CRAWFORD.

**Session 28. Human Biology II: Health and Disease.** Contributed Papers. *Abbey.*

Chair: C.W. KUZAWA, Northwestern University.

- 8:00 am Phenotypic and genetic associations between age at menarche and parameters of the pubertal growth spurt. B. TOWNE, S.A. CZERWINSKI, E.W. DEMERATH, A.F. ROCHE, R. M. SIERVOGEL.
- 8:15 am A longitudinal study of child growth, nutrition and health in five Rendille communities of northern Kenya. E.A. ROTH, E. FRATKIN, M. NATHAN.
- 8:30 am The effect of women's autonomy on child nutritional status in northern Kenya. E.K. BRUNSON, B. SHELL-DUNCAN.
- 8:45 am Infants' enamel growth disruptions and the quantity and quality of their mothers' perinatal diets in Solis, Mexico. A.G. ACOSTA, A.H. GOODMAN, J.R. BACKSTRAND, A.E. DOLPHIN.
- 9:00 am Food security and nutritional status among two Tanzania ethnic groups. C. HADLEY.
- 9:15 am The effects of age and ethnicity on daily stress hormone variation in employed women. G.D. JAMES.
- 9:30 am Father vs. nonpaternal allomothering effects on child health among the Toba of northern Argentina. P.L. ELLIS, C. VALEGGIA.

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**Friday Morning – April 25, 2003 (continued)**


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- 9:45 am Break
- 10:00 am Iron deficiency in infancy: A rhesus monkey model. G.R. LUBACH, C.L. COE.
- 10:15 am A study of the heritability of craniofacial asymmetry. R.E. WARD, J.A. RUSSELL, P.L. JAMISON, J.K. HARTSFIELD JR., D. KOLLER.
- 10:30 am The aging brain: An MRI-volumetric analysis of variation by sex and age in the gray-white composition of the major lobes of the human cerebrum. J.S. ALLEN, H. DAMASIO, J. BRUSS.
- 10:45 am Detection of myobacterial DNA in Andean mummies. E. LEBWOHL, K. MOWBRAY, I. TATTERSALL, D. ZHANG.
- 11:00 am An apparent case of treponematosis in a human skeletal sample from the Great Salt Lake, Utah. S. SMITH, B.G. BENSON, P.M. LAMBERT.
- 11:15 am The “Mysterious Cemetery” of Frankfort Kentucky: Letting the bones speak! P.E. KILLORAN, D. POLLACK.
- 11:30 am The role of morbidity in the mortality decline of the 19th century: Evidence from the Gibraltar garrison. J. PADIAK.
- 11:45 am Death in a mill town: Mortality in emergent industrial cities of New England. S.I. HAUTANIEMI, A.C. SWEDLUND.

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**Friday Afternoon – April 25, 2003**


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**Session 29. Tooth Chemistry: New Challenges, New Horizons.** Poster Symposium. *Dolores*. Organizers and Chairs: C. WHITE. University of Western Ontario, and A. DOLPHIN, University of Massachusetts, Amherst.

More information can be gleaned from a single tooth than any other organ of the skeletal system. Unlike bone, teeth contain three distinct tissues, each with different incremental growth patterns that become a permanent record of environmental conditions during their formation. This information can be accessed with the use of microscopic and chemical methods, and can provide us with the finest skeletal detail available for prenatal and postnatal conditions of life. This symposium brings together a group of international experts in tooth chemistry who have been using the unique qualities of teeth to push the boundaries of data gathering. Their research ranges from the challenges of diagenesis to the reconstruction of dietary, physiological, and migrational life histories.

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|----------------|--------------------------------|
| 2:00 – 2:30 pm | Poster set-up.                 |
| 2:30 – 4:00 pm | Authors present for questions. |
| 4:00 – 4:30 pm | Discussion: H.P. SCHWARCZ.     |
| 6:00 – 6:30 pm | Poster take-down.              |

1. Life-histories recorded in human teeth on the microstructural, ultrastructural and molecular level. G. GRUPE, I.L. GÜGEL, N. STROTT.
2. The mineralization, preservation and sampling of teeth: Strategies to optimise comparative study and minimise age-related change for lead and strontium analysis. J. MONTGOMERY, J. EVANS, C.A. ROBERTS.
3. Tooth enamel remains a virtually closed system for stable light isotope and trace element archives in fossils. J.A. LEE-THORP, M. SPONHEIMER.
4. Seasonality data from tooth enamel composition: The Levantine Holocene. K.A. HALLIN, M.J. SCHOENINGER, T.E. LEVY, H.P. SCHWARCZ.
5. Sources of variability in modern East African herbivore enamel: Implications for paleodietary and paleoecological reconstructions. J.D. KINGSTON.
6. High resolution, sequential chemical analysis of tooth enamel by ion probe mass spectrometry. J.E. ERICSON.
7. Microspatial analyses of intra- and intertooth variations in the distribution of trace elements. A.E. DOLPHIN, D. KANG, A.H. GOODMAN, D. AMARASIRIWARDENA.

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**Friday Afternoon – April 25, 2003 (continued)**


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8. Permanent molars and shifting landscapes: Elemental signature analysis of natality at the New York African Burial Ground. J.L. JONES, A.H. GOODMAN, J.B. REID, D. AMARASIRIWARDENA, M.E. MACK, M.L. BLAKEY.
9. Using  $^{87}\text{Sr}/^{86}\text{Sr}$  in teeth as clues to life histories of enslaved Africans buried in New York City. J.B. REID JR., A.H. GOODMAN, J. JONES, D. COLEMAN, J.D. WALKER, M.L. BLAKEY, M. MACK, C. DECORSE.
10. Immigration and ethnicity in two Teotihuacan neighbourhoods: The isotopic evidence. C.D. WHITE, M.W. SPENCE, R. STOREY, F.J. LONGSTAFFE.
11. Isotopic evidence of migration at the imperial port of Portus Romae, Italy. T.L. PROWSE, H. SCHWARCZ, R. MACCHIARELLI, L. BONDIOLI.

**Session 30. Forensic Anthropology. Contributed Posters. Colonnade.**

Chair: U. STRAND VIDARSDOTTIR, University of Durham.

2:00 – 2:30 pm	Poster set-up.
2:30 – 4:00 pm	Authors of even-numbered posters present for questions.
4:30 – 6:00 pm	Authors of odd-numbered posters present for questions.
6:00 – 6:30 pm	Poster take-down.

1. Sex determination from the human hip bone: A response to Bruzek. T.N. NEPSTAD-THORNBERRY, D.C. WHITELAW, D.P. VAN GERVEN.
2. Humeral and femoral head diameters in a contemporary ethnic Albanian population. L.B. HUNTER, M.W. WARREN.
3. Longitudinal assessment of quantitative and qualitative age-related change in the dental pulp chamber: An expert system approach using dental radiographs. D.G. MCBRIDE.
4. Adult stature estimation from the calcaneus of South African blacks. M.A. BIDMOS, S.A. ASALA.
5. Sexing the sella turcica: A question of English vs. Turkish saddles? S.C. FOX, K. ELIOPOULOS, S.K. MANOLIS.
6. Implications of sex differences for aging of the vertebral column. J.J. SNODGRASS.
7. Discerning veneration and violation in mortuary contexts: The case of Zacpeten. W.N. DUNCAN.
8. MorFIdS: Morphometric Forensic Identification of Sub-adults. U.S. VIDARSDOTTIR.
9. Identity and living conditions of the 'Red Queen': A bioarchaeological study of the sarcophagus tomb of Temple XIII at Palenque, Mexico. V. TIESLER BLOS, A. CUCINA, M. STREETER, A. ROMANO PACHECO.
10. Are virtual bones as good as the real thing? A test of measurement error. D. TO, W.D. SWEITZER.
11. A comparison of morphometric data and methods in classification. S.D. OUSLEY, A. MCKEOWN.

**Session 31. Paleopathology II: Trauma and Infection in Past Populations. Contributed Posters. Cavetto.**

Chair: A.L. TINE, Geo-Marine, Inc.

2:00 – 2:30 pm	Poster set-up.
2:30 – 4:00 pm	Authors of even-numbered posters present for questions.
4:30 – 6:00 pm	Authors of odd-numbered posters present for questions.
6:00 – 6:30 pm	Poster take-down.

1. The tale that tail bones tell about the antiquity of the human disease brucellosis. J.M. HODGKINS.
2. Trauma patterns in Western Hemisphere skeletal collections. P.L. WALKER, R. STECKEL.

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**Friday Afternoon – April 25, 2003 (continued)**


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3. Bioarchaeology and sociobiology in the pre-Columbian Grasshopper Pueblo, Arizona. M. SCHULTZ, T.H. SCHMIDT-SCHULTZ.
4. Paleopathological investigations at the historic cemetery of St. Martin's, England. M.B. BRICKLEY, J. ADAMS, H. BERRY, A.G. WESTERN.
5. Evidence of treponematosi s from a historic paupers' cemetery in Dallas, Texas. A.L. TINE, M.D. WURTZ, J.H. COOPER.
6. Schmorl's nodes at Orendorf: A test of clinical etiologies and paleopathological assumptions. K.E. SHERIDAN, D.W. STEADMAN.
7. Cannibalism and sample size: The new remains from Navatu, Fiji. S. MINTER, D. DEGUSTA, G.R. CLARK.
8. Periosteal reactions as indices of health status. M.L. POWELL.
9. Scanning electron microscopic analysis of oral surgery observed in a pre-Columbian Amerindian mandible. G.D. HACK, R.T. KORITZER.
10. Brucellosis in antiquity: An analysis of possible cases of brucellar sacroiliitis. J.FAN, D.J. ORTNER, B. FROHLICH, D.L. MARTIN.
11. The taphonomy of soft tissue preservation in anaerobic conditions - the Queen Street Mission crypt, Huddersfield, England. R.F. PASTOR, S. MCSHANE, M. GREEN.

**Session 32. Paleopathology III: Nutritional Status, Growth, and Metabolism. Contributed Posters. *Campanile*.**

Chair: P. LAMBERT, Utah State University.

2:00 – 2:30 pm	Poster set-up.
2:30 – 4:00 pm	Authors of even-numbered posters present for questions.
4:30 – 6:00 pm	Authors of odd-numbered posters present for questions.
6:00 – 6:30 pm	Poster take-down.

1. Bone structure and mineralization in a late antique skeleton with osteomalacia. D.K.E. SCHAMALL, M. KNEISSEL, K. WILTSCHKE-SCHROTTA, M.E. TESCHLER-NICOLA.
2. Evidence of subadult scurvy from Kagamil and Shiprock Islands, Alaska. D.M. MULHERN, E.B. JONES.
3. Iron deficiency anemia in pre-contact hunter-gatherers from Bay West (8CR200) and Windover (8BR246). H. WALSH-HANEY.
4. Childhood stress and determinants of adult sexual size dimorphism in late prehistoric skeletal assemblages from Guam, Mariana Islands. A.L.W. STODDER, M.T. DOUGLAS.
5. The health effects of Wari imperial control: Rates of enamel hypoplasia and carious lesions in prehistoric Nasca populations. C.M. KELLNER.
6. Severe enamel hypoplasia in a 19th century cemetery sample from North Carolina: Possible causes. P. LAMBERT.
7. Hereditary multiple cartilaginous exostoses in a young adult male from early medieval coastal Germany. W.R. TEEGEN, M. SCHULTZ.
8. Skeletal markers of occupational stress in the tibiae of a Bronze Age population. C.C. COOPER, D.L. MARTIN, D.T. POTTS.
9. Paleopathology at Jamaica Beach in Galveston, Texas. J.L.Z. RICE.

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**Friday Afternoon – April 25, 2003 (continued)**


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**Session 33. Recent Developments and Applications of Biomedical Anthropology In and Out of Academia: A Symposium in Honor of Francis E. Johnston.** Symposium. *Palm ABC*.

Organizer and Chair: L.M. SCHELL, State University of New York at Albany.

This symposium will bring together experts in the interrelated areas of human growth and development, health, and nutrition. This symposium is intended to honor Francis E. Johnston upon his retirement two years ago, and to inform the members of the AAPA of recent research developments and applications of biomedical anthropology. Johnston produced 13 edited books and over 160 papers and chapters. In addition, he served the AAPA as president from 1983-85 and as Editor-in-Chief of the *AJPA* from 1977-83. A particular feature of Johnston's type of biomedical anthropology is its incorporation of culture (and behavior) as a prime influence on biological variation, particularly variation related to health, and his Ph.D. students continue to work in that framework. Most of them have careers outside of academic anthropology where they apply biomedical methods and theories derived from his work in anthropology to understand and prevent or remedy health problems afflicting populations, often socially disadvantaged ones. A symposium of high scientific quality is not only a suitable honor to him, but will also provide valuable information from researchers who happen to be his students showing the application of biomedical theory and methods to problems in academic anthropology and in the allied health professions.

- 2:00 pm Biomedical anthropology: From emerging synthesis to established discipline. N. CAMERON.
- 2:15 pm Nutrition behavior change in Mali: A biocultural model. C.F. PARVANTA.
- 2:30 pm Socio-demographic and environmental correlates of obesity in US adolescents: The National Longitudinal Study of Adolescent Health. P. GORDON-LARSEN, L. ADAIR, B.M. POPKIN.
- 2:45 pm Insulin, gestational diabetes and maternal thrift. T.O. SCHOLL.
- 3:00 pm Stunting and obesity in the land of plenty: Children of migrant laborers in New Jersey. D.L. MARKOWITZ, S. COSMINSKY.
- 3:15 pm Milk and human development. B. BOGIN, M.I. VARELA-SILVA.
- 3:30 pm Patterns and pitfalls in the assessment of bone health in children. B. ZEMEL, V. STALLINGS, M. LEONARD.
- 3:45 pm Is vitamin A status related to outcomes in young children with sickle cell disease? J.I. SCHALL, D.A. KAWCHAK, K. OHENE-FREMPONG, K.E. TEMME, B.S. ZEMEL, V.A. STALLINGS.
- 4:00 pm Break
- 4:15 pm Reconstructing individual life histories using the chemistry of the skeleton. A. SILLEN.
- 4:30 pm Fetus to infant in biomedical perspective. M. LAMPL.
- 4:45 pm Long term consequences of early child growth restriction. L.S. ADAIR.
- 5:00 pm High HIV prevalence and incidence among young African American men who have sex with men in 6 US cities: What factors are contributing? L.A. VALLEROY, D.A. MACKELLAR, G.M. SECURA, S.K. BEHEL, THE YOUNG MEN'S SURVEY STUDY GROUP.
- 5:15 pm Ontogenetic changes in limb bone structure: A longitudinal analysis of the Denver Growth Study sample. C.B. RUFF.
- 5:30 pm Genetic and environmental correlations between age at adiposity rebound and subsequent changes in childhood BMI. E.W. DEMERATH, S.A. CZERWINSKI, B. TOWNE, S.S. SUN, W.C. CHUMLEA, R.M. SIERVOGEL.
- 5:45 pm Weight growth velocity from birth to 2 years of age in relation to lead burden. L.M. SCHELL, N. CAMERON.
- 6:00 pm Discussion: F.E. JOHNSTON.

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**Friday Afternoon – April 25, 2003 (continued)**


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**Session 34. Techniques, Applications, and Action: Moving Beyond the Call for Conservation.**  
 Symposium. *Palm DE.*

Organizers and Chairs: A. FUENTES, University of Notre Dame, and N. MALONE, University of Oregon.

Anthropological research projects are often interconnected with conservation issues. However, little attention has been paid to the wide range of actual conservation activity by biological anthropologists. Recent advances in genetic investigative tools, geographical information systems data analyses, and long-term field data from human and nonhuman primate studies have facilitated integration of conservation activities into an array of ongoing research projects. This symposium seeks to present aspects of the methods, practice, and outcomes of conservation related research by biological anthropologists.

2:00 pm Introduction. A. FUENTES, N. MALONE.

2:15 pm "Whose woods are these?": Ethnoprimateology and conservation in Sulawesi, Indonesia. E.P. RILEY.

2:30 pm Payoffs, community relations, and vocational training: Implementing local conservation in Ecuador's Yasuni National Park. F. KOESTER, A. DI FIORE.

2:45 pm Integrating research and education for orangutan conservation in Gunung Palung National Park, Indonesia. C.D. KNOTT, E. HILL, A. JOHNSON, J. HARTING.

3:00 pm Electric fences between farmers and monkeys?: Reconfiguring rural land use for wildlife conservation in Japan. D.S. SPRAGUE.

3:15 pm Scrambling for a common resource: Chimpanzees, humans, and *Saba senegalensis* in southeastern Senegal. J.D. PRUETZ, P. KNUTSEN.

3:30 pm Conservation through folklore: Ethnoprimateology in southeastern Senegal. K. CLAVETTE.

3:45 pm Road to extinction: GIS modeling of road development and hunting pressure on Amazonian primates. J.L. DEW, J. GREENBERG, M. FRANZEN, A. DI FIORE.

4:00 pm Discussion: K. STRIER.

**Session 35. Dental Anthropology III: Methods and Variation.** Contributed Papers. *Palm DE.*

Chair: D. GUATELLI-STEINBERG, Ohio State University, Newark.

4:45 pm Understanding and correcting molar robustness index error. C.W. SCHMIDT, M.K. HILL.

5:00 pm Taurodontism: Methodological limitations and pulpal dynamics. A.D. SCHAUBER.

5:15 pm A model for human canine growth in a medieval urban cemetery sample. M.E. REEVES.

5:30 pm Dental anthropology in Scotland: Medieval relationships between Whithorn, St. Andrews and the Carmelite friaries. A.J. ADLER, M. WATT, C.G. TURNER II.

5:45 pm Human dental microwear during the development from a hunter-gatherer to an agricultural economy in northern Israel. P. MAHONEY.

6:00 pm Dental decoration during the Postclassic at Lamanai, Belize: Sex and status differences. J.S. WILLIAMS, C.D. WHITE.

**Session 36. Genetics IV: Molecular Genetics of Non-Human Primates.** Contributed Papers.  
*Palm F.*

Chair: J.C. LONG, University of Michigan.

2:00 pm Population-level genetic variability in wild western gorillas. B.J. BRADLEY, D.M. DORAN, C. CIPOLLETTA, A. TODD, E. STOKES, C. BOESCH, L. VIGILANT.

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**Friday Afternoon – April 25, 2003 (continued)**


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- 2:15 pm X-chromosome phylogeny of the Platyrrhini. T.R. DISOTELL, A.J. TOSI, A. DI FIORE.
- 2:30 pm Matrilineage and allelic sorting within an expanding population. X. VALDERRAMA, J.G. ROBINSON, D.J. MELNICK.
- 2:45 pm Sex chromosome phylogenetics indicate a single transition to terrestriality in the tribe Cercopithecini. A.J. TOSI, K.E. KRASINSKI, T.R. DISOTELL, D.J. MELNICK.
- 3:00 pm Colobine molecular phylogeny. K.N. STERNER, R.L. RAAUM, A.J. TOSI, C.M. NOVIELLO, J.E. SCHIENMAN, R. V. COLLURA, C-B. STEWART, T.R. DISOTELL.
- 3:15 pm Population level DNA sequence diversity at the alpha-2 globin locus in orangutans. M.E. STEIPER, M. RUVOLO.
- 3:30 pm Characterization of variation at a Major Histocompatibility Complex locus in two wild gorilla populations. L. VIGILANT, D. LUKAS, B.J. BRADLEY, D.M. DORAN, A.M. NSUBUGA, M.M. ROBBINS.
- 3:45 pm MHC diversity in captive western lowland gorillas. L.A. KNAPP, E.M. WAINWRIGHT, T. EATHERLY, O.A. RYDER, S.K. LAWRENCE.
- 4:00 pm Break
- 4:15 pm Analysis of complete mtDNA sequences in *Pan*. A.C. STONE, L.A. SALTER, E. TRUDEAU.
- 4:30 pm LINE-1 evolutionary dynamics among apes. M.K. GONDER, J.E. NORMAN, A.V. FURANO.
- 4:45 pm Evolution and loss of cytochrome *c* oxidase subunit VIII in primates. A. GOLDBERG, D.E. WILDMAN, T.R. SCHMIDT, M. HÜTTEMANN, M. GOODMAN, M.L. WEISS, L.I. GROSSMAN.
- 5:00 pm The molecular evolution of primate energetics from the perspective of cytochrome *c*. D.E. WILDMAN, M. GOODMAN, T.R. SCHMIDT, M. HÜTTEMANN, M. UDDIN, A. GOLDBERG, L.I. GROSSMAN.
- 5:15 pm Molecular estimates of primate divergence dates. R.L. RAAUM, K.N. STERNER, T.R. DISOTELL.
- 5:30 pm A genetic fossil in great ape and human genomes suggests the presence of two active forms of ribonuclease H1 17 million years ago. E.J. DEVOR, K.A. MOFFAT-WILSON.
- 5:45 pm Using genomics to identify human brain specializations. T.M. PREUSS, M. CÁCARES, J. LAUCHER, M.A. ZAPALA, J.C. REDMOND, L. KUDO, D.J. LOCKHART, D.H. GESCHWIND, C. BARLOW.

**Session 37. Hominid Evolution IV: Modern Human Origins. Contributed Papers. Abbey.**

Chair: J. HAWKS, University of Wisconsin.

- 2:00 pm Quantitative genetics of the craniofacial complex in modern humans. D.L. DUREN, S.A. CZERWINSKI, R.J. SHERWOOD, A.F. ROCHE, R.M. SIERVOGEL, B. TOWNE.
- 2:15 pm Quantitative genetics of modern human craniofacial variation: Implications for the interpretation of the hominin fossil record. R.J. SHERWOOD, D.L. DUREN, S.A. CZERWINSKI, B. TOWNE.
- 2:30 pm Neandertal facial morphology and increased jaw gape. Y. RAK, W.L. HYLANDER.
- 2:45 pm The Late Pleistocene human species of Levant. S-H. LEE, M.H. WOLPOFF.
- 3:00 pm Masticatory loading and modern human origins. S.C. ANTÓN, V.B. DELEON.
- 3:15 pm Plover's Lake: A hominin-bearing Middle Stone Age site in the Witwatersrand area, South Africa. L.R. BERGER, S.E. CHURCHILL, D.J. DE RUITER.
- 3:30 pm Comparing Neanderthal and modern human long bone loading history from cross-sectional geometry. D.E. LIEBERMAN, J.D. POLK, B. DEMES.
- 3:45 pm Break

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**Friday Afternoon – April 25, 2003 (continued)**


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- 4:00 pm The proximal extremity of the humerus: morphology and adaptation. Application to neandertal remains. J-L. VOISIN.
- 4:15 pm Fragmentary specimens and missing data in osteological phylogenies: A test using living taxa and implications for human paleontology. M.L. CHANG.
- 4:30 pm Tooth size variation and dental reduction in Europe, the Middle East and North Africa between 120,000 and 5000 BP. S.W. HILLSON, C.M. FITZGERALD.
- 4:45 pm Patterns of dental variation in extant hominids and species recognition in the fossil record. J.E. SCOTT.
- 5:00 pm Variation in early and recent Australian populations: Implications for the settlement of Australia. A.P. VAN ARSDALE.
- 5:15 pm Paleodiet and the peopling of Sundaland: Modeling early human subsistence using stable isotopes of carbon. J.S. KRIGBAUM.
- 5:30 pm Geometric morphometric analysis of the human burial series from Niah Cave, Borneo. J.M. MANSER.
- 5:45 pm Teleology and human phylogeny. T. GUNDLING.

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**Saturday Morning – April 26, 2003**


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**Session 38. Skeletal Biology III: Bioarchaeology. Contributed Posters. Xavier.**

Chair: C.S. LARSEN, Ohio State University.

- 8:00 – 8:30 am Poster set-up.
- 8:30 – 10:00 am Authors of even-numbered posters present for questions.
- 10:30 am – 12:00 pm Authors of odd-numbered posters present for questions.
- 12:00 – 12:30 pm Poster take-down.

1. "Give us your tired, your poor"... An analysis of postmortem medical use of underprivileged individuals from the Albany County Almshouse skeletal sample. K.A. LUSIGNAN.
2. Dividing the dead: Bioarchaeological differentiation of sub-populations within the Albany County Almshouse Cemetery. M. PHILLIPS, G.M. HUGHES, M. SOLANO.
3. Assessment of traumatic injuries in an early industrial population: Occupational stress and interpersonal violence among the Albany County Almshouse Inmates, Albany, New York (1826-1926). M.C. SOLANO.
4. Social and historical factors for clay pipe smoking among residents of a late nineteenth and early twentieth century almshouse. V.J. NEWELL.
5. Miners or mine owners- Do the Hallstatt skeletons reflect occupation and social structure? D.E. PANY, M. TESCHLER-NICOLA, H. WILFING.
6. Musculoskeletal Stress Markers (MSM) and weaving activities at a prehistoric site in Peru. J.M. TOYNE.
7. Tracing prehistoric activities. P. MOLNAR.
8. Humeral retroversion: An activity pattern index in prehistoric Southern California. T. GJERDRUM, P. WALKER, V. ANDRUSHKO.
9. External auditory exostosis at Isola Sacra: An old chestnut revisited. F-M. CROWE, L. BONDIOLI, R. MACCHIARELLI, P. GARNSEY.
10. A bioarchaeological analysis of crania from Pachacamac, Peru. C. TORRES-ROUFF.
11. Bioarchaeological analysis of an agricultural population from late medieval Transylvania. J.T. ENG, P.L. SZOCS.

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**Saturday Morning – April 26, 2003 (continued)**


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12. Health and lifestyle inequalities among early and late pre-Columbian and intermediate period Native Americans in the Western Hemisphere. K.D. WILLIAMS, R.H. STECKEL.
13. Social variation and sexual dimorphism in Egypt. S.R. ZAKRZEWSKI.
14. Sexual dimorphism in Meroitic, X-Group and Christian populations from Sudanese Nubia. C. HERRINGTON, G. ARMELAGOS.
15. The ecological environment and stature among Native Americans in the Western Hemisphere. R.H. STECKEL, K.D. WILLIAMS.
16. History of behavior and lifestyle in the Western Hemisphere: Osteoarthritis and skeletal robusticity. C.S. LARSEN, K.D. WILLIAMS.

**Session 39. Skeletal Biology IV: Growth and Demography. Contributed Posters. *Dolores*.**

Chair: L.W. KONIGSBERG, University of Tennessee.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors of even-numbered posters present for questions.
10:30 am – 12:00 pm	Authors of odd-numbered posters present for questions.
12:00 – 12:30 pm	Poster take-down.

1. Metric sexing methods and commingled skeletal collections: A better demographic profile? M.M. AUBIN.
2. Fetal and subadult age estimation using the os temporale pars petrosa: Accuracy of quantitative and qualitative criteria. J.L. WAY.
3. Normal periosteal bone growth and skeletal pathology in documented fetuses, University of New Mexico, Maxwell Museum documented collection and University of Tennessee documented collection. A.L. EAST.
4. Determination of infant weaning patterns from juvenile dentition in Roman Egypt. T.L. DUPRAS, M.W. TOCHERI.
5. Subadult skeletons from the North African Epipaleolithic: Clues to patterns of growth found in the subadults from Afalou and Taforalt. J.D. MERRIMAN.
6. Craniofacial remodeling during adulthood: The supraorbital region. A. HOFBAUER, J.C.M. AHERN, S-H. LEE.
7. Variation in remodeling about the perimeter of the midshaft human femur. R.A. WALKER, N. MITLYANSKY.
8. The examination of age and sex-related changes in trabecular architecture in archaeological skeletons with pQCT. S.C. AGARWAL, J-P. DEVOGELAER, W. WHITE, M.D. GRYNPAS, X. BANSE.
9. Bone histological features in catarrhines: Implications for life history and paleobiology. S.C. MCFARLIN, C.J. TERRANOVA, A.L. ZIHLMAN, T.G. BROMAGE.
10. Obstetrics and pelvic dimensions in prehistoric Inuits. R.L. NUGER.
11. Big males are responsible for our recognition that females have big pelvises. R.G. TAGUE.
12. Vitamin D deficiency and mortality: Impaired immune response in infants and elevated cancer risk in adults. R.P. MENSFORTH.
13. Age-related changes to the intervertebral discs of the human sacrum. M. SKINNER.
14. Paleodemography of the Averbuch Site (40DV60). L.W. KONIGSBERG, S.R. FRANKENBERG, D.J. HOLMAN.
15. Human skeletal remains from a third century Roman cave necropolis in Croatia. S.A. NOVAK, D.V. KOPP, D.D. KOLLMANN, G. MACKINNON, M. SLAUS.

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**Saturday Morning – April 26, 2003 (continued)**


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**Session 40. The Atelines: Contemporary Issues in Behavior, Ecology, and Evolution.** Poster Symposium. *Colonnade*.

Organizers and Chairs: C. CAMPBELL, Pomona College, and A. DI FIORE, New York University.

Until recently, ateline primates have remained some of the most understudied New World monkeys, despite their broad geographic ranges, their large body sizes, and their interesting and marked socioecological and morphological convergences with hominoids. This symposium will provide a contemporary overview of ateline biology by drawing together many different avenues of recent research on atelines: phylogenetics and evolutionary history, biogeography, life history, behavioral ecology, paleontology, and functional anatomy. It focuses primarily on the genera comprising the tribe Atelini (*Ateles*, *Brachyteles*, and *Lagothrix*), which have all been the subjects of several recent studies.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors present for questions.
10:00 – 10:30 am	Discussion: K. STRIER.
12:00 – 12:30 pm	Poster take-down.

1. Locomotor character evolution in fossil and extant ateline primates. A.L. JONES.
2. Morphological and molecular implications for the ateline adaptive radiation. W.C. HARTWIG, A.L. ROSENBERGER.
3. Atelinae phylogenetic relationships: The trichotomy revived? A.C. COLLINS.
4. Biogeographic patterns of the Atelinae across the Northern Tier of South America. S.M. FORD.
5. Route choice in spider monkeys: A spatially explicit model using GIS. S.A. SUAREZ.
6. Dietary strategies and digestive efficiency of southern marmosets (*Brachyteles arachnoides*). M. TALEBI.
7. A multi-site comparison of dietary preferences and seed dispersal by spider monkeys (*Ateles* spp.). S.E. RUSSO, C.J. CAMPBELL, J.L. DEW, P.R. STEVENSON, M.M. SYMINGTON.
8. Terrestrial behavior of spider monkeys (*Ateles* spp.): A comparative study. C.J. CAMPBELL, F. AURELI, C.A. CHAPMAN, G. RAMOS-FERNANDEZ, K. MATTHEWS, S.E. RUSSO, S. SUAREZ, L. VICK.
9. Social and reproductive strategies of lowland woolly monkeys (*Lagothrix lagotricha*). A. DI FIORE.
10. Vocal communication at sleep trees by spider monkeys (*Ateles geoffroyi frontatus*). K.I. MATTHEWS, F. AURELI.

**Session 41. Hominid Evolution V: Archaeological and Taphonomic Issues of Hominid Sites.** Contributed Posters. *Cavetto*.

Chair: R. CIOCHON, University of Iowa.

8:00 – 8:30 am	Poster set-up.
8:30 – 10:00 am	Authors of even-numbered posters present for questions.
10:30 am – 12:00 pm	Authors of odd-numbered posters present for questions.
12:00 – 12:30 pm	Poster take-down.

1. Plio-Pleistocene mammalian migrations in the East Turkana Basin, Kenya: Testing the utility of stable strontium isotopes. R.L. QUINN, C.S. FEIBEL.
2. Possible ecological impact of tephra deposition in the Koobi Fora Formation, northern Kenya. C.J. CAMPISANO.
3. Taxonomic and feeding diversity in the Shungura Formation fauna (Ethiopia). C.M. HARADON.
4. Taphonomic analysis of one-million-year-old human hip bone (UA 173) from the Danakil (Afar) depression of Eritrea. I. FIORE, L. BONDIOLI, A. COPPA, H. KASHAY, R. MACCHIARELLI, L. ROOK.

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**Saturday Morning – April 26, 2003 (continued)**


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5. Deformations of the Steinheim cranium revealed by electronic preparation help reassess sex attribution, cranial volume, and circumorbital form. H.R. PROSSINGER, H. SEIDLER.
6. Preliminary report on the faunal remains and taphonomy of in situ and dumpsite breccia deposits from Gondolin, North West Province, South Africa. J.W. ADAMS, K.L. KUYKENDALL.
7. *Homo erectus* landscapes: Paleosols in the Bapang and Upper Sangiran Formations, Solo Basin, Central Java. R. CIOCHON, A. BETTIS III, R. LARICK, Y. ZAIM, SUMINTO, Y. RIZAL, M. REAGAN, M. HEIZLER.
8. ESR dating at Mezmaiskaya Cave, Russia. A.R. SKINNER, B.A.B. BLACKWELL, S.A. MARTIN, S. ABOUELLEIL, A. ORTEGA, J.I.B. BLICKSTEIN, L.V. GOLOVANOVA, V.B. DORONICHEV.
9. Semi-automatic assembling of skull fragments. J. KIM, A. NEUMAIER, G.W. WEBER.

**Session 42. Hominid Evolution VI: Pleistocene Evolution. Contributed Posters. *Campanile*.**

Chair: R.G. FRANCISCUS, University of Iowa.

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| 8:00 – 8:30 am      | Poster set-up.  |
| 8:30 – 10:00 am     | Authors of even-numbered posters present for questions. |
| 10:30 am – 12:00 pm | Authors of odd-numbered posters present for questions.  |
| 12:00 – 12:30 pm    | Poster take-down.                                       |

1. Primitive dento-gnathic morphology of Javanese *Homo erectus*. Y. KAIFU, H. BABA, F. AZIZ, F. SCHRENK, T. JACOB, E. INDRIATI, J. ARIF.
2. Frontal bone morphology and gene flow in Late Pleistocene Europe, Western Asia and Africa. R.E. CASE.
3. Limb proportions, climatic adaptations and Neandertals. W.L. MOORE.
4. The influence of dental wear on Neandertal mandibular morphology. K. HATTMAN, J.L. THOMPSON.
5. Correlated evolution in hominid midfacial morphology: Neandertals in a comparative context. J.A. BLUMENFELD, G.E. BLOMQUIST, M.M. KOWALEWSKI.
6. A new human skeleton from the Middle Palaeolithic Peristeri I Cave, Epirus, Greece. A. BARTSIOKAS.
7. Comparing internal nasal fossa dimensions and classical measures of the external nasal skeleton in recent humans: Inferences for respiratory airflow dynamics and climatic adaptation. R.G. FRANCISCUS.
8. Cranial morphology of European Upper Paleolithic hominins and other Pleistocene populations. P. CONSTANTINO.
9. Late Pleistocene postcranial skeletal remains from Tam Hang (Laos). L. SHACKELFORD.

**Session 43. Hominid Evolution VII: Miocene and Pliocene Evolution. Contributed Papers. *Palm ABC*.**

Chair: C.A. LOCKWOOD, Institute of Human Origins, Arizona State University.

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| 8:00 am | A comparison of <i>Kenyapithecus</i> and <i>Simiolus</i> from middle Miocene deposits at Fort Ternan and Maboko Island. B.R. BENEFIT.               |
| 8:15 am | New Miocene primate postcranial fossils from Rudabánya, Hungary. D.R. BEGUN, T.L. KIVELL, L. KORDOS.  |
| 8:30 am | Pliocene hominid postcranial evolution: Fossils from the Hata Beds, Middle Awash, Ethiopia. D. DEGUSTA.   |
| 8:45 am | Was <i>Australopithecus anamensis</i> ancestral to <i>A. afarensis</i> ? C.V. WARD, C.A. LOCKWOOD, W.H. KIMBEL, M.G. LEAKEY, D.C. JOHANSON, Y. RAK. |
| 9:00 am | How energetically efficient were early hominids? The effect of their relatively short hindlimbs. K.L. STEUDEL-NUMBERS, M.J. TILKENS.                |

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**Saturday Morning – April 26, 2003 (continued)**


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- 9:15 am Comparative energetics of human and primate locomotion. W.R. LEONARD, M.L. ROBERTSON.
- 9:30 am Can foramen magnum position be used to distinguish hominids from apes? J.C.M. AHERN, S. MCALLISTER.
- 9:45 am Running in human evolution. J.D. POLK, S. PSUTKA, S. COTE, D. LIEBERMAN.
- 10:00 am Break
- 10:15 am Hominoids, hindlimbs and Hox: Implications for hominid evolution. P.L. RENO, M.A. SERRAT, R.S. MEINDL, M.J. COHN, C.O. LOVEJOY.
- 10:30 am The lunate sulcus and early hominid brain evolution: Toward the end of a controversy. R.L. HOLLOWAY, D.C. BROADFIELD, M.S. YUAN, P.V. TOBIAS.
- 10:45 am A new brain volume for the Sts 60 specimen of *Australopithecus africanus* from Sterkfontein, S. Africa. M.S. YUAN, R.L. HOLLOWAY.
- 11:00 am Relative cerebellar proportions in humans and non-human primates. A.H. WEAVER, C.E. MACLEOD.
- 11:15 am A stable isotope and elemental study of South-African Plio-Pleistocene hominins. M. SPONHEIMER.
- 11:30 am Assessment of linear enamel hypoplasia (LEH) in early hominins. D. GUATELLI-STEINBERG.
- 11:45 am Testing models of human facial biomechanics with *in vivo* strain data on retracted versus protracted faces. F.W. YATES, D.E. LIEBERMAN.

**Session 44. 3D Approaches to Research in Physical Anthropology. Symposium. Palm DE.**  
 Organizers and Chairs: M.W. MARZKE, and M.W. TOCHERI, Arizona State University.

Three-dimensional approaches to research in physical anthropology have been rapidly accelerating, with new means for acquiring 3D anatomical data and with recent breakthroughs in quantitative 3D modeling and analysis. The symposium participants have been directly involved in exploring and developing several of these new approaches, and will discuss methodological issues encountered in their research as well as results of their analyses. The subjects they will address, which have become increasingly accessible to research with the development of these approaches, range from the quantitative analysis of variability in tooth and joint surface topography to investigations into cranial and mandibular microstructure.

- 8:00 am Aspects of virtual reconstruction in physical anthropology. C.P.E. ZOLLIKOFER, M.S. PONCE DE LEÓN.
- 8:15 am Three-dimensional analysis of elastic properties and microstructure in primate craniofacial bone. P.C. DECHOW.
- 8:30 am Sexual dimorphism in the hominid cranium: New data using 3D morphometrics. M. FRIESS.
- 8:45 am A 3D approach to the functional morphology of worn primate teeth. P.S. UNGAR, F. M'KIRERA.
- 9:00 am Finite element analysis applied to masticatory biomechanics. D.S. STRAIT, P.C. DECHOW, B.G. RICHMOND, C.F. ROSS, M.A. SPENCER.
- 9:15 am 3D approach to interpret enamel thickness and volume. D.G. GANTT, J. KAPPELMAN, R.A. KETCHAM, M.E. ALDER, T.S. DEAHL.
- 9:30 am Digital imaging of the pubic symphysis: A comparison of 2-D and 3-D approaches to assessing age-related changes. R. HOPPA, M. SITCHON.
- 9:45 am Break
- 10:00 am The structure of the tibia in bipeds. J. KAPPELMAN, M. MAGA, L. PYNE, T. RYAN.
- 10:15 am 3D morphometrics and the evolution of bipedality. W.E.H. HARCOURT-SMITH, P. O'HIGGINS, L.C. AIELLO.
- 10:30 am Three-dimensional analysis of the knee: Testing old assumptions with new techniques. W.D. SWEITZER.

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**Saturday Morning – April 26, 2003 (continued)**


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- 10:45 am 3D geometric morphometric analysis of hand joint surfaces and visualization of Neandertal thumb and index finger movements. W. NIEWOEHNER.
- 11:00 am Functional capabilities of modern and fossil hominid hands: A 3D comparative analysis of the trapezium. M.W. TOCHERI, M.W. MARZKE, D. LIU, M. BAE, G.P. JONES, R.C. WILLIAMS, A. RAZDAN.
- 11:15 am CAGD methods for physical anthropology. A. RAZDAN, G. FARIN.
- 11:30 am 3D visualization of inferred intermediates on a phylogenetic tree--applications in paleoanthropology. E. DELSON, D.P. REDDY, J.F. ROHLF, S.R. FROST, M. FRIESS, K.P. MCNULTY, K. BAAB, T. CAPELLINI, S.E. HAGELL.
- 11:45 am Discussion: B. WOOD.

**Session 45. Primate Evolution IV: Form and Function. Contributed Papers. Palm F.**

Chair: M.J. RAVOSA, Northwestern University Medical School.

- 8:00 am Anatomical correlates for suspensory behaviors in douc langurs. C.D. BYRON, H.H. COVERT.
- 8:15 am The bipedal locomotion of *Hylobates lar*: Preliminary results. E.E. VEREECKE, K. D'AOUT, S. VAN SINT JAN, P. AERTS.
- 8:30 am Limb compliance during walking: comparisons of elbow and knee yield across quadrupedal primates and in other mammals. E.P. LARNEY, S.G. LARSON.
- 8:45 am The functional significance of the primate fibula. B. DEMES, K. METZGER, S.G. LARSON.
- 9:00 am Evolution of anthropoid hands. N.J. DOMINY, P.W. LUCAS.
- 9:15 am Convergence of the "wishboning" jaw-muscle activity pattern in anthropoids and strepsirrhines: The recruitment and firing of jaw muscles in *Propithecus verreauxi*. W.L. HYLANDER, C.J. VINYARD, C.E. WALL, S.H. WILLIAMS, K.R. JOHNSON.
- 9:30 am Symphyseal fusion in anthropoids and ungulates: A case of functional convergence? S.H. WILLIAMS, C.J. VINYARD, C.E. WALL, W.L. HYLANDER.
- 9:45 am On the relationship between visual specialization and encephalization – a comparative analysis of relative optic foramen size. E.C. KIRK.
- 10:00 am Break
- 10:15 am Allometric and functional influences on orbit orientation in didelphid and phalangerid marsupials. A.M. DERBY, C.P. HEESY, C.F. ROSS.
- 10:30 am The ecology of mammalian orbit orientation. C.P. HEESY.
- 10:45 am A reassessment of variability in the hominoid postcranium: Issues of homology and homoplasy. N.M. YOUNG.
- 11:00 am Common components of growth in the postcranium of African apes. W.L. JUNGERS.
- 11:15 am Is the bonobo growth trajectory the ancestral one for the Hominoidea? P. MITTEROECKER, P. GUNZ, M. BERNHARD, K. SCHAEFER.
- 11:30 am Geometric morphometric analysis of palatal morphology in extant and fossil hominoids. K.P. MCNULTY.
- 11:45 am Patterns of surface shape in great ape endocasts. C.E. MACLEOD, D. FALK, H. MOHLBERG, K. ZILLES.

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**Saturday Morning – April 26, 2003 (continued)**


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**Session 46. Primate Behavior IV: Inter- and Intra-Specific Behavior.** Contributed Papers. *Abbey*.  
 Chair: P.A. GARBER, University of Illinois.

- 8:00 am Orangutan cultures and the comparative study of culture. C.P. VAN SCHAIK.
- 8:15 am A re-evaluation of human and macaque "imitation": Human children and rhesus macaques do not qualitatively differ in a copying task. F. SUBIAUL, J. CANTLON, H. LURIE, R. HOLLOWAY, H. TERRACE.
- 8:30 am Behavioral contrasts between Sykes' monkeys and vervet monkeys after adult male turnover. C.A. BRAMBLETT.
- 8:45 am Arboreality and infant behavioral development: New data from wild blue monkeys. S. FOERSTER, M. CORDS.
- 9:00 am Behavioral interactions between small juvenile and adult male white-faced capuchin monkeys (*Cebus capucinus*) in Costa Rica. K.C. MACKINNON.
- 9:15 am Sex differences in scent-marking in sifaka: Mating conflict or males services? R.J. LEWIS.
- 9:30 am The effect of ecology on aggressive interactions in White-faced capuchin monkeys, *Cebus capucinus*, in a Costa Rican dry forest. E.R. VOGEL.
- 9:45 am Break
- 10:00 am Aggression in *Hapalemur griseus griseus*: Evidence for female dominance? C. GRASSI.
- 10:15 am Social and spatial aspects of male subgrouping in a community of wild chimpanzees. J.C. MITANI, S.J. AMSLER.
- 10:30 am Female mate preference in chimpanzees of the Tai Forest, Côte d'Ivoire. R.M. STUMPF, C. BOESCH.
- 10:45 am Male dominance and reproductive success in white-faced capuchins (*Cebus capucinus*). K.M. JACK, L.M. FEDIGAN.
- 11:00 am Imaging the neural correlates of mate competition in dominant male rhesus monkeys. J.K. RILLING, C.D. KILTS.
- 11:15 am First line defense: Male dominance rank and aggression toward extra-troop males in a wild group of Formosan macaques (*Macaca cyclopis*). W.A. BIRKY.
- 11:30 am Male dominance rank and mating success in an extremely large chimpanzee community at Ngogo, Kibale National Park. D.P. WATTS.
- 11:45 am The role of male long calls in Sumatran orangutans. R.A. DELGADO.

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**Saturday Afternoon – April 26, 2003**


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**Session 47. Skeletal Biology V: Biomechanics.** Contributed Posters. *Xavier*.  
 Chair: C.F. ROSS, Stony Brook University.

- 1:00 – 1:30 pm Poster set-up.
- 1:30 – 3:00 pm Authors of even-numbered posters present for questions.
- 3:30 – 5:00 pm Authors of odd-numbered posters present for questions.
- 5:00 – 5:30 pm Poster take-down.

1. Limitations in the use of predominant collagen fiber orientation for inferring loading history in cortical bone. J.G. SKEDROS, B. DEMES, S. JUDEX.
2. The effects of epiphyseal shape on metacarpal diaphyseal proportions in hominoids: Implications for long bone growth. A.D. HOLDEN, C.V. WARD.
3. Effects of epiphysis shape on femoral diaphyseal proportions in hominoids. T.K. NALLEY, C.V. WARD.

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**Saturday Afternoon – April 26, 2003 (continued)**


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4. Developmental field fluctuation II: A potential basis for skeletal morphological variation. M.A. SERRAT, P.L. RENO, B.A. ROSENMAN, C.O. LOVEJOY.
5. Trabecular bone orientation in flexed versus extended postures in guinea fowl: A test of Wolff's Law. M.J. DEVLIN, H. PONTZER, D.E. LIEBERMAN, J.D. POLK.
6. Baby's first steps: The development of cortical bone in the human femur. M.M. MORAN.
7. Computer tomography and calculation of bone biomechanics in cross-sections of long bones. R. SAILER, V. SLADEK, M. BERNER.
8. Heterogeneous anisotropic elastic properties in a *Macaca fascicularis* mandible. A.J. RAPOFF, R.G. RINALDI, W.M. JOHNSON, S. VENKATARAMAN, D.J. DAEGLING.
9. Effects of structural heterogeneity and anisotropy on finite element model predictions for a mandible of *Macaca fascicularis*. D.J. DAEGLING, R. MARINESCU, S. VENKATARAMAN, A.J. RAPOFF.
10. Radiographic reconstruction of human long bone cross-sectional geometric properties: A test of two noninvasive techniques. M.C. O'NEILL, C.B. RUFF.
11. The effects of differential mechanical loading on articular surface area in miniature swine. J.H. PLOCHOCKI, J. ORGAN.
12. The biomechanics of warrior activity: Repetitive, strenuous unimanual activity and its role in skeletal adaptation. J.A. RHODES.
13. Mass matters: An evaluation of two body mass techniques in modern human populations. B.M. AUERBACH, C.B. RUFF.
14. Temporal relationship of EMG and muscle force in the anterior temporalis muscle and its utility for finite-element modeling. C.F. ROSS, B.A. PATEL.
15. Decomposing directional asymmetry for bilateral landmark data: Applications to the adult human face and body. F.L. BOOKSTEIN, K. SCHAEFER.

**Session 48. Skeletal Biology VI: Bone Chemistry and Morphology. Contributed Posters.**  
*Dolores.*

Chair: M.L. CARTER, University of Illinois.

1:00 – 1:30 pm	Poster set-up.
1:30 – 3:00 pm	Authors of even-numbered posters present for questions.
3:30 – 5:00 pm	Authors of odd-numbered posters present for questions.
5:00 – 5:30 pm	Poster take-down.

1. Age variation in isotopic and histological profiles in the Kulubnarti R-Group (1000 CE - 1550 CE) from Sudanese Nubia. E.A. QUINN, J. KINGSTON, G.J. ARMELAGOS, D.P. VAN GERVEN.
2. Diagenetic alterations in archeological human skeletal remains via light microscopy and their implications. F. NOVOTNY, M. TESCHLER-NICOLA, T. PROHASKA, C. LATKOCZY, G. STINGEDER.
3. The stable isotopic biogeochemistry of African rain-forest primates: Does bone chemistry record niche separation? M.L. CARTER.
4. The effects of alcohol abuse on the skeleton. S.J. KOHN.
5. Social and economic structures and health status of the early medieval population from Greater Moravia. P. VELEMÍNSKÝ, M. DOBISIKOVA, P. STRANSKA, P. TREFNY, J. LIKOVSKY.
6. Evidence of health among late prehistoric populations in the Hudson River valley, New York. L.M. ANDERSON.
7. Developmental instability and skeletal phenotypes in Down syndrome. C.A. HILL, R.H. REEVES, C.J. EPSTEIN, C.J. VALERI, E.S. LINDSAY, L.L. BAXTER, T. M. COLE, J.T. RICHTSMEIER.

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**Saturday Afternoon – April 26, 2003 (continued)**


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8. A comparison of cranial integration through development in four primate species. J.H. HUNT.
9. Geomorphometric study of artificially modified crania from coastal Ecuador. A.H. ROSS, D.H. UBELAKER.
10. Craniometric variation among medieval Croatian populations. D.V. KOPP.
11. Frontal grooves in African populations: A non-metrical trait analysis. L.E. COPES, R.L. HOLLOWAY, K. MOWBRAY.
12. Narial margin of the piriform aperture--epiphenomenon or forensic indicator? R.L. HALL, D.A. HALL.
13. Recent human mental foramen ontogeny: Its significance for craniofacial growth theory and phylogenetics of Pleistocene *Homo*. S. MOORE, G.D. RICHARDS, M. OLSON.
14. Frequency of posterior femoral neck facets in the Tipu Maya. K.M. HARTNETT.

**Session 49. Primate Biology V: Ontogeny, Hormones, and Life History. Contributed Posters. Colonnade.**

Chair: M.A. NORCONK, Kent State University.

1:00 – 1:30 pm	Poster set-up.
1:30 – 3:00 pm	Authors of even-numbered posters present for questions.
3:30 – 5:00 pm	Authors of odd-numbered posters present for questions.
5:00 – 5:30 pm	Poster take-down.

1. Anatomical growth and development in hamadryas baboons (*Papio hamadryas*) compared with the closely related vervet monkeys (*Cercopithecus aethiops*). D.R. BOLTER.
2. Can heterochrony explain patterns of craniofacial growth in three species of howler monkeys? A test using a multivariate tool. M.B. BLANCO, L.R. GODFREY.
3. Schultz's Rule and dental development in Malagasy lemurs: A cautionary tale. K.E. SAMONDS, L.R. GODFREY.
4. Implications of dental arch form on the maxillary sinus size in *Macaca nemestrina*. T. KOPPE, E. SCHMIDT, T.C. RAE, D.R. SWINDLER.
5. Growth and adipose tissue development in captive infant gorillas. A. BELLISARI.
6. Life history and folivory in primate species: The importance of juveniles. M.M. KOWALEWSKI, G.E. BLOMQUIST, S.R. LEIGH.
7. A phylogenetic approach to quantifying the relationship between age of first reproduction and maximum lifespan. G.E. BLOMQUIST, M.M. KOWALEWSKI, S.R. LEIGH.
8. Serotonergic influences on life history outcomes in free-ranging male primates. A. CLEVELAND, G.C. WESTERGAARD, B. HOOS, T.J. CHAVANNE, S.E. SHOAF, P.J. SNOY, S.J. SUOMI, J.D. HIGLEY.
9. Endocrine components of life history trade-offs in vervet monkeys (*Cercopithecus aethiops*). P.L. WHITTEN, T.R. TURNER.
10. Correlation of fecal testosterone levels with age in white-faced saki males (*Pithecia pithecia*). M.A. NORCONK, P.L. WHITTEN, K. VACCO.
11. Stimulation of the monkey HPA axis by SERMs: Elevated cortisol levels after SERM treatment. R.C. STAVISKY, J. NOWAK, M.R. ADAMS, J.R. KAPLAN.

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**Saturday Afternoon – April 26, 2003 (continued)**


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**Session 50. Primate Biology VI: Adaptation and Evolution.** Contributed Posters. *Cavetto*.

Chair: M. ZYLSTRA, Midwestern University.

1:00 – 1:30 pm	Poster set-up.
1:30 – 3:00 pm	Authors of even-numbered posters present for questions.
3:30 – 5:00 pm	Authors of odd-numbered posters present for questions.
5:00 – 5:30 pm	Poster take-down.

1. Primate bone microstructural variability: Relationships to mechanical and life history adaptation. J. WARSHAW, T.G. BROMAGE, C.J. TERRANOVA, F.S. SZALAY.
2. The effect of speed and gait changes on peak vertical forces in primates. J.B. HANNA, D. SCHMITT, P. LEMELIN.
3. A strategy for the reduction of mechanical internal work in primates. D.A. RAICHLEN.
4. Variation in morphology and musculoskeletal stress marker expression of the first dorsal interosseus muscle in catarrhines. M.C. JACOFISKY.
5. Forelimb forces during gouging and other behaviors on vertical substrates in common marmosets. P.E. HOURANI, C.J. VINYARD, P. LEMELIN.
6. Fruits, fingers, and form: Functional significance of Meissner's corpuscles. J.N. HOFFMANN.
7. Bending strength of primate metacarpals measured using computed tomography. M. ZYLSTRA.
8. The phylogenetic co-variation of anthropoid colour signaling. K.A. LARKIN.
9. Variations in stable isotope composition in *Propithecus diadema edwardsi* from disturbed and undisturbed rainforest habitats in Ranomafana National Park, Madagascar. E.M. MCGEE, S.E. VAUGHN.
10. Using LINE-1 insertions to distinguish between closely related hominoid species. K.L. SMITH, L.M. MATHEWS, S.Y. CHI, N. GREENBERG, I. OVCHINNIKOV, G.D. SWERGOLD.
11. Conservation biology of Kloss's gibbons (*Hylobates klossii*). D.J. WHITTAKER, J.C. MORALES, D.J. MELNICK.

**Session 51. Primate Biology VII: Brains/Allometry.** Contributed Posters. *Campanile*.

Chair: P.T. SCHOENEMANN, University of Pennsylvania.

1:00 – 1:30 pm	Poster set-up.
1:30 – 3:00 pm	Authors of even-numbered posters present for questions.
3:30 – 5:00 pm	Authors of odd-numbered posters present for questions.
5:00 – 5:30 pm	Poster take-down.

1. Co-evolution of communication and the brain in primates: New evidence from the brainstem and motor cortex. C.C. SHERWOOD, R.L. HOLLOWAY, A. SCHLEICHER, K. ZILLES, J.M. ERWIN, P.J. GANNON, P.R. HOF.
2. Evolution in the human primary visual cortex: Modifications of layer 4A. J.C. REDMOND, S. BARTONE, T.M. PREUSS.
3. Evolution of the prefrontal cortex: A stereological analysis of primate brain MRI scans. P.T. SCHOENEMANN, L.D. GLOTZER.
4. Allometry of the primate external ear. W.L. GUGLIOTTA, N. DOMINY.
5. Scaling effects on mental foramen position in *Gorilla gorilla*. C.A. ROBINSON, F.L. WILLIAMS.
6. Scaling of muscle mass in primates. M.N. MUCHLINSKI, J.J. SNODGRASS, C.J. TERRANOVA.
7. Does size really matter? Investigations of moment arms in the fifth ray of catarrhines. S.P. REECE.

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**Saturday Afternoon – April 26, 2003 (continued)**


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8. Allometry in the skulls of *Papio* subspecies: Alternative visualization techniques. D.P. REDDY, J. KIM, S. FROST, F. BOOKSTEIN, E. DELSON.
9. Size matters – does body mass? A.D. GORDON.

**Session 52. Hominid Evolution VIII: Early Hominid Evolution. Contributed Papers. Palm ABC.**  
 Chair: B. WOOD, George Washington University.

- 1:00 pm Modeling juvenile robust australopithecine faces. G.E. KROVITZ, R.R. ACKERMANN.
- 1:15 pm Correlation of prognathism in fossil hominin skulls. F. SPOOR, T. WRIGHT, M.G. LEAKEY.
- 1:30 pm A new hominin skull from Hadar: Implications for cranial sexual dimorphism in *Australopithecus afarensis*. W.H. KIMBEL, Y. RAK, D.C. JOHANSON.
- 1:45 pm A new hominin calvaria from Ileret (Kenya). M.G. LEAKEY, F. SPOOR, F.H. BROWN, P.N. GATHOGO, L.N. LEAKEY.
- 2:00 pm Material and structural properties of human and African ape cortical and cancellous bone: implications for the evolution of bipedality. C.A. KUNOS, B. LATIMER.
- 2:15 pm The effects of fetal load on bipedal kinematics and the evolution of lumbopelvic sexual dimorphism. K.K. WHITCOME.
- 2:30 pm Kinematics of vertical climbing in hominoids: Which type is more preadaptive for bipedalism? K. ISLER.
- 2:45 pm Break
- 3:00 pm Basicranial flexion and cranial vault architecture: Variation and structural relationships. P.Z. HUGHES.
- 3:15 pm Conditional independence modeling of neurocranial, facial, and masticatory integration in *Pan*, *Gorilla* and recent *Homo*. J.M. POLANSKI, R.G. FRANCISCUS.
- 3:30 pm Morphological integration in hominoids: A tool for understanding human evolution. R.R. ACKERMANN.
- 3:45 pm Body size estimation using cranial predictors in large-brained hominids. P.R. STUBBLEFIELD.
- 4:00 pm A new technique for reconstructing the vocal anatomy of fossil humans. S.F. MILLER, T.R. YOKLEY, S.E. CHURCHILL, R.G. FRANCISCUS, J-J. HUBLIN, K.L. EAVES-JOHNSON.
- 4:15 pm Taxonomic affinities of early *Homo* specimens from Sterkfontein and Swartkrans: Evidence from permanent molar cusp proportions. F.E. GRINE, C.P. HEESY, E. SMITH, H. SMITH.
- 4:30 pm Comparisons of variance-covariance (VCV) structure of the humero-ulnar joint in humans, apes and monkeys. P.S. VINYARD, C.J. VINYARD.
- 4:45 pm Magnetostratigraphy of the South African hominid palaeocaves. A.I.R. HERRIES.

**Session 53. Human Biology III: Reproduction/Demography/Variation. Contributed Papers. Palm DE.**

Chair: A.R. FRISANCHO, University of Michigan.

- 1:00 pm To breed or not to breed: Flexible responsiveness of the human female reproductive system to environmental signals. V.J. VITZTHUM, H. SPIELVOGEL.
- 1:15 pm Female attractiveness - Physical appearance as shape. K. SCHAEFER, P. MITTEROECKER, P. GUNZ, F.L. BOOKSTEIN, K. GRAMMER.
- 1:30 pm Prenatal influences on leptin levels in adolescent Filipinos. C.W. KUZAWA, L.S. ADAIR.

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**Saturday Afternoon – April 26, 2003 (continued)**


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- 1:45 pm Fueling infant growth: A longitudinal study of body composition and length. A. THOMPSON, L. HARRIS, M. LAMPL.
- 2:00 pm Effects of aging on normal adult brains. K. ALDRIDGE.
- 2:15 pm An original, empirically grounded evolutionary model of age at first birth in human females. N.R. ALLAL, R. SEAR, R. MACE.
- 2:30 pm Sedentarization and maternal body composition: Comparative longitudinal analysis of anthropometric dimensions of nomadic and settled mothers in Ariaal-Rendille of northern Kenya. M. FUJITA, M. NATHAN, E.M. FRATKIN, E.A. ROTH.
- 2:45 pm The age of plague: A palaeodemographic study of a catastrophic death assemblage. R.L. GOWLAND, A.T. CHAMBERLAIN.
- 3:00 pm Break
- 3:15 pm Population growth and decline in a multiagent model of the Prehistoric Anasazi of Long House Valley, Arizona. A.C. SWEDLUND, G.J. GUMERMAN, J.S. DEAN, J.M. EPSTEIN.
- 3:30 pm Neighbours or sisters? Testing models of cultural transmission in the Pacific using phylogenetic methods. F.M. JORDAN, R. MACE.
- 3:45 pm Multivariate analysis of intrapopulation variation in the Windover site. D.L. FREID, R.L. JANTZ.
- 4:00 pm Can differential mortality be inferred from post-cranial variability? A test from Medieval Scandinavia. C.S. SPARKS.
- 4:15 pm A multivariate apportionment of global diversity in contemporary humans based on craniometric traits. C.C. ROSEMAN, T.D. WEAVER.
- 4:30 pm Human genetic polymorphisms of hepatic enzymes: Physiological evidence of human dietary patterns and exposure to psychoactive substances in prehistory. R. SULLIVAN.
- 4:45 pm Inventorying through the lens: Anthropometric photography and racial categorization before 1945. K. MATIASEK, M. TESCHLER-NICOLA.

**Session 54. Ecology and Primate Zoonoses: Evolutionary, Environmental and Cultural Factors Associated with Emerging Infectious Diseases, Cross-Species Transmission, and Nonhuman Primate Conservation.** Symposium. *Palm F.*

Organizers and Chairs: R.A. NISBETT, Texas Tech University, and J. WALLIS, University of Oklahoma Health Sciences Center.

The primary purpose of this symposium is to provide an interactive forum for those scientists working at the interface of primate zoonoses and primate conservation biology. The key objectives are: (1) to facilitate multidisciplinary collaborations; and (2) to enhance interest among physical anthropologists in this emerging interdisciplinary field of study. The papers examine synecological and cultural aspects of cross-species pathogen transmission among primates as they relate to emerging infectious diseases in humans and conservation of nonhuman primate populations. In the first part, the evolutionary and ecological contexts of primate zoonoses will be reviewed. Then, data from field studies will explore the potential and empirical evidence for cross-species transmissions and the utility of such studies.

- 1:00 pm Introduction: M. CLARKE.
- 1:15 pm A review of zoonoses transmissible among primates. J.R. CARTER.
- 1:30 pm Community ecology and nonhuman primate macroparasitology. M.D. STUART.
- 1:45 pm Primate exploitation and bushmeat marketing in Liberia, West Africa. R.A. HOYT, J.M. FRAYNE.

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**Saturday Afternoon – April 26, 2003 (continued)**


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- 2:00 pm Medical survey of the local human population to determine possible health risks to the mountain gorillas (*Gorilla gorilla beringei*) of Bwindi Impenetrable Forest National Park, Uganda. J.M. SLEEMAN, W. GUERRERA, J.B. SSEBIDE, L.B. PACE, T.Y. ICHINOSE, J.S. REIF.
- 2:15 pm Human social issues, disease, and sympatric apes in the Central African Republic. A.A. LILLY.
- 2:30 pm The role of bio-cultural factors in assessing bi-directional pathogen transmission between human and non-human primates. A. FUENTES.
- 2:45 pm Break
- 3:00 pm Familiarity breeds disease: Human-macaque pathogen transmission in Asia. L.E. JONES-ENGEL, G.A. ENGEL, M.A. SCHILLACI, A. ROMPIS, A. PUTRA, U. PAPUTUNGAN, A. WILBUR, J. ALLAN, R. GRANT, R.C. KYES.
- 3:15 pm Arbovirus surveillance in free-ranging howling monkeys, with a case study of the seroepidemiology of vesicular stomatitis virus. R.A. NISBETT.
- 3:30 pm Primate conservation and human to nonhuman primate disease transmission. J. WALLIS.
- 3:45 pm Discussion: J. WALLIS.

**Session 55. Life History, Reproductive Strategies, and Fitness in Baboons. Symposium.**  
*Abbey.*

Organizers and Chairs: L. SWEDELL, Queens College, CUNY, and S. LEIGH, University of Illinois.

Baboons of the genus *Papio* are widespread throughout Africa, inhabit a diverse array of environments, and are well-known for their ecological flexibility. Savanna-dwelling baboons in particular have often been used as models for evolution and adaptation in early hominids. The goal of this symposium is to bring together recent research on morphology, behavior, ecology, and endocrinology of *Papio* baboons in order to investigate the life history traits and reproductive strategies that have made baboons so successful. Presentations will include a range of topics—reproduction, life history, growth, parenting, ecology, mating success, and reproductive strategies—with the ultimate goal of shedding light on the various components of reproductive success and fitness in both captive and wild populations of baboons.

- 1:00 pm Fisher's Fundamental Theorem and the maintenance of genetic variation in fitness components. K.A. HUGHES.
- 1:15 pm Integration among hormonal parameters of growth in baboons: Implications for patterns of maturation and reproduction. R.M. BERNSTEIN, S.R. LEIGH, S.M. DONOVAN, M.H. MONACO.
- 1:30 pm Baboon endogenous virus (BaEV) variation in natural anubis, hamadryas, and hybrid baboon populations. M. UDDIN.
- 1:45 pm Growth and life history in chacma baboons. S.E. JOHNSON.
- 2:00 pm Ontogeny, life history, and maternal reproductive strategies in baboons. S.R. LEIGH, R.M. BERNSTEIN.
- 2:15 pm Whose life is it anyway? Maternal investment and life history strategies in baboons. J.E. LYCETT, L. BARRETT.
- 2:30 pm Testicular size, developmental trajectories and male life history strategies in four baboon taxa. C.J. JOLLY, J.E. PHILLIPS-CONROY.
- 2:45 pm Survival and reproduction in chacma baboons. R.M. SEYFARTH, T. BERGMAN, D.L. CHENEY, J. BEEHNER.
- 3:00 pm Break
- 3:15 pm Social and ecological flexibility in guinea baboons as an adaptation to unpredictable habitats. A. GALAT-LUONG, G. GALAT.
- 3:30 pm Female reproductive strategies in a baboon hybrid zone, Awash National Park, Ethiopia. J. BEEHNER, T. BERGMAN.

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**Saturday Afternoon – April 26, 2003 (continued)**

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- 3:45 pm Female reproductive strategies in hamadryas baboons: Paternity certainty, infanticide avoidance, and copulation calls. L. SWEDELL, J. SAUNDERS.
- 4:00 pm 'Friendship' behavior as a reproductive strategy in savanna baboons: Intraspecific variation. R.A. PALOMBIT.
- 4:15 pm Infanticide and the evolution of baboon sociality. L. BARRETT, P. HENZI.
- 4:30 pm Discussion: C.J. JOLLY.

## Abstracts of AAPA Poster and Podium Presentations

### Human skeletal trauma patterns in a contemporary sample from Athens, Greece: Results from a pilot study.

S.M. Abel<sup>1</sup>, A.B. Falsetti<sup>1</sup>, A. Lagia<sup>2</sup>, S.K. Manolis<sup>2</sup>, <sup>1</sup>C.A. Pound Human Identification Laboratory, University of Florida, <sup>2</sup>Department of Animal and Human Physiology, University of Athens.

This report provides preliminary trauma analysis results of a contemporary Greek skeletal sample (n=31 of 200+). The remains originate from a cemetery collection curated at the University of Athens, Greece. There are 19 males and 12 females in the sample with an average age at death of 51.1 years. Of the 31 individuals, 27 exhibit some type of antemortem or perimortem trauma, with many displaying pathological fractures. Antemortem trauma is seen in 17 males and 10 females. Chi-square tests for independence between sex, age and postcranial injury site are not significant at the 0.05 level. Antemortem craniofacial trauma, however, is found on 5 individuals, all of whom are male. Perimortem injuries are observed on 6 individuals, many of which may actually have post-mortem modifications occurring soon after death.

Despite the age bias in the collection, there are relatively few cumulative antemortem injuries outside age-related trauma in the vertebrae. Surprisingly, no hip fractures due to osteoporosis are seen. Colles' fractures of the radius are noted in only 2 elderly females. Preliminarily, these findings suggest that individuals in the Athens cemetery receive few skeletal injuries during life and very little injuries associated with the circumstances of death. Craniofacial trauma is seen only in males, however, suggesting that some type of intra-male aggressive activity is perhaps taking place. Continued examination will test for the influence of demographic (i.e., sex, age, place of birth, health, cause of death, nationality and occupation) and environmental (geographic features of rural versus urban landscape) variables on skeletal trauma.

### Morphological integration in hominoids: A tool for understanding human evolution.

R.R. Ackermann. Dept. of Archaeology, University of Cape Town.

Morphological integration plays an important role in directing evolutionary change, as the relationships among integrated morphological elements constrain or facilitate the evolution of complex phenotypes. Because much of our understanding of evolutionary morphological change comes from the end products of evolution, we can assess the role of integration in evolutionary change through empirical approaches that interpret patterns of extant covariation in the context of phylogenetic relationships. By exploring the evolution of morphological integration in apes and humans we may be able to learn about developmental and evolutionary divergence in our hominid ancestors.

Here I present an analysis of morphological integration within African ape and human crania. The results indicate a high degree of connectivity among those skeletal elements associated most closely with mastication, and suggest that a consistent pattern of total morphological integration within the cranium may exist more broadly among great apes and humans. Overall, the degree of integration in the oral region also follows the pattern displayed by the rest of the anthropoid primates, and supports other research indicating a general pattern of morphological integration in primates. However, the results also point to some differences within this ape/human group, which could have interesting phylogenetic implications; the humans and gorillas exhibit high levels of zygomatic integration, unlike the rest of the anthropoid primates. This may reflect evolutionary change at two points in hominoid evolution, potentially linked to functional and developmental change. Such possibilities, and particularly their implications for understanding the fossil record of human evolution, require further exploration.

### Infants' enamel growth disruptions and the quantity & quality of mothers' perinatal diets in Solis, Mexico.

A.G. Acosta<sup>1</sup>, A.H. Goodman<sup>1</sup>, J.R. Backstrand<sup>2</sup>, A.E. Dolphin<sup>3</sup>. <sup>1</sup>Hampshire College, <sup>2</sup>University of Medicine and Dentistry of New Jersey, <sup>3</sup>University of Massachusetts.

A key debate in international nutrition concerns the relative importance of dietary *quantity* vs. *quality*. After decades of focusing on dietary quantity, the pendulum shifted to dietary quality in the

1990s, in part because Allen and colleagues (1992) found that childhood growth in Solis, Mexico was unaffected by energy, but was strongly affected by dietary quality. The purpose of this study is to evaluate the importance of quality and quantity in the diets of pregnant and lactating Solis women. We report on the relationship between these diets and histologically observed Wilson bands in their infants' teeth.

Using previously collected data on pregnant and lactating women's diets, we analyzed the differences between women whose children do or do not display prenatal and/or postnatal Wilson bands (total n=44). Mothers of infants with prenatally formed Wilson bands (20%) consumed a qualitatively poorer diet during pregnancy, including significantly less iron, calcium and total fat, as well as a daily average of 433 kcals less than other pregnant women. Similarly, mothers of infants with postnatally formed Wilson bands (47%) consumed a qualitatively poorer diet during lactation, including significantly less total fat, total protein and available zinc, as well as a daily average of 379 kcals less than other lactating women. These results suggest that (a) Wilson bands are sensitive to both dietary quantity and quality and that (b) dietary quantity may have been overlooked because of a previous focus on children rather than pregnant and lactating women with high-energy needs.

### Long term consequences of early child growth restriction in the context of the nutrition transition in developing countries.

L.S. Adair. Dept. of Nutrition, University of North Carolina at Chapel Hill.

Altered fetal organ structure and function in response to poor nutrition may predispose individuals to chronic disease in later life by altering susceptibility to factors such as atherogenic diets, excess energy intake and reduced physical activity, which are becoming more commonplace in developing countries. This paper assesses how size at birth and postnatal growth interact to affect risk of developing elevated blood pressure (BP) among 14-16 yr old Filipinos (n=2,026). Data are from the Cebu Longitudinal Health and Nutrition Survey, which enrolled women during pregnancy, then followed children, regularly collecting anthropometry, diet, physical activity and socioeconomic data.

High BP was defined as the top 10% of residuals from sex-specific regressions of systolic and diastolic BP on age and height.

Controlling for birth length, current BMI, age, and height, the odds of high BP in males significantly declined with each kg increase in birth weight, and were highest odds among males who were relatively thin at birth, but relatively heavy as adolescents. Thinness at birth significantly interacted with growth rate after age 8, such that high rate of weight gain increased risk only among boys who were in the lower two-thirds of the BMI distribution at birth. There were small or no effects of early growth in girls. The synergistic effect of rapid weight gain from late childhood into adolescence with thinness at birth is further evidence of fetal programming of blood pressure in males, and suggests long term health risks associated with rapid growth, even in the absence of obesity.

**Preliminary report on the faunal remains and taphonomy of *in situ* and dumpsite breccia deposits from Gondolin, North West Province, South Africa.**

J.W. Adams<sup>1</sup>, K.L. Kuykendall<sup>2</sup>. <sup>1</sup>Dept. of Anthropology, Washington University, <sup>2</sup>Dept. of Anatomical Sciences, University of the Witwatersrand.

The Plio-Pleistocene cave site Gondolin, located 35 km northwest of Pretoria, yielded abundant faunal remains from *in situ* breccias excavated in 1979. This sampled assemblage, which lacks identified primate remains, has only been briefly described in the literature, and faunal and taphonomic analysis has been limited. Further work at Gondolin in 1997 produced two isolated hominid teeth from a test trench dug into a breccia dumpsite. The first tooth, GA 1, is a non-'robust' left M<sub>1</sub> or M<sub>2</sub>. The other, GA 2, is the left M<sub>2</sub> of a 'hyper-robust' hominid whose dimensions far exceed those of any other *Australopithecus robustus* specimen currently identified. This paper first presents a preliminary report on the faunal representation and taphonomic interpretation of the 1979 *in situ* assemblage. Analysis of fossil fracture patterns, weathering, damage, and taxon and element representation reveal a complicated taphonomic history for these *in situ* deposits. Comparison with other South African faunal assemblages reveals differences in faunal representation. We also present the first listing of faunal remains and analysis of specimens excavated from the hominid-bearing dumpsite test

trench. The dumpsite-derived faunal assemblage, while exhibiting some similarities in element and taxon representation with the 1979 *in situ* assemblage, clearly incorporates fauna not found in the previously sampled *in situ* deposits from Gondolin. In addition, as a mixed, tertiary deposit, the dumpsite material analyzed here may serve as a model for understanding the taphonomy of time-averaged or resorted *in situ* assemblages at other South African cave sites.

**Dental anthropology in Scotland: Medieval relationships between Whithorn, St. Andrews and the Carmelite friaries.**

A.J. Adler<sup>1</sup>, Marie Watt<sup>2</sup>, C.G. Turner II<sup>1</sup>. <sup>1</sup>Dept. Of Anthropology, Arizona State University, Tempe AZ 85287. <sup>2</sup>Oral Sciences, Glasgow Dental School, University of Glasgow.

This study is a dental anthropological analysis of samples from at least three distinct regions of Scotland. Throughout the centuries Scotland has been invaded by a series of groups. The Picts, the Britons, the Romans, the Irish, the Anglo-Saxons and the Vikings all had an impact on the population structure and culture of Scotland. As a result, the question of genetic variation within different regions of Scotland is an interesting one. This study was performed in order to see if it is possible to address this question by examining physical remains.

To do this, a large sample of medieval individuals was examined. The largest sample came from Whithorn in Southwest Scotland. Whithorn is an important site as it is where Christianity was first introduced into the region. For comparison, samples from St. Andrews and the Carmelite friaries (Aberdeen, Linlithgow and Perth) were also examined.

To determine if genetic differences exist among these groups, the Arizona State University Dental Anthropology System (ASUDAS) was utilized. Some differences in trait frequencies were found between groups. In particular, there appeared to be greater variability between Northern and Southern Scotland than between Eastern and Western Scotland. The trait that exhibited the highest amount of difference was mandibular torus which was significantly higher in the Northern groups than the Southern groups. Frequency distribution suggests that this could be a Pictish trait.

**The examination of age and sex-related changes in trabecular archi-**

**ture in archaeological skeletons with pQCT.**

S.C. Agarwal<sup>1</sup>, J-P. Devogelaer<sup>2</sup>, W. White<sup>3</sup>, M.D. Grynepas<sup>4</sup>, X. Banse<sup>2</sup>. <sup>1</sup>Dept. of Anthropology, McMaster University, Hamilton, <sup>2</sup>Université Catholique de Louvain, Brussels, <sup>3</sup>Museum of London, <sup>4</sup>Dept. of Laboratory Medicine and Pathobiology, University of Toronto and the SLRI of Mount Sinai Hospital, Toronto.

Osteoporosis is a systemic skeletal disease that is a growing health concern in aging Western populations. Historical skeletal populations provide a unique model with which to study bone loss and fragility, offering an opportunity to examine bone maintenance in groups whose lifestyles were often very different from that of today. In order to non-invasively examine age and sex-related changes in bone quality in an archaeological sample, a study was made of vertebral trabecular architecture with the use of peripheral quantitative computed tomography (pQCT). Lumbar vertebrae from a total of 73 individuals (m=32, f=41), divided into 3 age categories (17-25, 26-45, 46+ yrs.) from two urban British medieval skeletal samples, were scanned using a pQCT Research SA+ Scanner (Stratec, Pforzheim, Germany). A mid-coronal section was taken from each vertebral body with a slice thickness of 150µm, effective pixel size of 84 x 84 µm, and scan time of approximately 8 min./slice. pQCT images were exported and converted into TIFF files and analyzed in a Qwin Pro (Leica) image system to evaluate classical trabecular morphological parameters. While both sexes showed age-related change of trabecular structure, only females demonstrated a significant decrease in trabecular bone volume (BV/TV), trabecular number (Tb.N), and a significant increase in trabecular separation (Tb.Sp) between the oldest and two younger age groups. A significant sex difference in trabecular structure is also seen in the oldest age group. The findings are similar to those suggested by modern patterns of trabecular bone loss, but differ from those observed in a previous study of a rural British medieval population. This suggests that differing "lifestyle" factors may play an important role in female bone maintenance, and highlights the need for further examination of trabecular bone quality in past populations. The study also demonstrates that pQCT is a rapid and effective method for the examination of trabecular architecture in archaeological bone.

### Can foramen magnum position be used to distinguish hominids and apes?

J.C.M. Ahern, S.L. McAllister. Dept. of Anthropology, University of Wyoming, Laramie.

The anteroposterior position of the foramen magnum distinguishes living *Homo sapiens* from apes. Humans exhibit foramina magna that are far anterior on the cranial base, while the great apes exhibit foramina magna that are more posterior. Foramen magnum position has been used as evidence for the hominid-status of numerable fossils in the history of human paleontology. Recently, foramen magnum position has been cited as evidence of the hominid status of *Sahelanthropus tchadensis* (Brunet et al. 2002). Specifically, the basion of *Sahelanthropus* is reported to both touch the biporion chord and intersect the bicarotid chord (Brunet et al. 2002).

We tested the hypothesis that the position of basion relative to the biporion and bicarotid chords can distinguish early hominids from *Pan troglodytes*. We measured the distances from basion to the biporion chord and from basion to the bicarotid chord on scaled, standardized digital images of a large sample of chimpanzee crania (N = 112) and a sample of Plio-Pleistocene hominid fossils (N = 4). The basion – bicarotid chord effectively distinguished the hominids from *Pan*. Half of the hominid fossils were also effectively distinguished from the *Pan* sample by the basion – biporion chord, however the other half fell well within the *Pan* sample for this chord. Our results indicate that the relative position of basion to the bicarotid chord can be used to distinguish hominids from *Pan troglodytes*, while the relative position of basion to the biporion chord cannot.

### Genetic etiology of autism endophenotypes.

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Autism is a neurodevelopmental disorder, with complex genetic etiology, characterized by deficits in language and social skills, and repetitive behaviors. Despite the strong genetic risk for autism, heterogeneity and variable expression of the disorder have limited efforts to localize susceptibility genes. Our approach has been to identify heritable components of this complex disorder and use these to find autism loci. Thus, rather than inves-

tigate autism based on psychiatric diagnosis, we focused our search on its underlying cognitive components or endophenotypes. We performed a nonparametric quantitative linkage analysis of language deficits and repetitive behaviors measured by items from the Autism Diagnostic Interview. Initially, we presented evidence of linkage for 'age at first word' to a 10 cM region on chromosome 7q35-36 in data from 152 families from the Autism Genetic Resource Exchange (AGRE; Alarcón et al., 2002). To confirm this result, we performed another multipoint analysis in an independent sample of 114 AGRE families. We included these new families and 9 additional markers in the linkage analyses and results support the original finding: a 5 cM region between D7S676 and D7S2511 was linked to 'age at first word' (Z = 2.9, p < 0.002). Although the second sample was small, preliminary results from the new families continue to support linkage in the 7q35 region for 'age at first word' (p < 0.05). Thus, there may be a locus specific for language deficits associated with autism on chromosome 7q. Results from an analysis of the most recent sample will be presented.

### Effects of aging on normal adult brains.

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The effects of aging on the human brain are not well understood. The aim of this study is to assess phenotypic effects of increasing age on the brain, and to determine whether these effects differ by gender. The study sample consists of in vivo magnetic resonance images (MRIs) of 109 healthy humans. Three-dimensional landmarks defined on surface and subcortical structures of the brain were located on 3-D MRI reconstructions for each individual. Data were scaled for differences in size and analyzed using Euclidean Distance Matrix Analysis (EDMA). Individuals were separated into three groups on the basis of age: 19-50, 51-70, and 71-99 years. Males and females were analyzed separately. Pairwise comparisons of each age group were performed. Patterns of differences observed between age groups for each sex were compared across males and females to determine whether the pattern of aging in the brain is similar for the two sexes.

Results show that there are obvious age-related changes in the human brain. The majority of changes occur early in

males, while females undergo more gradual changes over all age groups, indicating differences in timing of phenotypic change. Many of these changes are similar in males and females, suggesting a common pattern of aging among humans. However, gender-specific patterns of change are also evident. Thus, although there is an overall pattern of neural aging common among humans, specific aspects of the pattern and timing of change differ between males and females.

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### Hominid environments and faunal change in the lower Omo valley, Ethiopia: A comparison of the French and American databases.

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The lower Omo valley in southwestern Ethiopia provides crucial evidence on the evolutionary paleoecology of Plio-Pleistocene mammals, including hominids. The Omo sample is made up of nearly 50,000 vertebrate fossils collected by two teams of researchers -- the French and American contingents of the International Omo Research Expedition. The French and American collections constitute two independently derived samples that can be compared for taphonomic and collection biases in relation to patterns of faunal change and hominid paleoecology. Comparison of the two samples reveals interesting differences and similarities. In both collections, taxa indicative of open environments vary in concert and become more common through time. The earlier part of the sequence is characterized by a high abundance of suids whereas bovids dominate the latter part of the sequence, beginning at about 2.3 Ma. In general the same taxa are encountered from the bottom to the top of the sequence in both collections. The two collections do differ in the geographic distribution of some taxa, especially during the best-documented intervals (lower Member G units G4 to G13). Grazing bovids and *Kobus sigmoidalis* are more common in the northern exposures (collected primarily by the American team), while *Menelikia* and *Kobus ancystrocerus* are more common in the southern areas (collected primarily by the French team). The higher abundance of *Menelikia* in the southern areas implies that a wetter, more closed environment existed in the lower parts of the Omo drainage just as an expanding lake was

beginning to dominate the paleo-landscape at about 2 Ma.

**Are Harris lines an indicator of stress? A comparison between Harris lines and enamel hypoplasia.**

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Harris lines (HL) and enamel hypoplasia (EH) are two non-specific indicators of stress commonly used in the reconstruction of past and present populations' health status. The aim of this study was to determine the existence of a correlation between these two markers. This correlation was analyzed in terms of both its presence/absence and as well as the age of the individuals at the time of HL and EH formation. To achieve this aim, data from a sample of 136 individuals from two archaeological sites (AZ-71 and AZ-140) from northern Chile were analyzed. The results show that HL and EH are not correlated in terms of presence/absence. In addition, the ages of the individual at the time of HL and EH formation follow a completely different distribution. Moreover, when compared year by year in individuals that presented HL and EH formed during the first seven years of life, only 25% of the HL matched with EH. Thus, there is no correlation between these two indicators at any level. Instead, the distribution of HL, by age of the individual at the time of their formation, shows that HL are associated with periods of accelerated growth and not necessarily with stressful conditions. Thus, the results of this study have important implications for the field of Physical Anthropology and clinical studies; if HL are not an indicator of stress, future studies should not use HL as a proxy for health status.

**An original, empirically grounded evolutionary model of age at first birth in human females.**

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We present a new evolutionary model of age at first birth in human females, a key component of each individual's life history and Darwinian fitness. The cornerstone of the model is a trade-off between maturing earlier at a shorter height, or later, at a taller height. The model's novelty is our

focus on height rather than weight, and the benefit from height in terms of offspring survival rather than female fertility. Empirical analysis shows us that earlier maturers have a longer reproductive span and later maturers enjoy improved offspring survival. When fitted to parameters from a rural Gambian population, the model successfully predicts the median, 18 years, and the reaction norm for this population. Variation in model parameters, including growth rates, interbirth intervals, offspring mortality, or age at last birth, and their implications for optimal age at first birth are discussed. This model will be contrasted with previous models of optimal age at first birth in humans.

**The aging brain: An MRI-volumetric analysis of variation by sex and age in the gray-white composition of the major lobes of the human cerebrum.**

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Like all parts of the body, the human brain shows the effects of age. Autopsy and *in vivo* neuroimaging studies have shown that aging affects different parts and tissues of the brain at different rates, and that there may be sexual dimorphism in the rates of brain aging. We report on a study of age effects on the gray-white volumes of the major lobes and gyri of the human cerebrum. Regions of interest were defined by identifying neuro-anatomical surface landmarks on 3D reconstructions of T1-weighted contiguous coronal sections through the whole brain (1.5-1.6mm slices, 110-120 per brain). The following regions were manually traced in each hemisphere: frontal, temporal, parietal, and occipital lobes; cingulate gyrus; insula (see Allen et al. 2002, *AJPA* 118:341-358). Subjects included 44 women (23-74 years) and 43 men (22-88 years). All were right-handed, healthy, and without neurological or psychiatric disease.

As expected, the cerebral hemispheres decrease in size with age, with the white matter decreasing at a faster rate than the gray matter. The cerebrum atrophies more quickly in men compared to women: older women had about 5% less GM and 8% less WM than younger women; older men had about 8% less GM and 15% less WM than younger men. There is also variation by anatomical region in the loss of tissue with age.

These results have implications for understanding the aging process in general, and for testing evolutionary hypotheses associated with human aging that have a cognitive component.

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**Dental morphometric variation and human sex chromosome complement.**

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The determinations of tooth crown size and/or the thickness of enamel and dentin have been made from dental casts and intraoral radiographs in 47,YYY- and 47,XXY males, males with Y chromosome deletions, and 45,X, 45,X/46,XX, 46,Xi(Xq), 47XXX, 46,XY females. The results showed that deciduous and permanent teeth 47,YYY males are generally larger than those in conditions with other sex chromosome anomalies or in normal males or females. 45,X and 46,Xi(Xq) females showed the smallest tooth crowns and thinnest enamel. It is apparent that crown growth increase/decrease in these patients is final beginning from some months after birth up to the age of 67 years, at least. The process of excess growth e.g. in 47,YYY males is thus not limited to a certain critical period in pre- or postnatal life. Quite recent results have indicated that growth increase also occurs in permanent tooth root lengths in these males. Crown size increase in 47,YYY males results from an increase in the thickness of both enamel and dentin whereas the effect of the X chromosome on tooth growth seems to be restricted to enamel formation. The extra Y chromosome thus exerts a promoting effect both on cell secretion and proliferation. The results in 47,YYY males together with the results of other sex chromosome anomaly groups demonstrate a direct effect of the Y chromosome gene(s) on growth. Tooth size measurement in two males with deletions of part of the Y chromosome indicates that there may be a specific growth-promoting gene(s) in the proximal non-fluorescent part of the long arm of the Y chromosome. It is of great interest that molecular studies have now shown that loci for human amelogenin, which is the main component of the organic matrix in enamel are on both the X and Y chromosomes. It is suggested that the influence of the Y chromosome on amelogenesis is regulatory and that differential effects of the X and Y chromosomes on growth explain the expression of sexual dimorphism in various somatic features such as the size, shape and number of teeth, and under the assumption of genetic pleiotropy, torus mandibularis, statural growth and sex ratio.

### **Influence of trophic level on bone oxygen isotope ratios.**

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Controlled diet experiments and observations on wild East African mammals, show a clear influence of trophic level on bone apatite oxygen isotope ratios. Twenty litters of rats were raised from weaning age on seven kinds of controlled diets, each with 5%, 20% and 70% protein. Water oxygen isotope composition was constant. Oxygen isotope ratios of bone apatite carbonate decreased on average by 2.5‰ between 5% and 20% protein and 1‰ between 20 and 70% protein diets. Oxygen isotope ratios of bone of five litters raised under several configurations of heat and water stress on 20% and 70% protein diets did not differ significantly from those of non-stressed controls.

The oxygen isotopic composition of mammal bone and tooth apatite phosphate and carbonate was also determined for 81 individuals of 21 species collected in the central Rift Valley of Kenya, along an altitude transect from lake margin riparian woodland and savanna grassland to montane forest. There is substantial intra- and inter-specific variation in bone phosphate and carbonate  $\delta^{18}\text{O}$  within and between habitats. Lower  $\delta^{18}\text{O}$  values are found at high altitudes. Arboreal folivores (tree hyrax and colobus) in montane forest have the highest values. Carnivores and omnivores have the lowest values in all habitats.

High protein diets appear to be associated with low  $\delta^{18}\text{O}$  values on both experimental and natural diets. These data suggest the potential of oxygen isotope ratios of bone for identifying carnivory in fossil mammal communities.

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### **Fiber architecture in primate limb muscles with new data for triceps surae in *Eulemur fulvus*.**

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Fiber architecture is the study of how whole muscles are constructed with respect to weight, fiber or fasciculus length and pinnation angle, and relative proportion of myofiber to tendon. Its relevance is in combining these data to characterize a muscle physiologically, thereby predicting its biologic role in behavior and its comparative contribution to labor among muscles of a group. For this study, fiber

architecture of the triceps surae—*lateral* (GL) and *medial* (GM) *gastrocnemius*, *plantaris* (P), and *soleus* (S)—in the brown lemur (*Eulemur fulvus*) is examined with an eye to estimating maximum force output, excursion/velocity, expense of force transmission, and isometric versus isotonic contraction.

Calculated variables are interpretable with respect to the preferred locomotor modality of *E. fulvus*: arboreal quadrupedal walking and running, and leaping. With respect to estimated relative maximum force output, GL and GM each occupy ~30% of the total of the group, while P and S obtain ~15% and ~20%, respectively. Soleus stands out as the best suited for excursion/velocity but the least suited for expense of force transmission and isometric utilization.

These results complement previous findings for *quadriceps femoris* in *E. fulvus* and in cats, and these, and other, muscle groups in two guenon species. Generally, structural components of anti-gravity muscle groups, e.g., *quadriceps femoris*, *triceps surae*, tend to emphasize force output, vis-à-vis excursion/velocity, and lower cost of force transmission in muscles tending toward isometric, rather than isotonic, contraction. The reverse is true for the gluteal and hamstring groups. Funded by NSF (DBS-9221795).

### **Evidence of health among late prehistoric populations in the Hudson River valley, New York.**

L.M. Anderson. New York State Museum.

Prior to European contact, the Hudson River valley in eastern New York State was inhabited by Algonkian speaking groups including the Mahican and Munsee tribes. Unlike their Iroquoian neighbors to the west, who occupied highly defensible, nucleated settlements, Algonkian groups maintained a dispersed settlement pattern that included small, unfortified floodplain hamlets used for horticulture and fishing and upland camps for hunting. This mode of lifestyle, presumably free of endemic warfare, afforded an abundant and varied diet as noted by early Dutch explorers who described local Algonkian people as "friendly and polite", unfettered by famine or disease.

Bioarchaeological evidence from late prehistoric sites in the mid-Hudson valley, ca. A.D. 1200-1425, largely supports this view of Algonkian life. Data compiled under the Native American Graves Protection and Repatriation Act from the Menands Bridge site (n=39) and the Hurley site (n=25) indicate comparatively low

frequencies of skeletal stress markers, such as porotic hyperostosis and cribra orbitalia, and little evidence of traumatic injury among individuals in the sample. Frequencies of caries, dental disease, and skeletal lesions indicative of infectious disease however, suggest that individuals were not disease free, although overall population health does not appear to have been further compromised by factors such as poor nutrition.

### **Genito-genital rubbing as a female bonding strategy in a group of captive chimpanzees (*Pan troglodytes*).**

S.F. Anestis. Dept. of Anthropology, Yale University.

Same-sex socio-sexual interactions are common in primates. Genito-genital (GG) rubbing, a distinct behavioral pattern where individuals rub genital regions, is one such behavior that has been hypothesized to serve several functions, such as to reduce tension in feeding contexts, facilitate reconciliation, and attract mates. GG rubbing between females has been observed in multiple wild and captive bonobo (*Pan paniscus*) groups and is considered unique to this species.

Here I report on a group of captive, young adult chimpanzees (*Pan troglodytes*) in which the females GG rubbed at rates equivalent to those observed in bonobos. The study animals are housed at the University of Louisiana's New Iberia Research Center in a four-male, four-female peer group. I collected 70 hours of data in July and August of 2000 and recorded the identity of the GG rubbing females, sexual swelling sizes, physical positions, vocalizations, and duration of each GG rubbing session.

I used these data to test five hypotheses about the function of GG rubbing in this peer group. Of the reconciliation, tension-reduction, mate attraction, female bonding, and status reinforcement hypotheses, I found support only for the hypothesis that GG rubbing reinforces social bonds between particular females. Female dyads with the highest rates of GG rubbing also groomed each other the most. I discuss several significant ways in which GG rubbing in this group differed from the pattern observed in bonobos, and potential reasons why captive, but not wild, chimpanzees engage in this behavior.

### **Masticatory loading and modern human origins.**

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Australian cranial characters figure prominently in debates over the origin of modern humans. A multiregional model is frequently supported by reference to shared characters of the vault common to both SE Asian *Homo erectus* and Australian *H. sapiens*. Alternatively, some of these characters have been attributed to a heavy masticatory pattern coupled with a long, narrow cranial base rather than to a close phylogenetic relationship. However, evidence of such a masticatory pattern has not been well established.

We test the extent to which such evidence can be demonstrated in Australian mandibles. We compare Australian mandibles with those from native Alaskans known for exhibiting high occlusal loads and those from prehistoric Peru and 20<sup>th</sup> century African-Americans that are not known for their masticatory robusticity. Each sample includes 30 adult mandibles with full dentition. We use external measurements and score tendon-associated bone features of the masticatory musculature. We calculate biomechanical properties from Computed Tomography (CT) scans at M1.

Australian mandibles do not exhibit the bony relationships best-suited to dissipating high occlusal forces. They do not have particularly broad or tall corpora and are relatively long. Tendon-associated bone features are not markedly robust. CT scans suggest a somewhat different picture. Although absolute cortical thickness does not appear to differ among groups – the Australian mandible has greater amounts of trabecular bone. These results suggest the possibility that, restricted by a relatively narrow cranial base, high occlusal loads were present and accommodated in novel ways in the Australian mandible. Supported by NSF BCS 9804861.

#### **Why has skeletal biology remained typological?**

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In the five decades since Sherwood Washburn presented a framework for defining the strategy of the "new physical anthropology," there have been shifts in skeletal biology that reflect his proposal for change. He described the need to move beyond measurement and classification in which there is little theory and much speculation to a science in which was a concern for process, theory and hypothesis testing. While has been movement away from typological racial

classification, the changes have been slow and skeletal biology has remained descriptive. During the decade of the 1950s, 30 percent of the articles published in the *American Journal of Physical Anthropology* were analytical (an increase from 13.5 percent recorded in the decade of the 1930s). In the '70s, analytical articles reached a high of 44 percent and have remained at this level to this day. Two topical areas within skeletal biology, functional anatomy and bioarcheology, have experienced change that reflect the Washburnian prediction. Within bioarcheology, the use of "strong Inference" to test the biological impact of subsistence changes has been a factor in its growth. However, skeletal biology has experienced a reversion to a more descriptive phase with a return to historical particularism that is limiting its progress. An increasing interest in forensic anthropology and resurgent interest in measures of population distances and migrations represents a reversion to an earlier descriptive past.

#### **The origin of Mayans according to HLA genes and the uniqueness of Amerindians.**

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The HLA allele frequency distribution of the Mayans from Guatemala has been studied and compared with those of other First American Natives and worldwide populations (a total of 12,364 chromosomes and 6,182 individuals from 60 different populations). The main conclusions are: 1) The closest Amerindian group to Mayans is the Arhuacs, who were the first Caribbean Islands inhabitants. 2) Mayans are not so close to Mesoamerican Zapotec, Mixe and Mixtec Amerindians, who genetically cluster together. Mixe had been related to Mayans only on linguistic bases. 3) DRB1\*0407 and DRB1\*0802 alleles are found in 50% of Mayans; these alleles are also found in other Amerindians, but the Mayans high frequencies may be showing a founder effect for this Mesoamerican-Caribbean population. 4) Extended Mayan specific HLA haplotypes are described for the first time. 5) Language and genes do not completely correlate in microgeographical studies. 6) Peopling of the Americas was probably more complex than postulated by Greenberg and others (three peopling waves). Sig-

nificant genetic input from outside is not noticed in Meso and South American Amerindians according to the genetic analyses; while all world populations (including Africans, Europeans, Asians, Australians, Polynesians, North American Na-Dene Indians and Eskimos) are genetically related. Meso and South American Amerindians tend to remain isolated in the neighbour joining, correspondence and plane genetic distances analyses.

#### **Habitat effects on positional behavior and fine branch use in red-tailed monkeys (*Cercopithecus ascanius*) and grey-cheeked mangabeys (*Lophocebus albigena*) in the Kibale Forest, Uganda.**

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A current debate in the study of primate positional behavior and support use asks the question: can primates flexibly employ a range of positional behaviors and support choices, or are they highly canalized, meaning that only a restricted suite of behaviors is available, regardless of habitat characteristics? I collected data on positional behavior and support use in two arboreal cercopithecids (*Cercopithecus ascanius* and *Lophocebus albigena*) at Ngogo, within the Kibale National Forest, Uganda, during July-August, 2001. These data were compared to previous work at nearby Kanyawara, also in Kibale. I find significant differences in locomotor behavior and support use in each species, and between sites. At Ngogo, *C. ascanius* walks and bound more frequently, while the larger *L. albigena* leaps more often over wider distances. Comparison to Kanyawara finds that Ngogo *C. ascanius* uses more quadrupedal walking and bridging, and less vertical climbing; while *L. albigena* bridges and bounds more, with less leaping than their Kanyawara conspecifics. Postural modes appear similar across sites. Finally, Ngogo taxa use more small and oblique supports than the Kanyawara taxa.

I suggest that these differences relate to a more contiguous canopy and increased small branch availability at Ngogo. Positional behavior on small branches was also most variable, suggesting that small branches represent a critical factor for future studies. My preliminary results are consistent with hypotheses that support availability and distribution affect positional behavior and support use profiles. Further investigation into the role of habitat structure and primate ecoflexibility across sites and taxa is needed.

### **Using physical anthropology to diffuse the controversy over the teaching of human origins in middle school.**

P. Ashmore. Dept. of Anthropology, University of Missouri-St. Louis.

Teachers working in middle school environments are greatly concerned about teaching evolution in their classes especially when the topic is human evolution. Many teachers working in the St. Louis area avoid the subject for a variety of reasons including that some of their students may be from fundamental Christian homes that other teachers and or administrators won't support their efforts should they be challenged or because school board members prefer the topic to be left out of the science curriculum. An additional factor is that the teachers themselves are simply not comfortable with their own level of understanding regarding the subject of evolution. To assist teachers in the teaching of evolution a unique program offered through the Center for Human Origin and Cultural Diversity uses content provided by physical anthropology, a hands-on approach and an experiential learning strategy to address the topic of human evolution. Using a sampling of fossil casts, middle school students investigate the human fossil record to discover trends in human evolution. Students are given data about early hominids and then self discover the answers to questions posed. Pre and post assessment instruments indicate that a significant amount of content learning takes place and additional qualitative feedback from both students and their teachers reflect the fact that after experiencing the program, that they are more open and comfortable with the topic of human origins. This paper will highlight strategies used to teach evolution in a middle school environment.

### **Metric sexing methods and commingled skeletal collections: A better demographic profile?**

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The standard method of skeletal sex determination assesses morphological traits of the skull and pelvis. With commingled samples, morphological sexing is problematic because there are generally many more long bones present than skulls or pelvis. Therefore, sex distributions obtained from skulls and pelvis may underestimate the numbers of both sexes or skew the distributions from that actu-

ally present. This study compares morphological and metric methods to investigate the impact on sex distribution in a commingled sample from Nuvakwewtaqa (Chavez Pass), Arizona.

Long bone measurements taken include maximum lengths and measures of articular areas that were statistically analyzed using cluster analysis to determine which bones were more probably male or female. The sex distributions obtained were compared with those derived from morphological assessment of skulls and pelvis. Sexable skulls and pelvis yielded small MNIs (32 left os coxae and 36 crania) with very different sex ratios: 50% females using os coxae and 71% females using crania. Measurable adult long bones provided larger MNIs, ranging from 66 left humeri to 88 left femora. Metrically obtained sex ratios ranged from 41 - 60% females, demonstrating that one should not assume a collection is accurately represented by sex distributions obtained from morphological assessments alone. Bioarchaeological studies, such as those concerning paleoepidemiology or sex-specific activity patterns, of commingled collections may be better served through use of metrically-derived sex distributions, where the number of sexable individuals can be 23 times higher than estimates obtained solely from morphological methods.

### **Mass matters: An evaluation of two body mass estimation techniques in modern human populations.**

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Body mass has been reconstructed from hominin skeletal remains using both mechanical methods that rely on the support of body mass by weight-bearing skeletal elements, and "morphometric" methods that reconstruct body mass through direct assessment of body size and shape. A previous comparison of two such techniques, using femoral head breadth (mechanical) and bi-iliac breadth and stature (morphometric), indicated a good general correspondence between them (Ruff et al., 1997). However, the two techniques have never been systematically compared across a large group of modern humans of diverse body form.

This study incorporates skeletal measures taken from 791 Holocene adult individuals, including Europeans (N=482), Pueblo Native Americans (N=104), East Africans (N=46), Aleut/Eskimo (N=149), and Andaman Islanders (N=13). Femoral

head breadth, bi-iliac breadth (after rearticulation) and long bone lengths were measured on each individual. Statures were estimated from long bone lengths using appropriate reference samples. Body masses were calculated from femoral head breadth and bi-iliac breadth/stature using previously published sex-specific equations (Ruff et al., 1997).

The two techniques yield similar results. Over all samples pooled, the correlation between estimates is 0.78, the mean directional difference between estimates is about 6% (femoral head estimates larger), and the mean absolute difference is about 9%. In general, there is more of a difference in results for females than for males. Results also vary by population/region, with the largest difference for Andaman Islanders, followed by Aleut/Eskimo females. The latter result may be caused by underestimation of a soft tissue (fat) correction factor for bi-iliac breadth.

### **Precision in 3-D landmark data collection for geometric morphometrics.**

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Geometric morphometrics is an important tool in examining shape variation among and within taxa, and throughout ontogeny. Among the numerous instruments used to collect three-dimensional (3D) data for morphometric analysis are the Microscribe-3DX, a mechanical arm 3D digitizer and the Cyberware 3030 RGB laser surface scanner. While these two instruments accomplish the same goal, inter-device consistency has not yet been carefully tested, nor has inter-observer reliability. Inter-observer and inter-device consistency are required for the sharing and reuse of data. We each collected a series of landmarks (xyz coordinates) on a *Papio ursinus* cranium with both devices and applied multivariate analysis of variance (MANOVA) to examine observer and device effects on the collected data after Procrustes alignment.

Centroid size differed significantly by device, but not by observer. For most landmarks MANOVA indicated significant inter-observer and inter-device differences. Fewer observer-device interac-

tion differences were indicated. Overall, results suggest that precision (consistency) is comparable in both devices, although for a few landmarks, the laser scanner was significantly less precise. One reason for the inter-device differences in precision may have been the difficulty in visually locating landmark-defining sutures on the laser scan image. However, when landmarks were clearly visible on the laser scan image, the precision between devices was not significantly different. Therefore, while both devices were nearly equivalent in the precision of their measures, it is not possible to say which of these instruments is more accurate ("correct") with this data set.

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### **Quantitative analysis of P<sub>4</sub> shape in Neandertals and anatomically modern humans.**

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This paper presents the results of a quantitative analysis of P<sub>4</sub> shape of Pleistocene and recent humans. It builds on earlier work, which revealed notable differences between Neandertals and other Pleistocene and recent humans in several aspects of their P<sub>4</sub> morphology. One of these aspects is the shape of the occlusal crown outline. Elliptic Fourier analysis was used to obtain coefficients describing the P<sub>4</sub> occlusal outline. These coefficients were used to derive "mean tooth shapes" in different hominid groups. The coefficients were then analyzed using Principal Components (PCA) and Discriminant Function Analyses.

A comparison of mean shapes shows that the average Neandertal P<sub>4</sub> crown is asymmetrical relative to that of anatomically modern humans (AMH) and *Homo erectus*. A PCA of the elliptic Fourier coefficients groups Neandertals together, but variation in the AMH sample overlaps that of Neandertals. The results of the discriminant function analysis indicate that P<sub>4</sub> shape classifies groups reasonably well: correct classification for amHs was very good (97%), while correct classification for Neandertals was not as good (65%). Anatomically modern humans were as likely to be misclassified as *Homo erectus* as they were to be misclassified as Neandertal. Both analyses indicate that the primary reason for group overlap and/or misclassification is the presence of individual AMH P<sub>4</sub>s that possess mesio-distally narrow lingual cusps, rather than asymmetrical crowns. This suggests that

asymmetry affects lingual crown area and that both contribute to the distinctive Neandertal P<sub>4</sub> shape.

### **Mitochondrial DNA sequence analysis of the Holmes-Vardeman-Stephenson Cemetery.**

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DNA extraction and analysis was performed for individuals from burials located within the Holmes-Vardeman-Stephenson Cemetery in Lincoln County, Kentucky. These burials are from a period between the 1830s and 1940s. The Vardeman family in particular made important contributions to the settlement of Kentucky in the late 18<sup>th</sup>-century. DNA was extracted from either bone or tooth samples from individuals recovered during archaeological excavations. Sequence analysis of the mitochondrial DNA control region was performed for 49 burials, 12 participating descendants and 4 anthropologists working on the project. The mtDNA sequence lineages were compared among the 49 burials and consistencies were noted. The mtDNA sequences of the 12 descendants were then compared to each other and the burial samples. Lastly, the 4 anthropologists' mtDNA was analyzed and compared to the burial samples in order to rule out possible contamination of modern DNA in the historic samples. Sex determination was performed for each of the 49 burial samples by simultaneously amplifying the X-specific and Y-specific fragments of the Amelogenin gene which are 106bp and 112bp in length respectively. Thirty-two of the 49 samples were successfully or tentatively typed as male or female.

The main objectives of this research were to successfully extract and analyze mitochondrial DNA from these historic bone and teeth samples, determine the maternal relationships of individuals within the cemetery, and determine their historic maternal relationships with living descendants.

This project was supported by the Kentucky Transportation Cabinet.

### **3D morphometric study of the temporomandibular joint and its implication on species recognition in *Homo erectus*.**

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The problem of species recognition in paleoanthropology has been the subject of numerous studies. In the present work we used 3D morphometric analysis to quantify the morphology of the temporomandibular joint, in order to assess its potential as a taxonomic tool. Six points were selected and recorded using a microscribe 3Dx digitizer on the following species: *Pan paniscus*, *Pan troglodytes*, *Gorilla gorilla* (17 males, 17 females for each species), and two modern groups of *Homo sapiens* (34 per group, 17 males, 17 females). These points were superimposed using GLS, and analyzed using principal component analysis. The results clearly indicate differences between the species: the first PCA separated the apes from humans ( $p < 9.0 \times 10^{-20}$ ), while the second differentiated between the ape species (chimpanzee-bonobo, for instance,  $p < 4.0 \times 10^{-3}$ ). The third PCA separated between the two *Homo* groups ( $p < 1.0 \times 10^{-8}$ ).

This method was applied to a sample of 11 casts of Pleistocene hominids from Asia, Europe and Africa, known as Asian *Homo erectus*, African *Homo erectus* and *Homo heidelbergensis*. The first PCA separated *Homo heidelbergensis* from Asian - African *Homo erectus* ( $P < 0.08$ ), while the second PCA separated Asian *Homo erectus* from African *Homo erectus* ( $p < 0.02$ ). Given the small sample of the hominids, these results seem to favor the view that *Homo erectus* actually includes two different species. The present method has important technical taxonomic implications, because this small anatomic region, generally preserved in the fossil record, combined with the use of few points of measurement, can assist in species recognition.

### **Infanticide and the evolution of baboon sociality.**

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Baboons have been pre-eminent in attempts to understand how ecology underpins social structure in gregarious animals for the simple reason that their terrestriality and dietary plasticity enable them to confront a very wide range of environmental conditions. In this paper we argue that attempts to provide a unified explanation for the relationship between environment and observed differences in the behavioural profiles of different baboon populations cannot succeed unless account is taken of the species'

evolutionary history. We demonstrate this by using the relationship between chacma baboon (*Papio hamadryas ursinus*) ecology and infanticide to provide an account of the pressures selecting for the distinctive social structure of hamadryas baboons (*Papio hamadryas hamadryas*).

**Morphological variation of the lumbar vertebrae of *A. africanus*: Implications for locomotor differences between small and large individuals.**

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The lumbar vertebrae of *Australopithecus africanus* show clear differences in morphology between small and large individuals. The smaller individual (Sts 14) has small vertebral body dimensions relative to the size of the transverse and spinous processes, whereas the larger individual (Stw 431) has large vertebral body dimensions relative to the transverse processes. This difference in morphology could indicate locomotor or postural differences between small and large forms of *A. africanus*.

To assess locomotor differences, measurements of the vertebral body, transverse processes, and spinous processes were taken on the *A. africanus* specimens and a comparative sample of extant hominoids. Ratios of both raw and logged variables were analyzed for significant differences using ANOVA and pairwise comparisons, and principal component analysis was used to determine shape differences.

The results show that, compared to extant hominoids, Sts 14 has a small vertebral body relative to the transverse and spinous processes of the first lumbar vertebra. In addition, Sts 14 has a small vertebral body relative to transverse processes of the penultimate and last lumbar vertebrae. In contrast, Stw 431 displays a large vertebral body relative to the transverse processes in the last lumbar vertebra, and this proportion is similar to that of extant hominoids. Stw 431, with its large weight-bearing area relative to muscular leverage, is most similar to humans, indicating it had a bipedal locomotion or erect posture. Sts 14 has less weight-bearing area compared to muscular leverage, and this relationship is most closely resembles that of chimpanzees and gorillas.

**A new human skeleton from the Middle Palaeolithic Peristeri I Cave, Epirus Greece.**

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We report here on a new and relatively complete human skeleton of a child from the site of Peristeri I Cave, Kouklesi village, Epirus, Greece – a steeply dipping cave 67m deep. The specimen was recovered from the deepest part of the cave (39° 21' 55" and 20° 51' 06") in an isolated chamber named Lower Cave in which Middle Palaeolithic stone artifacts and charcoal have been found in excavations that started since 1995 by the author. Lower Cave was used as a place for stone knapping and contains only Palaeolithic finds. No associated artifacts were found with the skeleton so the chronological age of the skeleton is still unknown until any radiometric methods are employed. Parts of the skull, pelvis, teeth and long bones have been found so far. The epiphyses of the long bones are unfused. The skeleton was found completely covered by speleothem in a natural stalagmitic pit in a side wall of the cave in August 2002. The bones, though not articulated in an anatomical position, they were all closely packed together in the confined space of the pit. No rodent activity has been discerned so far that could have mingled the bones. Alternatively, gravity might have some effect in mingling the bones. Various hypotheses are still examined as to whether it was a deliberate bone or carcass disposal or a secondary interment. The excavation proceeded with a hammer drill and a chisel. The exposed bones were solidified *in situ* when necessary and protected with bandages before extraction of the stalagmitic blocks took place. Cleaning is taking place in the lab.

**Female reproductive strategies in a baboon hybrid zone, Awash National Park, Ethiopia.**

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The social differences between hamadryas and anubis baboons are associated with conspicuous differences in male behavior towards females. Although less conspicuous, the social behavior of females is also markedly different between these two baboon forms. Anubis females live in groups characterized by female-bonded, hierarchically ranked matrilineal while hamadryas females live in groups comprised of one-male units (OMUs). OMU females are thought to be unrelated and therefore male-female bonded. These

social differences may be divergent female reproductive strategies, reactions to the male behavioral environment, or both. In this study we address this issue using the social and reproductive behavior of female baboons in a hybrid group (*Papio hamadryas hamadryas* x *P. h. anubis*) located in the Awash National Park, Ethiopia. Data for this study come from three years of observation on a group located at the phenotypic center of the hybrid zone. The social structure of the target group reflects its mixed ancestry with elements of both anubis and hamadryas society present. Most target females show characteristics of typical anubis social structure. A smaller number of females show characteristics of hamadryas social structure and are tightly bonded to one of the four males with OMUs. The remaining females are characterized by an intermediate OMU social structure. Here, we compare data on ancestry, social and competitive interactions, and reproductive behavior across these three social categories. The results suggest that female social behaviors are not merely reactions to a male social agenda but may represent different reproductive strategies within the same group.

**New Miocene primate postcranial fossils from Rudabánya, Hungary.**

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Since 1993 when the last primate postcrania from Rudabánya were described, numerous new fossils have been recovered. These add considerably to our understanding of the diversity of primates from the locality, and call into question some previously published ideas. New specimens include associated femora briefly described in an earlier abstract, and 2 humeral shaft fragments, 3 talar fragments, three cuneiforms fragments, two capitate fragments, 1 nearly complete scaphoid, the distal half of a metacarpal and 12 phalanges or phalangeal fragments. Based on size and morphology most of the specimens are assignable to one of the 2 known catarrhines from Rudabánya, *Dryopithecus* and *Anapithecus*. The metacarpal is morphologically close to Can Llobateres *Dryopithecus*, having very prominent collateral ligament dorsal notches, but a proximal phalanx base differs in the proximally oriented proximal phalangeal articular surface. The capitates are mediolateral compressed, as in non-hominid catarrhines, but have broad, rounded articular surfaces as in most hominids. The scaphoid also mixes primitive and derived charac-

ters. Most notable is the lack of os centrale fusion. The cuneiforms, tali and phalanges also show a combination of primitive and derived characters. This is the typical pattern in late Miocene hominids, and suggests an interesting pattern of emergence and homoplasy in the evolution of modern hominoid morphology. Finally, a complete, fully ossified talus is close in size to that of 5-6 kg anthropoids, much too small to be easily attributable to either Rudabánya catarrhine. Funded by NSERC, OTA, A. von Humboldt Stiftung, Wenner-Gren and Leakey Foundation.

**Key issues in the analysis of faunal changes across the East African Pliocene.**

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Vertebrate faunas provide important evidence for hominid paleoecology over a wide range of scales, from site-specific analysis of taxa directly associated with hominid fossils and archeological materials to assessments of faunal indicators for ecological change through time that affected human evolution. At each level of resolution, the quality and credibility of the paleoecological data depend on the successful integration of three areas of study: taxonomy, taphonomy, and geology (stratigraphy / sedimentology / geochronology). The foundation for paleoecology rests on accurate taxonomic identification of specimens and correct placement of these taxa in a time/space continuum. There are two aspects to the time/space continuum problem: (1) primary data - the locality, stratigraphic position, and geological context of each taxonomic occurrence in the rock record, (2) inferred data - the original ecological habitat of a taxon and its temporal and spatial relationship to other taxa, including hominids. Taphonomy, sedimentology and ecomorphological inference provide the means to take primary data from the occurrence of a fossil taxon and use this to infer past ecology. The validity of inferences relating faunal evidence to the ecology of a hominid species depends on the level of resolution of this evidence, i.e., how it relates spatially and temporally to the hominid remains. Contributions to this symposium provide an overview of primary data from many East African Pliocene sites and present different methods for inferring paleoenvironmental contexts, paleoecological relationships, and evolutionary patterns that work together

to increase understanding of the ecological context of human evolution.

**Growth and adipose tissue development in captive infant gorillas.**

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In contrast to nonhuman primates, humans have well developed adipose tissue deposits at birth (Kuzawa 1998, *Yrbk. Phys. Anthropol.*). In association with slow somatic growth and maintenance of large, metabolically expensive brains, humans rapidly accumulate additional adipose tissue from gestation through early childhood. This uniquely human pattern of early adiposity serves as energy buffer for brain metabolism during periods of nutritional stress. Human growth rates and adipose tissue development are well documented, but there is little information on early growth and development in nonhuman primates.

This study compares anthropometric measurements taken at birth and at 1, 3 and 6 months from four healthy infant male gorillas in the Columbus Zoo (Bellisari et al 2001, *AJPA*) and from infant males in the Fels Longitudinal Study. While mean recumbent lengths are similar for the gorillas and humans, human mean weights, head circumferences and upper arm circumference are greater than those for gorillas. Human triceps and anterior chest skinfolds greatly exceed those of gorillas.

These data from a very small sample of male gorilla infants support the observation that humans differ from their hominoid relatives in the development of adipose tissue deposits. Hominids have been subject to starvation pressure throughout their prehistory. But lowland gorillas, which rely mainly on terrestrial herbal vegetation and have an abundant food supply available to support rapid somatic growth and cerebral energy requirements, are less dependent on energy reserves stored in adipose tissue.

Many thanks to the Columbus Zoo African Forest staff for their assistance and collaboration.

**A comparison of *Kenyapithecus* and *Simiolus* from middle Miocene deposits at Fort Ternan and Maboko Island.**

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Controversy surrounds the phyletic affinity of hominoids from the middle

Miocene sites of Maboko Main (15 MA) and Fort Ternan (14 MA). Some authorities refer the small-bodied ape fossils from MB Main to *Micropithecus leakey-orum* and those from FT to *Simiolus* sp. The large-bodied hominoid from MB Main has been referred to several taxa, including "*Equatorius*" *africanus*. FT is the type locality of *Kenyapithecus wickeri*. Radiometric dates indicate that fossils from MB Beds 12-16 are contemporaneous with FT, affording a unique perspective on the relationships of the hominoids from the two sites.

Small-bodied apes from Bed 12 exhibit numerous clear similarities to *Simiolus* from Fort Ternan and Kalodirr rather than to *Micropithecus clarki* from Napak and Koru. These similarities include several non-adaptive features that are unlikely to be functionally convergent upon *Simiolus*. The collection of large-bodied apes from Beds 12-16 is clearly more similar to *Kenyapithecus* from FT than to Eurasian hominoids such as *Griphopithecus*. Upper central incisors from Bed 12 are more similar to *K. wickeri* than they are to *K. africanus* from MB Main. However, incisor variation within the *Kenyapithecus* sample does not surpass that observed in extant species. By combining features seen in hominoid samples from all MB strata and FT, the Bed 12 specimens corroborate attribution of the Maboko hominoids to *Simiolus* and *Kenyapithecus*. *Simiolus* and *Kenyapithecus* experience slight changes in size between MB strata. Contrary to expectation, fossils from Bed 3, the oldest stratum, are most similar in size to congeneric populations from FT.

**Bone pathologies and anomalies: A view from American war dead.**

G.E. Berg, H.D. Dockall. USA-CILHI.

Efforts to recover and identify missing U.S. war dead by the Central Identification Laboratory, Hawaii (CILHI) have been undergoing for several decades. Often, missing service personnel were involved in high-speed impacts and little osseous material is recovered. Recently, CILHI's efforts have been focusing on losses from World War II and the Korean War, which has resulted in more complete skeletal remains being repatriated to the laboratory (individuals were typically ground losses versus aircraft impacts). Trauma and pathology are documented more frequently in complete sets of remains and have been occasionally used to strengthen identifications.

Approximately sixty cases of complete or nearly complete skeletal remains will

be the focus of this paper. While the majority of the pathologies and bone anomalies are found on the vertebral column, additional sites include the cranium, long bones, and ribs. We will explore the rates of pathological occurrence and give several possible explanations for their unusually elevated presence in this population. Pathological involvement of the spinal column in the collection is relatively high and includes Schmorl's nodes, osteophytic growth, spondylolysis, and cleft spine of the sacrum. We suspect that most of these pathologies were asymptomatic, as few were diagnosed in the individuals' service and medical records. Craniosynostosis was found in exceptionally high percentages, occurring at a rate of 100 to 1000 times greater than reported in the modern medical literature. Unusual bone morphology and pathology will be further discussed, principally in terms of specific morphological features, e.g. septal apertures, bifid ribs, in cases of unusual and undiagnosed pathology, and in percentages of antemortem healed fractures.

**Plover's Lake: A hominin-bearing Middle Stone Age site in the Witwatersrand area, South Africa.**

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The Middle Stone Age (MSA) in South Africa is well documented at numerous sites, with the majority of excavated localities situated in or near coastal areas. Although the MSA is represented in the Witwatersrand area (e.g. Member 4 of Swartkrans, upper deposits of Gladysvale), no hominin fossils have yet been recovered from these localities. In fact, human skeletal remains associated with MSA assemblages in southern Africa in general are rare, and tend to be quite fragmentary. The hominin fossils recovered from the *in situ* decalcified deposits of Plover's Lake, although fragmentary, represent the first hominins directly associated with an MSA industry in the Witwatersrand area. These fossils are consistent with modern *Homo sapiens*, although taxonomic attribution based on isolated teeth must be considered tentative.

The faunal assemblage associated with the hominin fossils is rich and varied. Although predominantly modern forms are represented at Plovers, at least six extinct taxa are also recognized. Carnivores are plentiful, being dominated by

smaller body size forms, in particular the Canidae. The Bovidae are the most abundant group in the assemblage, accounting for five of the six extinct taxa at the site. The presence of tooth-marked specimens and coprolites in the assemblage indicates that carnivores were responsible for at least a portion of the bone accumulation. However, human occupation of the cave or its surroundings is indicated by the presence of MSA flakes and debitage on locally available quartz and quartzite, suggesting that humans were also at least partially responsible for the accumulation at Plover's Lake.

**Cranial sexual dimorphism, allometry and mating systems among hominoids.**

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Hominoid social groups vary in size, in composition (females versus males) and in mating and residence patterns. Comparative analyses demonstrate that the extent of sexual dimorphism in primates corresponds somewhat to the structure of these groups. To explore this relationship in more detail, we investigate cranial sexual dimorphism in five hominoid species: *Homo sapiens*, *Pan paniscus*, *Pan troglodytes*, *Gorilla gorilla* and *Pongo pygmaeus*. 3D-coordinates of 35 traditional landmarks and 61 semilandmarks are measured for each of the 268 adult and sub-adult specimens and analyzed using geometric morphometric methods.

There is an association between the amount of size dimorphism and one aspect of the mating system, namely, the ratio of males to females per group. Furthermore, we find an association between a quite different measure of intrasexual competition among males (sperm competition) and another measure of dimorphism specific to shape: the divergence angle between within-sex growth allometry and between-sex mean shape difference. We interpret these findings by considering various male mating strategies and interspecific differences in the actual pattern of growth allometry.

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**Integration among hormonal parameters of growth in baboons: Im-**

**plications for patterns of maturation and reproduction.**

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Baboon life histories are characterized by relatively discrete phases of somatic maturation and reproduction compared to other papionins. Hormones are important physiological regulators of body growth, sexual maturation and reproduction. Comparative analyses of hormones involved in both growth and reproduction provide insight regarding physiological mechanisms responsible for differences in fitness components. In particular, such analyses allow the influence of hormones on baboon life history parameters to be assessed and compared to other papionins. Captive populations of *Papio anubis* (olive baboons) and *Cercocebus atys* (sooty mangabeys), sampled and measured longitudinally, are used. Serum levels of IGF-I, IGFBP-3, DHEA-S, testosterone, and estradiol are quantified using RIA and IRMA techniques.

Hormonal profiles of growth in baboons are characterized by a high degree of regularity in relation to mangabeys. Baboons show higher levels of hormonal integration than mangabeys. Steroids and somatomedins are closely integrated in baboons. For example, in females, estradiol, IGFBP-3, and IGF-I are strongly correlated. In male baboons, DHEA-S, IGFBP-3, and IGF-I are strongly correlated. Compared to mangabeys, baboons show stronger correlations between hormone levels and somatic measurements; male baboons in particular show significant correlations between all hormones and all somatic measurements.

These results suggest that baboon life history patterns result, at least in part, from hormonal integration during growth. Devotion of hormonal resources to growth first and reproduction later enable dissociation of fitness components that are interrelated in other papionins. These findings are discussed, and implications for understanding the physiological mediators of primate development and life histories are considered.

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**The interrelationship of status and health in the Tellico Reservoir: A biocultural analysis.**

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Anthropologists have been interested in the interaction of health and status in prehistoric populations for many years. This paper investigates how social stratification affected health at three Dallas phase (A.D. 1300-1600) sites from the Tellico Reservoir in eastern Tennessee: Citico (40MR7), Toqua (40MR6), and Tomotley (40MR5). Skeletal indicators of stress are used to determine the health of the people interred at the three sites, while burial location is utilized to establish the status of these people. Analyses conducted on the data collected from 649 skeletal remains compare the occurrence of stress markers between mound and village burials, among village burials, and among mound burials.

The results of these analyses indicate that there are differences in the incidence of stress markers based on status; individuals buried in mounds were less affected than individuals buried in villages, which is probably due to differential distribution of food. Individuals in the Toqua mound were more stressed than those in the Citico mound, which may be the result of population size, and, therefore, food availability. Toqua village had the most stress of the three villages, which is possibly a function of political structure and food distribution. While various studies have examined the interaction of health and status, few have studied this phenomenon on a multi-site basis. This paper focuses on how site structure, population size, political structure, and other factors affect this interaction. The complex nature of status and health is demonstrated through the use of a biocultural perspective.

**Patterns of positional behavior in juvenile and adult white-faced capuchins (*Cebus capucinus*).**

M.F. Bezanson. University of Arizona.

An understanding of ontogenetic differences in patterns of positional behavior and substrate utilization in nonhuman primates offers insight into the effects that changes in body mass, motor coordination, and limb proportions have on behavior and ecology. The genus *Cebus* is characterized by a pattern of growth in which compared to the adult condition, limb segments are shorter at birth and grow at slow rates relative to the trunk.

In this research I compare patterns of positional behavior in juvenile and adult *Cebus capucinus* and examine the degree to which adult patterns of locomotion and posture develop during ontogeny. *Cebus capucinus* was observed from April-September 2002 at Estación Biológica La Suerte in Northeastern Costa Rica. Quantitative behavioral data were collected on juveniles and adults utilizing one-minute focal animal instantaneous sampling. Data were collected on positional behavior, activity pattern, details of prehensile-tail use, and substrate utilization. *Cebus* were observed for 205 hours totaling 12,300 activity records.

Results indicate that adults and juveniles were similar in their use of positional modes. During feeding and foraging, the most common positional modes observed in adults and juveniles included sit, squat, quadrupedal stand, and quadrupedal walk. During feeding, juveniles used the positional mode squat more often (46%) than adults (16.5%) while adults were observed to sit (59.4%) more often than juveniles (29.8%). Tail-assisted feeding and foraging accounted for 34% of the adult and 46% of juvenile observations. During travel, prehensile tail use was less common (2.2% in adults and 4.3% in juveniles). While juveniles and adults exhibited a similar positional repertoire, differences in the frequency of particular positional modes may relate to differences in limb and trunk proportions. Additional relationships among substrate use, positional behavior, and limb proportions in *Cebus* are discussed.

**The win-stay rule in within-patch foraging decisions in free-ranging titi monkeys (*Callicebus cupreus cupreus*) and tamarins (*Saguinus imperator imperator* and *S. fuscicollis weddelli*).**

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Spatial memory of the distribution of potential resources plays an important role in primate foraging efficiency by minimizing time and energy in random search. Resources exploited by rainforest primates may vary in availability on time scales of weeks, days, or hours within the same day. Consequently, distinct foraging rules need to be applied for efficiently using the spatial knowledge of the distribution of resources showing different temporal patterns of renewal. In this respect, a win-stay rule is very important for monkeys exploiting abundant, long-lasting resources, whereas a win-shift

rule is more appropriate when exploiting highly depletable, slow-renewing resources. Here, I test the use of the win-stay rule in one group of red titi monkeys, two groups of black-chinned emperor tamarins, and two groups of Weddell's saddleback tamarins during a series of foraging tasks. This study was conducted at the Parque Zoobotanico/UFAC, Rio Branco, Brazilian Amazon, from September 1997 to January 1998. Four feeding stations composed of eight visually identical feeding platforms were constructed. In all test settings, two platforms at each feeding station contained a food reward (banana) and the remaining six platforms contained a sham reward (plastic or inaccessible banana). Spatial information (location of food rewards) was reliable during some experiments and unreliable during others. All three species consistently adopted a win-stay rule for returning to reward platforms when their location was predictable over time, but stopped using it when their spatial distribution changed randomly. Research supported by CAPES, FBP, WWF-Brazil, Wenner-Gren, ASP, CLACS/UIUC, UFAC, and S.O.S. Amazonia.

**Adult stature estimation from the calcaneus of South African blacks.**

M.A. Bidmos, S.A. Asala. School of Anatomical Sciences, University of the Witwatersrand.

Stature is an important factor in establishing the identity of a person in the living as well as in the skeletonized state. When stature is estimated from the bones of the limbs, regression equations, which estimate the ratios of the bones to the height of the individual, are generated. The majority of the bones that have been used are the long bones. The calcaneus has been used for estimating stature only in the American whites and blacks (Holland, 1994). The regression equations that he generated were found to be useful for stature estimation in these population groups. Since the calcaneus has not been used for the same purpose in South Africa, the aim of this study was to derive regression equations that will allow this bone to be used for stature estimation amongst South African blacks. A total of 116 complete skeletons (60 males and 56 females) were selected from the Raymond A. Dart Collection of Human Skeletons, School of Anatomical Sciences, University of the Witwatersrand, Johannesburg. The total skeletal heights of these sets of skeleton were calculated using Fully's (1956) anatomical method. Nine calcaneal parameters were measured and regressed

against the total skeletal heights using univariate and multivariate regression methods. Regression equations were therefore obtained for use in estimating stature from the calcaneus of the South African black population. The standard error of estimate that was obtained when univariate regression analysis was done was higher than the corresponding values following multivariate regression analysis. In both cases, the standard errors of estimate compared well with the values that have been obtained for fragmentary long bones by previous authors.

**Are juveniles at greater risk than adults? Preliminary data on ecological risk aversion in two species of neotropical monkeys (*Cebus albifrons* and *Saimiri boliviensis*) in Peru.**

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It has been proposed that slow growth rates of many juvenile primates may constitute a tactic to avoid starvation during an age period where they may experience both (1) high predation risk, and (2) high food competition, if they stay near the center of the group to avoid that predation (Janson and van Schaik, 1993). However, preliminary research on *C. albifrons* and *S. boliviensis* over a two-month period at Cocha Cashu Biological Field Station in Peru suggests that juveniles may not respond as predicted to the ecological risks of starvation and predation.

Data were taken at the onset of the dry season when fruit was relatively scarce. One raptor attack on a *S. boliviensis* troop was observed during the study, and numerous potential predators have been observed and studied at the site (e.g. Terborgh, 1983; Emmons, 1987). Thus, it is assumed that ecological risks were not trivial for the juvenile primates during the study period. However, the juveniles did not avoid low or high levels of the canopy more than adults or forage nearer neighbors than adults did. Additionally, juveniles spent similar amounts of time feeding, foraging and engaging in vigilant behavior as adult troop members. While preliminary, these initial data indicate that juvenile behavior in certain species of neotropical monkeys may not necessarily fit a model for risk aversion. Further research is necessary not only to confirm the spatial patterning and behavioral tactics observed during this study, but also to more fully assess ecological risks specific to juvenile primates.

**First line defense: Male dominance rank and aggression against extra-troop males in a wild group of Formosan macaques (*Macaca cyclops*).**

W.A. Birky. Dept. of Anthropology, California State University, Northridge.

This study examined which resident males were most aggressive toward extra-troop males. Three resident males were present in the group and extra-troop males followed the group during the mating season. During the mating season, a daily average of two of the six adult females in the study group were mating (range = 1-5). Inter-male aggression was correlated with the number of observed mounts and males were most aggressive toward other males during the mating season. While aggression among the three resident males was highest during the mating season, most inter-male aggression involved extra-troop males. During the breeding season, 75% of all observed male-male aggression was between resident males and extra-troop males. Extra-troop males were rarely observed near the group outside of the mating season and 99% of all observed resident male aggression toward extra-troop males occurred during this time. There was a negative correlation between resident male dominance rank and aggression toward extra-troop males. The lowest ranking male performed the most attacks on extra-troop males and the highest ranking male the least. These differences among the resident males were statistically significant. The presence of supernumerary males may benefit an alpha male in that he maintains primary access to females while the other males defend against extra-troop males. The gamma male's high rate of agonistic interaction with extra-troop males may indicate that among the three resident males, his access to females was most threatened by extra-troop male incursions.

**The paleoenvironmental setting of hominin activities at Kanjera South, western Kenya.**

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rado, <sup>9</sup>National Museum of Natural History.

Kanjera South, western Kenya, preserves early hominin behavior in a unique geographical and ecological context. In 1995, our team found fauna and Oldowan artifacts from the relatively unknown Southern Exposures at Kanjera South. Taphonomically controlled excavations were begun in 1996 in sediments approximately 2 Ma. The largest of these, Excavation 1 (175 m<sup>2</sup>), has yielded Oldowan artefacts and fossils exhibiting hominid and carnivore damage. The earliest known Oldowan sites date from ca 2.6 Ma and are located within the East African Rift Valley. Located on the shores of Lake Victoria's Winam Gulf, Kanjera is between the branches of the rift valley – a geographical setting from which there are no other known Oldowan occurrences. Abundant faunal remains are well preserved owing to the sedimentation regime dominated by the Homa Mountain carbonatite volcano complex. Fossils have good stratigraphic provenance and preserve anatomical detail, so we can use several methods of paleoecological analysis. Taxon-free, ecomorphic analysis of antelope postcrania and taxon-based faunal analysis suggest that the majority of faunal remains came from animals that preferred open-country habitats. Isotopic analysis of paleosols from Excavation 1 corroborate these results, suggesting that the accumulation of stone artifacts and faunal remains at Kanjera occurred in a relatively open grassland setting. This contrasts with somewhat later sites at Olduvai, where archeological site formation is documented in more closed and wooded habitats. Our studies demonstrate that Oldowan hominins had considerable behavioral flexibility and lived in a range of habitats during the later Pliocene and early Pleistocene.

**Can heterochrony explain patterns of craniofacial growth in three species of howler monkeys? A test using a multivariate tool.**

M.B. Blanco, L.R. Godfrey. Dept. of Anthropology, University of Massachusetts.

We applied a new statistical tool, HETPAD (Heterochronic Prediction and Diagnosis), to ontogenetic data collected for three species of howler monkeys: *Alouatta palliata* (n=98), *A. pigra* (n=43) and *A. seniculus* (n=67). HETPAD treats suites of traits simultaneously and tests the efficacy of heterochronic processes (either globally or in distinct modular units) in explaining ontogenetic differences. For

each skull, 33 cranial landmarks were digitized using a Microscribe. Digital photographs of the dentitions were used to quantify the degree of macrowear (using SigmaScan Pro), and (with dental eruption data) to assign ages (from 0.2 to 20 years) to individuals. Using distances between cranial landmarks, logistic growth curves were calculated for pooled sexes of each species, and for males and females in *A. palliata*. HETPAD was then applied to test alternative heterochronic explanations of their differences.

Molecular data have demonstrated that *A. palliata* and *A. pigra* are more closely related to each other than is either to *A. seniculus*. Heterochrony (changes in the timing of developmental events) is thought to be an important source of morphological differences between closely related organisms. One might therefore assume that the ontogenetic trajectories of conspecific males and females, or of individuals belonging to closely related species, would be more likely to differ via simple heterochronic shifts than would more distantly-related species. This paper examines that supposition for howler monkeys.

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#### **Quantitative trait locus mapping in psychiatric/behavioral genetics: The state-of-the-science.**

J. Blangero. Dept. of Genetics, Southwest Foundation for Biomedical Research.

The revolutionary advances in human genetics during the last decade promise to finally open up the black box of complex trait genetics early in this new century. Important breakthroughs in both molecular and statistical genetic techniques now make it possible to localize and identify the genes that influence quantitative phenotypes using studies of extended human families. Applications of this powerful strategy are still in their earliest phases in the immensely complicated area of psychiatric and behavioral genetics. This phenotypic area has been the subject of much controversy regarding the relative importance of heredity versus environment since classical biometric approaches generally confound these two important dimensions making their separate evaluation difficult. Given this problem, some biological anthropologists have spent a great deal of time attempting to repudiate simplistic definitions of heritability. However, the modern genomic approach eliminates the confounding of genes and environment. Thus, classical arguments regarding the inadequacy of

genetic approaches still currently in vogue in the anthropological community are no longer valid. In this paper, I will review the current state-of-the-science for mapping and identifying genes influencing quantitative traits in human populations. I will show that by using a genome scan approach, even the most complex of phenotypes (such as behavioral phenotypes) can be genetically dissected, including the localization of underlying quantitative trait loci (QTLs) and the complete description of their functional allelic architectures. Using these methods, many of the controversies regarding the genetic basis of neurobehavioral traits can be resolved.

#### **Comparative cranial anatomy and cladistic analysis of Paleocene primate *Carpolestes simpsoni* using ultra high resolution X-ray computed tomography.**

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Newly discovered crania of *Carpolestes simpsoni*, acid prepared from latest Paleocene limestones from the Clarks Fork Basin, Wyoming, are the first described for the family Carpolestidae. The two most complete skulls were studied using ultra high resolution X-ray computed tomography. Data presented here demonstrate that diversity of cranial form in archaic primates (Plesiadapiformes) is greater than previously thought. The skull of *Carpolestes* differs from Euprimates and is similar to other plesiadapiforms (*Ignacius* and *Plesiadapis*) in lacking a postorbital bar and a reduced snout. Unlike *Ignacius*, which has an entotympanic bulla, *Carpolestes* appears to have a petrosal bulla, a condition also found in *Plesiadapis* and Euprimates. *Carpolestes* has an unreduced internal carotid circulation with clear grooves for both the promontorial and stapedia arteries. These vessels take a transpromontorial route from a posteromedially positioned posterior carotid foramen, with no evidence that bony tubes surrounded them (unlike those of euprimates and *Ignacius*). *Carpolestes* differs from other plesiadapiforms and all primitive euprimates in possessing a two-chambered auditory bulla similar to that of modern *Tarsius*. However, cladistic analysis of cranial characteristics supports a monophyletic Euprimates, excluding *Carpolestes*, suggesting that this bullar configuration is the result of convergent evolution. A primate clade that includes all non-

microsopoid plesiadapiforms and euprimates to the exclusion of dermopterans, chiropterans, or scandentians is also supported. Further cladistic analyses utilizing cranial, postcranial, and dental evidence are underway and promise to more fully resolve the phylogenetic position of Carpolestidae relative to other primates.

#### **A phylogenetic approach to quantifying the relationship between age of first reproduction and maximum lifespan.**

G.E. Blomquist, M.M. Kowalewski, S.R. Leigh. Dept. of Anthropology, University of Illinois.

Recent models of human life history evolution imply correlated evolution among a variety of reproductive and survivorship variables. However, questions remain about the strength of structural relationships among these variables. Moreover, relatively few analyses have applied rigorous phylogenetic controls to this problem. This study explores the patterns of correlations among life history variables in order to evaluate mechanisms that influence specific human life history attributes.

Data are derived from literature sources, and include age at maturation (alpha), lifespan estimates, and body mass for anthropoid primates. Regression analyses and partial correlations are applied to these data to assess structural relations among variables and provide scaling information. Phylogenetic control is undertaken using independent contrasts. Nine clades within the anthropoid sample are defined, six of which are nonoverlapping. Partial correlations with phylogenetically unadjusted data show no significant associations between alpha and maximum lifespan in anthropoids. Contrasts, however, indicate that alpha and maximum lifespan are moderately correlated ( $r = .720$ ,  $p < .001$ ). Adjusted data scale near isometry ( $m = .934 \pm .179$ ).

These results provide evidence for correlated evolution between alpha and maximum lifespan. However, the strength of these correlations creates problems in interpreting specific cases and implies there is substantial room for divergent adaptive histories between these two traits. This may suggest that long delays in human maturation are not necessarily offset by compensatory changes in lifespan. Other life history, demographic, or cultural variables may play significant roles in structuring human life histories.

### **Correlated evolution in hominid midfacial morphology: Neandertals in a comparative context.**

J.A. Blumenfeld, G.E. Blomquist, M.M. Kowalewski. Dept. of Anthropology, University of Illinois.

Much attention has been focused on understanding the significance of Neandertal craniofacial morphology in terms of both function and phylogeny. Comparative studies examining the functional significance of the Neandertal midface have revolved around climatic, phylogenetic or biomechanical explanations. Alternatively, these features may be related to species differences in size.

In this study, characteristic Neandertal facial features that are generally thought to be adaptations to either a cold climate or intense anterior tooth use are examined in relation to a diverse comparative sample of both fossil and recent humans in order to determine whether they are significantly correlated with species differences in size. These features are: pronounced midfacial prognathism (measured by the zygomaxillary angle and the nasio-frontal angle) and nasal apertures that are very broad in relation to facial breadth (measured by the nasal/facial breadth index). Size was estimated for the purpose of this analysis as the geometric mean of five facial measurements.

Incorporation of size-adjustment in this analysis strongly affected the results. The two midfacial angles show correlated evolution, the strength of which increases once size-adjusted. However, the nasal/facial breadth index and the zygomaxillary angle covary only in the unadjusted data. This analysis shows a strong structural integration between the two midfacial angles. However, this does not discriminate between climatic, phylogenetic or biomechanical explanations for Neandertal midfacial prognathism.

### **Assessment of upper premolar morphological traits as reliable phylogenetic indicators.**

L.C. Blundell. Dept. of Anthropology, University of Durham.

Upper premolar morphological traits have been used in several studies that argue for alternative phyletic placements of early and middle Miocene fossil hominoids relative to extant primate clades. The underlying interpretation is that upper premolar enlargement relative to the first and/or second molar and a reduction in upper premolar cusp heteromorphy are characteristic of extant apes.

This study tests the strength of the phylogenetic signal contained within these characters to determine whether they diagnose the groups of living primate taxa for which they are proposed.

The hypotheses are evaluated by means of character state analysis performed on seven metric characters derived from associated upper premolar and molar data collected from seventeen extant and fifteen extinct catarrhine species. The computer programme MacClade is used to optimize character state distributions at hypothetical extant ancestral nodes and subsequently, to evaluate the reconstructed nodes on published topologies that incorporate fossil taxa.

The results indicate that there is only a very weak phylogenetic signal contained within upper premolar size and cusp heteromorphy, as both characters fail to unambiguously diagnose groups of living apes as clades. Further analyses suggest that relative upper premolar enlargement is an adaptation to hard object feeding, but the functional significance of cusp heteromorphy remains unclear. These findings imply that phylogenetic analyses that incorporate one or both dental traits to develop a phylogenetic framework within which to place fossil taxa relative to extant anthropoids are fundamentally flawed because neither character provides convincing evidence of common ancestry relationships.

### **A comparative approach to faunal analysis in the Hadar and Turkana regions.**

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The relationship between climatic and faunal change provides key evidence for hypotheses concerning cause and effect in evolution. In this context, an appropriate scale of faunal analysis is the sedimentary basin, which presents an intermediate level of resolution between large-scale patterns of climatic change and local patterns observed in paleontological localities. Here we integrate and compare data from two of the most fossiliferous sedimentary basins that preserve East African Plio-Pleistocene mammals, the Turkana Basin and the Hadar Region (Kenya and Ethiopia). The data derive from the Hadar Faunal catalog and the Turkana Basin Paleocology Database. Our results show that the fauna from different areas of the Turkana Basin (Omo, West Turkana, Koobi Fora) did not always vary synchronously. Thus, the proportion of

alcelaphine and antelope bovids in the Omo is very low (less than 5% of the fauna) in the early part of the sequence, but increases after 2.5 Ma and shows pronounced peaks after 2 Ma. In contrast, at East and West Turkana, these bovids have higher abundances than in the Omo and do not show pronounced trends through time. At Hadar, a marked increase in alcelaphine bovids occurs several hundred thousand years earlier than in the Omo. These results show that although climate may have driven some faunal changes in Africa, local and regional environmental differences linked to tectonic and volcanic processes also played a role in shaping the habitats and adaptive pressures affecting early hominid evolution.

### **Milk and human development.**

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Milk is a problem food for medical, nutritional, and biological anthropologists. Milk consumption causes more allergies and adverse reactions than most other foods. Milk also is associated with many positive health measures, including greater stature, greater bone density, and lower blood pressure early in life as well as less risk for premenstrual syndrome and for osteoporosis later in life. Data from post-World War II Japan, several pastoralist cultures around the world, nutrition supplementation programs, and experimental studies are, generally, consistent in support of milk consumption.

The nutrients contained in milk, especially calcium, vitamin D, protein, phosphorus, and fats, are known to be necessary for adequate bone development and growth, both in length and in bone density. The risk for health problems in later life, particularly for osteoporosis, may be reduced by greater consumption of milk during infancy and childhood. Milk supplementation programs in schools improve both school attendance and school performance. A Portuguese milk supplementation program is highlighted as an example of the benefits of milk on both physical and cognitive development. Original research with the offspring (10-14 years old) of Cape Verde immigrants to Portugal shows that the end of the milk program in 1994 is associated with a negative secular trend in stature for boys and no change in stature for girls. Estimates of milk consumption by the children (5-12 years old) of Maya immigrants to the United States show no statistically significant effect on stature. For these

Maya-American children milk consumption may be part of an obesogenic diet.

**Genetic relationships among the prehistoric Adena and Hopewell.**

D.A. (Weiss) Bolnick. Dept. of Anthropology, University of California, Davis.

The prehistoric Adena (2500-1800 ybp) and Hopewell (2100-1600 ybp) cultural traditions of the Ohio and Illinois Valleys are well known for their elaborate mortuary practices, large burial mounds and earthwork sites, and extensive exchange networks. These two cultural traditions have been the subject of intense archaeological research for over a century, but many questions still remain about the populations who practiced them. In particular, since archaeological data cannot provide direct evidence of genetic relationships, the biological relationships among Adena and Hopewell populations are unknown and it remains uncertain whether the appearance of these cultural traditions resulted from biological changes (e.g. population expansions and subsequent admixture or replacement events). The biological relationships between these ancient populations and modern Native American groups also remain unknown.

To help resolve these questions, skeletal samples were obtained from two Adena burial mounds in Kentucky and from the Middle Woodland (Hopewell) Klunk site in Illinois. DNA was extracted from these samples and mitochondrial DNA (mtDNA) haplogroups, defined by restriction fragment length polymorphisms and the presence or absence of a 9-bp deletion, were identified. A portion of the mtDNA control region was also sequenced in a subset of individuals. These data were compared with data from other prehistoric and modern Native American populations to evaluate genetic relatedness and to help characterize the genetic prehistory of the Ohio and Illinois valleys.

**Anatomical growth and development in hamadryas baboons (*Papio hamadryas*) compared with the closely related vervet monkeys (*Cercopithecus aethiops*).**

D.R. Bolter. University of California, Santa Cruz.

Growth patterns were compared between a mixed-age sample of 16 hamadryas baboons collected from Ethiopia with a collection of 63 vervets from Uganda. In both samples, body mass and trunk lengths were recorded at collection.

Epiphyseal union and dental eruptions were assessed for each skeleton, and cranial capacities measured.

Hamadryas baboons and vervet monkeys show similarities in growth, specifically in the expression of sex differences. Females and males of both species differ in trunk length, a measurement that becomes evident only after dental eruption is complete; in addition, adult females have a greater brain size relative to body mass compared to the adult males.

However, the two species differ in female growth rates. Female vervets fuse all pelvic elements at a younger dental age than do female hamadryas. In contrast to the differences in hip joints, the elbows, knees, ankles, wrists and shoulder joints of both species fused at the same dental age.

These findings suggest that males "bulk up" during juvenility without an increase in trunk length or brain size, which may be part of a cercopithecine model of development. Female growth rate differences in the pelvis suggest that dental and skeletal growth may be independently regulated and that the differences represent species-specific adaptations. The earlier completion of vervet pelvic growth may be necessary to support earlier reproduction (as young as 4 years compared to the hamadryas baboons at about 6.5 years). This study refines our knowledge of Old World monkey patterns of growth, and female/male differences in maturation.

**Decomposing directional asymmetry for bilateral landmark data: Applications to the adult human face and body.**

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For landmark point data, fluctuating asymmetry (FA) and directional asymmetry (DA) have recently been reinterpreted not as numerical summaries of trait values but instead as statistical components of the difference between the shape of a landmark configuration and of its mirror image as that shape difference varies over a sample of organisms. Both DA and FA can then be displayed as thin-plate spline grids (for FA, the display is of principal components). These grids obey an unusual formal constraint: the left and right halves are exact mathematical opposites. This peculiar property leads to a convenient special language for reporting the grids in biological terms. For instance, DA at the unpaired (midline) landmarks is

necessarily summarized by a simple height profile, while a uniform asymmetry still appears uniform in these grids.

We emphasize three problems of enduring interest to anthropologists: directional asymmetry of bony craniofacial form, soft-tissue facial form, and whole-body soft tissue form in humans. Particularly interesting for applications in applied anthropometrics is a new model of pure size bilaterality, wherein the mirrored landmark configurations differ in size but not in shape between left and right. This model corresponds to the unspoken assumption behind most of the classic trait-driven asymmetry methods. When landmark data are available, it becomes a testable hypothesis instead.

**Space available in the mandible does not influence times of molar initiation.**

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A fundamental question in primate or dental evolution is whether space available in the growing mandible for the developing permanent dentition influences or controls tooth initiation times. The aim of this study was to identify any differences in mandibular growth that might underlie known differences in the timing of permanent molar tooth initiation that exist between baboons (*Papio anubis* n=52) and great apes (*Pan troglodytes* n=60, *Pan paniscus* n=44). Radiographic and three-dimensional (3D) co-ordinate landmark data were taken from individuals of these three taxa representing a broad range of developmental ages. Multivariate statistical shape analyses (MSSA) show that baboon and ape mandibles develop across statistically different ontogenetic trajectories of shape change, while those of the two ape species are identical. MSSA of all developing molar crowns and the mandibular canal demonstrate that ontogenetic trajectories of shape change of the molar row are indistinguishable among these three taxa. Qualitative studies of the 3D molar data show that neither space between adjacent molar crowns nor space distal to the last initiated molar to the mandibular foramen is significantly different between *Papio* or *Pan* at any time. While the pattern of mandibular growth is different between genera, neither pattern of permanent molar crown mineralisation nor the space surrounding each developing crypt or germ is taxonomically distinct. Rather, the mandible and dentition are a

good example of two developmentally autonomous systems that have evolved in compliment, each under strong selection pressures.

**Population-level genetic variability in wild western gorillas.**

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Previous studies of genetic diversity in gorillas have reported a high degree of mitochondrial DNA (mtDNA) sequence variability in western gorillas as compared to mountain gorillas (nucleotide diversity,  $\pi = 5.19\%$  and  $0.580\%$  respectively). However, this finding was based largely on samples from captive individuals of unknown, but probably widespread, geographical origin. Here we report results from the first investigation of genetic variation in western gorillas at the population level using a limited geographic sampling regime similar to that used in studies of mountain gorillas. We collected feces samples from wild western gorillas ( $n = 26$ ) at three sites in the Central Africa Republic – Republic of Congo border region (Mondika, Bai Hokou, and Mbeli Bai) with a maximum distance of  $< 70$  km between sites. A 382 bp segment of the mtDNA control region (HVR1) was cloned and sequenced. Our results indicate that although western gorillas may have a high degree of genetic variability across their range, genetic diversity within this regionally-defined population is quite low ( $\pi = 0.327$ ), and is in fact similar to that observed in mountain gorillas. We found only 5 haplotypes, or unique sequences, among the individuals sequenced, and the most common haplotype was shared by 60% of these individuals. This result is consistent with a scenario in which the high mtDNA diversity of western gorillas is a result of population substructuring, and also suggests female gene flow may be limited.

**Behavioral contrasts between Sykes' monkeys and vervets after adult male turnover.**

C.A. Bramblett. Dept. of Anthropology, The University of Texas, Austin.

Sykes' monkeys and vervet monkeys characteristically have multimale, multi-

female social groups, but they exhibit very different spatial and social organization. Though matriline dynamics of both species are similar, vervet males exhibit the complex adult male alliances and interactions that are frequently seen in *Papio* and *Macaca* Sykes' monkeys, in contrast, did not tolerate more than one adult male in close quarters.

In our laboratory, when an adult male vervet monkey was aggressively defeated by another male, the loser had numerous options - migration, within group avoidance, redirection of tension, appeal to a supporting matriline, and support of male allies. However the defeat of a Sykes' monkey male resulted in only two options, migration or death. Although there was no observable aggression or intimidation, defeated Sykes' monkey males underwent a "wasting" regime where they refuse food and water. Movement across a cognitively defined barrier turned wasting behaviors on and off. These behaviors offer a unique insight in some of the mechanisms that underlie the species differences in male spatial and social behaviors.

The Department of Anthropology and the College of Liberal Arts at the University of Texas at Austin maintained these guenon groups from 1968 to 1998 as a resource for undergraduate students in a primate behavior class.

**The Neandertal-modern transition: Models, gene flow and the fossil evidence.**

G. Bräuer. Dept. of Human Biology, University of Hamburg.

There are a number of different scenarios regarding the relationship between Neandertals and early modern Europeans, ranging from a gradualist ancestor-descendant model to complete replacement of the Neandertals by immigrant modern populations. Most researchers appear to favor an African origin of modern morphology and some degree of gene flow during the period of co-existence in Europe. However, controversy exists as to the possible degree of Neandertal contribution to the early modern gene pool, which led to differing models. The present paper focuses on the different assumptions regarding the gene flow in the various models and shows that they are partly due to misunderstanding. For example, the Out-of-Africa model, as seen by most of its supporters, is not identical to the extreme complete replacement view but assumes the possibility of gene flow and accepts any convincing evidence of it in the fossil record. With this intention,

morphological features which have been suggested to show regional continuity are examined among early modern Europeans. Based on these results and other pieces of evidence critical to the gene flow problem, it is considered which of the different scenarios best fits with the fossil evidence.

**Paleopathological investigations at the historic cemetery of St. Martins, England.**

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Investigation of historic cemeteries, for which documentary sources exist, provides a unique opportunity to investigate the effects of socio-economic conditions on the health of individuals. Re-development and landscaping of the area around St. Martin's church, Birmingham, England, required excavation of the site. 35 vaults and 775 earth-cut graves, dating predominantly to the 18<sup>th</sup> and 19<sup>th</sup> centuries were located and investigated.

Documentary work undertaken demonstrates that those buried in vaults were part of the new middle class of the rapidly developing city. For example, older members of the extended family buried in vault 5 had moved to Birmingham from villages in the region at the turn of the 19<sup>th</sup> century and established what became successful businesses, allowing a move to the new suburbs around the city. Analysis of individuals from vaults demonstrated that 78% of individuals were largely complete and most (70%) were well preserved, allowing comprehensive recording of skeletal pathology and abnormalities.

Investigation of skeletal pathology has revealed a number of interesting results. Although, levels of deformity linked to vitamin D efficiency was low in individuals from vaults (1.3%), other conditions were seen more frequently than in the rest of the site, for example DISH (4.9%) and nasal fractures (5.8%). The differences in levels of pathologies is reviewed and it is demonstrated that although the move out of the city to the suburbs may have protected against some conditions 'better' levels of health did not automatically follow.

**Broca's area homologue in great apes: Implications for language evolution?**

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Functional language dominance in humans has been related to anatomical asymmetry of Broca's area and the planum temporale. The evolutionary history of these asymmetric patterns, however, remains obscure. Although testing of hypotheses about the evolution of language areas requires comparison to homologous regions in the brains of our closest living relatives, the great apes, to date little is known about normal inter-individual variation of these regions in this group. Here we focus on Brodmann's area 44 of *Pan troglodytes* and *Gorilla gorilla*, an area that corresponds to the pars opercularis of the inferior frontal gyrus and has been shown to exhibit both gross and cytoarchitectural asymmetries in humans. We calculated frequencies of sulcal variations and mapped the distribution of area 44 to determine whether its boundaries occurred at consistent cytoarchitectural landmarks. A considerable amount of variation was found in the distribution of inferior frontal sulci among great ape brains. The inferior precentral sulcus, in particular, was often bifurcated making it impossible to determine the posterior boundary of pars opercularis. Additionally, the distribution of area 44 showed very little correspondence to surface anatomy. We conclude that gross morphologic patterns do not offer substantive landmarks for the measurement of Brodmann's area 44 in great apes. While the general architecture of this region is similar between apes and humans only further analyses of the cytoarchitectural components of Broca's area homologue will resolve questions of functional similarities. However, we are skeptical, given these results, that this region in apes is homologous in function.

#### **Noninvasive assessments of stress in male sifaka (*Propithecus verreauxi*).**

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Although stress plays a central role in models of lemur social evolution, estimates of stress in wild populations are limited. We have previously shown that social disruption associated with male dispersal in free-ranging male *Propithecus verreauxi* elevates male testosterone. This study examined the utility of several noninvasive corticosteroid assays for as-

sessing stress responses to male dispersal in sifaka.

Analyses were based on a total of 525 fecal samples collected over 3 field seasons from 84 adult males residing in 47 different groups at Beza Mahafaly, Madagascar. Cortisol (CORT) and corticosterone (CCOS) radioimmunoassays were compared for their ability to detect glucocorticoid metabolites in sifaka feces and to index stressful events and states. Correlations between CORT and CCOS were compared across samples and across means for individual males. Associations with male rank were tested for both CORT and CCOS. Variations in fecal glucocorticoid levels were examined in relation to the diurnal cycle and dispersal-related events.

Results showed that CORT and CCOS could be reliably and accurately measured in sifaka feces. However, mean CORT levels for individual males were poorly correlated with their mean CCOS. CORT and CCOS profiles were qualitatively similar, but peaks were proportionately larger with the CCOS assay. Both CORT and CCOS varied annually, which may be attributable to climatic or demographic variables. Neither glucocorticoid was significantly associated with male rank, but varied in relation to dispersal events. These data demonstrate that noninvasive measures of stress can provide new insights into the regulation of male dispersal.

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#### **The effect of women's autonomy on child nutritional status in northern Kenya.**

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This study explores the role of female autonomy – the ability to control household and societal resources – among the Rendille of northern Kenya. In this society, as in many others, women are often responsible for making choices that affect their household members, including the type and amount of food they eat and what medical attention they receive. The degree to which they are able to make these decisions on their own, without having to consult with or ask permission from their husbands or in-laws, in other words their level of autonomy, can dramatically affect how successful their efforts are, however. In this study, it is hypothesized that as the level of a woman's autonomy increases, so will the nutrition and consequently the health of her children.

This hypothesis is tested using data collected from 915 Rendille women and their children, representative of both nomadic and settled households. Measurement of women's autonomy is based on the cumulative score from an eleven-item questionnaire that ranks how much decision making power women have in things such as birth control, children's health care and purchasing food. Children's nutritional status is based on anthropometrics, particularly height for weight Z scores. In a preliminary analysis using a hierarchical regression model, controlling for community and individual-level factors, women's autonomy was found to be marginally significant ( $p > .07$ ) for children over 36 months. In this model, autonomy was positively correlated with children's nutritional status ( $R = .161$ ), that is as women experienced greater levels of decision-making power, their children's nutrition improved.

#### **Facial expression musculature in *Otolemur* with a comparison to the lemuroids.**

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Facial expression is a form of social signaling among mammals and is a primary means for close proximity non-verbal communication is achieved, most notably in primates. Muscles of facial expression have been well described in catarrhines and many lemuroids but their arrangement is poorly known in the lorises. This study presents gross and histologic aspects of facial expression musculature in *Otolemur* spp. and compares them to the arrangement in lemuroids. Dissections of 18 preserved faces of *Otolemur* spp. were used (10 *Otolemur crassicaudatus*, 8 *O. garnettii*). Arrangement and appearance of muscles were examined and samples were gathered from each muscle for histologic processing. The present study found 17 muscles of facial expression in *Otolemur* as compared to previous studies that located only seven. Histologically, muscles of the ear region were arranged in tight, dense fascicles while muscles of the orbital region were arranged more loosely. Grossly, facial expression muscles in *Otolemur* were similar in morphology and attachments to those in the lemuroids, with some differences in the ear region. *O. garnettii* had several muscles that appeared to be more robust than in the larger *O. crassicaudatus*, which may relate to dietary and/or social differences. Pre-

vious studies concluded that *Otolemur* possesses a primitive arrangement of facial expression muscles relative to lemuroids. Results from this study do not support this conclusion and, in fact, support a far greater similarity between greater bushbabies and lemuroids. These results may have taxonomic value relative to the position of *Otolemur* with lemuroids and indicate the need to examine other species of bushbabies.

#### Brain disorders in human evolution.

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To the extent that evolution of modern *Homo sapiens* was influenced by creative genius, the expression of potentially harmful genes associated with disorders of the brain and mind, become an important part of the human condition, and not something ancillary to it. A problem arises because in their full-blown manifestations these genotypes seem to offer no selective advantages, while decreasing the chances for procreation. However, this is a pseudo-problem if the genotypes are seen as distributed within a continuum. Furthermore, the environments in which they appeared were constantly changing thereby creating the potential for new adaptive niches. Beginning with the Upper Paleolithic, the human species created and adapted to new ecosystems, culminating in the modern 'artificial' world of the 21<sup>st</sup> century. These parallel worlds favored genotypic expressions that lacked adaptive significance before the rise of *Homo sapiens*. The favorable conditions for these 'new' geno-and-phenotypes evolved, generally, in three major stages. The first corresponds roughly to the Upper Paleolithic, the second to the onset of civilization, and the final one to the modern technological-scientific society. Labels for these stages are convenient rather than definitive; nor do developments within and between them occur linearly. In each stage the adaptive value of links between genius and certain mental disorders would favor certain genotypes over others. Thus, the current technological-scientific environment may favor the expression of behaviors formerly considered divergent more than any previous period in human history or evolution.

#### Ecological partitioning in Tai Forest guenons: *Cercopithecus campbelli*, *C. petaurista*, *C. diana*.

P.J. Buzzard. Columbia University, NY-CEP.

To investigate interspecific competition in guenons, I studied ecological niche partitioning in terms of diet and strata use during a 13 month study of *Cercopithecus campbelli*, *C. petaurista* and *C. diana* at Tai Forest, Cote d'Ivoire. Fruit was the most common diet item for *C. campbelli* and *C. diana*, but animal matter was also important for *C. campbelli*. Foliage especially the young leaves and shoots of lianas was the most common diet item for *C. petaurista*. Adult males of all species ate more fruit than adult females, and juveniles ate more insects than adult males. However, intraspecific diet overlap in food items was greater than interspecific overlap. Fruit availability decreased in the short dry season (June-July). During this time, *C. campbelli* ate primarily invertebrates; *C. diana* ate primarily foliage, and *C. petaurista* ate primarily flowers and fruit. Vertical stratification resulted in *C. diana* utilizing primarily the canopy, *C. campbelli* the lower strata and ground, and *C. petaurista* the middle strata. The majority of *C. campbelli* fruit came from the ground and small fruit trees. *C. diana* fed more often in large fruit trees, and *C. petaurista* fed most often in medium and large fruit trees. Ecological niche partitioning was more distinct in the Tai guenon community than in most guenon communities studied to date. Intraspecific diet differences and seasonal shifts in diet were not as great as in some guenon communities suggesting that interspecific competition is not as important in Tai.

#### Anatomical correlates for suspensory behaviors in douc langurs.

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While it has been argued that none of the Old World monkeys habitually brachiate, our recent research at the Endangered Primate Rescue Center of Cuc Phuong National Park, Vietnam has documented that both red-shanked and grey-shanked douc langurs (*Pygathrix nemaeus* and *P. cinerea*) frequently use suspensory locomotion and postures. Moreover, these douc species express these suspensory behaviors much more frequently than do Hatinh or Delacour's langurs (*Trachypithecus laotum* and *T. delacouri*). For example, while suspensory locomotion accounts for more than 45% of the locomotion of red-shanked douc langurs it accounts for less than 5% of the locomotion of the Hatinh or Delacour's langur.

A comparison of the skeletons of Southeast Asian colobines document that red-shanked and grey-shanked doucs are distinctive in being characterized by a suite of anatomical features commonly associated with the suspensory behaviors of spider and wooly spider monkeys and hominoids. These include a long vertebral and short cranial border on the scapula, a broad sternum and long clavicle, an elongated humerus, a medially oriented medial malleolus, a trochlea with medial and lateral margins of approximately the same size, extremely elongated radius and ulna, a reduced olecranon process, a small pisiform, and long digits. This anatomical suite along with the positional behavior of red-shanked and grey-shanked douc langurs allows for a reappraisal of the locomotor sub-category Old World semibrachiator of Napier and Napier (1967).

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#### Biomedical anthropology: From emerging synthesis to established discipline.

N. Cameron. Dept. of Human Sciences, Loughborough University, UK.

The thought that medicine and anthropology could be synthesised and that the product was greater than the sum of the two parts would have been a radical departure from the compartmentalization that characterised scientific thought, and action, in the middle of the 20<sup>th</sup> century. The fact that we now recognise a field of legitimate academic study called "biomedical anthropology" is a tribute to the pioneering work of a handful of anthropologists and clinicians who defined, shaped, and nurtured this emerging field of enquiry. Johnston and Low (1984) – a physical anthropologist and a medical anthropologist – sought to define biomedical anthropology as a combination of the theory and methods of both physical and medical anthropology that provides an approach to questions of health and disease from an anthropological perspective. This approach explains the biological basis of health and diseases but appreciates the socio-cultural context within which they coexist. Biomedical anthropology owes its distinction to three factors: (1) it applies anthropological theory to problems of health and disease, (2) its research focuses on a biological outcome, and (3) explanations of health and disease processes incorporate both biological and cultural perspectives. In this way it is distinct from physical anthropology that

focuses on evolutionary and ecological outcomes, and medical anthropology that focuses on cultural systems of meaning and behaviour to explain health and disease. This paper reviews 20 years of biomedical anthropology from its emergence as a synthesis to its acceptance as an established discipline.

Johnston FE, Low SM. 1984. Biomedical Anthropology: An Emerging Synthesis in Anthropology. *Yearbook of Physical Anthropology* 27:215-227.

**Terrestrial behavior of spider monkeys (*Ateles* spp.): A comparative study.**

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Spider monkeys (*Ateles* spp.) are well known for their highly arboreal lifestyle, spending much of their time in the highest levels of the canopy, rarely venturing down to the ground. We analyze *ad libitum* data from five study sites, covering two species and five subspecies, to investigate ground use by this genus and attempt to illuminate the conditions under which spider monkeys venture to the ground. Three of the sites are located in Central/North America: Barro Colorado Island, Panama (*Ateles geoffroyi panamensis*), Santa Rosa National Park, Costa Rica (*A. g. frontatus*), and Punta Laguna, Mexico (*A. g. yucatanensis*). The two remaining sites are in South America: Manu National Park, Peru (*A. belzebuth chamek*), and Yasuni National Park, Ecuador (*and A. b. belzebuth*). Data suggest that ground use by *Ateles* across all sites is rare, however it is more restricted at the two South American sites. In South America, ground use was only observed in the contexts of eating soil or rotten wood and visiting saladeros (salt licks). In contrast at the three *A. geoffroyi* sites it was observed in the contexts of drinking from streams during dry seasons, adult females escaping attack by adult males, and as part of a "chase game". In addition, on BCI adult males were seen on the ground while eating soil and prior to attacking adult females. Potential explanations (e.g., climate, taxonomy, predator pressure) for the differences between the Cen-

tral/North and South American sites are discussed.

**Possible ecological impact of tephra deposition in the Koobi Fora Formation, northern Kenya.**

C.J. Campisano. Dept. of Anthropology, Rutgers University.

While there have been numerous studies regarding volcanic deposits as isochronous markers at paleoanthropological sites, little research has focused on the ecologic and paleogeographic response to the abrupt and in some cases voluminous influx of volcanic material upon the hominid landscape. Here, sedimentological and microstratigraphic analyses of floodplain deposits of the Tulu Bor Tuff (ca. 3.4 Ma) from the Koobi Fora Formation as well as studies from modern volcanic eruptions are used to elucidate both the time frame of tephra deposition its potential impact on the pre-existing landscape and subsequent recovery. While variation in the formation does exist, a large area (>25km discontinuous transect) was mantled by an average of three meters of very fine-grained tephra, possibly in seasonal flooding regimes over a period as short as three years. Initial impacts include the burial of grasses and at least sub-meter shrubs and brush as well as the isolation of the nutrient rich top soil. Tephra deposition could also have significantly delayed the subsequent recovery of the usually dynamic floodplain environment for decades, leading to a relatively barren landscape consisting mainly of surviving large brush and trees. At the bare minimum, this event converted a variable environmental landscape into one that was most likely extremely uniform and with less topographic variation. Similarly, it would have modified the structure, species composition, and overall abundance of the area's vegetation. Such changes in floral communities would no doubt have affected the distribution of faunal communities, including hominids, across the Pliocene landscape.

**Mineral density patterns in femora and humeri of African pongids.**

K.J. Carlson. Dept. of Anatomical Sciences, State University of New York at Stony Brook.

Mineral density (MD) data of 226 African pongids encompassing both species of *Pan*, as well as all subspecies, and all subspecies of *Gorilla* are quantified using Computed Tomography (CT) images and

macros written for Scion Image image analysis freeware. Data from ipsilateral femora and humeri at mid-distal (35% length), midshaft (50% length), and mid-proximal (65% length) diaphyseal cross-sections are compiled. Left or right pairs from each individual are randomly chosen.

Trends in MD of the femur relative to the corresponding location on the humerus emerge. Gorilla sexes, particularly in western lowland gorillas, differ significantly at each diaphyseal location. Females typically exhibit greater humeral than femoral MD at each location along the diaphysis, while males typically exhibit greater humeral than femoral MD only at the mid-distal diaphysis. Chimpanzees do not differ significantly by sex. Each sex tends to follow the same pattern as male gorillas; greater humeral than femoral MD usually occurs only at the mid-distal diaphysis. Side relative differences (i.e., in left pairs versus in right pairs) are usually more prevalent in *Pan* groups than *Gorilla* groups. Subspecies-specific relative differences in femoral and humeral MD are also observed within each African pongid genus.

One factor associated with fluctuations in local MD of healthy individuals is muscle mass. Thus, these data suggest relative differences in forelimb and hindlimb musculature of African pongids.

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**A quantitative test of natural selection under changing environmental conditions.**

E.A. Carson. Dept. of Anthropology, University of New Mexico, Albuquerque.

Model-bound analyses of microevolutionary processes have contributed significantly to our understanding of the mechanisms operating on phenotypic traits. These methods, however, make the important assumption that interaction with the environment is either absent or comparable across data sets, and therefore has little effect on the ultimate existence and dispersal of phenotypic traits. Anthropologists have acknowledged the importance of the environment in the evolution of modern humans, and although recent work has placed increasing emphasis on the environment as the primary catalyst for micro- and macroevolution, actual quantification of its role in these processes has not been attempted.

This study proposes to alter an existing quantitative genetics equation for phenotypic evolution by natural selection (Via and Lande, 1985) to include a term that accounts for temporal changes in broad environmental variables. The ultimate objective is to determine whether the inclusion of environmental variation in evolutionary models produces more accurate estimates of phenotypic diversity than one that equates phenotypic changes with those in the genotype. Data consist of five craniofacial measurements from 269 modern and 29 Pleistocene crania from southeastern Australia. The genetic component, represented by the variance/covariance matrices of trait heritabilities, is balanced by an environmental term that includes temperature, humidity, solar radiation, and air pressure, among others. Differential weighting of the genetic and environmental contributions to the known phenotypic variation yields a model of evolution by natural selection that can account for temporal changes in Australian craniofacial morphology within the natural context of these populations.

#### **A review of zoonoses transmissible among primates.**

J.R. Carter. Texas Tech University.

Due to their close evolutionary and often synecological relationships, humans and simians share a broad range of pathogens. The purpose of this paper is to set the background for subsequent papers in this symposium presenting field data regarding cross-species transmissions. Accordingly, there are two key objectives: 1.) to review disease classifications germane to primates and 2.) to provide updated tabular summaries of those transmissible agents which have been demonstrated to infect nonhuman primates. For example, free-ranging primates are recognized as reservoir hosts for a variety of pathogens and presumed in others: bacterioses (e.g., shigellosis bidirectional between captive nonhuman primates and humans), rickettsioses (e.g., Boutonneuse fever in wild vervet monkeys in South Africa), viroses (e.g., forest monkeys are the primary hosts in the "jungle" and "sylvatic" cycles of flaviviruses such as yellow fever among *Cercopithecus* species in sub-Saharan Africa and dengue fever in several non-human primate species in Asia and in South America) and parasitic diseases (e.g., intestinal strongyloidiasis is common in Old World nonhuman primates).

Finally, the evidence for co-adaptation and co-speciation between parasites and

their primate hosts will be discussed briefly (e.g., *Enterobius* species of nematode pinworms and the nonhuman primate species they inhabit). This paper will emphasize the evolutionary context of primate zoonoses and the value of field investigations into concurrent infections and immunology in sympatric primates in order to fully appreciate the potential for, as well as the ecological and human socio-behavioral mechanisms of, cross-species transmissions.

#### **The stable isotopic biogeochemistry of African rain-forest primates: Does bone chemistry record niche separation?**

M.L. Carter. Illinois Transportation Archaeological Research Program, Champaign, IL.

This paper reports results of a study that examined the sensitivity of stable isotope ratios of carbon, nitrogen, and oxygen in bone to niche separation among five well-studied primate species (*Pan troglodytes*, *Papio hamadryas anubis*, *Lophocebus albigena*, *Ptilocolobus tephrosceles*, and *Cercopithecus ascanius*) from Kibale National Park, Uganda. Soil and plant-food samples were also analyzed to characterize the local isotopic ecology. Kibale is primarily a mid-altitude tropical evergreen forest composed of diverse habitats, including exotic pine forests, swamps, and grasslands. The nutritional ecology of these primates has been documented since the 1970s. This study confirmed that certain forest primates regularly consume carbon-13-enriched crop foods and tropical grasses, but the carbon isotopic signatures of these species are not consistently more positive than values from primates that eat only carbon-13-depleted forest plants. Carbon isotope ratios in primate bone collagen and apatite were not correlated with documented vertical niche stratification within the forest canopy. This might indicate greater overlap among microhabitats than estimated by means of field observation. Bones of arboreal primates were more enriched in carbon-13 than bones of terrestrial herbivores (e.g., *Tragelaphus scriptus*). Nitrogen isotope ratios in primate bone collagen did not reflect relative consumption of animal flesh. Although other studies have suggested that eating legumes would decrease nitrogen isotope signatures, this study found that a preferred leguminous plant food (*Newtonia buchananii*) in Kibale had relatively high nitrogen isotope ratios. Unexpectedly high nitrogen isotope signatures in bones of red colobus

might be explained by microbial fermentation and urea recycling in the foregut of this folivore. Oxygen isotope ratios from bone carbonate, which have been shown to record local climate and seasonal change, were positively correlated with the relative dependence on leaves in the diet. Of the Kibale primates, folivorous colobines (n = 27) had the highest oxygen isotope signatures. These results indicate that stable oxygen isotopes in bone record at least one aspect of niche separation among sympatric primates who inhabit overlapping microhabitats. Results of this research add to the increasing knowledge about stable isotope fractionation in natural food webs. Refinements in interpretations of stable isotopic bone chemistry will benefit paleodietary and paleoecological modeling of fossil primates and past human groups.

#### **Locomotor modes of primates at moderate speeds. II. Analysis of support patterns.**

M. Cartmill. Duke University Medical Center.

Most mammals adopt symmetrical walking gaits at low speeds and asymmetrical gaits at high speeds. At intermediate speeds, typical nonprimates use symmetrical running gaits — trotting or pacing — in which pairs of feet strike down together and all four feet are off the ground (aerial phase) twice during each cycle. The percentage of the total cycle spent in aerial phase is a function of forelimb and hindlimb duty factors (percentage of the cycle during which a foot is on the ground). Symmetrical intermediate-speed gaits of primates (other than *Callithrix*) exhibit duty factors like those of the running trot or pace, but the fore and hind limbs have separate, non-overlapping aerial phases, so that at least one foot is always in contact with the support. These "ambles" (Muybridge) may be regarded as either running or walking gaits. In a diagonal-sequence amble, diagonality (the percentage of cycle duration by which each fore footfall trails the ipsilateral hind footfall) must be at least 100 minus the forelimb duty factor, and at most 50 plus the hindlimb duty factor. Preliminary data show that primate ambles exhibit diagonalities near the low end of this range. This distribution eliminates the whole-body aerial phase, preserves diagonal-sequence and diagonal-couplets footfall patterns, and minimizes support by two ipsilateral feet. In running as in walking (Cartmill *et al.*, *AJPA* Suppl. 34: 52), quadrupedal primates adopt gait parameters emphasizing

security and stability rather than acrobatics. [Supported by NSF grant BCS-0137930]

**Frontal bone morphology and gene flow in Late Pleistocene Europe, Western Asia and Africa.**

R. Case. Dept. of Anthropology, Western Michigan University.

The Recent African Origin Model of human evolution posits that anatomically modern *Homo sapiens* evolved in a speciation event 100-200 kya somewhere in Africa. One prediction implicit in this statement is that there was little or no gene flow connecting populations of archaic *Homo sapiens*. Any evidence to the contrary would imply that speciation was unlikely and would force a rejection of the RAO model. Past studies have indicated there is no real evidence of gene flow among these populations, but these studies relied on data derived from individual specimens. This study analyses the pattern of morphological variation in the frontal bone present in archaic *Homo sapiens* in Africa, Western Asia and Europe. Rather than relying on individual specimens, however, demes were constructed based on regional affinities, which were then compared with one another. In addition, distances were calculated for two populations of non-human primate, *Papio cynocephalus* and *Papio anubis*, which are known to hybridize. Distances for each deme were calculated and input into a Cluster Analysis, which produced a dendrogram of the likely relationship of the populations. The distances between adjacent demes were then compared to those of the *Papio* sample in order to establish the likelihood of interbreeding. Morphological overlap among the demes is evident and may represent clinal variation, although further research is needed to confirm this. In addition, the Middle Eastern deme occupies an important position in the Cluster Analysis, suggesting that it played an important role in gene flow among populations of archaic *Homo sapiens*.

**Morphometric analysis of *Cercopithecus solatus*.**

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*Cercopithecus solatus* - the Sun-Tailed Monkey - is a little known species endemic to lowland rainforest of central Gabon. This taxon described by Harrison

in 1988 (*J. Zool. Lond.* 215:561-575) is a predominantly terrestrial, sexually dimorphic guenon with a white throat-ruff and orange-tipped tail. Although *C. solatus* shares a number of similarities with two species (*C. preussi* and *C. lhoesti*) belonging to the *lhoesti* species group, the phyletic affinities of the Sun-Tailed monkey continue to be debated. Efforts at clarifying relationships of the Sun-Tailed monkey have been hampered by lack of study material.

In the course of a broader survey of guenon phylogeny, we undertook a morphometric analysis of an adult male Sun-Tailed monkey skull recently obtained from an individual that died of natural causes at the Primate Centre at CIRMF (Gabon). The comparative data set consists of 40 cranial measurements taken from 735 individuals of 25 guenon (including *Cercopithecus*, *Allenopithecus*, *Erythrocebus* and *Miopithecus*) species. We use discriminant function, canonical variance and principal components analyses to determine the position of *C. solatus* in multivariate space. Our results are consistent with phylogenies suggesting that *C. solatus* is morphometrically similar to *C. lhoesti*. The results of this and future studies of postcranial material will shed more light on the phylogenetic position of *C. solatus* amid its guenon relatives.

We thank Dr. Jean Wickings and the Primate Centre at CIRMF (Gabon) for permission to study the specimen.

**Fragmentary specimens and missing data in osteological phylogenies: a test using living taxa and implications for human paleontology.**

M.L. Chang. Depts. of Anthropology and Biology, University of Pennsylvania.

To understand the relationships of extinct taxa it is necessary to examine fossil specimens which are often fragmentary. Because incomplete data sets can cause proliferation of most parsimonious trees and reduce resolution of consensus trees, some advocate excluding characters or taxa with missing data. However, these solutions are unsatisfactory when dealing with questions of human evolution, where every data point is precious. Perhaps even more important is the question of whether or not missing data contribute to inaccurate phylogenies. Simulation studies suggest that in some circumstances, addition of character sets with missing data may actually increase phylogenetic accuracy.

This study investigates the effects of deleting data and taxa on the resolution and accuracy of phylogenies based on

discrete cranial characters in two samples, one examining relationships below the species level (modern human populations), and one above (non-human primates). Data were drawn from the literature and incomplete data sets generated by randomly or nonrandomly removing characters from the matrix. A series of analyses were performed to determine the effects of (1) adding incomplete data sets to a complete data matrix, (2) deleting highly incomplete characters, and (3) excluding highly incomplete taxa. These analyses were compared to phylogenies derived from complete data sets and, where possible, well-supported molecular phylogenies. The results of this study suggest that including incomplete data sets decreases resolution of consensus trees (not a small concern considering the already low resolution of many osteological analyses), but may increase phylogenetic accuracy. Implications for the treatment of fossil data are discussed.

**The 1737 *Matlazahuatl* epidemic in Mixquiahuala and Tecpatepec, Mexico.**

A.F. Christensen. Rutgers University.

Estimates of the magnitude of early colonial indigenous population decline in Mesoamerica range from 25% to 90%. Because detailed mortality reports do not exist for sixteenth-century epidemics, scholars rely upon general descriptions of their extent, as well as modern epidemiological accounts of the diseases that may have been responsible. Eighteenth-century epidemics can be studied in greater detail. One of the most destructive was the *matlazahuatl* epidemic which raged across Mexico between 1736 and 1738. Contemporary accounts report 40,000 deaths in Mexico City alone. The name *matlazahuatl* was also used to describe an earlier pandemic in 1576-1580. What pathogen was responsible? Typhus, plague, smallpox, and most recently an arenaviral hemorrhagic fever have been proposed.

The parish records of Mixquiahuala and Tecpatepec, Hidalgo, Mexico include burial records from 1737-1738, which can be tied to a 1718 nominal census as well as birth and marriage registers. Family reconstruction indicates that the causative agent was regularly spread by interpersonal contact between immediate family members. Over the 15 month span of the epidemic in these towns, 218 people were buried in Mixquiahuala and 380 in Tecpatepec. If we assume no change in population size between 1718 and 1737, this indicates a mortality of 53% and 57%.

In Mixquiahuala, 95 unmarried and 123 married individuals died, equivalent to 52% and 54% of the 1718 population in each category, and in Tecpatepec 194 and 186 died, or 54% and 61%. The high mortality and familial transmission suggest that neither typhus nor a zoonotic hemorrhagic fever was responsible.

**Homo erectus landscapes: Paleosols in the Bapang and Upper Sangiran Formations, Solo Basin, Central Java.**

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The stratigraphically lowest *H. erectus* fossils in the Solo basin occur in the upper Sangiran Formation and date to < 1.58 Ma. *H. erectus* fossils increase in abundance in the overlying Bapang Formation and occupy the area until 1.0 Ma. Archaeological sites in the Solo basin, such as Ngebung, are concentrated in the terraced gravels or the conglomeratic Grenzbank zone of the Bapang Formation. No lithologies reflecting low energy depositional environments have been identified or associated with any hominin locality. In August 2001 our team identified paleosols in the middle Bapang Formation and in the upper Sangiran Formation. These ancient soils mark the presence of habitable land surfaces in the Solo basin. Two paleosol horizons were found at Pucung, Bapang Formation. The soil features of these horizons are pedogenic carbonate accumulations, risoliths (root casts) of grassy plants, and insect burrows. Two other paleosol horizons were identified at stratigraphically-lower Bukuran, upper Sangiran Formation. Here the soils are associated with lake margin environments and exhibit characteristics of poor drainage, including gray colors, redoximorphic features, and the preservation of detrital organics including *in situ* tree trunks.

The identification of paleosols in the Solo basin provides a robust depositional and environmental context for *Homo erectus* in Java. The buried soils will provide information about local and regional paleoenvironments prior to and during *Homo erectus*' occupation of central Java. Paleosol frequency through time will yield information about *Homo erectus* occupa-

tion patterns, and their identification should result in the discovery of new *Homo erectus* localities with primary contexts.

**Conservation through folklore: Ethnoprimatology in southeastern Senegal.**

K. Clavette. Dept. of Anthropology, Northern Arizona University.

Anthropologists stress a holistic approach in their discipline. Combining cultural anthropology and physical anthropology into a new field, ethnoprimatology, proves useful in investigating the coexistence of human and non-human primates. Adding a cultural perspective to primatology aids in understanding that human culture influences the kinds of behaviors that take place between these two groups.

Chimpanzee (*Pan troglodytes verus*) habitat in the Tomboronkoto region of southeastern Senegal is unusual in that human populations live in close contact with chimpanzees. A recent study shows that these two populations live together sympatrically. Research conducted between May and July 2002 explains why this relationship is possible by better understanding the cultures involved. This study examines traditional stories and folklore using cultural anthropological methods, such as participant observation and key informant interviews. The main finding is that within these cultural groups taboos exist against killing chimpanzees. Therefore, the Bedik, Bassari, Dhiajenke and Malinke cultures contribute to the survival of chimpanzees.

The goal of this research is to apply this qualitative data to assist in primate conservation efforts in areas where humans threaten non-human primate populations. The data will aid in the production of educational materials such as posters, pamphlets and short stories. Dissemination of the items will take place within the research sites surrounding Kedougou, Senegal and bordering countries.

**Serotonergic influences on life history outcomes in free-ranging male primates,**

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for Biologics Evaluation and Research, Food and Drug Administration, <sup>4</sup>Laboratory of Comparative Ethology, National Institute of Child Health and Human Development.

Previous studies have shown that non-human primate males with low CSF 5-HIAA concentrations exhibit impulse control deficits and high frequencies of intense aggression of the type that can lead to premature death. We undertook an analysis of our longitudinal data set which encompasses ten years of research from the juvenile through middle-age periods of development documenting CSF metabolites, behavior, and early mortality in free-ranging rhesus macaque (*Macaca mulatta*) males. This study represents the first use of a long-term data set to examine these physiological factors in association with life history and behavioral variables among nonhuman primates.

Our results indicate: 1. Interindividual differences in serotonergic and dopaminergic activity were stable across the study period. 2. CSF 5-HIAA concentrations were lower in animals that died during the study period than in animals that survived. 3. We found a significant positive correlation between CSF 5-HIAA concentration and age at emigration (in months) among animals that migrated prior to the age of sexual maturity, and a significant negative correlation between CSF HVA concentration and age at emigration among animals that migrated subsequent to the age sexual maturity. 4. We noted negative correlations between CSF 5-HIAA concentration and both natal and acquired dominance ranks. CSF HVA concentration was negatively correlated with only natal dominance rank.

We conclude that interindividual differences in CSF 5-HIAA and HVA concentrations remain stable across time, and that these differences reliably predict interindividual differences in patterns of dominance, migration patterns and early mortality in free-ranging males rhesus macaques.

**Behavioral evolutionarily stable strategies and genetic polymorphism at loci affecting behavior in humans.**

G.M Cochran. University of Utah.

There are distinct morphs that embody different life-history strategies in a number of species. Alternate male forms are particularly common. Such strategies can be either conditional, where choice of strategy is determined by environmental cues, or they may be genetically based. In the cases that have been investigated so

far, that genetic control usually takes a simple form, with different alleles of a single gene determining the strategy. Whenever genetically determined strategies exist, we expect that the fitness of each morph will depend on the frequency of other morphs, and at equilibrium, each morph will have the same average fitness. In other words, the population mix is an evolutionarily stable strategy or ESS.

Some recent work suggests that such genetically controlled life-history strategies may exist in humans. This may explain some of the observed heritable variation in behavior, and may also help explain persistent differences in life-history strategies between different ethnic groups. Different ethnic groups may well exist in significantly different behavioral ESSes, influenced by long-term ecological trends. In some cases, particular psychological or behavioral morphs may be common in some societies and quite rare in others. In particular, the androgen receptor gene (AR) is a strong candidate for this kind of strategy gene. It may play a substantial role in explaining variation in paternal investment. The ecological situation that seems likely to favor a high frequency of low-paternal-investment alleles is female farming.

#### **mtDNA analysis does not detect Asian lineages in Cameroon.**

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In a recent high-resolution study of Y chromosome variation it has been observed that the haplotype 117 (belonging to the haplogroup IX) occurs at a frequency ranging from 0% to 95% in northern Cameroon. This finding is of particular interest since the 117 haplotype seems to have been involved in a back migration from Asia to Africa.

As a logical development of this study, we have analyzed mitochondrial variation in the same populations analyzed for Y chromosomes (Bakaka, Bamileke, Daba, Ewondo, Fali, Fulbe, Ouldeme and Tali) and in four additional populations (Bassa, Mandara, Tupuri and Podokwo). We analyzed the hypervariable region-1 by a standard sequencing method and 4 nucleotide positions of the mtDNA coding region (10400, 12308 and 12705, 10873) using the Snapshot method in a total of 439 individuals.

We observed five different haplogroups, three of which are sub-Saharan (L1, L2, L3), one northern African (U6) and one European (U5). The presence of the northern African haplogroup (among Podokwo and Uldeme) could be due to recent gene flow from north-eastern Africa. The U5 haplogroup was found only in one Fulbe individual. The lack of Asian haplogroups in Cameroon suggests that the migratory flow which spread the 117 haplotype was conducted predominantly by males and that the female contribution, if present, was not as large to escape extinction by genetic drift.

#### **An investigation of scaling relationships in sensory and masticatory systems of New World primates.**

M. N. Coleman. Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University.

This study explores the effects different scaling factors have on interpretations of sensory and functional systems. Although surrogates of overall head size (e.g., geometric mean) are often used to scale various structures of the skull, it remains unclear how the composition of such proxies influence the results or if there are other more biologically relevant scaling factors which should be considered.

To address these questions, a large sample of Platyrrhines, ranging in mass from approximately 300g to 10kg was examined. Up to 40 measurements were taken on each skull including standard osteometric landmarks and other relevant structures (such as the eardrum). These were used to compute various combinations of geometric mean as well as measure aspects of function. To estimate skull mass, a "geoskull" was calculated as the summation of the volume of an ellipsoid representing the neurocranium, two cones representing the orbits, and a cube representing the rostrum. Estimates of size were then regressed against measures of the visual, auditory, and masticatory systems.

Results indicate that body mass is highly correlated with mastication showing values that are as high or higher than the best performing combinations of g-mean. In contrast, the relationship between sensory systems and body mass appears weaker compared with g-mean. In addition, the relationship between a given system and g-mean is variable when a low number of elements is used to compute g-mean but becomes more stable as more elements are incorporated. The implications of these findings for functional in-

terpretations and other possible uses are discussed.

#### **Atelinae phylogenetic relationships: The trichotomy revived?**

A.C. Collins. Dept. of Anthropology, University of Wisconsin – Milwaukee.

This presentation will discuss phylogenetic relationships between members of the Atelinae subfamily (*Ateles*, *Brachyteles*, and *Lagothrix*) based on analysis of three genetic regions. DNA sequence was determined for Cytochrome c Oxidase Subunit II (COII) is a mitochondrial gene, the hypervariable I portion of the mitochondrial control region, and a single copy nuclear intron, Aldolase A Intron V.

Most previous genetic studies supported grouping *Brachyteles* with *Lagothrix* leaving *Ateles* in a subclade. However, the present data sets produce conflicting results compared to previous genetic analyses of Atelinae relationships. Different genes and methods of analysis provide some support for all possible relationships between the three genera. Overall the findings based on these genetic regions are more consistent with investigations of morphology and behavior among these primates.

The primary cause of discrepancy between this study and other genetic studies is postulated to be due to the increased assessment of genetic variation among members of the Atelinae, specifically *Ateles*, discovered in this study. This is because the present study utilized multiple samples of *Ateles* from all postulated species for this genetically variable primate, while previous studies used only one, or two species of *Ateles*. This paper goes further to demonstrate the shifting support that can be produced when different species of *Ateles* are used to reconstruct phylogenies. This research concludes that a trichotomy should still be supported between members of Tribe Atelini until further analyses including additional Atelinae haplotypes occur for the previous genetic studies.

#### **Microsatellite polymorphisms: Relevance to issues in anthropology.**

D.E. Comings. Dept. of Medical Genetics, City of Hope National Medical Center, Duarte, CA.

STRPs (short tandem repeat polymorphisms) are common with one to five or more occurring at each gene. The following aspects of STRPs will be discussed:

1. *Regulate gene expression*<sup>1</sup>. 2. *Alleles are common*. Since the STRPs are common and the alleles are common, this suggests that each gene comes in a range of hypo- and hyper-functional variants. This is in contrast the usual assumption of a 'normal' gene and a few rare mutations of the gene. 3. *Basis of polygenic inheritance*. In conjunction with some SNPs, STRPs are likely to form the genetic foundation of polygenic inheritance. 4. *Fodder for evolution*. In the presence of a change in the environment, a variant species can quickly develop by selection of those individuals with the set of STRPs better adapted to the new environment. 5. *Father absence*. The transmission of STRPs in exon 1 of the androgen receptor gene can explain both the father absence and the early age of menarche and behavioral disorders in the daughters<sup>2</sup> 6. *Genostasis* (geno = gene, stasis = neutralization) refers to a situation in which the presence of condition A of a second factor increases the effect of a gene-phenotype interaction while condition B of the second factor reverses the effect. Examples will be given to have shown that the AR gene is an important genostatic factor. The power of gene-phenotype association studies is markedly increased when genostatic factors are included in the analysis.

<sup>1</sup>Comings *Molecular Psychiatry* 3:21, 1998. <sup>2</sup>Comings et al: *Child Dev.* 73: 1046, 2002.

### **Speciosity in the early *Homo* lineage: Too many, too few, or just about right?**

G.C. Conroy. Dept. of Anatomy & Neurobiology/Anthropology, Washington University Medical School.

Recent fossil hominid discoveries and genetic analyses have rekindled debate about levels of speciosity, or species richness, characterizing the early *Homo* fossil record. At one extreme are those taxonomic "splitters" who believe paleoanthropologists have seriously *underestimated* the number of early *Homo* species. At the other extreme are those "lumpers" who believe paleoanthropologists have seriously *overestimated* the number of early *Homo* species. Neither side takes many prisoners. An interesting perspective regarding speciosity within the early *Homo* lineage may be gained by asking the following question – how many coexistent species might we expect if early *Homo* is simply treated as a genus of medium-sized Old World mammal? In order to address this question, the relationship between speciosity and body size in extant mammals and early *Homo* is explored.

Such an analysis reaches the somewhat surprising conclusion that (a) relatively few mammalian species actually fall within estimated early *Homo* body weight ranges; and (b) speciosity among mammals within early *Homo* body weight ranges is extremely limited. If early *Homo* is considered within a broad mammalian context and considered simply as a genus of medium-sized Old World mammal following similar patterns of body weight and speciosity, it seems highly unlikely it could be as speciose a genus as extreme "splitters" envision. Accommodating the presently known specimens within a few synchronous species such as *H. erectus* and *H. ergaster* seems just about right.

### **Cranial morphology of European Upper Paleolithic hominins and other Pleistocene populations.**

P. Constantino. Hominid Paleobiology Doctoral Program, The George Washington University.

Raw and size-adjusted craniometric data of European Upper Paleolithic hominins are compared with data from Neanderthal, modern Holocene, and other Late Pleistocene populations. The results of distance, cluster, and principal component analyses, as well as multivariate and univariate tests, indicate that the European Upper Paleolithic hominins are most similar to other Late Pleistocene groups and to modern Europeans. Combined with the calculated degree of intrapopulation variation, the evidence points to possible continuity from Late Pleistocene to Holocene populations, but not from Neanderthals to the Upper Paleolithic. A further look at the data shows that the majority of traits that are significantly different between groups are from the cranial base and neurocranium, not the face, and therefore suggests that these interpopulation differences are real (Wood and Lieberman, 2001).

Following this work, the data were transformed using divergence coding (Thorpe, 1984) and a cladistic analysis was performed. Initial results indicate general agreement with the phenetic study and suggests a significant distinction between Neanderthals and European Upper Paleolithic hominins while maintaining close association between the European Upper Paleolithic hominins and Holocene Europeans. (Supported by NSF IGERT Grant No. 9987590).

### **Skeletal markers Of occupational stress in the tibiae of an adult Bronze Age population**

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The objective of this study was to analyze morphological variations occurring in the proximal and distal tibiae of an adult Bronze Age population recovered from a previously undisturbed tomb located at Tell Abraaq, a stratified mound in the emirate of Umm al-Qaiwain (United Arab Emirates) excavated in 1993, and, in combination with the artifactual record, to translate these observations into a set of possible realistic behaviors or lifestyle tasks. The results of the study suggest that a significant proportion of the adult population of Tell Abraaq engaged in heavy physical labor. Arthritis and non-specific infections were common, and the long hours of kneeling, repetitive bending, twisting and lifting necessary for subsistence in this culture is clearly imprinted on their ankles and knees. A rare but probable example of Osgood Schlatter's disease noted in one skeletally immature left proximal tibia indicates that at least this individual was subject to regular intense physical activity involving traumatic contraction of the quadriceps from an early age. Eighty per cent of the total sample displayed moderate to severe facets on the anterior surface of the distal tibia caused by contact with the talus during dorsiflexion of the foot, with approximately half of the non-faceted specimens displaying severe degenerative changes, periostitis or other signs of non-specific infection or trauma, indicating possible physiological limitations that prevented these individuals from participating in normal labor intensive activities. Further illumination about the behaviors, division of labor, health and diet of this ancient population may be achieved with supplementary research.

### **Frontal grooves in African populations: A non-metrical cranial trait analysis.**

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Frontal grooves, first described by Dixon (1904) and later by Ossenberg (1969), are grooves occurring in various number, bilaterally or unilaterally, on the frontal bone of the human skull. All previously published studies have agreed that they are caused by the lack of growth of the supraorbital nerve in relation to the

growth and curvature of the frontal bone, whereby the nerve acts as a constricting cord and makes its imprint on the underlying bone. This study attempted to find an alternate explanation for the grooves, arguing that they are too flexible in their growth to make such a mark. This study analyzed over five hundred different skulls, from fourteen geographical areas. Their sex, age, cephalic index, and the number and depth of any frontal grooves was recorded.

Frontal grooves occurred significantly more frequently, and in greater depth, on South and West African skulls than on those of any other population (Chinese, East African, Italian, Peruvian, etc.). There was no significant relationship found between cephalic index and the presence or depth of frontal grooves. Previously published data indicate frontal grooves to be an age-stable trait that is more prevalent in females. This study found the opposite of both of these conclusions. Several hypotheses are offered for the significantly higher frequencies of this trait among South and West Africans, including higher incidences of frontal bossing and the production of osteoclasts, and lower cephalic indices.

**Living conditions at the time of the Roman Emperors: Centralization of power and its effect on populations.**

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Living conditions in Imperial Roman times greatly depended on the access to resources that were under control of the political power. In particular, because of the centralization of power, the town of Rome did drain large amounts of resources. The present study reports results on lifestyle and living conditions in some Imperial Roman age samples from rural and urban sites encountered along the peninsula's east coast, thus far from Rome, in comparison with samples from around Rome.

The analysis is part of a large scale project on the Imperial Roman age. Demographic parameters have been estimated and oral pathologies scored on individuals from Urbino (AD I-III century), Fano (AD II-III century), Potentia (AD II century) and Civitanova Marche (AD IV century) and compared with published and unpublished data from the suburbium of Rome. All the samples are affected by an underestimation of infants and old adults, likely related to ta-

phonomic factors. The comparison of mortality tables calculated on adult individuals indicates worst living conditions in the province far from Rome. Despite the taphonomic problems, the low values of life expectancy and prevalence of deaths in the 20-29 years class seem to witness poorer living conditions. Oral pathologies provide results that strengthen such pattern. In conclusion, the distance from Rome seems to have affected the overall living conditions in a province that was not economically self sufficient.

**Paleobiogeography, taphonomy, and the origin of the African hominoid clade.**

S.M. Cote. Dept. of Anthropology, Harvard University.

The origin of the African hominoid clade is a matter of current debate with one hypothesis proposing that chimpanzees, humans, and gorillas originated in tropical Africa, while another hypothesis suggests that the clade originated in Eurasia and migrated to Africa during the late Miocene. Support for the latter hypothesis includes proposed Miocene hominoid phylogenetic relationships and biogeographical patterns inferred from the fossil record. Specifically, the apparent absence of fossil apes from Africa dating to the late Miocene has been used as evidence that crown hominoids were not present in Africa during this period.

An alternative explanation for the paucity of these hominoids is that biases in collection and preservation have affected the fossil record during this period. The chimpanzee and gorilla lineages have presumably lived in Africa for at least 6 million years, but their fossil remains are extremely rare. Even when apes are preserved, such as in Eurasian Miocene sites, they form a relatively small percentage of the total fauna, indicating that the preservation of these hominoids is a rare event. A survey of currently known African later Miocene sites and their respective faunas shows that most sites would not be expected to contain hominoids due to their small sample sizes, poor preservation, or sampling the wrong type of habitat. Few if any of the currently known African Miocene sites appear to represent an ecological community similar to those of modern apes. These preservation biases have important implications for evaluating the origins of the African hominoid clade.

**New primate fossils from northern Vietnam.**

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Because little is known about the evolutionary history of mammals in Southeast Asia the Department of Geology and Minerals of Vietnam and the University of Colorado have been carrying out surveys of Cenozoic deposits in Vietnam for mammalian fossils. In May of 2002, we discovered a new vertebrate fossil-producing locality in Ninh Binh Province in Northern Vietnam. The fossils occur in a dark brown breccia consisting of soil, sand, and gravel situated in a light brown-gray limestone of the Dong Giao Formation. The majority of the fossils are isolated teeth that represent a range of taxa including suids, cervids, rodents, rhinocerotids, and primates. The primate sample consists of at least three orangutan molars and a macaque upper molar. The occlusal surface enamel of the orangutan molars is crenulated as with that of modern orangutans. These molars are slightly larger than those of modern orangutans and thus resemble previously described fossil orangutan teeth from China, Vietnam, and Indonesia. This locality differs from previous sites that have yielded orangutan teeth in Vietnam in its close proximity to the Red River delta. The macaque molar falls within the size range of rhesus, stump-tailed, and Assamese macaques, species that presently live in northern Vietnam. Based on present evidence this locality appears to date to the middle or late Pleistocene and additional research at this site should allow for a more specific date. This research was supported in part by NSF BCS 0086208.

**Differential foraging strategies and diets of Hadza men and women.**

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The foraging stratagem of women differs from that of men in almost all human foraging societies, although the reasons are debated (Bird 1999 *Evol. Anthropol.* 8:65-75). In the absence of complete food-sharing, differential foraging should result in differential diets such as occurs in chimpanzees (Hunt 1993 *AJPA Supplement* 16:112). Few quantitative data, however, are available for humans especially when hunting is not a major focus of male activity.

Here we provide quantitative observations on berry, honey, tuber, and baobab collection, processing and ingestion for one group of Hadza from Northern Tanzania. Based on reliability and detail, we selected 10 consecutive days out of 56 wet season foraging days, chosen to emphasize non-hunting activities and take advantage of smaller camp size. In contrast to men, women forage in large groups and focus on tubers and baobab (48% and 38% of daily calories respectively). Men mainly collect honey (65% of daily calories), a simple sugar that can be eaten directly. Women's foods consist largely of complex carbohydrates and require processing before consumption. Protein for both sexes comes from baobab. Daily caloric intake for both sexes exceeds requirements, but men consume 1500 calories more than women per day. Women's foraging behavior tolerates interruptions and compensates for constraints of motherhood as previously proposed for humans (Kelly 1995 *The Foraging Spectrum*) and chimpanzees (Wrangham 2000 in *Primate Males*). Expanded research on extant forager diets holds great potential in modeling relationships between early hominid subsistence activities and sexual division of labor.

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#### **External auditory exostosis at Isola Sacra: An old chestnut revisited.**

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Previous estimates based on a limited number of observations have suggested an extraordinarily high incidence (>30%) of External Auditory Exostosis (EAE) in a limited skeletal sample from Isola Sacra, the 2nd-3rd century necropolis of *Portus Romae* (Manzi *et al.*, 1991). Re-examination of the much larger skeletal record (n=1181) now available for Isola Sacra suggests that the incidence was much lower (<10%), though still significant, and that the interpretation of the data presents us with a much more complicated picture of the Roman community buried in the necropolis. In fact, it will be demonstrated that using EAE as a starting point, Isola Sacra presents us with a unique opportunity to combine skeletal records, the archaeological record, epigraphical and literary sources to examine

aspects of society in a complex, cosmopolitan Roman port city.

In this study both a macroscopic and microscopic analysis of the hyperplastic growths associated with the condition are presented. Findings suggest that a distinction should be made between exostoses, osteomata and normal variation in the cortical bone of the auditory canal. All individuals associated with EAE for whom a sex could be estimated (n=93) were male. Further, a significant cluster of sufferers were located within a single monumental tomb with which a burial club may be associated. In this same tomb the earliest example of a surgical amputation of a limb was also found (Weaver *et al.*, 2000). The combined evidence raises important questions about gender divisions and the construction of identity within the community represented by the necropolis.

#### **A survey of the mucosa distribution in the small intestine of the primate genus *Macaca*.**

E.L. Cruz, H. Colyer, L. Allen, L.L. Mai, M. Young Owl. Dept. of Anthropology, California State University, Long Beach.

Mucosa contains the absorptive tissue of the small intestine (SI). In the primate genus *Macaca*, it has been suggested that the area of greatest absorption lies within the proximal jejunum. However, no quantitative data regarding distribution of mucosa in the macaque SI has been measured. Macaques are generalized frugivores; it has been suggested that they may be adapted to this diet via their SI mucosal distribution. We used Derting and Bogue's (1993) method for measurement of mammalian mucosa. 12 individuals in 3 species of macaques were utilized. SIs were divided into nine sections, mucosa scraped off, and dried for 24h at 60°C. The amount of mucosa per square centimeter was calculated and subjected to ANOVA. Results indicated that greatest mucosal concentration was at the end of the anterior portion of the SI. This is similar to the pattern found in humans and callitrichids and supports the observation that the greatest concentration of mucosa is in the proximal jejunum. There are two possible explanations: this may be a phylogenetic characteristic of primates or it may be a physiological adaptation to the diet of the animal. More primates will have to be examined before a definitive statement can be made. Gastrointestinal tracts were graciously supplied by the Oregon Regional Primate Center and the Los Angeles Zoo.

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#### **Dental morphometry and indicators of developmental stress in precontact and contact Maya populations from Yucatan.**

A. Cucina, V. Tiesler-Blos. Universidad Autonoma de Yucatan.

The macroscopic expression of dental size is conditioned by genetic and environmental factors, yet the contribution of each of them is still not clearly understood. The present paper investigates dental size in classic and contact Maya populations from the Yucatan peninsula in relation to the expression of developmental defects of the enamel.

The samples chosen are characterized by very variable levels of hypoplastic defects both between and within sites, though the morphometric variables do not differ between groups. In order to avoid dental attrition, only the bucco-lingual diameters, scored close to the cemento-enamel junction were used. Stress does not result to be a factor in the expression of dental size, as correlations always close to zero between bucco-lingual dimension and number of defects from individual teeth indicate. Dental size does not differ also in the comparison between young subadults and adults, for curves constantly overlap and differences are not significant.

In conclusion, the differential external pressure the individuals had to face during the time of their lives when teeth were forming did not represent a factor interfering with the growth biological potentials.

#### **Addressing student misconceptions about human evolution.**

D.L. Cunningham, D.J. Wescott. University of Missouri-Columbia.

Misconceptions about science and evolution are widespread among undergraduates. These include: confusion between the vernacular and the scientific meaning of the word "theory", Lamarckian ideas about inheritance, misunderstandings about mutation, underappreciating the importance of variation in a species, teleological views of natural selection, difficulties in population-level thinking, and confusion about the types of phenomena that science is able to address. Even upon completion of science classes, these mistaken views are still often held by students. If students graduate college without an understanding of the processes of

science, and the basics of human evolution, it is unlikely that this situation will ever be remedied. Misunderstandings about human evolution have fueled the push to include "intelligent design" curricula in the science classroom. If science is to triumph over politics when curriculum decisions are made, it is imperative that instructors do a good job of addressing scientific misconceptions and teaching science to non-science majors. That way, parents and members of the school boards and local legislatures can be fully informed.

This paper will review the common scientific misconceptions held by undergraduates, and will offer suggestions to improve undergraduates' understanding of human evolution in the physical anthropology classroom. Making such misconceptions explicit in class, paired-problem solving strategies, and the use of a historically rich curriculum are all methods that improve students' understanding. Additionally, we will present data from a questionnaire administered to an introductory physical anthropology class that illustrate students' major misconceptions about human evolution.

#### **Effect of fruit scarcity on use of memory.**

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Primates are known to respond to fruit scarcity by forming smaller subgroups, diversifying their diet to include less highly preferred foods and adjusting their daily path length. In this paper we present results that indicate that in periods of scarcity primates may also reduce their reliance on memory to locate foods and increase their reliance on search.

A study of *Pithecia pithecia* was conducted on an island in Guri Lake, Venezuela during the end of the dry and beginning of the wet season. *Pithecia's* movements were analyzed with logistic regressions and computer models created by Janson: one that predicts the next resource to be visited and a second that simulates movements.

During periods of abundance, the sakis used memory to travel efficiently to the most highly productive fruit trees. When highly productive fruit trees became extremely scarce, the sakis increased their reliance on insects, leaves and flowers. Although they still tended to visit sites that had previously been visited, analysis of their movement pattern did not support the memory hypothesis.

These results are consistent with theory that associates use of memory with rich, patchily distributed resources. They indicate that primates can alternate between memory and search as a foraging strategy depending on conditions. Understanding the strategies primates use to increase their search efficiency at times of food scarcity may be important to interpreting the evolution of foraging and social behaviors, as well as formulating management and conservation policies.

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#### **Developmental anomalies in the dentition of a large sample of mouse lemurs (*Microcebus*) from Amboasary, Madagascar.**

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The study of primate dental variation has long been a focus of attention in physical anthropology. Despite several detailed volumes describing morphological variability and developmental anomalies in extant primates (e.g., Miles and Grigson, 1990; Swindler 2002), data on these topics remain limited for small-bodied prosimians. As these extant forms are among the animals used to understand the evolution, ecology, and adaptations of extinct small-bodied primates, knowledge of the patterns of dental variability in these extant forms is an integral part of primate evolutionary biology. Here I present a description of the developmental anomalies present in the dentition of the large sample (n = 128) of mouse lemurs (*Microcebus*) from Amboasary, Madagascar housed in the American Museum of Natural History.

Several individuals in this sample possess distinct developmental anomalies. Specimens exhibiting morphological variants include AMNH 174523, which displays lower third molars lacking the distal extension and distinct hypoconulid characteristic of mouse lemurs, and AMNH 174496, which possesses a unique upper left third molar, with this tooth being a single-cusped, conical tooth, rather than the usual triangular, three-cusped tooth. In addition, AMNH 174499 exhibits a supernumerary molar on each of the lower tooth rows. This large sample of mouse lemurs from a single locality provides an opportunity to assess population level patterns of primate dental variability. Therefore, these data, when combined with the general patterns of dental variation previously described for this sample (e.g., Cuzzo, 2000), provide an excellent

model for understanding the potential range of dental variability in fossil assemblages.

#### **Numerical dental anomalies among the early inhabitants of the Northwest Coast.**

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Numerical dental anomalies, including agenesis and polydontia, occur with variable frequencies in human populations, with supernumerary teeth being much less common than congenitally absent teeth. In general, agenesis most commonly affects third molars, followed by upper lateral incisors, second premolars, lower central incisors, and first premolars, while supernumeraries occur most often in the anterior dentition. Unusually high frequencies of numerical dental anomalies were observed in two skeletal samples from the Gulf of Georgia region of British Columbia, dating to the Locarno Beach (3300-2400 BP) and Marpole (2400-1600 BP) periods of Northwest Coast prehistory. The most common numerical anomalies were agenesis of the mandibular third molars and the mandibular central incisors, with two individuals exhibiting bilateral agenesis of both tooth types. Congenital absence in the maxillary arcade, affecting third molars and lateral incisors, was much less common. Supernumerary teeth, including mesiodens, mandibular premolars, and mandibular lateral incisor, were also observed in these populations. The etiology of these anomalies, and the possibility of familial patterning, is discussed with reference to published data on other Northwest Coast skeletal samples.

#### **JC Virus genotypes in Papua New Guinea.**

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Human polyomavirus JC (JCV) has proven useful as a virologic marker of human migration based on its geographically correlated strain variation and apparent stability over many millennia. We are analyzing JCV genotypes in Papua New Guinea (PNG) to better understand the peopling of this area. Samples were collected from Madang Province (38 villages, Austronesian and non-Austronesian speakers) and Eastern Highlands Province (EHP) (34 villages,

non-Austronesian speakers). Results show a high prevalence of Type 8B in Madang Province (82%) and a more even distribution of Types 8A and 8B (51% and 48%, respectively) in EHP. Type 2E is in low frequency in both provinces (1% EHP, 4% Madang). The SE Asia genotype (Type 7A) was not found in these samples. The Type 8 group is phylogenetically the oldest in Asia. Type 2E is most closely related to Japanese and Korean strains (Type 2A). Type 8A, apparently restricted to PNG, likely entered with the earliest settlers 40,000 YBP or earlier. While closely related phylogenetically, Type 8B is known to be widely distributed in the western Pacific. Thus, Type 8A characterizes groups that have remained more isolated in the highlands since initial colonization, while Type 8B characterizes groups that moved within the highlands, along the coast, and into Melanesia. These data, together with studies throughout the region, may provide new insight into the peopling of the Pacific.

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**Effects of structural heterogeneity and anisotropy on finite element model predictions for a mandible of *Macaca fascicularis*.**

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Finite element models ostensibly facilitate our understanding of the relationship between form, function, and mechanical load history, a relationship that is incompletely understood yet crucial for biomechanical inference. However, the accuracy and reliability of finite element models used in anthropological research is incompletely established. We describe a finite element model of an adult female *Macaca fascicularis* mandible which includes data on spatial variation (heterogeneity) and directional dependence (anisotropy) of elastic properties obtained from micromechanical tests on this specimen. The geometric model is obtained through volumetric reconstruction from computed tomography scans. Effective scan thickness is 1 mm (1.5 mm thick with 0.5 mm overlap); resolution within each scan is less than 0.2 mm. Pixel grayscale depth is 24 bit. Each scan is

segmented to provide separate volume models of cortical and trabecular bone and regions of the teeth. The volume model is exported to a finite element analysis package for performance of linear elastic stress analyses. Validation of the model is accomplished using surface bone strain data obtained from mechanical tests of the specimen subjected to occlusal loading with constraints applied bilaterally at the condyles and angles. We find favorable comparisons with readings from the experimental strains and predictions from our heterogeneous anisotropic model. Further simulations are performed to elucidate differences in the model mechanical responses assuming various combinations of heterogeneity-homogeneity and anisotropy-isotropy. Characterization of localized strain gradients is highly sensitive to the elastic properties used in model definition.

**Patterns of correlation among morphological traits in the deciduous and permanent dentitions of juveniles.**

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Although dental morphology has long been used in reconstructing genetic relationships, surprisingly little information exists concerning the degree of similarity of trait manifestation between the deciduous and permanent dentitions within the same individual. A systematic study of patterns of such correlation within and between gene pools might lead to a better understanding of the genetic control of such traits. Furthermore, if sufficiently high, it might even allow for substitution of traits between deciduous and permanent teeth in distance studies, which could benefit sample size. This study explores the correlation in two large skeletal populations.

Some 200 juveniles, aged five to eleven, from Moundville in prehistoric Alabama and Tipu in colonial Belize were evaluated for twelve molar traits using the ASU dental casts. Unusual variants, such as extra cuspules, were noted as well. Several traits, such as parastyle and maxillary M1 cusp 5, were too infrequent to recognize consistent patterns of formation. Carabelli's cusp by far showed the most variability in both presence/absence in both sets of dentitions as well as degree of expression. Protostylids and deflecting wrinkles were present in one tooth type but missing in the other at least 40% of the individuals in which they were scored. Traits with the greatest

levels of correlation within individuals include mandibular M1 cusp number (5,6,7), mandibular M1 cusp pattern, and presence of metacone and hypocone; they also generally showed marked differences in formation patterns between the populations evaluated. These findings are discussed in light of field theory for tooth morphology formation.

**Asymmetrical aspects of bipedal and quadrupedal walking in bonobos (*Pan paniscus*).**

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Bipedal and quadrupedal walking are classified as symmetrical gaits because the footfalls of both body sides are evenly spaced in time. However, even in humans, subtle left-right differences or asymmetries are described in several respects. In apes, some literature data point to quantitative asymmetries with respect to ground-reaction forces and to the amplitude of arm muscle electromyograms. Most likely, these asymmetries are also reflected in kinematics and in locomotor anatomy, and may be related to behavioral laterality and handedness. Bonobos are good facultative bipedal walkers with a "bent-hip, bent-knee" gait. For morphometrical and paleo-ecological reasons, they may be a particularly good study species to contribute to our understanding of early hominid locomotion.

We studied eight bonobos, walking on an instrumented walkway allowing for synchronous recording of kinematics (two 50 Hz cameras), ground-reaction forces (three AMTI force platforms), and plantar pressures (three Footscan pressure plates). Although bonobo walking is very variable, asymmetries are observed in terms of kinematics, ground reaction forces and plantar pressures. During quadrupedal locomotion, bonobos typically take long strides (compared to bipedal walking) and overstride, placing one foot inside, and the other foot outside the position of the hands. During bipedalism, bonobos also walk obliquely to the walking direction, with the preferred "leading" and "trailing" sides being individual characteristics. Kinetic and pedobarographic data are consistent with the asymmetries observed kinematically, and suggest that both body sides may be, to some extent, functionally different during locomotion.

This study is supported by the FWO-Vlaanderen and by the CRC.

### **A morphological comparison of incisor variation in extant apes, *Kenyanthropus africanus*, and *K. wickeri*.**

C.A. Davis. Southern Illinois University.

Some minor morphological variations on a small sample of *Kenyanthropus* sp. incisors at Fort Ternan, (e.g., incisor spiraling) have been used by Ward *et al.* (1999) and Kelley *et al.* (2000, 2002) to justify creation of a new genus, "*Equatorius*" under which they claim *K. africanus* should be subsumed. However, many examples of intraspecific variation in incisor morphology that illustrate the need for caution can be found throughout studies of hominoid fossils from Africa, Europe, the Middle East, and Southeast Asia from the early Miocene to the Pliocene.

Two morphological studies of incisor variation in extant great apes were carried out at the Cleveland and National Museums of Natural History. Results show that incisor variation occurs intraspecifically and between antimeres in individuals. Lingual topography was more variable than root shape or mamelon number across genera. Incisor spiraling, for example, was found as a variation across *Gorilla*, *Pan*, and *Pongo* and in all incisor types. Casts of incisors of both *Kenyanthropus africanus* reveal that, of 6 UI-2s, only 2 exhibited spiraling (one slight; one moderate). Of 7 UI-1s, only 1 exhibited spiraling. No spiraling was found on lower incisors.

This study demonstrates that incisors in many hominoid species, extant and extinct, sometimes exhibit spiraling as a variation. Incisor spiraling is not unique to *K. africanus*. Furthermore, spiraling occurs on a continuum and is not a discrete trait. It lacks the polarity necessary for a trait to be useful in determining phylogeny. Therefore, the "*E. africanus*" remains are probably *K. africanus*.

### **Comparative postcranial morphology of the marmosets.**

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Based on ecobehavioral, dental, and molecular distinctions, recent taxonomic revisions separate the marmosets into three genera (*Callithrix*, *Mico*, and *Cebuella*), with some 21 species recognized. While several osteological differences between *Callithrix* (the Atlantic Forest or "jacchus" group) and *Cebuella* (the pygmy

marmoset) have been previously documented, little has been described for the skeletons of *Mico* (the Amazonian or "argentata" group), the most speciose marmoset genus.

Here we compare the postcranial anatomy of two *Mico* species (*M. argentatus* and *M. melanurus*) with that of *Cebuella pygmaea* and four *Callithrix* species (*C. aurita*, *C. geoffroyi*, *C. jacchus*, and *C. penicillata*). *Saguinus midas* is included in the sample as an outgroup. Metric and non-metric data are presented from the scapula, innominate, and all long bones. Metric data are body size-corrected and examined using both univariate and multivariate methods.

Results demonstrate that the marmosets form a distinct group from the tamarin. Each marmoset genus is somewhat unique. However, *Cebuella* is most distinctive, especially in the hindlimb. *Cebuella* and *Mico* share several traits exclusive of *Callithrix*. These features are concentrated in the elbow and include a narrowed posterior humeral trochlea and narrowed proximal ulnar notch. These traits may be indicative of a shared *Cebuella/Mico* history marked by increased vertical orientations compared to their callitrichid ancestors. Thus, postcranial features support the arrangement of three distinct marmoset taxa, with separate adaptations, but a closer connection and shared history between the two more western marmoset genera. Research supported by National Science Foundation (DBS 92-03884).

### **Complete mitochondrial genome sequencing of Tanzanians: Implications for the origin of modern humans.**

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East Africa is culturally and linguistically diverse. All four of the major language families (Afro-Asiatic, Nilo-Saharan, Niger-Congo, and Khoisan) are represented by the more than 100 languages spoken in the area. Although several lines of analysis suggest that the earliest migrations out of Africa originated from East Africa, analyses of mitochondrial (mt)DNA sequences have been pivotal in refining hypotheses about the demographic histories of the earliest modern humans in East Africa. However, these analyses have been largely confined to the rapidly mutating control region, which makes up about 7% of the mtDNA genome. These mtDNA control region

studies have been complicated by homoplasy and variation in substitution rates between sites, particularly in tree branches containing the most ancient mtDNA haplotypes of people from Africa. Analysis of a worldwide sample of complete mtDNA genomes (16.5 kb) has recovered a more resolved tree, but this study has not included key samples representing the peoples of East Africa.

Here we present several complete mtDNA sequences (n>20) obtained from five Tanzanian populations representing all four language groups. These sequences have been examined along with 91 publicly available human mtDNA genome sequences. Our preliminary analysis suggests that: 1) complete genome sequences of people from Tanzania add resolution to the most basal branches of the human phylogenetic tree; and 2) some Khoisan speakers of Tanzania carry the most ancient mtDNA haplotypes and are closely related to the Khoisan speakers of southern Africa.

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### **Mind the gap. Reconstructing the lemuriform colonization of Madagascar using insights from geophysics and the comparative method.**

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Some time between the end-Cretaceous and mid-Tertiary, Madagascar's cosmopolitan biodiversity became isolated and endemic. A significant gap in the fossil record does not permit an accurate reconstruction of this event. We use proxy methods to decipher the dynamics of this dramatic change, focusing on the origin of lemurs. A recent statistical model of primate history based on estimates of species preservation in the fossil record indicated an age of 81.5 Ma for the last common primate ancestor. Because the separation of Madagascar-Africa and Madagascar-India date around 140 Ma and 90 Ma, respectively, this leaves unanswered the problem of how terrestrial animals moved between these 3 Gondwana fragments. Alternative routes may lie along the suite of fracture zones between Antarctica and Africa/Madagascar (known as the Antarc-

tic-Africa corridor, which must therefore have episodically been exposed), and the Deccan hotspot corridor between India and greater Africa.

Most reconstructions of the colonization event construe the waif as a mouse lemur-like in body size, and perhaps also in biological organization, that survived the trip by making use of torpor. However, this does not accord either with the fossil record, or with molecular reconstructions of lemuriform phylogeny. A reconstruction of the waif's body size using the comparative method yields a value of around 2 kg, which fits with the body sizes of early Eocene adapiforms. Having reached Madagascar, lemuriforms evolved into gigantic, dwarf and medium-sized forms.

#### Dental development in *Anapithecus*.

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The sample of *Anapithecus* from Rudabánya, Hungary is remarkable in preserving a large number of immature individuals. We used perikymata counts, measurements of root lengths and cuspal thickness, and observations of the sequence of tooth germs that cross match specific developmental stages in *Anapithecus* to construct the first composite picture and time scale for dental development in a pliopithecoid (Catarrhini, Primates). We conclude that the age of eruption of M1 in *Anapithecus* was similar to various macaque species (~17 months), but that M2 and M3 emergence were close to 2.5 and 3.5 years respectively (both earlier than expected in similarly sized cercopithecids). There may have been little difference in individual tooth formation times between cercopithecoids and *Anapithecus*, but the degree of molar overlap during M1, M2, and M3 crown development, which is extreme in *Anapithecus*, is fundamentally different. Overall dental development in *Anapithecus* was very quick. Old world monkeys appear derived in lacking significant molar overlap, and hominoids may be derived in having longer tooth formation times, both resulting in longer overall dental development times. This is consistent with the general conclusion that the Pliopithecoidae is the outgroup to the Cercopithecoidae and the Hominoidea.

On the other hand, rapid dental formation in *Anapithecus* may be an apomorphy indicative of an unusually rapid life history. Whatever the case, *Anapithecus* with an M3 emergence of about 3.5 yrs. is dramatically faster than any living catarrhine of similar body mass. This represents yet another unusual attribute of this poorly known fossil catarrhine.

#### A new morphometric approach to inferring diet from hominoid incisors and canines using Analytical Comparison of Digitized Curvatures (ACDC).

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Diet is certainly one of the most basic ecological parameters defining a species. A particular dietary strategy is, in many cases, a primary ecological determinant for a variety of behavioural, demographic and social adaptations. Although field studies identify the complex dietary strategies of extant hominoids, traditional methods of dietary inference relying on dentition (dental wear, gross morphology, enamel microstructure, molar shearing-crest length) often fail to reflect the true dietary complexity of apes. Conversely, Smith's (1999) analysis of hominoid molar cusp proportions ably demonstrates that a detailed morphometric approach to dietary inference is capable of an intrinsic degree of dietary resolution consistent with the known feeding behaviours of apes.

This study addresses the potential for detailed dietary inference based on morphometric analysis of incisor and canine crown curvatures. While traditional curvature indices are calculated from manual measurements, this study serves as a demonstration of a new computer assisted method for calculating curvature from 2-D digitized images. This methodology is a significant improvement over traditional methods that are limited by the assumption that curvature is symmetrical. ACDC makes possible a more thorough interpretation and analysis of the 'true curvature' and reduces the potential for measurement error.

Data was collected from dental samples representing all species and sub-species of the extant hominoidea, and a maximum of 23 measurements were recorded per individual. The results confirm that diet is the overriding selection mechanism for anterior dental morphology, and that more frugivorous taxa differ from more

folivorous taxa in a number of key curvature indices.

#### Three-dimensional analysis of elastic properties and microstructure in primate craniofacial bone.

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Mechanical analysis of primate craniofacial bone requires information on 3-dimensional elastic properties. Our objective is to study variation in elastic properties from throughout the primate craniofacial skeleton, use this information to formulate accurate mechanical models, and assess how these variations are related to cortical microstructure. We have developed methods for (1) quantifying off-axis ultrasonic velocities in increments as small as 1° around the perimeter of cylindrical cortical specimens allowing an estimate of deviations from orthotropy within the plane of the cortical plate and (2) comparing variations in orthotropy with 3-dimensional cortical microstructure determined from reconstructions of confocal microscopic images. Off-axis ultrasonic data from a comparison sample of 10 human femoral cortices fit an ideal sine curve model. In 10 human mandibular specimens, we also had a close fit to the model, but differences in coefficients indicated more variation in amplitudes, anisotropies, and orientations of the axes of maximum stiffness. In 10 specimens from human cranial vault, results varied among sites in how well they fit the sine function. Most sites showed a maximum and minimum velocity at 90° intervals, but much variation in amplitudes, and anisotropies, suggesting 3D structures in some parts of the craniofacial skeleton that are not orthotropic. Comparisons of the primary directions of stiffness with the orientation of osteons showed consistency in 4 specimens. Osteon orientation was least variable within the plane of the cortical plate. These results suggested that variations in some tissue elastic properties result from variations in osteon orientation.

#### What lies beneath? Testing the taxonomic validity of *Homo heidelbergensis* using endocranial morphology.

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Since its 1908 proposal (Schoetensack), fossil crania from Africa and Europe have been assigned to *Homo heidelbergensis*. This attribution of hominins is based

exclusively on exocranial morphology; however, recent research by other scholars suggests that external structural similarity may not reflect morphologically related internal structural similarity. In this study, the validity of determining taxonomic affiliation solely on the basis of exocranial morphology is challenged: here, endocranial components of cranial structures are included in the analysis.

This analysis was conducted using radiographic as well as external craniometric data taken from several crania currently attributed to *Homo heidelbergensis* (e.g. Rightmire 1996). Cranial features typically thought to be diagnostic of this taxon, such as the supraorbital torus, were quantified both internally and externally to determine the extent to which the specimens vary. While presenting similarity in external structures, some crania show marked differences in the internal morphology of these structures; these differences may be taxonomically relevant. Overall, when endocranial morphology was considered, the fossil sample was no longer homogeneous; therefore, the current assignment of all specimens analyzed to *Homo heidelbergensis* is most likely inaccurate.

Years ago, LeGros Clark pointed out the importance of considering the total morphological pattern when making taxonomic assignments. This research demonstrates the importance of this concept, as any analysis of fossil hominins which does not consider both the external and internal elements of cranial structure may effectively overlook a significant portion of the total morphological pattern, and thus the true taxonomic relevance, of cranial morphology in hominin evolution.

#### **Pliocene Hominid postcranial evolution: Fossils from the Hata Beds, Middle Awash, Ethiopia.**

D. DeGusta, Laboratory for Human Evolutionary Studies, Museum of Vertebrate Zoology, and Dept. of Integrative Biology; University of California, Berkeley.

A recent study of hominid postcrania concluded that, "The results of this study serve to remind us about how little we know about the evolution of the hominin postcranium and locomotion in the Plio-Pleistocene," (Aiello *et al.*, 1999, *AJPA* 109:89). This lack of knowledge stems in large part from the paucity of hominid postcranial fossils from East Africa in the crucial period of 2-3 million years ago (mya). Hominid remains recently recovered from the Hata Beds (~2.5 mya) in the Middle Awash Valley of Ethiopia have the potential to contribute important new

knowledge regarding the evolution of the hominid postcranial skeleton and locomotor behavior. This material, which includes a partial skeleton, dramatically expands the known sample of East African hominid postcrania from 2-3 mya. The partial skeleton is one of the very few Pliocene specimens preserving both arm and leg elements, allowing a reassessment of the evolution of hominid limb proportions. This paper presents the results of the detailed description and analysis of this material, and its implications for our understanding of Pliocene hominid postcranial evolution.

This research is based on fieldwork supported by NSF grants BNS-9632389 and BCS-9910344 to Tim White and analytical work supported by the Laboratory for Human Evolutionary Studies and a LSB Leakey Foundation grant to DeGusta.

#### **Asymmetry, developmental instability and non-directional growth constraints in the human skull.**

V.B. DeLeon. Johns Hopkins University.

Developmental instability is associated with increased fluctuating asymmetry of morphometric characters. This study addresses developmental instability in the human skull created by non-directional constraints on growth. Previous research suggests that deviations from normal growth trajectories increase the degree of random variation between sides within individuals. Based on this literature, I hypothesized that midline premature craniosynostosis would be associated with increased fluctuating asymmetry in the skull.

A sample of children with premature midline fusion of the sagittal and/or metopic sutures was compared to an age-matched sample of morphologically normal children. Three-dimensional landmark coordinate data from the face, base and vault were collected in multiple trials using computer reconstructions of CT data, and asymmetry was quantified using a two-way ANOVA in Procrustes coordinates. Contrary to predictions based on the developmental instability literature, preliminary results indicate that the degree of fluctuating asymmetry in the individuals with constrained growth is LESS than that of the normal control sample. The presence of antisymmetry, which has a bimodal distribution of asymmetry, may be a confounding factor.

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#### **The role of male long calls in Sumatran orangutans.**

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Although adult orangutans do not live in permanent male-female associations, they participate in consortships, travel bands and temporary feeding aggregations. Because orangutans are normally dispersed in dense rainforests, adult male long calls are likely to regulate such encounters, performing an important function in orangutan social organization and reproductive strategies. To better understand the role these vocalizations play in orangutan communities, it is necessary to describe the patterns of long calls and their correlates, both social and ecological. Further, field studies using experimental techniques can determine 1) if long calls serve as a basis for intra-sexual competition and mate preference and 2) if orangutans use acoustic properties to identify and assess males.

I examined vocal behavior of adult male orangutans and conducted field experiments on orangutan populations in northern Sumatra. Males do not vary significantly with respect to calling rate or call duration and there is no effect of fruit availability or the presence of females on calling rate. However, there is high inter-annual variance and high-ranking males are more likely to respond vocally upon hearing another male. Among social factors, the best predictor of calling rates is the presence of other males, supporting a role in intra-sexual competition. Males can be identified by their long calls alone and there is some indication of indirect assessment and mate preference based upon these vocalizations. Males also indicate the direction of their next travel bout and I provide evidence that long calls coordinate spatial movements among individuals within a network of loose associations.

#### **3D visualization of inferred intermediates on a phylogenetic tree--applications in paleoanthropology.**

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at Stony Brook, <sup>7</sup>Anatomy, New York College of Osteopathic Medicine, <sup>8</sup>Anthrotech, Inc., Yellow Springs, OH, <sup>9</sup>Anthropology, Hunter College, CUNY.

Paleoanthropology has always suffered from an incomplete fossil record and the resulting relative paucity of intermediate forms; the fragmentary nature of many fossils compounds this problem. In a visualization approach, we collect surface data on exemplar specimens with a laser scanner and landmark coordinate data with a Microscribe 3D digitizer on larger samples for each taxon of interest. Generalized Procrustes analysis produces average landmark configurations for each taxon, by sex, which are scaled to the same size and can be compared statistically. Given an a priori cladogram relating these taxa, our program (building from Rohlf's TPS tree) visualizes an intermediate landmark configuration at any point along the cladogram. A thin plate spline is then computed between a chosen taxon and the computed intermediate, and the taxon's exemplar surface is then splined to the inferred intermediate. This 3D image can be rotated to any view and compared visually to known fossils, some of which may be too fragmentary or distorted to have been included in the statistical analysis. We demonstrate this program using data on modern and fossil cercopithecoid monkeys and on hominids (great apes and humans). While the resulting visualizations are based solely on the morphometric properties of the chosen landmarks, and do not include character or genetic data, the resulting forms are of value for a more complete understanding of the role of shape in phylogenetics and the proximity of various fossils to theoretical inferred intermediate forms.

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### Genetic and environmental correlations between age at adiposity rebound and subsequent changes in childhood BMI.

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**Introduction.** The relationship between the timing of the adiposity rebound and obesity in adolescence and adulthood has received considerable attention from obesity researchers, but because of the rarity of familial serial data, little is known of its genetic underpinnings. **Methods.** We applied polynomial models to serial BMI

data collected from 368 individuals aged 2-25 years in the Fels Longitudinal Study. Parameters obtained from each individual's BMI curve include 1) age at BMI rebound (AGE-REBOUND), 2) BMI at age at rebound (BMI-REBOUND), 3) BMI at maximum pubertal BMI velocity (BMI-PUBERTY), and 4) maximum post-adolescent BMI (BMI-POSTADOL). These four parameters were then examined in a series of bivariate maximum-likelihood-based genetic models. The heritabilities and the additive genetic ( $\sigma_G$ ) and random environmental ( $\sigma_E$ ) correlations between these parameters were then estimated. **Results.** From the best models, AGE-REBOUND, BMI-REBOUND, BMI-PUBERTY, and BMI-POSTADOL had heritabilities ranging from 0.63 to 0.68 (all  $p < 0.0001$ ). The estimated  $\sigma_G$  between AGE-REBOUND and BMI-REBOUND, BMI-PUBERTY, and BMI-POSTADOL were  $-0.55 \pm 0.07$ ,  $-0.60 \pm 0.08$ , and  $-0.54 \pm 0.08$ , respectively. The  $\sigma_E$  between AGE-REBOUND and the other three BMI parameters was not significantly different from zero. **Conclusions.** Thus, we found high heritabilities for all parameters, and incomplete pleiotropy between the timing of the adiposity rebound and BMI during childhood and adolescence. That is, some, but not all, of the genes that influence the age at adiposity rebound also influence BMI from early childhood to post-adolescence. There is no evidence, however, of a correlated response of these parameters to shared environmental factors.

### The functional significance of the primate fibula.

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Almost all primates have complete and separate fibulae, whereas most mammals either partially or completely fuse the fibula with the tibia or reduce it to a bone spur. The functional significance of the primate condition (which is also shared by cats and bears) is poorly understood. We conducted a series of *in vitro* experiments to address the role of the fibula in weight-bearing and force transmission between the two leg bones. Muscles were removed from the legs of one human, two baboon, and two chimpanzee cadavers and three rosette strain gauges were attached to the midshafts of each bone. Legs were loaded in bending by applying force through the intact knee and ankle joints, and reloaded after sequentially cutting the interosseous membrane, tibiofibular ligaments, and the fibula itself. Severing the interosseous

membrane does not cause significant changes in strains in the two bones. Disconnecting the ligaments subtly effects the direction of bending in some specimens. Cutting the fibula leads to a moderate increase of tibial strains and a more marked shift of the bending axis. This change is most pronounced in the chimpanzee legs that have robust fibulae. It is concluded that the contribution of the fibula in weight-bearing of the leg is minor, and the interosseous membrane has no bearing on force transfer between the two bones. The two-bone arrangement with a membrane in between is more likely being driven by the demand for muscle attachment area in animals with large deep flexors rather than by weight-bearing demands.

### Dental topographic analysis of molar wear in *Alouatta palliata*.

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Studies of dental biomechanics have demonstrated that tooth shape reflects the mechanical properties of foods that primates eat. Most studies have focused on unworn teeth, thus begging the question "how does tooth wear affect dental functional morphology?" This presentation reports on a longitudinal study of wear-related changes in tooth form in *Alouatta palliata*.

Dental impressions were taken of lower M2s of 14 howling monkeys at Hacienda La Pacifica, Costa Rica between 1989 and 1999. Each monkey was darted a number of times during that period and dental impressions were taken each time. Resulting tooth replicas were digitized to a resolution of 0.0254 mm using a laser scanner, and 3D models of occlusal surfaces were interpolated using GIS software. Data for average surface slope, relief, and angularity were generated for each sampling of each individual. Changes in values were calculated over 2, 4, and 7-year intervals, and tested for normality. These data were then assessed for significance using Student's *t* and Signed Rank tests.

Results indicate that the howling monkeys generally showed decreased molar surface slopes and relief over time. However, consistent changes were *not* evident for molar surface angularity. The lack of change in angularity between most intervals suggests maintenance of some func-

tional aspects of morphology. This is consistent with results indicating no age related differences in food particle sizes in the feces and stomach contents of these monkeys.

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**Allometric and functional influences on orbit orientation in didelphid and phalangerid marsupials.**

A.M. Derby, C.P. Heesy, C.F. Ross. Stony Brook University.

Several species of marsupials ecologically converge on primates and therefore may prove useful for testing adaptive hypotheses for primate origins. Several researchers (e.g., Rasmussen, 1990) have cited the seemingly high orbit convergence in more predatory didelphids, such as *Caluromys derbianus*, as consistent with the predictions of the nocturnal visual predation hypothesis. Cartmill (1972), however, suggests that the measure of orbit orientation in marsupials may be complicated by the morphology of the enlarged masticatory apparatus. If so, this would limit the utility of marsupials as comparative taxa for primate studies.

In this study, the functional and allometric correlates of orbit orientation in marsupials were examined. Orbit orientation and various measures of size and shape were quantified for 24 taxa of didelphid and phalangerid marsupials. Data on substrate preference and feeding ecology were also collated. Contrary to expectation, folivorous taxa have higher orbit convergence than primarily faunivorous or occasionally faunivorous taxa. An explanation for this result is derived from the observation that among didelphids, and when didelphids and phalangerids are considered together, there is a positive allometric relationship between orbit convergence and skull size. The morphology and position of the anterior root of the zygoma, which forms part of the orbit in marsupials, may be dorsally extended in larger and more folivorous taxa and thereby biasing the measurement of orbit orientation. These results suggest that whereas other aspects of marsupial ecology and morphology may be useful for studying the adaptive origin of primates, orbit orientation data may not be appropriate.

**Evidence of differential evolution of male and female lineages in African hunter-gatherers and food producers.**

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The availability of numerous markers of mitochondrial DNA (mtDNA) and Y-chromosome with known and comparable rates of evolution since the mid 90s has opened the door to comparative analyses of maternal and paternal heritage in human populations. Using this approach, it has been observed that Fst values for the non-recombining portion of the Y-chromosome in human populations are markedly higher than those of mtDNA. A higher female than male migration rate associated with the widespread habit of patrilocality has been proposed as the most likely explanation for this finding. The studies carried out among populations from sub-Saharan Africa produced different results; a higher female than male migration rate has been reported for populations from Ethiopia, Mali and Sudan, while a higher male-versus-female migration rate has been suggested in another study on Pygmies, Khoisan, East Bantus, Bagandans and Gambians.

In this communication, we test the hypothesis that the contrasting results on male and female migration rate in sub-Saharan Africa could reflect a differential evolution of male and female lineages in sub-Saharan hunter-gatherers and food producers. To do this we use unpublished mitochondrial and Y-chromosomal data on the Bamileke, Ewondo, Bakaka and Bassa from Cameroon and Mbenzele Pygmies from the Central African Republic, together with literature data. The possible role of polygamy and sex-biased gene flow in determining a differential evolution of male and female lineages is discussed.

**Dental wear patterns of hunter-gatherer and agriculturists: The direct human impact of human behavioural changes accompanying this transition.**

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Features that make hunter-gatherer wear patterns distinct from agriculturists are high occlusal wear rate, (relative to independent age indicators); strong gradient of wear with heaviest at the front of the jaw and lightest to the back of the jaw; heavy approximal wear relative to occlusal wear, and slow rate of change in the angle of occlusal plane in the molars.

The purpose of this project is to show changes in dental wear patterns due to changes in subsistence strategies. The materials used were skeletal samples from the Archaic period (7000BP - 4000BP) in the Green River Valley in Kentucky, and Channel Islands Santa Barbara. A few sites from the Levant during the Natufian period were also used in the hunter-gatherer samples. The transitional group or the Woodland (4000BP - 3000BP) group is from Illinois and the Mississippian (3000BP - 800BP) samples are a variety of different sites from Florida, Virginia, and New Mexico. A site from the Levant PPNB or Pre Pottery Neolithic B was used in the agricultural group. From the preliminary results it was found that tooth wear in the hunter-gatherer samples had greater occlusal surface wear from back to front relative to age, and greater angles on the upper first molars only. The agricultural samples showed less wear of the occlusal surface relative to age, and smaller angles in the upper first molars only. The approximal measurement was found to not be as dependent to the occlusal wear in either subsistence group.

**Trabecular bone orientation in flexed versus extended postures in guinea fowl: A test of Wolff's Law.**

M.J. Devlin, H. Pontzer, D.E. Lieberman, J.P. Polk. Dept. of Anthropology, Harvard University.

Although bipedal locomotion is a hominin synapomorphy, disagreements persist about whether early hominin bipeds were capable of fully extended limb posture, or used a bent-knee, bent-hip gait. Several recent studies have used the orientation of trabecular bone in limb joints to infer postural differences during bipedal locomotion between early bipeds and later *Homo*. These analyses depend on the assumption that the orientation of the trabeculae in joints corresponds to the orientation of compressive forces that are transmitted through the joints. However, the hypothesis that trabecular struts will differ in orientation because of differences in the orientation of loads they experience during growth has not been tested.

This study experimentally tests the hypothesis that there is a quantifiable relationship between the orientations of trabeculae and joint posture. The experiment included 16 guinea fowl (*NNumida meleagris*): 6 extended-posture runners, 6 flexed-posture runners, and 4 sedentary controls. The exercised animals ran 6 days per week at 1.9 mph for 15 minutes, on either a flat treadmill or a

treadmill inclined to 20°. Kinematic and ground reaction force data collected as the birds moved on horizontal and inclined substrates confirm that the degree of flexion at the knee at toe-off is 10° greater when moving up inclines relative to level running. Micro-CT scans were analyzed using image analysis software to relate this difference to trabecular and subchondral bone morphology within the distal femoral epiphysis, including subchondral bone thickness, and trabecular orientation, number, thickness, volume, and connectivity.

**A genetic fossil in great ape and human genomes suggests the presence of two active forms of ribonuclease H1 17 million years ago.**

E.J. Devor, K.A. Moffat-Wilson. Molecular Genetics and Bioinformatics, Integrated DNA Technologies, Coralville, Iowa.

Ribonuclease H1 (RNH1) is a ubiquitous enzyme that specifically degrades the RNA moiety of RNA-DNA duplexes. While its precise biological role is not completely understood, RNH1 is thought to function in lagging-strand synthesis during DNA replication. In addition, RNH1 is the crucial component in RNase H inactivation antisense gene silencing.

Human RNH1, located on chromosome 2p25, contains eight exons and seven introns spanning some 15kb. While mapping the human RNH1 gene, we identified two genetic fossils. One, called RNH1P1, is located on human chromosome 1q32 and meets all of the canonical attributes of a retroprocessed pseudogene. The other, called RNH1P2, located on human chromosome 17p13, is mostly canonical but contains a T→C transition at the Exon 7/ Intron 7 splice junction. This results in RNH1P2 containing the first seven exons plus 1 kilobase of Intron 7 with no Exon 8 material. As the mechanism through which retropseudogenes are generated requires the presence of a mature mRNA transcript, the existence of RNH1P2 suggests that an RNH1 gene containing the splice junction mutant was actively transcribed at the time of retrotranscription. This is supported by the observation of an in-frame stop codon and a minor polyadenylation signal just downstream from the mutation site.

We have estimated that the RNH1P2 retrotranscription occurred 17.1 million years ago. This date is supported by direct sequencing data that show the pseudogene to be present in human, chimpanzee, and orangutan genomic DNAs but not in any Old World or New World monkey samples.

**Road to extinction: GIS modeling of road development and hunting pressure on Amazonian primates.**

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Large-bodied primates such as woolly monkeys and spider monkeys are among the Neotropical mammals most vulnerable to over-exploitation from hunting. We examine the effects of road development on wildlife removal, modeling changes in access of local hunters to their prey. Specifically, we examine the scale at which increased access can cause traditional local hunting patterns to unsustainably decrease primate populations across a wide landscape. To address this issue we combine field data on primate populations in the rainforests of eastern Ecuador with GIS and population growth models, comparing differences in hunters' travel times between forest and roads on foot and with vehicular transport. Our results show that although road construction causes the removal of a relatively small amount of forest area, the access that even relatively short roads provide quickly opens large areas of habitat to exploitation. Roads cut into the heart of an Ecuadorean National Park and Biosphere Reserve provide avenues for rapid game removal and may quickly render large portions of the reserve depauperate of large-bodied primates and other vulnerable prey. So-called "temporary" roads built in the reserve for oil extraction are being used as avenues for commercial game harvest and farm colonization in spite of previous agreements made to prevent such devastation.

**Social and reproductive strategies of lowland woolly monkeys (*Lagothrix lagotricha*).**

A. Di Fiore. Dept. of Anthropology, New York University and the New York Consortium in Evolutionary Primatology.

Among primates, many species are characterized by female philopatry, resulting in social groups organized around a core of related females. In woolly monkeys and other atelin primates, however, males are more likely to be philopatric than females, which has important implications for the patterning of within-group social behavior and for the expression of various forms of reproductive competition. I studied these aspects of the behavioral

biology of woolly monkeys in Ecuador during a two-year field study. Data were collected on intragroup spatial relations, mating and grooming behavior, and patterns of agonism, and molecular techniques were then used to examine within-group genetic relatedness.

Woolly monkeys are similar to other atelins in that males within a group are more closely related to one another than are females. Furthermore, males tend to be tolerant of one another, especially during the context of mating; direct male-male reproductive competition appears minimal. Unlike in other atelins, however, adult males are not actively affiliative with one another. Relationships among females are likewise generally tolerant but nonaffiliative. Adult females (specifically those with dependents) appear to avoid same-sex conspecifics, and females frequently harass the mating attempts of others. Those affiliative interactions that do occur among nonjuvenile animals tend to be directed either between the sexes (primarily female to male) or from juvenile and subadult males towards adult males. These observations suggest that intersexual bonds may be more important than intrasexual ones, and that male mate choice and direct female-female competition may be important features of woolly monkey reproductive biology.

**X-chromosome phylogeny of the Platyrrhini.**

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To date, four nuclear loci (epsilon-globin, beta-2-microglobulin, IRBP, G6PD) have been surveyed for all extant genera of New World monkeys. Though these works agree on the monophyly of each of the Atelidae, Pitheciidae, and Cebidae (Cebinae + Aotinae + Callitrichinae), they disagree on the relative relationships among the families. Epsilon-globin and beta-2-microglobulin (both autosomal) infer a sister-relationship between the Atelidae and Pitheciidae; IRBP (autosomal) supports a clade of Pitheciidae and Cebidae; G6PD (X-chromosomal) groups the Atelidae with the Cebidae. Such disagreement among molecular datasets is consistent with the hypothesis that an evolutionarily short internode separates the two divergence events giving rise to the progenitors of the platyrrhine families; the conflicting nuclear topologies would then be the result

of differential lineage sorting at various genetic loci.

To help resolve the relative relationships among the platyrrhine families, we sequenced and analyzed a ~1.6 kb intergenic region of the X-chromosome. Though the sequenced region is several hundred thousand bases from the G6PD locus and can therefore be considered a separate, unlinked marker, the phylogeny inferred from our analyses is highly congruent with that published for G6PD, including an Atelidae-Cebidae clade exclusive of the Pitheciidae. We believe this is the strongest hypothesis of platyrrhine familial relationships at present, not only because the G6PD and X-intergenic datasets yield a congruent topology, but also because they are both X-chromosome markers which, by default, have a lower effective population size than autosomal markers and, consequently, a higher probability of tracking the true organismal relationships. (Supported by NIH# R01\_GM60760 to TRD.)

#### **Microspatial analyses of intra- and intertooth variations in the distribution of trace elements.**

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Understanding the distribution of trace elements within human teeth has widespread implications for paleodietary reconstruction, as well as for the biomonitoring of nutrition and pollution in living populations. Traditional chemical analyses of teeth have relied primarily upon the dissolution of entire teeth, or fragments, with the aim of retrospectively glimpsing the environmental interactions locked within. The research presented here summarizes recent findings regarding variability in the distribution of trace elements within human tooth enamel, as measured using LA-ICP-MS. With the analysis of deciduous teeth (N=45) from Solis, Mexico, we have found that there are significant increases in the intensities of Mg, Zn, Ba, and Pb ( $p = >0.001 - 0.05$ ) between pre- and postnatal enamel, reflecting the dramatic change from *in utero* to postnatal environments. Also, no significant differences (N= 41) were found between average prenatal or postnatal trace element intensities of incisors versus canines. Finally, we looked at the microspatial distribution of trace metals (Zn, Fe, Pb, Ca, Sr) in enamel areas of deciduous teeth including the neonatal line, pre- and postnatal enamel areas, at the dental-enamel junction (DEJ), and at the dental-pulp junction. Of the elements

analyzed, Zn showed a distinct increase at the neonatal line, with normalized intensity readings 3 to 6 times higher than the rest of the enamel. Documenting variation in trace element compositions of human teeth using microspatial analyses provides a framework from which we can begin to ask new questions regarding palaeonutrition and other environmental interactions.

#### **Tooth modification from the Neolithic to the Iron Age in Southeast Asia.**

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Research on the prehistoric peoples of Southeast Asia has until recently been based almost exclusively on skeletal remains from burial sites in Thailand, because of the political situation in neighbouring states. The improvement of the political situation in Cambodia has recently permitted research to extend beyond the modern state borders. A skeletal sample from a newly excavated Iron Age cemetery in northwest Cambodia, Phum Snay, is one of the first to be available. The sample to date is small and poorly preserved, restricting the analysis, but one feature, dental modification, is reported here. This study presents this new evidence and discusses its significance in relation to that from prehistoric Thailand. There are two main types of tooth modification in the Phum Snay material: tooth ablation and tooth filing. There is evidence for dental ablation of the upper lateral incisors and the canines, in both males and females, in 63% of a sample of 19 anterior maxillae. Tooth filing was evident in five individuals (26%), in the central or lateral incisors and the canines. Overall, 84% of the sample had some form of tooth modification. Despite the small sample size, the high proportion of individuals involved is suggestive of widespread tooth modification in this population. The skeletal sample from the Neolithic southeast Thai site of Khok Phanom Di also had high rates of ablation (Tayles 1996) with some similar patterns as at Phum Snay, hinting that this practice had a long history. Evidence from other samples reported from Thailand will also be discussed in order to place the Cambodian evidence in the context of the Southeast Asian cultural record.

Tayles, M. (1996) Tooth ablation in prehistoric Southeast Asia. *International Journal of Osteoarchaeology* 6:333-345.

#### **Evolution of anthropoid hands.**

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The skill of anthropoid forelimbs is unparalleled among vertebrates. Classic evolutionary hypotheses stress the importance of insect capture or terminal-branch foraging. Here we extend these hypotheses and suggest that increased anthropoid dexterity evolved principally to evaluate fruit texture. We examined this hypothesis with respect to three anthropoids and the spectral, mechanical, and chemical properties of dietary fruits in Kibale Forest, Uganda. Additional fruits were studied during a general mast-fruiting event in the Pasoh Forest Reserve, Peninsular Malaysia.

We distinguish between seasonal fruits and figs, which may offer critical sustenance during periods of fruit dearth. We show that the perceptual cue eliciting fruit ingestion is not color or size - cues viewed historically as essential to primate frugivory - but fruit mechanical properties, which alone predict sugar concentration. We reject the role of fruits in the evolution of catarrhine color vision and instead emphasize the importance of evolving independently mobile digits coupled with neural specializations in the cortex and skin. These hallmark adaptations were indispensable in the Eocene, an epoch when stem anthropoids were faced with a coterie of confusing fruit colors already adapted to consumption by diurnal birds or nocturnal frugivores, such as flying foxes.

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#### **Modeling and remodeling responses to normal loading in the human lower limb.**

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Normal loads produce bone microdamage, which can result in bone failure with time if not continuously remodeled. The incidence of microcracks in long bones can be slowed by increasing diaphyseal cross-sectional dimensions, which reduces strains incurred during bending or axial loading. Concurrently, within a limb,

distal bones have to be smaller than proximal bones to avoid large angular moments during locomotion. With this constraint in mind, Lieberman and Crompton (1998) proposed that bone response to strain varies along the proximo-distal axis of the limb. Proximal bones should adapt to loading by increasing cross-sectional dimensions, while distal bones must increase remodeling pace. Although this mechanism appears to occur in pigs, this hypothesis remains untested in humans.

Lieberman and Crompton's hypothesis predicts that cross-sectional dimensions, measured as polar moment area (J) and cortical area (CA), should be greater in femurs than in tibias, while measures of remodeling activity, measured as osteon population density (OPD) and percent remodeled bone (%REM), should be smaller. Femurs and tibias of 20 human forensic cases (6 females and 13 males, all 18 to 70 years of age with a mean age of 32, all assumed to be normal physiologically) were used for this analysis.

Although CA and J are greater in femurs than in tibias, neither OPD nor %REM differs between these bones. However, when bone length is controlled for, tibias are not less resistant to bending than femurs. This suggests that humans and pigs may differ in bone modeling and remodeling adaptations.

#### **Discerning veneration and violation in mortuary contexts: The case of Zacpetén.**

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Discerning veneration and violation in archaeological mortuary contexts remains problematic. Difficulties include the fact that what constitutes veneration and violation varies between and within cultures over time and space. Drawing on cross cultural ethnographic studies of mortuary practices (Carr 1995), I previously suggested that considering four variables may help distinguish veneration and violation archaeologically: nature of grave goods, location of interment, body treatment, and form of disposal (Duncan 2001). Using ethnographic, ethnohistoric, and archaeological lines of evidence from the Maya area, the author suggested how these variables might be manifest differently between acts of veneration and violation among the Maya. In northern Guatemala, under Proyecto Bioarqueológico de Zacpetén the author and others excavated and analyzed a late Postclassic (AD 950-1524) ossuary at the site of Zacpetén.

In the ossuary, each of the four variables was congruent with an act of violation. Specifically, there was a dearth of grave goods, the ossuary was located to the west of a temple assemblage, the individuals were disposed in a manner that did not retain individual identity, and cutmarks covered the remains in a fashion consistent with dismemberment and defleshing. This paper has two goals: to present the archaeological and skeletal data from the ossuary at Zacpetén demonstrating that the ossuary is congruent with that predicted to reflect violation; and to consider other lines of data and alternative scenarios that might have produced the ossuary in an effort to evaluate the variables' potential to discern veneration and violation in other archaeological contexts.

#### **Determination of infant weaning patterns from juvenile dentition in Roman Egypt.**

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Studies of infant weaning in past populations commonly rely on stable isotope analysis of infant remains. A major problem with using infant samples in this manner is that these individuals did not survive past infancy. It is impossible to determine if the isotopic signals of these individuals reflects the ideology of that society concerning infant feeding. One potential way to answer this is to examine the dentition of individuals who survived infancy. Teeth are static tissues, capturing isotopic signals during development, affording a "snap-shot" of diet.

This study examines the dental isotope signatures from 22 juveniles (4 to 9 years old) from the Kellis 2 cemetery, Dakhleh Oasis, Egypt (circa 200 AD) to reconstruct weaning history. Both deciduous and permanent teeth were sampled, with a total of 7 to 12 teeth per individual. A homogenized enamel sample was isolated from each tooth and prepared for stable carbon and oxygen isotope analysis on a SIRA mass spectrometer.

The resulting data are analyzed using Factor Analysis, and then rotated using a Varimax rotation to determine if any patterns exist in the data that may indicate changes in diet. Preliminary results suggest that the carbon and oxygen isotope data distribution, when examined separately, is best explained as representing a permanent teeth factor. However, the individual permanent teeth that are significantly correlated with these factors are different for carbon versus oxygen

isotope data. When the carbon and isotope data are combined, resulting common factors show clear deciduous versus permanent teeth components as well as carbon versus oxygen components. This evidence may suggest changes in diet during early childhood most likely associated with weaning.

#### **A re-examination of purported "Meganthropus" cranial fragments.**

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The genus "*Meganthropus*" was originally coined for the large mandibular fragment Sangiran 6. Since its introduction, a number of workers have placed both cranial and mandibular specimens into this genus primarily due to their size and robusticity. Many studies have shown that the mandibular specimens attributed to "*Meganthropus*" merely reflect the more extreme end of a normal range of variation for the fossil species *Homo erectus*. In the present study, three cranial fragments from Sangiran that have been assigned to "*Meganthropus*" are examined in an effort to determine whether this placement is justified or if these specimens can be accommodated within *H. erectus*. The results of this study call into question previous interpretations of this material, and indicate that none of the three specimens can be separated from *H. erectus*. "*Meganthropus*" I is interpreted to be a portion of the lateral cranial vault, a position that differs from the original description of this fossil, and the specimen is found to be well within the range for the known *H. erectus* sample. Likewise, the "*Meganthropus*" III occipital fragment, a specimen that was difficult to interpret based on earlier descriptions of the fossil, is found to be similar to known examples of Asian *H. erectus*. Sangiran 31 ("*Meganthropus*" II) is the only specimen studied that does not immediately group with *H. erectus*, however even this specimen fits within the recognized *H. erectus* hypodigm and does not provide adequate evidence for the maintenance of the genus "*Meganthropus*."

#### **Quantitative genetics of the craniofacial complex in modern humans.**

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Significant genetic influences on craniometric variation as assessed by anthropometry are well documented. Fewer studies, however, have examined genetic influences on internal craniofacial morphology obtained from radiographs. In this study, we estimated heritabilities ( $h^2$ ) of 13 craniofacial measures from lateral cephalograms of 460 participants in the Fels Longitudinal Study using a maximum likelihood method for pedigree data (SOLAR; Almasy and Blangero 1998). These individuals are from 111 nuclear and extended families and ranged in age from birth to 72 years at the time of examination. Because many of these individuals were examined serially, for these initial analyses data from a single observation of each person were selected at random. Ten iterations of this sampling procedure were conducted and the mean heritability of each craniofacial measure from the separate analyses was calculated. High heritabilities were found for three angular measures (basion-sella-nasion  $h^2 = 0.54$ ; sella-nasion-subspinale  $h^2 = 0.58$ ; nasion-sella-posterior nasal spine  $h^2 = 0.50$ ). Two indirect linear measures of brain size also were found to be highly heritable (sella-ectocranial vertex  $h^2 = 0.54$ ; sella-endocranial vertex  $h^2 = 0.57$ ), while a third was moderately heritable (maximum neurocranial length  $h^2 = 0.37$ ). Heritability estimates of the other linear measures ranged from low to high (sella-sphenoccipitale  $h^2 = 0.12$ ; cranial thickness at vertex  $h^2 = 0.26$ ; sella-sphenothmoidale  $h^2 = 0.34$ ; basion-sella  $h^2 = 0.36$ ; sella-nasion  $h^2 = 0.41$ ; basion-sphenoccipitale  $h^2 = 0.43$ ; basion-nasion  $h^2 = 0.54$ ). Overall, these findings show that the human craniofacial complex is comprised of several moderately to highly heritable traits.

**Normal periosteal bone growth and skeletal pathology in documented fetuses, University of New Mexico, Maxwell Museum documented collection and University of Tennessee documented collection.**

A.L. East. University of New Mexico.

The purpose of this study was to examine the pattern of skeletal pathology present in two documented fetal samples and document differences in normal and abnormal periosteal new bone addition. The samples were from the University of New Mexico, Maxwell Museum (n=16) and the University of Tennessee (n=18). All individuals died between 1970-2001. Documentation on age, sex, race, and cause of death was available for many of the individuals. However, due to uneven docu-

mentation availability, some analyses were limited. Three general age groups are represented: 2nd trimester fetus, perinate, and neonate (<1 month).

Preliminary analyses documented three types of skeletal pathologies: abnormal periosteal bone growth, anencephaly, and craniolacunae. According to the medical literature (Harwood-Nash and Fitz, 1976; Kaplan et al., 1991), craniolacunae are only associated with neurospinal congenital disorders; however, no skeletal evidence or documentation supports that any fetus exhibited a congenital neurospinal disorder. In addition, four initial trends were observed: 1) individuals exhibiting skeletal pathology were in the perinatal age range, 2) few exhibited skeletal pathology, 3) there was a relatively high incidence of cranial defects that may be related to minor congenital abnormalities that otherwise do not present skeletally, and 4) every individual exhibited normal periosteal bone addition that could be confused with pathology if expected normal growth patterns are not incorporated in the research design and analysis of fetal and perinatal skeletal remains.

**Prediction of social race category using characteristics of dental morphology.**

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Patterns of biological variation coincide, in part, with the social category of race. Historically, forensic anthropology has concentrated on social race determination using skeletal morphological variation. Conversely, dental anthropology has been concerned with worldwide patterns of variation in the expression of dental characteristics. This paper represents a synthesis of the goal of forensic anthropology with the methods of dental anthropology.

Using dental morphology, probability tables based on samples of modern African Americans and European Americans were created for use in the determination of an individual's social race. Consequently, the tables are applicable for determining the probability that an individual was categorized as African American or European American.

All individuals in the samples (African American N=110, European American N=151) were born between 1920 and 1975. For this study, 32 morphological characteristics were possible per dentition. Probability tables were produced using logistical regression, a categorical data specific analysis that can be used to

predict the probability of an individual's population affinity.

Analysis was done with dichotomized character states for two, three and four trait combinations. Trait combinations were chosen to represent the greatest difference of expression between the two groups. Population affinity can be determined with upwards of 90% probability with particular trait combinations. The probability tables will be briefly described, and the results of a test of this method are presented.

**Father vs. nonpaternal allomothering effects on child health among the Toba of northern Argentina.**

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Nonpaternal allomothering may have played a large role in the shaping of our species. Today, cross-culturally, only a minority of child care is performed by men. Women need assistance in raising their children; however, does it matter where that assistance comes from? Are there any advantages to having a father in the home, if mothers have access to other caretakers? Such questions were investigated with the Toba of NamQom in Northern Argentina. The Toba are one of eight ethnic groups currently inhabiting the Argentine Chaco. Originally hunter-gatherers, many groups have moved to urban and periurban environments over the last fifty years. Childrearing traditions have, however, remained largely intact. Mothers make use of extensive kin networks; older daughters, grandmothers, aunts, cousins – everyone helps the mothers raise their children. Among the Toba of NamQom, two alternative hypotheses were tested: 1) the presence of a father is associated with better health outcomes in infants and young children, and 2) the presence of alternative kin caretakers (nonpaternal) is associated with better health outcomes. Health records of children under 4 years of age were obtained and are being analyzed. Interviews were conducted with the mothers to see whether or not fathers were present within the household and/or if kin were present within the village during the rearing of the children. Sex and age of nearby kin were noted. Preliminary results indicate that the presence of a father does not confer a benefit to child health if there are maternal kin networks available to the mother.

**Bioarchaeological analysis of an agricultural population from late medieval Transylvania.**

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Recent excavations in northwest Transylvania uncovered over 150 individuals from a 14<sup>th</sup>-17<sup>th</sup> century cemetery. Bioarchaeological analysis of this Magyar (ethnic Hungarian) peasant population has provided demographic and health data for a previously little studied area of medieval Eastern Europe. Although preservation was poor, subadults comprised 47% of the total sample. Only 5 infants were present in the subadult sample. This suggests that many of the fragile remains of very young individuals were not preserved. Lesions indicative of specific and nonspecific infectious diseases, nutritional deficiencies, trauma, and degenerative joint disease were scored.

Most of the adults in this sample were in their 30's to 40's at time of death, which is considered "old" in medieval literature. The adult sample did not show much evidence of pathological conditions aside from loss of teeth and arthritis, which is indicative of the diet and activity of this agricultural population. Cribra orbitalia was observed in nearly half of the 36  $\alpha$ -bits examined; over 50% of the affected individuals were found in juveniles. Long bone measurements indicate that adult height was similar to that of people in contemporaneous Eastern European populations.

These data suggest that this population had a high childhood mortality rate. People surviving to adulthood, in contrast, appear to have lived reasonably long lives, and have skeletons with comparatively little evidence of pathological conditions. Several alternative explanations of this apparent paradox between high childhood mortality and "healthy" adult skeletons are discussed.

**Predation risk and habitat structure affect habitat preference and vertical use of space by wild patas monkeys (*Erythrocebus patas*).**

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Habitat structure can be an important factor in determining animal habitat preference because it is often closely linked to aspects of ecology, such as food availability and predation risk, that affect

survival and reproduction. Here we examine how microhabitat structure and predation risk affect the habitat preference of wild patas monkeys (*Erythrocebus patas*). Patas monkeys in Kenya are restricted to *Acacia drepanolobium* habitat, but within our study group's home range, there are two distinct microhabitats, one with taller trees ("tall microhabitat") and one with apparently perennially shorter trees ("short microhabitat"). Examination of their ranging behavior indicates that the patas group did not use each habitat in proportion to its availability. Patas preferred the tall microhabitat, using it more often than expected. In the tall microhabitat, focal animals climbed into trees that were significantly taller than the average, indicating that they preferred tall trees. Indirect evidence suggests that the use of tall trees decreased predation risk for patas by increasing their ability to detect predators. In the tall microhabitat, female patas spent more time scanning from taller trees than from shorter trees, and detected predators only from taller than average trees, based on alarm call data. We found no evidence of increased food availability or reduced predator presence in the tall microhabitat to account for the monkeys' preference for the tall microhabitat.

**High resolution, sequential chemical analysis of tooth enamel by ion probe mass spectrometry.**

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Ion mass spectrometry has been used to measure sequential chemical profiles of elemental nutrients and pollutants from prenatal to postnatal periods in tooth enamel histological structure. Elements (Ca, Fe, Mn, and Pb) are measured in 40 micron spots in the enamel. The time of formation of the enamel in analytical spot is determined using the birth line as reference and counting diurnal lines in the histology. The technique, called the Tooth Enamel Biomarker, has been applied to study the exposure history of children to heavy metals having public health significance. The technique is directly applicable to the study of palaeonutrition, viability of fetal development, geographical location of mother's residence, early industrial pollution, and other applications of anthropological significance.

**Analysis of base misincorporations in ancient and modern mtDNA.**

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pology, UC Davis, <sup>2</sup>Genomic Ancestry Labs, UC Davis, <sup>3</sup>Dept. of Anthropology, Indiana University.

Ancient DNA (aDNA) extracted from prehistoric biological material has proved to be a valuable tool for testing a number of hypotheses concerning phylogenetic relationships, migrations, and prehistoric population histories. However, as aDNA is exists in low copy number and is highly degraded, contamination and authentication of the results remain significant problems. Additionally, PCR-mediated base-misincorporations due to post-mortem modifications in the DNA may also significantly influence the results from ancient sequence data. The presence of even a small number of misidentified polymorphisms can dramatically affect diversity measures drawn from these sequences as well as the perceived phylogenetic relationships between different DNAs. We compare polymorphic positions in modern and ancient mtDNA to see if mutations reported in aDNA studies are likely to contain errors. Additionally, we examine effects errors may have on diversity estimates drawn from aDNA.

**The supralaryngeal vocal tract (SVT) as an exaptation.**

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The lowered position of the larynx in adult modern humans has created a unique enlargement of the airway—the supralaryngeal vocal tract (SVT)—which has been shown to be necessary for the production of modern speech. No one has claimed that human ancestors prior to the descent of the larynx were not capable of verbal communication, but it has been argued that they would not have had the capacity to produce the rapid, varied and nuanced sounds of modern human speech. Exactly *when* laryngeal descent occurred during human evolution has been a long-running and contentious topic in paleoanthropology. A less-explored issue is *why* it occurred, perhaps the underlying assumption being that it was obviously related to vocalization. However, a number of recent studies on various topics—the requisite capacity of the aerodigestive passage necessary for ventilation and swallowing functions (presented here); the timing of the developmental descent of the larynx; the lowered position of the hyoid apparatus in individuals with a compromised airway and its superior re-positioning when surgically relieved—suggest that the descent of the larynx was not related to speech production. Rather, it may have

evolved to protect the functional capacity of the aerodigestive passage in response to impingement caused by the dental reduction/mandibular retrusion associated with technological advances. The SVL was an exaptation during this process and only after its origin did the sophisticated nervous control necessary for modern speech develop. It will be argued that the impingement would have more significantly effected populations with a narrow cranial base and that such a group would be the most likely candidate for first developing the anatomy necessary to produce modern speech.

**Dental asymmetry among the Oraibi Hopi population: Evidence for decreases in stress among young males.**

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Fluctuating dental asymmetry (FDA) is the asymmetric development of the left and right dental antimeres. Although the etiology of FDA is poorly understood, numerous studies show that the presence of stressors during development can contribute to its expression. Regardless of specific cause, FDA is negatively correlated with general physical health as well as fitness.

In this study, casts of the first permanent molars of 141 individuals from the Oraibi Hopi village were examined for FDA. The sample consists of 63 males and 78 females, ranging in age from 5 to 16 years, and was collected by A. Dahlberg in 1950 as part of the Southwest Indian dental project. Young males (<10 years old) have significantly lower levels of asymmetry in the mesiodistal dimension of the maxillary M1 compared to the rest of the sample (older males, older females, and females of the same age). There are no significant correlations between tooth size, age, sex, and asymmetry.

This result suggests that significant decreases in the levels of biological or social stressors affecting males took place in the Oraibi population circa 1940-1945. These decreases may have been due, in part, to initiation of preferential treatment of males over females. In addition, other changes in social conditions during this time include the closure of boarding schools, decline in Hopi subsistence farming, and the recovery from both the Great Depression and the Livestock Reduction program. These possibilities illustrate the ability of asymmetry studies to shed light on changes in social conditions and the environment.

**Brucellosis in antiquity: An analysis of possible cases of brucellar sacroiliitis.**

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Brucellosis is a zoonotic disease endemic to the Middle East and Mediterranean regions, where it poses both a public health and economic burden. Goats are the primary vector for *Brucella melitensis*, the species most pathogenic to humans and most likely to affect the skeleton. The domestication of sheep and goats in the Middle East 10,000 years ago and the presence of the vectors in the archaeological record suggest the early presence of human brucellosis. Given the importance of domesticates and the unavailability of antibiotics in ancient times, brucellosis was likely to have been a significant cause of human morbidity in antiquity.

Paleopathological studies have only recently described brucellosis and have focused on brucellar spondylitis. A review of current clinical literature, however, suggests that sacroiliitis is also a common if not equally frequent osteoarticular complication of human brucellosis and should be useful in the differential diagnosis of brucellosis and other diseases.

The current study surveys adult human skeletons from Middle Eastern archaeological populations for evidence of skeletal lesions associated with brucellosis. This report describes possible cases of brucellar sacroiliitis from skeletal samples that were previously analyzed for evidence of brucellar spondylitis. Initial findings reveal that the prevalence of probable brucellosis ranged from zero to 11% in samples from the Early Bronze Age site of Bab edh-Dhra, Jordan (ca. 3150-2900 BC), Tell Abraq in the United Arab Emirates (ca. 2500-2000 BC), burial mounds from Bahrain Island, Bahrain (ca. 2000 - 1600 BC), and the Qa'alat al Bahrain settlement of Bahrain (ca. 1450-1900 AD). These data indicate that brucellosis was a significant human disease in the past and that an understanding of brucellar sacroiliitis is critical to the identification of brucellosis.

**Coprophagy indicates stress in lowland gorillas (*Gorilla gorilla*).**

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Coprophagy is a behavior observed in great apes. However, to date, most reports are anecdotal. In this work, a sub-

set taken from the larger project "Cross-Environmental Behavioral Study of Western Lowland Gorillas", we present systematic data for this behavior and test its relationship to specific variables. Data were gathered on a group of 4 western lowland gorillas housed at Miami's MetroZoo. We analyzed data from 120 sampling sessions to test for correlations between the frequency of coprophagy and the sex of the gorilla, time of day, and day of the week. Only the 3 females engaged in coprophagy. Coprophagy was most frequent in the afternoon hours (59%). Coprophagy was most frequent on Fridays (81% of all cases). Both afternoons and Fridays have the highest number of visitors. This behavior has been documented in wild gorillas and may be a means of maximizing nutritional returns from an herbivorous diet. It may be that these gorillas ate feces because their diet was presented only twice daily and was small in volume, although equal in calories. So diet may explain this behavior to some extent in captive gorillas as well. However, we suggest that visitors were a source of stress because as the number of visitors increased, so did the frequency of coprophagy. Although our sample size is small, this finding suggests that coprophagy in captive animals may be a response to social stress as well as dietary stress.

**Development of human hand preference in the first year of life: The role of maternal influence.**

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Research indicates that the process by which handedness emerges in human infants is highly variable. Most conclude, however, that maternal influence plays some part in the development of infant handedness. We videotaped mothers and infants and looked at each of their hand preferences during a ten-minute period when they were alone. The sample consisted of thirty mother-infant pairs who visited the Mother-Infant Communication Lab at New Mexico State University. Infants were six months of age, and both Hispanic and Anglo mothers and infants participated in the study. In order to understand better the emergence of handedness in infants, three primary questions were considered: 1. Which hand does the infant use in interacting with objects, its mother, and its environment?, 2. Does the mother affect the infant's lateral preference through her own actions?, and 3. Are there similarities be-

tween hand preference among human and non-human primates in handling objects? Preliminary results show that the mother's dominant hand does not influence which hand the infant uses. Because previous research with non-human primates has indicated that handedness is variable, as is with humans, this research attempts to add to the understanding of hand preference in both human and non-human primates. Results of these observations were compared with similar studies of the emergence of handedness in nonhuman primates.

**Taphonomic analysis of one-million-year-old human hip bone (UA 173) from the Danakil (Afar) depression of Eritrea.**

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The UA 173 one-million-year-old human hip bone was discovered associated with the *erectus*-like UA 31 cranium at Uadi Aalad, in the sedimentary basin of Buia, northern Danakil depression of Eritrea (Abbate *et al.*, 1998). The specimen consists of two portions representing most of the iliac blade (i) and the acetabulum and ischium (ii) from a right adult hip bone. UA 173 is almost free from incrustations and preserves macroscopically intact most of its original bone surface.

On the medial aspect of the ischium, two parallel "scratch lines", similar to those resulting from the action of a lithic instrument, were detected during cleaning of the specimen. Interestingly, unequivocal marks of butchering and skinning had been recorded on a number of faunal remains coming from the nearby late Early Pleistocene outcrops.

The SEM analysis of high-resolution replicas of the ischial surface revealed a more complex pattern. While some portions of the lines (extended for c. 12 mm) display secondary striae in the main groove, thus suggesting the possible mechanical action of a tool, others distinctly show a concave section, more likely related to a vascular sulcus. Topographic investigation of the whole surface also revealed a number of microdamages of taphonomic nature (weathering agents).

In conclusion, also in view of a relatively low frequency reported in the refer-

ence literature for medial aspect of the ischium (White, 1992), currently available micromorphological evidence does not adequately support a diagnosis of "cut-marks" for the UA 173 "scratch lines."

**Rapid deployment of the five founding Amerind mtDNA haplogroups via coastal and riverine colonization.**

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Numerous studies of variation in mtDNA in Amerindian populations have established that four haplogroups are present throughout both North and South America. These four haplogroups (A, B, C, D) and perhaps a fifth (X) are postulated to be present in the initial founding migration to the Americas. Furthermore, studies of ancient mtDNA have suggested long term regional continuity of the frequencies of these founding haplogroups. Present day tribal groups possess high frequencies of private mtDNA haplotypes (variants within the major haplogroups) consistent with early establishment of local isolation of regional populations. Clearly these patterns have implications for the mode of colonization of the hemisphere.

I have recently shown that an earlier consensus among archaeologists for an initial colonization by Clovis hunters arriving through an ice-free corridor and expanding in a "blitzkrieg" wave is inconsistent with extensive genetic variability in Native Americans while a coastal migration route avoids this problem. The present paper demonstrates through a computer simulation model how colonization along the coasts and rivers could have rapidly spread the founding lineages widely through the Americas.

**The Omo I partial skeleton from the Kibish Formation.**

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In 1967 a team from the Kenya National Museum, directed by Richard Leakey, recovered the remains of three fossil hominids from the late Quaternary Kibish Formation of southwestern Ethiopia. Among these was a partial skeleton, designated Omo I, which has been consistently identified as anatomically modern in its anatomy. The fossil was recovered from surface collections and excavations at the KHS site in the upper part of

Member I of the Kibish Formation and was dated at 130,000 years old. For various reasons, many subsequent discussions of modern human origins have questioned the age of the Omo 1 remains.

Since 1999 we have conducted field research in the Kibish Formation in an effort to clarify the debated regarding the age of the Kibish hominids from the 1967 expedition and to provide a broader stratigraphic, paleontological, and archeological context for the Kibish Formation. Using maps and photographs from the 1967 expeditions we have relocated the site of the 1967 finds and subsequent excavations; we have recovered additional remains of the Omo I skeleton; and we have obtained new radiometric dates for members of the Kibish Formation. In addition, we have recovered abundant archeological remains from new excavations at the KHS site. Our results support the results of the 1967 expedition in placing the Omo I skeleton at over 100,000 years old and provide further information about the anatomy and associated archeological remains of this fossil that are significant for understanding modern human origins in Africa.

**Arboreality and infant behavioral development: new data from wild blue monkeys.**

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Infant behavioral development has been little studied in wild arboreal monkeys. To test the hypothesis that development of independence is delayed in arboreal species because of a high risk of injury from falling, we studied 12 infant blue monkeys during the first six months of life in the Kakamega Forest, Kenya. Blue monkey infants developed spatial independence from the mother rather rapidly. By the end of the second month some infants already spent less than 50% of their time in contact to the mother, a figure that decreased to an average of 35% in the third month, and to about 3% in the sixth month. Interindividual differences were small and significant only for infants of primiparous vs. multiparous mothers. A comparison of mother-infant contact scores with those from similarly sized terrestrial species does not support the hypothesis that arboreality delays the development of spatial independence. In fact, blue monkey mothers ceased to restrict the independent movements of their infants very early in life, at an age of about two weeks, and most of our infant subjects did fall out of a tree at least once

without sustaining serious injury. These observations, and a comparison of our results with those from wild *Macaca fascicularis*, another highly arboreal species, suggest that the development of infant independence reflects the risk of intra-group aggression and predation more than arboreality.

#### Dental health in North America.

C.D. Foose, P.W. Sciulli. Dept. of Anthropology, The Ohio State University.

The analysis of a health index for major groups who lived in the Western Hemisphere over the last 7000 years shows a general decrease over time (Steckel and Rose, 2002). The major question resulting from this research is the following: Does the health index or specific indicators included herein change over time due to the altered environments of the populations or due to some forces associated with time that have not been considered?

In this analysis, one component of the health index—dental caries—is analyzed for 65 samples (N~12,000) of Native Americans, European Americans and African Americans. The prevalence of dental caries is analyzed by ecological context (food source, vegetation, topography, climate, elevation, and settlement pattern) and time.

Although there are some differences among ecological factors in the prevalence of dental caries, the primary factor influencing this health indicator appears to be food source: populations with domesticated plants, regardless of setting, exhibit a significantly higher prevalence of dental caries compared to populations with no domesticated plants. We conclude that change in subsistence base best explains the decline over time in this health indicator.

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#### Biogeographic patterns of the Atelinae across the Northern Tier of South America.

S.M. Ford. Southern Illinois University.

The atelines found across northern South American and the isthmus represent many morphologically distinct forms, although their taxonomic status (as separate species or subspecies) remains in dispute. One factor is the degree of geographic separation or overlap of the various morphs. A better appreciation of the spatial relationships between forms can be gained using the mapping power of Geographic Information System (GIS)

software. Latitude and longitude data were determined for all ateline specimens in four major museum collections, using a variety of gazetteers and maps, for localities from Ecuador to the Guyanas and north to Nicaragua. They were analyzed using ArcView GIS (ESRI, Inc.).

This database demonstrates the well-known relationship of *Lagothrix* with higher elevations and the link of subspecies to specific river drainages, with lowlands as effective barriers. Borders between *Ateles* taxa demonstrate sympatry in the lower Cauca River Valley of *A. fusciceps*, and *A. hybridus*, and in northeastern Venezuela between *A. hybridus* and *A. belzebuth*. The far-flung but somewhat disjointed distribution of *A. belzebuth* indicates their spread around the boundary of the llanos region of Venezuela. The closeness of populations of *A. geoffroyi* and *A. fusciceps* in the southern isthmus is apparent. Contrasting the distributions of *Ateles* with *Aloutta* is instructive. Some boundaries to dispersal appear similar (e.g., lower vs. upper Rio Cauca, west vs. east of the Guianan highlands), but on a lower taxonomic level for howlers. However, the lower isthmian boundary appears different, and howlers have clearly been able to invade and surround the llanos region of Venezuela more effectively.

#### Sexing the sella turcica: A question of English vs. Turkish saddles?

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Numerous researchers have addressed the possibility of quantifying sex differences in the sella turcica (hypophyseal or pituitary fossa) of the sphenoid, but with less than encouraging results. The hypophyseal fossa is a plastic bony region responding to changes in the pituitary throughout an individual's life history. Additionally, the anterior pituitary is sexually dimorphic (even among subadults); larger in females when compared to males. This study rather than a metrical approach focuses on a morphological examination of the pituitary fossa. The initial sample is comprised of 23 males and 9 females (with craniotomies) from the Wiener Laboratory Modern Human Skeletal collection of the University of Athens in Athens, Greece.

Initial results confirm the variability of the sella turcica. However, the anterior and lateral aspects of the sella turcica may be sexually dimorphic. Females were

observed with the typical "Turkish saddle" appearance signified by a pronounced tuberculum sella, whereas males were characterized by what could be called an "English saddle" morphology, with a less pronounced tuberculum sella. Furthermore, the lateral aspects of the sella among some females appear delineated, unlike the appearance observed among most males. This region may be more indicative of sex than the morphology of the tuberculum sella. All three authors attempted sexing of this region in blind studies, with results of correct sexing as accurate as 88%. The authors anticipate that this morphological technique could be used to aid in sexing subadult as well as adult human skeletal material, both of forensic anthropological concern and from archaeological context.

#### Comparing internal nasal fossa dimensions and classical measures of the external nasal skeleton in recent humans: Inferences for respiratory airflow dynamics and climatic adaptation.

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The association between classical measures of the external nasal skeleton (the nasal index and nasal bridge projection) and eco-geographical variation in temperature and humidity is well established in biological anthropology. These associations, together with clinical studies of *in-vivo* internal nasal fossa airflow and heat and fluid transfer, have provided a sound basis for inferentially modeling climatic adaptation via natural selection on nasofacial variation in recent and fossil hominins. A key issue that has not been addressed is the degree to which external and internal nasal dimensions are actually associated. Do internal nasal fossa shape and size covary with classical external measurements of nasal form within groups? Do internal nasal fossa measurements separate eco-geographically diverse human groups to the same degree as external measurements?

To test these hypotheses, measurements of internal nasal fossa length, breadth and height (v=12) and associated external nasal measurements (v=18) were collected and compared in eco-geographically diverse recent human samples of intact crania (total n=522). Univariate and multivariate modeling indicates that not all internal measurements follow the well established regional patterns for external measurements. Most surprising is the result that internal

nasal fossa breadth at the level of the inferior turbinates does not distinguish regional groups, or covary in predicted ways with external nasal breadth and projection measures. However, internal nasal fossa breadth in the superior ethmoidal region covaries strongly with classical external measures in the predicted fashion. These results, considered in terms of airflow patterning, help clarify the adaptive basis for variation in human nose form.

#### **Multivariate analysis of intrapopulation variation in the Windover site.**

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The Windover site (8Br246) is a 5400m<sup>2</sup> peat deposit in east central Florida. Well-preserved human skeletal remains representing a minimum of 168 individuals were recovered during field investigation in the mid-1980s. Radiocarbon dating of the site places the earliest peat deposition at approximately 10,750 ybp (Beta - 13907), with burials occurring between 6990 and 8120 ybp. The Windover site has previously been the subject of craniometric analyses focused on biodistance comparisons of the Windover population with other skeletal populations. In the current study, the biological relationships *within* the Windover population are examined.

Intrapopulation variation within the Windover site is examined using multivariate analysis of craniometrics from adult males and females. Subgroups of individuals based on morphological similarity of the crania are hypothesized to share a greater degree of genetic similarity -- the more morphologically similar the individual or individuals, the greater likelihood of genetic relatedness.

The Mahalanobis distances among Windover crania were obtained using a covariance matrix from modern Native Americans. Internal variation is judged against distances expected from sampling pairs of skulls at random from a single population. Morphometric relationships indicate that the site is fairly homogeneous, although there are several Mahalanobis distances that exceed expectation of distances from two skulls at random from the reference samples. The crania are plotted onto principal coordinate axes for graphical presentation.

#### **Sexual dimorphism in the hominid cranium: New data using 3D morphometrics.**

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Sex determination of skeletal remains is commonly based on discrete postcranial characters. While the pelvic bones carry most of the features of skeletal sexual dimorphism in humans, much emphasis has also been put on cranial sexual dimorphisms, especially if only skulls are available, as is often the case of fossil populations. Major differences between male and female skulls are generally considered to relate to robusticity, the size of muscle attachment areas, and, to a lesser degree, differences in overall shape. In order to further investigate patterns of sexual dimorphism, a series of 125 ethnically diverse modern human skulls were compared using traditional and 3D geometric morphometric methods. The metric data were acquired using a cyberware laser surface scanner, which captures 3D surface data accurately within 0.5mm. In addition to standard linear measurements, volume and surface area calculations were also performed in order to capture size differences. Landmark data were then recorded to compute a generalized Procrustes analysis (GPA) in order to extract features of shape variation. All data were compared with respect to their usefulness for sex determination using standard multivariate statistics. The results indicate that absolute size differences mainly drive both between-group differences and cranial sexual dimorphism, whereas scaled dimensions exhibit much less variation. Furthermore, shape differences, as expressed by the difference in relative landmark location, were identified and used to characterize male and female skulls. This study illustrates the potential of combining 3D data acquisition and analysis using geometric morphometrics for the statistical assessment of sexual dimorphism.

#### **Comparison of the Pliocene and Pleistocene cercopithecoid faunas from the Afar and Turkana Basins.**

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There has been considerable debate whether major global cooling ca. 2.5 Ma caused a turnover pulse (extinction/speciation event) among African mammals. This analysis compares patterns of species turnover and relative abundance in the cercopithecoid fossil records from the Afar and Turkana basins. If global climatic factors are the principal

cause, then major events of species turnover and changes in relative abundance should be synchronous in the two basins, and occur at times of known global climatic change.

Species presence/absence data and ranges are compared between the two basins. Relative abundances of the four suprageneric molar categories of Delson (Szalay and Delson, 1979) are also compared. These categories are useful as they can be applied to isolated teeth, and therefore to a much larger proportion of the total sample. The abundances of these dental categories were compared using a correspondence analysis on both taxa and stratigraphic units.

Both basins show turnover in both species presence and relative abundance of dental groups ca. 3.4 Ma. There is a second turnover event in the species presence data for the Afar Depression between 2.9 – 2.5 Ma, whereas in the Turkana basin one occurs ca. 2.0 Ma. Therefore, there were important changes in the cercopithecoid fauna prior to 3.4 Ma where there is no known global climatic event. The ca. 2.5 Ma cooling event seems to have had less impact on species turnover in these two samples. I thank the Werner-Gren and Leakey Foundations, NSF (NYCEP RTG award) and the ETE consortium for support.

#### **The role of bio-cultural factors in assessing bi-directional pathogen transmission between human and non-human primates.**

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Human and nonhuman primate physiologies, especially the MHC and other immune system components, can vary across geographic distribution. Modern cultural patterns facilitate the wide spread movement of humans across areas also occupied by nonhuman primates. To effectively understand the risks and contexts for pathogen transmission we need to attempt to incorporate an understanding of the diverse array of interconnections between human and nonhuman primates. In order to facilitate the construction of a comparative dataset for the examination of potential pathogen transmission patterns I propose a set of biocultural variables as minimal descriptors for the assessment of HP-NHP interactions. This type of database might also facilitate a meta-analysis from which macro-trends in transmission may emerge.

Examining the interrelations between cultural contexts, ecologies and physiological patterns can enable researchers to

assess pathogen transmission in an evolutionary context. The growing body of investigation into pathogen transmission between human and nonhuman primates suggests the importance of biocultural patterns as predictors and descriptors of risk and management. Increased levels of contact between human and nonhuman primates coupled with growing trends in long-distance travel, reduced health in many human communities, and the increasing array of vectors for pathogen transmission are potentially altering the selective environment for human and nonhuman primate populations. Here I review relevant data on human-nonhuman primate interaction patterns and expand their implications to the broader context of health, cultural mores, and inter-continental travel.

**Sedentarization and maternal body composition: Comparative longitudinal analysis of anthropometric dimensions of nomadic and settled mothers in Ariaal-Rendille of northern Kenya.**

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This paper analyzes longitudinal repeated measures data collected as part of the Rendille Sedentarization Project. Anthropometric dimensions for 38 mothers in the nomadic pastoral community of Lewogoso and 40 mothers in the settled agricultural community of Songa are analyzed in association with several factors including lactation, and pregnancy status. Ariaal-Rendille of northern Kenya are nomadic pastoralists adapted to highly seasonal environments, who have become increasingly sedentary. Lewogoso remains a nomadic community, but Songa is a sedentary highland agricultural community whose residents have a relatively stable diet consisting mainly of maize meal instead of milk, the staple for the nomadic pastoralists. Previous analysis indicated that lactating mothers in Lewogoso showed neither body-fat nor body-protein depletion relative to non-lactating mothers in the same community despite their elevated energy requirement for lactation. In contrast, settled lactating mothers showed lower anthropometric dimensions than non-lactating mothers, including significantly lower mean weight values. This paper examines the longitu-

dinal effects of rainfall, milk consumption, wealth, pregnancy and wealth statuses on maternal anthropometric dimensions using a Generalized Estimating Equations approach. Preliminary analysis shows a highly significant effect of lactation on body weight and a significant effect of pregnancy on mid-upper arm circumference in Songa. In Lewogoso, only wealth status was a significant factor affecting maternal arm circumference. This suggests that nomadic pastoralism promotes more stable maternal body composition during lactation, despite their more seasonally volatile diet.

**Social and ecological flexibility in guinea baboons as an adaptation to unpredictable habitats.**

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Due to their wide range, from northern sahelian habitats to southern secondary high forests (100-1400mm annual rainfall), Guinea baboons face great climatic contrasts. Including Guinea baboons in evolutionary comparisons with other baboon taxa is therefore of great interest. What factors contribute to their ability to adapt to such a wide range of environments? If social flexibility in Guinea baboons is an adaptation to unpredictable habitats, then we expect to find variability in aspects of social organization such as group size and structure. Here we report data from annual surveys in Senegal from 1988 to 1998. Data collected included diet, distribution, density and group size. We found that dietary variability reflects high adaptation ability. The density of the Niokolo National Park population is relatively stable despite the fact that most other mammals are declining in number. The inter-annual rainfall variation factor was as high as 2.4. Years of maximum rainfall were followed by greater reproductive success. The four levels of social organization were foraging OMU's, multi-male subgroups, long columns of moving troops, and large sleeping aggregations. Mean size of groups varied over time between years, seasons and hours of the day. Ecological flexibility and particularly their multi-level social organization seem to be efficient ways to adapt to unpredictable environmental conditions. Similarly, one characteristic of Man is his ability to jump from one level of social organization to another one, from family cells to scholar fellows, from research departments to association meet-

ings. Funded by grants from Orstom, IRD, DPNS, FFEM, AFD, Sodefitecx.

**New perspectives on the hominin elbow joint.**

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This study re-examines the morphology of the distal humerus and proximal ulna of two fossil hominin samples, *Australopithecus* sp., and the Neandertals. The elbow joint morphology of *Australopithecus* is reminiscent of *Pan* and *Gorilla*, possibly reflecting underlying behavioural correspondence, namely arboreal suspension. The Neandertal elbow joint comprises primitive and derived features that likely reflect enhanced stability during loading. This analysis investigates these proposed morphological distinctions using Procrustes Superimposition procedures. A large comparative African ape (*Pan*, *Gorilla*) and recent human sample was utilised.

Principal component analyses of the 18 distal humeral and 14 proximal ulnar landmark series were performed using Morphologika. Resultant PC scores were entered in to a Discriminant Analysis. Recent humans and the African apes are distinguished by the location of their respective centroids on the first PC axis for both data sets and on further, analysis-specific axes. Recent *Homo* is considerably more variable in its epiphyseal morphology than is *Pan* or *Gorilla*. Contrary to expectations, the substantial majority of australopithecine distal humeri were classified as *Homo* rather than as African apes. The principal distinctions of the Neandertal distal humerus are primarily functions of their expanded olecranon fossae. The unique morphology of the proximal ulna of Eurasian Neandertals is considerably more complex than has been previously proposed. AL 288-1 is not convincingly 'ape-like' in her proximal ulnar morphology.

**Sharing commonly available foods in human evolution.**

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How food was gathered and shared among group members changed during human evolution. Several models emphasize introduction of hunting meat or collecting other highly desirable foods in

combination with nutritional differences and social interactions that contributed to our development as a species. The ability to exploit widely dispersed foods or foods that were energetically expensive to obtain, such as meat and sugar-rich fruits or honey, partly depends on the willingness of the main troop members to share commonly available resources with those who seek these highly desired foods. How did this change evolve and upon what relationship was it based?

We propose a model for cooperative foraging of commonly available foods based on the paleoanthropological record and comparisons with our closest living relatives. Among chimpanzees and bonobos, sharing commonly available foods usually is limited to mothers assisting young to exploit foods new to them or those that require some processing. We propose that this relationship between mother and offspring formed the basis for continued sharing. Mothers provisioned adult offspring while the offspring ranged beyond the core troop to seek highly desirable foods. These foods were used to facilitate the offspring's social and sexual networks. Mothers, therefore, formed the support structure that enabled offspring to devote energy to activities that provided highly desirable foods for the group and, at the same time, eventually increased the offspring's reproductive success.

### 3D approach to interpret enamel thickness and volume

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Enamel thickness is an important diagnostic character of Hominoidea. Recent discoveries of fossil hominoids, *Ardipithecus*, *Kenyanthropus*, *Orrorin* and *Sahelanthropus*, have all considered the thickness of enamel as a diagnostic trait of the taxon. However, the sample size is extremely small, relying upon mostly fractured specimens and a few sectioned hominoid specimens. These sectioned specimens only provide a two-dimensional estimate of enamel thickness. What is

needed to determine enamel thickness is to obtain the volume of enamel in order to accurately calculate enamel thickness and its pattern of distribution. Investigators have attempted to circumvent this problem by developing a variety of indexes. However, we are still left with subjective descriptions such as thin, thick, intermediate thick, and hyperthick, etc., without any quantitative means of comparison or a baseline upon which to derive numerical values.

The purpose of this investigation is to demonstrate the ability of high-resolution x-ray computed micro-tomography (HRXCT) as a nondestructive method to accurately and reliably produce contiguous slices revealing the thickness and area of enamel and dentin. Slice thickness of 50 and 70 micron of unworn hominoid molars was used, resulting in 250 to 300 slices per tooth. Using Vital Images Vitrea<sup>®</sup> 2 imaging software 3D reconstructions were produced, which provided volume data for enamel, crown dentin and pulp as well as the pattern of enamel distribution over the crown. 3D reconstruction of HRXCT images provides for the first time the capability of quantifying enamel volume and thickness, thereby eliminating the necessity of destructive thin sectional analysis.

### Evidence for computational spatial memory in wild capuchin monkeys (*Cebus capucinus*).

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Studies of primate spatial cognition indicate that certain landmarks may be encoded as associative representations whereas in other cases the spatial location and structural features of several landmark cues may be represented relationally and used to compute novel paths of travel. In the present research, we conducted an experimental field study of spatial cognition and foraging strategies in a group of 15 wild white-faced capuchins (*Cebus capucinus*) in northeastern Costa Rica. Specifically, we examined the ability of wild capuchins to use the relative spatial relationships among three landmark cues to predict the location of baited feeding sites. The research design involved the construction of 8 visually identical feeding platforms arranged in a circle with a diameter of 8 meters. We then conducted a series of six experiments in which the relative spatial positions of landmarks (yellow and pink colored poles measuring 2 m in height) were the only

information available to the forager to distinguish efficiently the two reward platforms from six sham feeding sites. These experiments tested the ability of the capuchins to (1) associate the proximity of a landmark with a food reward and (2) generate novel spatial information computationally using the configuration of three landmark cues. Data were collected from September through November 2000.

The capuchins visited the feeding platforms during 227 experimental trials over the course of 55 consecutive days. The results indicate that foragers were successful in using both static and dynamic spatial representations to locate food rewards ( $p < .05$ ). In several of these experiments, capuchin foragers first selected the reward platform whose location required computation of the spatial relationships of three landmark cues ( $p < .01$ ). Additional relationships between capuchin foraging strategies and spatial cognition are discussed. Funds provided by the Office of the Vice Chancellor of Research of the University of Illinois.

### A blind test of the auricular surface aging technique on a known age at death and sex skeletal collection.

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The determination of age at death in the human skeleton is a crucial aspect of skeletal analysis. In 1985, Lovejoy *et al.* published a method of aging the human skeleton based on their observation of the changes that occur in the subchondral bone of the auricular surface in the sacroiliac joint. The auricular surface aging technique has since been used to age 'older' skeletons, with an age at death over 20 years.

The present study takes a closer look at the auricular surface aging technique to determine its reliability when used as a single aging criterion. A blind test, using the scoring technique of Lovejoy *et al.*, was conducted using a known sex and age at death skeletal collection to compare the relationship between the scored auricular surface age and the real age of the skeletons. The skeletons analyzed were from the documented Christ Church at Spitalfields Crypt burials.

A total of 361 innominate bones were analyzed. Each auricular surface was scored. The scored age was plotted against the actual skeletal age. A review of the data collected portrayed that although the morphological changes observed within the bone were consistent with the individual phases of the auricular surface aging method, the true skele-

tal ages were higher than the age range limitations of each phase. The current study demonstrates that the auricular surface aging method is not consistent when comparing the scored age with the real skeletal age.

**Friendly faces and sexy behinds: Variable signal content contained in female rhesus macaque (*Macaca mulatta*) facial and sexual skin coloration.**

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As expressed in several other primates, both the face and sexual skin of female and male rhesus macaques (*Macaca mulatta*) reddens during the mating season. The purpose of the present study was to determine whether facial and sexual skin colors act jointly as a signal representing a singular message, or whether these colors operate independently to convey multiple messages. Subjects were 22 female (19 adults, 3 juveniles) free-ranging rhesus macaques on Cayo Santiago (1km off SE coast of Puerto Rico). A subset of these subjects was observed to assess the relationship between color and behavior (9 adults, 2 juveniles). Color was digitally measured non-invasively via the RGB Method, an objective means for quantifying color (Gerald *et al.* 2001).

Results from this study demonstrate no relationship between facial and sexual skin color in any color component. There was also no relationship between age and sexual skin color, but facial color reddened with age ( $n=22$ ,  $r=.456$ ,  $p=.039$ ). While every facial color component was inversely related to the number of affiliative intrasexual interactions that females initiated (red:  $n=11$ ,  $r=-.720$ ,  $p=.012$ ; green:  $n=11$ ,  $r=-.735$ ,  $p=.010$ ; blue:  $n=11$ ,  $r=-.726$ ,  $p=.011$ ; luminosity:  $n=11$ ,  $r=-.755$ ,  $p=.007$ ) and received (red:  $n=11$ ,  $r=-.784$ ,  $p=.004$ ; green:  $n=11$ ,  $r=-.694$ ,  $p=.018$ ; blue:  $n=11$ ,  $r=-.720$ ,  $p=.012$ ; luminosity:  $n=11$ ,  $r=-.755$ ,  $p=.007$ ), sexual skin color components were positively correlated with mating activity (green:  $n=7$ ,  $r=.808$ ,  $p=.028$ ; blue:  $n=7$ ,  $r=.773$ ,  $p=.042$ ; luminosity:  $n=7$ ,  $r=.758$ ,  $p=.048$ ). Together these findings suggest that the signal function of facial color and sexual color differs in female rhesus macaques.

**Reconstructing and comparing primate communities from the Eocene of North America and Europe.**

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Most studies on primate communities have focused on individual community ecology; relatively few have compared primate community ecology and primate ecological niche space ("ecospace") within and between continents. Fleagle and Reed (1996) addressed this problem by analyzing primate ecospace within and between the four major biogeographic areas inhabited by extant primates. Their results indicated that within a given biogeographic area, primate community structure was fairly uniform but between biogeographic areas, primate communities were markedly different. In a related paper, Fleagle and Reed (1999) also found that ecological distance roughly correlates with divergence time.

In this study, adapoid and omomyoid primate communities from the Eocene of North America and Europe were examined. Estimates of body weights and shearing quotients calculated from lower molars were plotted on a coordinate graph as a representation of dietary niche space occupied by extinct species. By computing both the areas and the average distances from the centroid of the resulting polygons, comparisons between primate communities in North America and Europe can be made. Results indicate that primate niche space expands significantly in North America from the Early to Middle Eocene, and at all times during the Early and Middle Eocene the niche space occupied by North American communities exceeds that of corresponding European communities. These results, similar to Fleagle & Reed, confirm that fossil primate community structure differed across biogeographic areas. The data may also suggest that adapoid and omomyoid primates had an earlier origin on the continent of North America than in Europe.

**Testing hypotheses of demes within *Homo erectus* using parsimony analysis.**

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BOU-VP-2/66, a *Homo erectus* calvaria, provides morphological details critical to understanding Pleistocene hominid systematics. The cranium was discovered *in situ* in the million year old Daka Member of the Bouri Formation, located in the Afar rift of Ethiopia inside the Middle Awash research study area. Acheulian

artifacts and a diverse fauna accompany the cranium. A set of 41 Early and Middle Pleistocene cranial specimens was analyzed using PAUP for the original publication of BOU-VP-2/66. This large dataset is used for this analysis, but with individual crania as Operational Taxonomic Units (OTUs) rather than the demes of the original phylogenetic work. The distal branching of resulting trees is compared to demic hypotheses based on time and space.

Morphological cladistics cannot be applied effectively to interbreeding individuals in a population because they would fail a fundamental Hennigian assumption: that OTUs are related to one another by a pattern of divergent branching. This same principle holds when any genes of the analytical units reticulate, even in units as large as metapopulations within a species. Therefore, branching relationships among different Pleistocene demes are insoluble with cladistic algorithms. Some single assemblages have several contemporary individuals and can be used as population proxies. Crania from single sites tend to cluster when cladistically analyzing Early Pleistocene hominids using individual crania as OTUs. PAUP produces these intelligible results because individuals from single sites have population level synapomorphies. Numerical analysis that distinguishes shared derived characters, for example Hennigian parsimony analysis, is useful in falsifying hypotheses of population-level affinities.

**Humeral retroversion: An activity pattern index in prehistoric southern California.**

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Humeral torsion or retroversion refers to the angle created by the transcondylar axis of the distal humerus and a line that bisects the humeral head. This measurement has been described in the literature since the 19th-century but its precise functional significance has remained unclear. A recent study of major league baseball pitchers demonstrates a significantly greater retroversion in the dominant throwing arm of these high-performance athletes. This asymmetry was not seen in age and activity matched controls. To determine if retroversion asymmetry could provide information on the activity patterns of Native Americans

who used contrasting weapons technologies (spears and atlatls vs. the bow and arrow), computed tomography was performed on the humeri of 28 individuals from the Channel Island area of southern California. None of the individuals from the Mission era showed humeral asymmetry greater than 10 degrees. Other individuals, especially those dating to the early prehistoric period when spears and atlatls were the weapon of choice for hunting and warfare, sometimes showed marked asymmetry comparable to that seen in professional pitchers. Four of the 11 individuals from this early prehistoric period sample, all of them probable males, had retroversion asymmetries of greater than 10 degrees. Detailed studies of the parameters other than retroversion such as robustness indices, bone density, cortical mass, and moments of inertia show that asymmetries in humeral retroversion are associated with a suite of morphological features related to habitual throwing activities that involving marked external rotation. Further studies into the ontogeny and functional correlates of this trait appear to be warranted.

#### **Population density and home range size of *Indri indri* in the Betampona Reserve, Madagascar.**

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Studies of population density and ranging patterns in several primate taxa provide evidence of marked intraspecific variation across habitats. For example, Pollock (1975) reports a home range of 18 hectares and a population density between 9-16 individuals/km<sup>2</sup> for *Indri indri* in a selectively logged high altitude rainforest. However, in a nearby undisturbed forest, Powzyk (1997) reported *Indri* home range of 35-40 hectares and a population density of 6.6 individuals/km<sup>2</sup>.

This study examined the population density and home range size of *Indri* in the lowland rainforest of Betampona Reserve in eastern Madagascar. Roughly 50% of Betampona is secondary rainforest resulting from slash-and-burn agriculture and selective logging. Over three months, a census of the entire *Indri* population of Betampona was conducted by mapping the location of loud calls. Following the survey, a year-long study of patterns of ranging and habitat utilization for three *Indri* groups was conducted. The census results provided an estimate of 79 individuals and a population density

of 7.1 individuals/km<sup>2</sup> in the reserve. However, based on home range sizes of the study groups (21-32 ha), we estimated that as many as 155 individuals at a density of 14 individuals/km<sup>2</sup> may occupy the reserve. These data suggest that the population of *Indri* at Betampona is similar to population densities and home range sizes reported at other sites. However, given site differences in *Indri* demography, the relationship between habitat type, population density, and level of habitat disturbance is unclear. The implications for conservation are discussed.

Funding provided by the St. Louis Zoo Fieldwork for Conservation Program.

#### **What were the "monkey lemurs" of Madagascar up to?**

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Modern tools of paleobehavioral reconstruction (including dental use-wear, dental microstructure, dental ontogeny, carbon isotope, and coprolite analysis) along with quantitative analysis of the paleoecological context in which extinct species lived, have enabled us to reconstruct the lifeways of the giant extinct "monkey lemurs" of Madagascar more thoroughly than ever before. We examine ontogenetic and geographic variation in dental use-wear signals for the Archaeolemuridae, along with data on enamel microstructure, enamel thickness, carbon isotopes, and fecal pellets. We demonstrate heavy pitting and hypercoarse scratches on the molars of both *Archaeolemur* and *Hadropithecus*. Thin sections of the molars of *Archaeolemur* display heavy decussation and a relative enamel thickness that rivals those of *Proconsul nyanzae*, *Lufengpithecus lufengensis*, and *Graecopithecus freybergi* and is exceeded in primates only by those of *Paranthropus* spp. Fecal pellets suggest a diverse diet.

We argue that: (1) along with *Babakotia radofilai*, *Daubentonia robusta*, and *Daubentonia madagascariensis*, the Archaeolemuridae were skilled at exploiting exceptionally hard food resources; (2) archaeolemurid diets were more like those of *Cebus apella* and the pitheciins than like those of baboons or macaques; (3) *Hadropithecus* was not a small-object feeder, nor was it a specialized graminivore; (4) *Hadropithecus* was more specialized than *Archaeolemur* for hard-

object feeding; (5) unlike the great majority of (if not all other) extinct lemurs, *Hadropithecus* consumed plants with CAM or C4 pathways; (6) *Archaeolemur* was able to exploit a wide variety of habitats; and (7) *Archaeolemur* was probably among the last of the giant lemurs to become extinct.

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#### **Evolution and loss of cytochrome c oxidase subunit VIII in primates.**

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The mammalian electron transport chain (ETC), encompassing five multisubunit complexes in the inner mitochondrial membrane, carries out aerobic energy metabolism. Cytochrome c oxidase (COX) (complex IV) comprises three mitochondrial DNA-encoded subunits and ten nuclear DNA-encoded subunits in mammals. Subunit VIII is one of four nuclear-encoded subunits demonstrating tissue-specific and developmental isoforms, one expressed in contractile muscle tissue and encoded by *COX8H*, and one expressed ubiquitously and encoded by *COX8L*. We have shown expression of *COX8H* in strepsirrhines, tarsiers, and platyrrhines but catarrhines, including humans, do not express *COX8H*. Old World monkeys retain the two-exon structure of species expressing *COX8H* but contain point mutations and other disruptions that converted *COX8H* into a pseudogene. In apes and humans DNA repeats have disrupted the *COX8H* locus, eliminating exon 1 and much of the intron. In addition to the gene loss, there have been increased rates of nonsynonymous nucleotide substitutions in both COX8 isoforms in anthropoid primates, an observation noted also in genes encoding other COX and ETC proteins. The pattern of nucleotide substitutions suggests positive selection for adaptive amino acid replacement in the COX8 isoforms. Considered with the evolution pattern of other ETC proteins, these data suggest a remodeling of the ETC in anthropoid primate evolution, possibly related to expansion of the highly aerobic neocortex in primates.

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### Sectional survey series: A new maxillary and mandibular radiographic technique.

M.B. Goldberg, Philadelphia, PA.

A review of the literature shows that forensic and paleoanthropologists routinely study extraoral radiographs of the hominid skull. Traditional radiographic cassette films produce images that display anatomic distortion and superimposition of structures, thus limiting anatomic and pathologic analyses. When asked to produce a radiographic record of the crania from the Tenth Street First African Baptist Church Cemetery (Philadelphia, PA), the project first relied upon the usual full plate frontal, lateral, and lateral-oblique views. To supplement these views, this researcher devised a procedure utilizing dental intraoral radiographic films and techniques to record a mosaic image of the maxilla and mandible, thereby minimizing anatomic superimposition and distortion. This method maximizes the potential for accurate measurement of calcified structures, greatly expanding diagnostic potential. This approach also has application to studies of fossil hominids and paleopathology.

### Does topography affect the foraging effort of mountain gorillas in Bwindi Impenetrable National Park, Uganda?

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Gorillas in Bwindi Impenetrable National Park, Uganda, live at high altitudes (1400-2300 m) with a terrain composed of multiple peaks and valleys. This study examined the extent to which slope affects the daily foraging effort of a habituated gorilla group. With a hand clicker, paces were counted following the gorillas' complete path length from morning to evening noting trail incline. Inclines ranged from minus three (steepest slope down) to plus three (steepest slope up) with zero representing flat land. The mean daily path length of the Nkuringo group was 710 m (n = 118, range = 38 - 2398 m, SD = 395). Although we expected an inverse relationship between the proportion of trail spent climbing and daily path length, no such relationship was evident ( $r^2 = 0.01$ ,  $p = 0.35$ ). In addition, no relationship existed between the proportion of trail descending

and path length ( $r^2 = 0.01$ ,  $p = 0.68$ ). To examine this further, the mean proportion of trail climbing and descending were compared for extremely short (< 200 m, n = 8) and long (> 1200 m, n = 12) path lengths. Forty-four percent of short and 41% of long path lengths were spent climbing ( $p = 0.68$ ), while 31% of short and 29% of long path lengths were spent descending ( $p = 0.82$ ). These findings suggest that topography has no effect on the foraging effort of Bwindi's gorillas, and that extra energetic requirements normally necessary for climbing do not interfere or constrain their daily travel distance.

### LINE-1 evolutionary dynamics among apes.

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LINE-1 (L1) elements constitute a large family of mammalian retrotransposable elements that have been replicating and evolving in mammals for more than 100Myr and now compose 20% or more of the DNA of some mammals. In addition, L1 activity probably caused the amplification of SINE (short interspersed repeated DNA) elements. As L1 and SINE insertions can inactivate genes, cause genetic rearrangements, and affect gene regulation, L1 activity has had a defining effect on the structure and function of modern mammalian genomes. Most L1 copies are defective on insertion and cannot be excised; and it is possible to recognize cohorts of these elements that inserted into the genome at various times and to follow their fates in different regions of the genome and in different species.

Successive emergence and amplification of distinct L1 (Ta) subfamilies occurred in the human genome, beginning about 4 Mya. However, little is known about the evolutionary history of L1 elements in other primate genomes. Here, we characterize L1 activity since the divergence of all the extant hominoid clades (Hylobatidae, Pongidae and Hominidae). Our analysis of L1 elements (n > 600) includes DNA sequences from representative species belonging to each of the hominoid clades. Our preliminary analysis suggests that L1 activity has been greatly reduced in *Pan* and *Gorilla*, while unique subfamilies appear to have been active in *Pongo* and in *Hylobates*. These results suggest that that L1 retrotransposition has

played an important and an active role in shaping the genomes and evolution of these lineages.

### Size matters - Does body mass?

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A class of body size variables derived from skeletal measurements known as global skeletal size variables (GSVs) exists in which the variables 1) scale isometrically with mass and 2) are directly proportional to mass - both within single populations and across multiple species. These variables are volumetric transformations of geometric means of measurements from multiple skeletal elements (e.g., the geometric mean of linear measurements raised to the third power). Direct proportionality of the size variables (body mass and GSV) has several useful mathematical properties, particularly that 1) variable means are directly proportional, 2) variable variances are directly proportional, 3) regression slopes for log-log plots are identical using either size variable, and 4) regression intercepts are transformed by a known constant for a log-log plot using either variable. Since GSVs are measured, not predicted, they may be used without concerns regarding associated prediction intervals.

This poster presents a variety of sample applications using GSVs to address typical anthropological research questions. GSVs are superior to body mass for a wide variety of studies. GSV will vary less over an individual's adult life than body mass, providing a more stable measure of overall adult body size than single measurements of body mass. Additionally, GSV can be measured for specimens that do not have associated body mass information, including relatively complete fossil individuals.

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### Diet in pre-contact Central California explored through dental microwear and stable isotope analyses.

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Pre-contact California was populated largely by hunter-gatherer groups, at densities much higher than usual for hunter-gatherers elsewhere. Reliance on resources which could be obtained in

quantity and stored resulted not only in these higher population densities, but also in other developments usually associated with agricultural societies (semi-sedentary communities, cultural elaboration, and stratification). Acorns were one of the main staples of most Californian tribes. Although high in fats and carbohydrates, acorns are bitter unless the tannin is removed. California Indians accomplished this by either burying the nuts in mud for long periods of time, or by soaking the ground meal in water. Processing acorns was labor intensive, and required a distinctive array of containers and grinding apparatus, some of which persist in the archeological record. Although acorns were seemingly little used in Central California in the Early Horizon (ca. 4,500 to 3,000 yrs BP), archeological signs of intensive use are more abundant in Middle and Late Horizon sites.

Here we compare results of analyses of two different skeletal dietary indicators, dental microwear and stable isotope composition of bone, in order to test hypotheses about how such changes in diet might alter physical indicators, and to compare these results with those obtained from other North American populations that also utilized stoneground plant staples. Samples from three Central California archeological sites in Sacramento County represent Early (Windmiller) and Late (Nicolaus and Mosher Mounds) Horizons. These are compared with previous studies of Pueblo maize agriculturalists (Havikuh, New Mexico) (Gordon 1994; Schoeninger et al 1983).

#### **Socio-demographic and environmental correlates of obesity in US adolescents: The National Longitudinal Study of Adolescent Health.**

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While ethnic disparities in overweight and the association between socioeconomic factors and overweight are well known, surprisingly little empirical research has examined the extent to which ethnic disparities in overweight are accounted for by SES differences. Environmental determinants of overweight are similarly understudied, although recognized to be important in the etiology of overweight.

Using nationally representative data collected from 13,113 US adolescents (including 2,902 non-Hispanic blacks, 2,286 Hispanics, and 919 Asians) enrolled in National Longitudinal Study of Adoles-

cent Health, we examined the relationship of family income and parental education to overweight prevalence (BMI $\geq$ 85th percentile of age and sex-specific 2000 CDC/NCHS growth curves). We investigated the extent to which race/ethnic differences in income and education account for ethnic disparities in overweight prevalence, and projected the effects on overweight prevalence of equalizing these SES differences between the groups. In addition, we examined the environmental and sociodemographic determinants of physical activity and inactivity, two major behavioral determinants of overweight. Simulations generating predicted overweight prevalence showed that changing only income and education (not physical environment) had a limited effect on the disparities in overweight prevalence. Results also showed important effects of environmental factors on activity patterns of adolescents and strong impact of sociodemographic factors on inactivity. One can not automatically assume that the benefits of increased SES found among white adults will transfer to other demographic groups. Intervention efforts to reduce obesity should progress beyond income and education and focus on other factors, such as environmental, contextual, biological, and sociocultural factors.

#### **The age of plague: A palaeodemographic study of a catastrophic death assemblage.**

R.L. Gowland, A.T. Chamberlain. Dept. of Archaeology and Prehistory, University of Sheffield.

The palaeodemographic signatures of epidemics are of perennial interest to biological anthropologists. The identification of catastrophic as opposed to attritional mortality profiles in archaeological samples of human skeletons clearly has important social and palaeopathological implications. A catastrophic mortality profile should mimic the age structure of the living population because all individuals have an equal probability of dying irrespective of age or sex. Currently the demographic effects of catastrophic events, such as the 'Black Death' (AD 1348-1350) which significantly impacted the population of England, are poorly understood. While the bubonic plague is strongly implicated as the cause of the Black Death, the event occurred prior to the detailed recording of deaths and so little is known about its epidemiology or demography.

This paper examines the demographic structure of a Black Death plague cemetery. We demonstrate that previous inter-

pretations of this assemblage have been based on statistically flawed analyses of age at death. Instead we adopt a Bayesian methodology in order to produce a more reliable demographic profile of the victims of the Black Death. This catastrophic age at death profile is then compared to that of a contemporary attritional cemetery where age at death was estimated using an identical methodology. Further comparisons have been made with historical records concerning plague mortality and with age structures taken from model life tables. This study offers important insights into the mortality of the Black Death and has implications for current debates concerning the aetiology and epidemiology of this episode of mass mortality.

#### **Aggression in *Haplemur griseus*: Evidence for female dominance?**

C. Grassi. The University of Illinois at Urbana-Champaign.

The definition of female dominance is a hotly debated topic in physical anthropology. A more flexible definition of dominance that includes feeding priority expands the use of this term and the number of lemur species that may be considered "female dominant." The results of this study indicate that *H. griseus* may be considered female dominant within or without this more flexible definition of dominance.

I studied three wild groups of *H. griseus* over a one-year period, which varied from three to 12 inds./group. *Ad libitum* data of all instances of aggression were recorded including the sex of the participants, the nature and context of the interaction, and if a "winner" could be identified. Some interesting patterns emerged. First, aggression rates differed significantly between groups and were positively correlated with group size. Contrary to expectations based on models of intragroup competition, aggression during feeding varied inversely with group size. Second, although all three groups favored the use of overtly aggressive actions, the three groups differed in their use of more subtle aggressive interactions such as displacements and vocalizations. Third, there were more aggressive acts directed by females towards males than between any other sex classes. Finally, female *H. griseus* are more often the aggressor, less often the recipient, and more often the winner of aggressive interactions. These results indicate that social interactions and to a lesser extent

feeding competition may determine patterns of dominance in this lemur species.

**Aping the ape: Force plate patterns associated with bipedal posture and gait.**

T.M. Greiner, K.A. Ball, S.P. Woodward. New York Chiropractic College.

Most studies of human locomotor evolution employ some type of ape based model as a surrogate for early hominin locomotion. Humans habitually stand and walk with their hips and knees at, or near, full extension – the straight hip straight knee posture (SHSK). The bipedal ape habitually stands with the hips and knees in a flexed posture – the bent hip bent knee posture (BHBK) – which has also been described as the compliant posture. Although there are many structural differences between ape and human locomotor anatomy, the choice of bipedal posture is an obvious functional distinction. Yet, it is not clear if bipedal posture is primarily a behavioral choice or a difference dictated by the underlying anatomy.

This study addresses postural differences by gathering force plate data from human subjects walking in the SHSK and BHBK bipedal styles. Results indicate that humans walking with the BHBK posture do not typically replicate force plate patterns associated with ape bipedalism. Instead, the BHBK humans continue to produce a recognizably human force plate pattern. Only after coaching subjects to adopt a bounding gait were some people able to produce the ape-like force pattern. It seems that uncoached humans do not provide the best model for reproducing ape-like bipedalism. By implication, uncoached bipedal apes may not provide the best models for early hominin locomotion. We must therefore ask if investigations that make use of ape-like bipedalism are addressing issues that are always necessarily relevant to the reconstruction of human locomotor evolution.

**Mitochondrial DNA variation at a Late Woodland Michigan site.**

K. Grennan, D.A. Merriwether. Dept. of Anthropology, University of Michigan.

We compare control region variation between mitochondrial DNA sequences from human remains from a prehistoric Michigan site and published contemporary and ancient DNA sequences. The sample consists of 17 individuals from the Late Woodland site of Juntunen, which was occupied at intervals from 800 A.D. to 1400 A.D., and is located on Bois Blanc

Island, in the Straits of Mackinac. DNA was extracted from bones and teeth using a phenol/chloroform protocol, and was sequenced. The results so far indicate a haplogroup A frequency of 37%, a haplogroup C frequency of 37%, a haplogroup D frequency of 12%, and a Brown's X frequency of 12%. We are continuing to expand the sample size and put the sequences into phylogenetic context using Bandelt Median Joining Networks for each observed haplogroup.

**The influence of substrate on the skeletal structure of the human foot on Mangaia, Cook Islands.**

N.L. Griffin, S.C. Antón. Rutgers University.

Based on the dynamics of the forefoot and Wolff's Law, we hypothesize that the structure of the forefoot of a biped should be influenced by the substrate over which one locomotes. In the forefoot of a biped, metatarsal shafts act as beams to maintain the integrity of the longitudinal arches, with the first through third metatarsals bearing the greatest loads. Proximal phalanges are also subject to axial loading, torsional, and bending stresses. Forefoot flexibility allows adjustment to terrain and helps resist ground reaction force during standing, walking, and running. Thus, differences in substrate between populations should lead to observable differences in pedal structure.

We test this hypothesis by considering the foot skeleton of prehistoric Mangaian and modern industrial samples. On Mangaia, Cook Islands inland agricultural fields are separated from the coast, and ocean resources, by a 70 m limestone cliff, the Makatea. Inland archaeological sites and ethnohistoric accounts attest to the daily movements of people up and over the Makatea. We compare adult pedal elements from prehistoric Mangaian (n = 41) with 19<sup>th</sup> and 20<sup>th</sup> century samples (n = 43) of Black, White, and Asian individuals who moved over mostly flat terrains. The industrial sample was designed to include individuals with ancestry from three geographic regions in an attempt to consider both phylogenetic and functional influences on foot structure.

Using external metrics of articular surface area, shaft length, and girth and Computed Tomography of shaft cross-sectional area and cortical thickness, we tested for signals attributable to differences in loading patterns. External measurements of distal articular surfaces of the Mangaian metatarsals, adjusted for size, suggest hypertrophy occurred as a

response to flexion on a steep terrain. The Mangaian first ray also exhibits shaft hypertrophy relative to length, suggesting greater loading. However, CT scans measured using Scion Image (Scion Corporation, 1997-2000) do not reveal any increases in cortical thickness in the Mangaian. Thus substrate differences appear to influence foot structure.

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**Taxonomic affinities of early *Homo* from Sterkfontein and Swartkrans: Evidence from permanent molar cusp proportions.**

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Molar cusp areas have been employed previously in the taxonomic evaluation of Plio-Pleistocene hominin fossils, but interpretation of these results has been hindered by lack of comparable data for extant taxa. Here, cusp proportions were determined from occlusal photographs for *Gorilla gorilla gorilla*, *G. gorilla berengei*, *G. gorilla graueri*, *Pan troglodytes*, *P. paniscus* and *Pongo pygmaeus*. Measurements were recorded also for *Australopithecus africanus*, *Paranthropus robustus*, East African fossils attributed to *Homo ergaster*, *H. habilis* and *H. rudolfensis*, and early *Homo* molars from Sterkfontein and Swartkrans, South Africa. Canonical discriminant functions reveal that mandibular molars provide better differentiation among modern taxa than maxillary molars. Lower M1s correctly distinguish 67% of *Pan troglodytes*, 48% of *P. paniscus*, 85% of *Gorilla gorilla gorilla*, 73% of *G. gorilla berengei* and 48% of *G. gorilla graueri* specimens; 68% of *Paranthropus robustus* and 65% of *A. africanus* specimens are correctly differentiated. These data distinguish among *Homo habilis*, *H. rudolfensis* and *H. ergaster* lower molars, and the East and South African *Homo* fossils are differentiated by both discriminant functions and Euclidean distances. The Sterkfontein and Swartkrans specimens are linked regardless of stratigraphic derivation. Where the South African specimens exhibit linkage with a particular East African sample, it is with *H. habilis* rather than *H. ergaster* or *H. rudolfensis*.

### Life-histories recorded in human teeth on the microstructural, ultrastructural and molecular level.

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The various levels of inspection of archaeological human teeth can combine to integrated information on prehistoric populations from general living conditions to defined stages in individual life. On the microstructural level, age-at-death diagnosis by counting incremental lines in adult teeth should be by far superior to morphological estimations, since the resulting palaeodemographic reconstruction of the former population will be based on the calendar age rather than on the biological age. It will be demonstrated that the histological average age at death in adults (and consequently the resulting life expectancy at birth) can be considerably higher than the morphological one in well-off populations and lower in underprivileged ones. In addition, the occurrence and ontogenetic dating of hypomineralized lines as indicators of various forms of stress can provide good examples on how the microstructural level relates to general living conditions.

Many biomolecular approaches to archaeological teeth aim at the reconstruction of palaeodiet. While stable isotope analysis of bone collagen of a skeletal find is suitable for the determination of the trophic level, a combination with abrasion parameters and dental microwear analysis of the same individual will lead to more detailed information on the diet and related dental health. Last, trace element analyses of the enamel of different tooth types of the same individual dentition are suitable for a monitoring of ontogenetic changes in dietary behaviour, and heavy metal exposure. Especially the latter example relates to environmental conditions and the age-specific risk of heavy metal incorporation of small children.

### Assessment of linear enamel hypoplasia (LEH) in early hominins.

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This study tests hypotheses about how LEH should vary across early hominin genera if intrinsic attributes of enamel strongly influence LEH expression. First, because of generic differences in imbricational enamel formation times, the longer-

forming canines of *Australopithecus* and early *Homo* are expected to exhibit multiple defects more frequently than those of *Paranthropus*. Second, based on generic differences in perikymata spacing, the average width of defects in *Paranthropus* is expected to be greater than that of *Australopithecus* in comparable crown regions.

The first prediction is supported. Of 17 *Australopithecus* canines affected by LEH and with 80% or more of their crown heights present, 11 exhibited 2 or more defects compared to only 1 of 15 such *Paranthropus* canines. The small sample of *Homo* canines (primarily east African), also shows a significant difference from *Paranthropus*. Thus longer periods of imbricational enamel formation seem to afford greater opportunity for enamel growth to be disrupted. The second prediction is not supported by a test on *Australopithecus* (n = 13 defects) and *Paranthropus* (n = 8 defects) canines from South Africa. Defects measured under an SEM were shown not to be significantly wider in *Paranthropus*. In fact, several *Australopithecus* defects took the form of wide groves while those of *Paranthropus* principally took the form of minor furrows. Possible causes for these results are considered, including differences between *Australopithecus* and *Paranthropus* in the resistance of their enamel to growth disruption or in their experience of significant episodes of stress.

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### Allometry of the primate external ear.

W.L. Gugliotta. Dept. of Anthropology, University of Chicago.

The primate pinna not only protects the inner ear but also aids detection and localization of sound. Accordingly, pinnal size may be (1) an isometric function of body size or (2) determined by ecological auditory variables. Although anecdotal reports indicate that some nocturnal primates possess relatively large pinnae to detect prey, this intuitive assumption has apparently never been quantified. I report here on the pinnae of 61 specimens from 32 genera housed in collections at the University of Chicago and the Field Museum of Natural History. As a proxy for body size, I calculated the geometric mean of two cranial measurements. Ear length was regressed on cranial size using a reduced major axis (RMA) regression. Across Primates, the RMA slope is  $0.62 \pm 0.09$ . The 95% confidence interval for this

slope shows a significant departure from the expected isometric slope of one ( $P < 0.0001$ ), confirming that larger primates possess relatively smaller ears. Collectively, the relative ear size of *Galago* spp. and *Tarsius* spp. eclipsed those of all other primates in the sample (Mann-Whitney  $U = 379.0$ ;  $P < 0.0001$ ).

The results indicate that primate pinnae are plastic to some degree. Relatively large ear size is linked to a nocturnal lifestyle and a faunivorous diet. However, these data suggest that the mode of capture favors larger pinnae, not diet *per se*. Among faunivores, bush babies and tarsiers are unique for their highly acrobatic means of predation. *Periodicticus potto* is noteworthy for its strikingly small ears, which may be related to increased olfactory skills.

### Teleology and human phylogeny.

T. Gundling. Dept. of Anthropology, William Paterson University.

Post-Medieval scholars received a view of the natural world that was static and organized in a simple linear fashion along a Great Chain of Being or *Scala Naturae*. Later scientific inquiries concluded that mutability was the norm. One way to reconcile the two contrasting philosophies was to view the Great Chain as an unfolding, yet predetermined, work in progress. Philosopher Arthur Lovejoy dubbed this the temporalization of the Great Chain, and unilineal phylogenies with *Homo sapiens* as the ultimate goal appeared during the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. Since the evolution of modern humans was considered inevitable, unrelated species might conceivably evolve human traits in attempting to achieve this most desirable end. Orthogenesis became a convenient "force" of evolution that provided for the dismissal of anatomical similarities as the result of parallelism, rather than reflecting common ancestry.

The modern synthesis undermined the idea of orthogenesis, instead emphasizing Darwinian principles of continuous phylogenetic branching with no predictable outcomes. Human phylogenies became less linear and more tree-like. Recent "bushy" phylogenies undoubtedly belie current perspectives on the evolutionary process that may retain teleological elements. For example the Eve hypothesis states that *Homo sapiens* evolved from a recent African ancestor and that other archaic forms are not directly related. Hence the evolution of modern human like traits, such as increased cranial capacity in the Ngandong descendents of

small-brained classic Javanese *H. erectus*, must be the result of parallel evolution. Arguments invoking "canalization" to explain this phenomenon can be interpreted as veiled teleology.

**Primate ecomorphospace: Anthropoidea and the African-Asian origin paradox.**

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Phylogenetic analysis has failed to resolve the question of anthropoid origins. Ecomorphology offers a means of examining morphological disparity as an entity separate from taxonomy. Ecomorphospace can be perceived as a set of attributes that define a species' role within an ecological community. For mammals these qualities can include body size, locomotor pattern, social and reproductive behavior, physical space occupied, and diet.

We developed four ecomorphs for extant primates: I – small bodied arboreal faunivores/frugivores; II – medium-sized arboreal frugivores; III – medium-sized arboreal folivores; and IV – larger-bodied terrestrial/arboreal folivores/frugivores. Based on known morphology, we assigned Eocene through Miocene African and Asian primates to these categories. We then superimposed these ecomorphological patterns on paleogeographic and paleoclimatic reconstructions of the Old World. Primate ecomorphological profiles differ in Africa and Asia during the Eocene and Oligocene but match one another in the Miocene. Asian Eocene and Oligocene primates occupied tropical lowland forests while African primates occupied gallery forest habitats along coastal areas and rivers that cut through arid, open savannah-like habitats. While these differences appear subtle, tropical lowland primates would have had a difficult time moving from Asia towards Africa during the Eocene and Oligocene. Eocene and Oligocene African primates that occupied more open habitats may have been better adapted to move across the broad, arid latitudinal belt present during the Miocene. The final closing of the Tethys Seaway resulted in the spread of hominoids and cercopithecoids into Asia from Africa at the beginning of the Miocene. These patterns support an African origin for Anthropoidea.

**Completing fossil *Homo* crania by statistical and geometrical estimation methods.**

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We present statistical and geometrical techniques to reconstruct incomplete crania and exemplify our approach by two fossil specimens, Bodo and Kabwe. Our techniques formalize the biologist's prior understanding of the considerations that govern form: considerations like continuity, symmetry or integration. The modern morphometrics of landmarks and curves makes it possible to blend statistical and biological reasoning in this domain. Factors such as size allometry or sex and also directional asymmetry whether zero or nonzero can be explicitly incorporated into the data estimation by way of the corresponding covariance structures. For tasks of estimation based on very small samples we show two variants based on the continuity assumption of the thin-plate spline: one for landmarks, one for semilandmarks. When complete specimens are adequate in number our estimation can be regression-driven instead. All the missing points can be estimated at once by maximizing the likelihood of the resulting configuration in a reduced-rank model of a multivariate Gaussian distribution. Whatever integration the form possesses is automatically exploited in the course of these regressions.

We demonstrate the accuracy of these approaches using a dataset of 388 anatomical landmarks and semilandmarks on 52 complete *H. sapiens* crania. After deliberately deleting regions of landmarks we estimate the missing data and compare the estimated specimen to the original. As our results indicate that the accuracy of estimation is sufficiently close to the precision of measurement, we apply our algorithm to complete the incomplete Middle-Pleistocene *Homo* specimens.

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**Predator experiments on infant spectral tarsiers.**

S. Gursky. Dept. of Anthropology, Texas A&M University.

Predation is believed to be one of the biggest threats to infant survival. The goal of this study was to ascertain how mother and infant spectral tarsiers, *Tarsius spectrum*, respond to the presence of potential predators. This study was conducted at Tangkoko Nature Reserve in Sulawesi, Indonesia from June-Nov 1999. Two infants were each exposed to 3 types of predators (large birds of prey, large

rubber snakes, and the vocalizations of large birds of prey) for a total of 36 nights. Infants moved a greater distance from their parked location when exposed to a rubber snake compared to the distance infants of the same age moved from their parked locations when no predators were present. When large birds of prey were placed nearby the parked infant, the infant did not move from its parked locale but remained completely still. Parked infants also consistently gave alarm calls in response to the presentation of all predator types. However, the type of alarm call they emitted varied depending on the predator. The infants consistently emitted a twittering alarm call in response to the bird of prey and a harsh loud call in response to the model snake. When new mothers were exposed to potential predators, they always alarm called. Mothers also decreased the distance between themselves and their parked infant when exposed to snakes whereas they increased the distance between themselves and their parked infants when exposed to model birds of prey or bird of prey vocalizations.

**Scanning electron microscopic analysis of oral surgery observed in a pre-Columbian Amerindian mandible.**

G.D. Hack, R.T. Koritzer. Dept. of Restorative Dentistry, University of Maryland Dental School, Baltimore.

The present authors report evidence of dental surgery observed in a 1200-year-old Amerindian skull. Although ritual dental modification (mutilation) is well documented in the literature, attempts at therapeutic dental treatment are less frequently reported, as it is necessary to establish a paleopathology that was purposefully managed. Examination of the mandible of an approximately 23-year-old male Illinois Indian evidenced a mesiolingual cusp fracture of the mandibular left first molar. The tooth fracture resulted in pulp exposure, leading to probable abscess formation with subsequent pain. We observed two holes (~4 mm dia.) drilled in the bone (alveolar trephination) on the buccal surface of the mandible, inferior to the traumatized tooth that may represent attempts to relieve discomfort. Present day endodontists have reported that trephination can relieve the pain of necrotic teeth (Elliot, 1988). These two holes are quite similar to the double trephination discovered in a 4500-year-old Egyptian mandible (Hooton, 1917). The edges of the fenestrations suggest stone drill use, and treat-

ment directionality can be inferred. The sharp edge of the antemortem tooth fracture appears intentionally filed, smoothing an edge that would have irritated the tongue. Being below the occlusal plane, the edge would not have worn in this way from normal masticatory processes. Postmortem tooth fractures, observed on other teeth of this individual, present with unmodified edges. Scanning electron microscopic analysis of replicas of both the fractured tooth and surrounding bone exhibit characteristics consistent with stone tool use (Havill et al., 1997).

#### **Food security and nutritional status among two Tanzania ethnic groups.**

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A common finding among communities depending primarily on agricultural economies is that seasonal variation in food, workloads, and morbidity leads to deterioration of nutritional status and health. Thus, seasonality may reinforce poverty and poor health, within and between groups. This paper tests whether significant differences in nutritional status observed between two Tanzanian ethnic groups (herders and farmers) living in the same area are the result of differences in household food security. Anthropometric data were collected on children and their mothers during two periods corresponding to the periods of maximum and minimum food availability. Questionnaires were also administered to measure household food security. Preliminary results suggest a much higher percent prevalence of food insecure households among the farmers. Interestingly, the nutritional status of children from both groups responded similarly to the "hunger season". This suggests that the observed differences in nutritional status among these two groups are the result of factors other than household food security, and these differences are set at a very young age. Alternative hypotheses, such as variation in child feeding practices, are explored.

#### **Limb proportions of *Homo habilis* reviewed.**

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*Homo habilis*, the earliest member of the genus *Homo*, is commonly believed to have possessed relatively ape-like body proportions. Thus, the fragmentary proximal femur of the OH 62 partial

skeleton from Olduvai Gorge is more gracile than that of AL 288-1 (*Australopithecus afarensis*), whereas the arm skeleton is longer than in its reputed ancestor. This is at odds with its craniodental morphology, which is more modern than in *Australopithecus*.

In contrast to previous claims, however, both OH 62 and KNM-ER 3735, the second *H. habilis* partial skeleton, fall for all shaft proportions inside the range of variation of modern humans, and, particularly for the larger-bodied KNM-ER 3735, outside that of chimpanzees. A better guide than the stocky femur of the AL 288-1 used by Johanson et al. (1987) for reconstructing OH 62's femur length is suggested to be the nearly complete femur from Olduvai Bed III, OH 34, that perfectly matches OH 62's morphology. Its slender proportions are probably neither due to pathology nor to a significant abrasion (Day & Molleson, 1976), but match a modern human of that body size. If this femur is used, then not only relative shaft proportions, but also the relative length of OH 62's leg is human-like. This is also supported by the human-like slender tibia of *H. habilis*, OH 35. Upper-to-lower arm proportions, however, remained primitive in *H. habilis*, thus resembling *A. garhi*, whereas its hindlimb is relatively lengthened like later *Homo*. Distance travel might therefore have been evolved early in human evolution.

#### **An assessment of hylobatid monomorphism using geometric morphometrics.**

S.E. Hagell, K.P. McNulty. Anthropology, City University of New York Graduate Center; New York Consortium in Evolutionary Primatology; American Museum of Natural History, Division of Paleontology.

Sexual dimorphism is a prominent characteristic of nearly all anthropoids. One exception to this is the hominoid genus *Hylobates*. Previous analyses, both qualitative and quantitative, have demonstrated a severe reduction or lack of intersexual differences in this taxon, concluding that gibbons and siamangs are monomorphic. Here we present a geometric morphometric analysis of hylobatid cranial morphology designed to identify and quantify differences between the sexes and to compare patterns of dimorphism to those in other hominoids.

This study included nearly 200 hylobatid specimens across six species. A representative sample of the other hominoid genera was also examined for comparative analysis. Three-dimensional coordi-

nate data were collected from sixty-six landmarks distributed around the cranium. Landmark configurations were superimposed by generalized Procrustes analysis and the aligned coordinates were used in multivariate statistical analyses.

Results of this study indicate that a distinct pattern of sexual dimorphism is present within all sampled species of *Hylobates*. Of particular note are differences in the canine alveoli, lower facial width, and neurocranial dimensions. Nevertheless, discriminant analysis is only moderately successful at sorting male and female specimens based on the landmark data collected here. The pattern of dimorphism found here is similar to patterns noted among other extant apes, suggesting a general morphogenetic scheme of dimorphism for all hominoids. Recognition of this pattern within the monomorphic hylobatids strengthens the case for using such features to distinguish sexes among fossil taxa.

This research was partially funded by NSF grants to NYCEP (DBI 9602234) and the NYCEP Morphometrics Group (ACI 9982351).

#### **Narial margin of the piriform aperture-epiphonemnon or forensic indicator?**

R.L. Hall, D.A. Hall. Oregon State University.

Because the human nose varies with geography and climate, and also contributes greatly to the individuality of each face, forensic scientists and evolutionary anthropologists have multiple reasons to be interested in all skeletal features that determine its form. In this study we relate the lower border of the piriform aperture to features of the mid-facial region examined in each of the 658-skulls in our worldwide sample. Unlike prior approaches (Gower 1923; Lahr 1996), our 10-category typology considers aperture shape as well as features of the lower margin. We profiled each type by age and sex; geography and climate (continent, precipitation, temperature, and humidity); three non-metric traits describing projection of upper nasal area; nine measures of breadth, height, and projection; and two indices. Though all 10 types appear in our largest continental sample (325 cases from North America), there are some geographic and climatic associations, such as the predominance in Asia Minor skulls of single-bordered lower margins with prominent nasal spines. Presenting frequencies and statistical descriptions of types, this paper discusses our conclusion that although the narial

margin's form results from a number of features affecting the aperture, it has potential forensic uses, including for reconstruction of individual facial features.

We thank the American Museum of Natural History, the Smithsonian Institution, the Royal British Columbia Museum, Simon Fraser University, the San Diego Museum of Man, and the University of Oregon for access to collections and Oregon State University Library for travel funds.

**Seasonality data from tooth enamel composition: The Levantine Holocene.**

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Intratooth variation in carbon and oxygen stable isotope ratios of domestic goats indicate marked seasonality in rainfall and plant cover at a Post-Pottery Neolithic Period B (PPNB, 7,500-6,500 yr BP) site located in modern Jordan. In contrast, modern Israeli goats record little annual variation. The  $\delta^{13}\text{C}$  values in four modern goats show a range from -12.5‰ to -11‰ with 1‰ range of intratooth variation. This shows significant input from C3 browse in diet and little annual variation. Three PPNB goats have a  $\delta^{13}\text{C}$  range between -10‰ and -4‰ with intratooth ranges of 4 to 6‰. This indicates greater overall dependence on graze with marked annual variation. Some use of browse occurred near the time of birth with a switch to graze (including C4 grasses) after six months of age. The  $\delta^{18}\text{O}$  values complement the carbon data. PPNB goats show an overall range from -1‰ to +4‰ with intratooth variation around 4‰. The most positive values occur near the time of birth when browse is taken. Modern goats show a smaller overall range (-6‰ to -4‰) and intratooth variation (1‰). This suggests that during the early Holocene seasonal, year-round rainfall with varying  $\delta^{18}\text{O}$  occurred in this region, with a transition to modern Mediterranean climate (with winter rains of uniform  $\delta^{18}\text{O}$ ) sometime after 6,500 yr BP. They also suggest an open grassland system during the PPNB.

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**Metric and nonmetric dental variations of major human populations in the world.**

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Metric and nonmetric dental variations in major human populations from around the world were analyzed. The results of uni- and multivariate analyses provide dental morphological support for the distinctiveness of each geographical population. At the same time, the significant interregional differences between sub-Saharan Africans and the other regional populations except for some similarity of sub-Saharan Africans to Australians/Melanesians can be detected. The two populations share generalized and conservative dental features such as large size and less simplified molars more frequently than other geographical populations. The dental traits of Europeans and West Asians, and to a lesser extent North Africans and South Asians, are characterized by size reduction and crown simplification. The Asian dichotomy of dental features, known as sinodonty and sundadonty, is reevaluated in this study. It is likely, moreover, the sundadont dental pattern evolved out of the early- or proto-sundadont dental pattern that characterizes recent Australian crown features. In the present study, some minor differences between East/Northeast Asian sinodont dental pattern and Arctic/New World dental feature are suggested. The metric and nonmetric dental characteristics of Arctic/New World populations may allow us to suppose that the dental features of them may be regarded as proto-sinodont dental pattern.

**The effect of speed and gait changes on vertical peak forces in primates.**

J.B. Hanna, D. Schmitt, P. Lemelin. Dept. of Biological Anthropology and Anatomy, Duke University Medical Center.

Most mammals use the running trot, which is intermediate in speed between walking and galloping. The running trot is characterized by contralateral pairs of limbs moving synchronously, a whole-body aerial phase, and relatively high stresses on the limbs compared to walking and slow galloping. This latter characteristic may explain why primates do not trot at intermediate speeds (Schmitt, 1995). Instead, primates "amble" at intermediate speeds, during which forelimb and hindlimb contact alternates, there are forelimb and hindlimb aerial phases, and these aerial phases are never synchronous so that the body is always supported by at least one limb. Primates may use ambling instead of trotting as a

way to moderate substrate reaction forces as speed increases. To test this hypothesis, we examined peak vertical substrate reaction forces ( $V_{pk}$ ) on the limbs of five primate species (*C. medius*, *M. coquereli*, *C. aethiops*, *P. anubis*, and *M. mulatta*) for a range of speeds and gaits. Our results show, for each limb, that  $V_{pk}$  increase linearly and continuously as primates shift from walking to ambling, and from ambling to galloping. Our results for primates contrast those obtained for other mammals, showing discontinuity in peak stresses at gait transitions. Our data suggest that at intermediate speeds, primates select ambling instead of trotting in order to minimize locomotor loads. Locomotor transitions in primates appear to involve subtle changes in limb loading, which minimize sudden increases in peak locomotor forces.

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**An unusual hypoplastic defect of the maxillary lateral incisors in great apes.**

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This paper describes a diagonal defect of the permanent maxillary lateral incisors (referred to here as DDMLI) not previously reported in the literature despite it being the second most common defect observed in the sample. The goal of this study is to describe and assess the frequency of DDMLI in the great apes, with particular attention to sub-species and geographic differences. Frequencies are reported, as well as analyses of DDMLI association with taxon, locality and linear enamel hypoplasia (LEH). The study sample consists of 136 great ape specimens and includes 41 gorillas, 25 chimpanzees and 70 orangutans from the Smithsonian's National Museum of Natural History great ape collection. Analyses of frequencies show that 25.27% of individuals are bilaterally affected by DDMLI. Overall, gorillas (5.88%) exhibit lower frequencies of DDMLI than chimpanzees (35.71%) and orangutans (37.21%). Analysis of subspecies differences shows that among gorillas, only the lowland gorillas exhibit DDMLI. There is no difference, however, in DDMLI frequencies between the Sumatran and Bornean orangutans. Analysis by locality shows no significant differences in frequencies of affected individuals. DDMLI defects tend to occur bilaterally, suggesting physiological stress as the cause, but this defect does not tend to occur in asso-

ciation with LEH (known to be caused by physiological stress) on either the same tooth or in the same individual. The etiology of DDMLI remains obscure, though systemic stress and genetic factors are unlikely to be the proximate causes.

### **Taxonomic and feeding diversity in the Shungura Formation fauna (Ethiopia).**

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Timing of major faunal speciation and extinction events in Africa between 3.0 and 1.0 million years ago (mya) remains unclear, although testing for episodes of high turnover during this period is of widespread interest, particularly in response to the predictions of the turnover pulse hypothesis (Vrba 1980, 1995). Differing views exist on the timing of significant change in mammalian communities, specific lineages, and the turnover pattern within single basins versus across Africa (Behrensmeyer et al. 1997, Bishop 1999, Alemseged 2002, Bobe et al. 2002). The nature of associated adaptive change, i.e. which adaptations arose, persisted, or declined, is even less well understood. Examining changes in feeding adaptations (e.g. grazing, browsing, and mixed feeding), and comparing these changes with taxonomic turnover contributes to a broader understanding of the consequences of environmental change on faunal evolution.

This study, which analyzes taxonomic and feeding turnover patterns in the Shungura Formation, Ethiopia, has two objectives: to determine if and when species turnovers occurred between 3.0 and 1.0 mya, and to compare feeding turnover patterns with taxonomic turnover. Three peaks of high taxonomic turnover occur at 2.8, 1.8, and 1.2 mya. Turnover of feeding adaptations generally follows a similar pattern as taxonomic turnover, although a conservation of feeding types at 1.8 mya, a period of high taxonomic change, suggests ecosystem stability. Establishing mammalian taxonomic and feeding turnover patterns provides a context for understanding the evolutionary history of hominins and how taxa diversified in response to environmental change. Supported by a National Science Foundation Graduate Research Fellowship.

### **3D morphometrics and the evolution of bipedality.**

W.E.H. Harcourt-Smith, P. O'Higgins, L.C. Aiello. Dept. of Anatomy and Devel-

opmental Biology and Dept. of Anthropology, University College London.

There is considerable debate over the bipedal capability of late Pliocene hominins. Analyses to date have relied on traditional measurements, such as inter-landmark distances, angles or indices to quantify postcranial form. Advances in geometric morphometrics now make it possible to greatly increase analytical resolution. This study develops an integrated approach to the interpretation of hominin tarsal morphology (OH 8, STW 573, and selected Hadar specimens) based on Generalized Procrustes Analysis using 3D landmark configurations for the talus, calcaneus, cuboid, navicular and medial cuneiform. A number of tools are used to investigate these data. Phenograms are employed to compare similarities and differences in shape between the fossils and modern comparators (*Pongo pygmaeus*, *Gorilla gorilla*, *Pan pansicus*, *Pan troglodytes* and *Homo sapiens*). Pairwise Procrustes distances are calculated between all extant comparators to assess the range of inter- and intra-specific variation in tarsal form. Fossil pairs are tested against these data to assess Pliocene morphological and inferred functional diversity. Finally, a "meta-analysis" combines the PC scores for all tarsals within a single analysis, providing a set of results that reflect a number of functional complexes rather than the morphology of the isolated pedal elements. This new integrated analytical approach reveals two distinct morphotypes in fossil pedal morphology, one characterizing *A. africanus* and *H. habilis* and the other *A. afarensis*.

### **Gene-culture co-evolution: The dopamine D4 receptor and other polymorphisms that may reflect social evolution.**

H.C. Harpending. Dept. of Anthropology, University of Utah.

Traditional anthropology envisioned a synthesis of social and biological sciences, but only scattered parts of this have appeared. Within the last decade, two developments provide grounds for optimism that the synthesis will proceed. First, molecular genetic analysis of interesting loci can identify those that have been subject to selection. Criteria include the frequency spectrum of SNPs in and near the locus, the shape of the gene genealogy, and extreme values of  $F_{ST}$  in world samples. Second, psychologists working in behavior genetics have described loci where extant variation has substantial

effects on individual behavior. Examples include several dopamine receptors, the androgen receptor, the serotonin transporter, and possibly luteinizing hormone.

We have proposed a model to explain worldwide variation in dopamine D4 receptor frequencies, and our model competes with a model by Chen and Burton. I will discuss our model, the Chen and Burton model, and ways that these models can be tested. I will then discuss other interesting loci and the ways in which variation at them might be related to ecological histories of human populations.

### **Where's the variation? Variance components in the permanent dentition.**

E. F. Harris. University of Tennessee, Memphis.

Despite numerous crown dimensions that might be measured, there are few canonical axes of tooth crown variation in the permanent dentition. This study used maximum likelihood components of variance analysis to quantify where the major sources of statistical variation occur. Mesiodistal and buccolingual crown dimensions were measured on all permanent teeth (excluding M3s and averaging sides) in 100 American whites and 100 American blacks, evening divided by sex. A SAS program (varcomp) was used to estimate the sources of variation across 7 aspects of the dentition, namely race, sex, arcade (maxillary, mandibular), tooth (incisor, canine, premolar, molar), tooth position in a field (mesial, distal), dimension (MD, BL), and a residual term composed of unique variation. Looking at just the six components of the shared variance, most (82.8%) was due to tooth type (I, C, P, M). In contrast, only 4.9% was due to the American black-white difference—the preponderance of variation is within groups, not among them. The MD-BL component was 3.6%. Striking was the lack of variance between sexes (1.2%). Also, only trivial variance (0.6%) was ascribable to tooth position; the "pole" tooth possesses about the same information statistically as the "variable" tooth. Whether the tooth was maxillary or mandibular accounted for 6.9% of shared variance, suggesting that crown size control between arcades is fairly weak. Overall, little (6%) of the shared variation distinguished blacks and whites or males and females. Instead, morphogenetic field, which reflects a tooth's position in the arch, accounted for the preponderance of variation.

### **Kanapoi: Fauna and paleoenvironments.**

J.M. Harris<sup>1</sup>, M.G. Leakey<sup>2</sup>. <sup>1</sup>George C. Page Museum, Los Angeles, <sup>2</sup>National Museums of Kenya.

The early Pliocene locality of Kanapoi is located to the southwest of Lake Turkana in northern Kenya. The Kanapoi sites were first collected in the mid 1960s (1965-67) by expeditions from Harvard University. Significant specimens collected at that time include a hominid humerus that was tentatively identified as *Australopithecus* sp. and several new species of non-hominin vertebrates. The site was subsequently recollected in the mid 1990s by National Museums of Kenya expeditions. The vertebrate fauna was considerably augmented and the hominin hypodigm was expanded to include cranial, dental and postcranial material of the earliest known australopithecine, *Australopithecus anamensis*. The Kanapoi biota is tightly constrained in age to between 4.12-4.17 and it documents a perillacustrine assemblage from an interval of time that is not well represented elsewhere in the Lake Turkana Basin. Paleosols from the Kanapoi sequence have been interpreted to represent similar habitats to those that occur today in the vicinity of the Omo River delta at the north end of Lake Turkana. That interpretation is not entirely supported by the evidence from the Kanapoi fossil vertebrates.

### **A comparison of limb preference in captive bonobos, chimpanzees, lowland gorillas and orang utans.**

R.M. Harrison, Dept. of Archaeology and Prehistory, University of Sheffield.

Limb preferences in apes are examined in order to further our understanding of when the species-level right limb preference found in modern humans evolved. Preferential limb use is associated with the increased complexity and compartmentalisation of the brain that has been correlated with the development of language and cognition. Consequently studying limb preference has become considered a means, albeit indirect, to approach such topics as the evolution of cognition. Much work has been conducted on apes, yet the level of limb preference remains unclear. Comparisons between studies and species are often difficult because different methodologies are utilised and behaviours of differing complexity are recorded. Consequently a comprehensive study examining limb preference

in the same set of behaviours across ape species is required.

In the present study limb preference is examined in four ape species. Captive groups of bonobos (n=22), chimpanzees (n=6), lowland gorillas (n=21) and orang utans (n=20) were observed for a total of 1000 hours with all aspects of their daily routine recorded by focal animal sampling. Preliminary results suggest that no species-level preferences are present. Some individual preferences are evident but these are sporadic and do not elicit any effect at species level. These findings support the suggestion that right limb preference evolved after the divergence of the extant chimpanzee and hominid lineages. Thus, using limb preference in apes to map the evolution of cognition in humans may have to be re-evaluated.

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### **Changing student perceptions about human variation in an honors college program.**

D.L. Hart, P.C. Ashmore. Dept. of Anthropology and Pierre Laclède Honors College, University of Missouri, St. Louis.

Students enrolled in an Honors College program at the University of Missouri – St. Louis are generally considered to be exceptionally bright, high-achieving students. The university exists in one of the most segregated cities in the country and, to date, no class concerning human variation had ever been offered at this urban institution. Approximately forty honors students enrolled in the Human Variation: Concepts of Race seminar taught by two physical anthropologists. At the beginning of the semester these students were assessed to determine the range of perceptions they had about human variation. In particular we wanted to see if their perceptions were representative of historical "race thinking," including the following ideas: 1) humans form concrete biological entities representative of races; 2) physical characteristics can be linked to behavior; 3) physical characteristics can be linked to IQ; 4) so-called racial characteristics are inherited as a genetic "package." The students were later assessed at the end of the semester to determine if and how their perceptions had changed during the course of the seminar. In addition students in this class had to identify a study population and disseminate a questionnaire aimed at identifying perceptions of human variation in their study group. The findings from all of

these surveys will be discussed as well as constructive strategies used to investigate human variation in a diverse college classroom.

### **Frequency of posterior femoral neck facets in the Tipu Maya.**

K.M. Hartnett. Dept. of Anthropology, Arizona State University.

Facets on the posterior femoral neck were discovered on 35 of 121 males (28.9 %) and eight of 77 females (10.4 %) examined from the Colonial Period Maya cemetery of Tipu, Belize. Posterior femoral neck facets are also known as posterior cervical imprints, posterior acetabular imprints, and Wamsley's facets. The facets are bilateral, are not non-metric traits, and are attributed to stress on the hip joint when flexing the knee and extending the hip while squatting, standing, or walking long distances.

The distribution of femoral neck facets among the Tipu males and females strongly suggests a difference in activity patterns, which corroborates a previous study by the author on their habitual activity patterns utilizing musculoskeletal stress markers (MSM). The facets found on the males may be linked to distance walking or running, as well as canoeing, for the posture assumed by males while canoeing likely contributed to the greater frequency of these facets. The facets found on the females may be linked to distance walking or running, but may also be caused by maintaining a squatting or kneeling posture for long periods of time.

The frequency of posterior femoral neck facets is also examined in males and females in relation to their burial locations in and around the church. There appears to be no difference in the distribution of facets among males relating to burial location, but there is a slight difference in the patterning among the females. This pattern, however, may be a product of small sample size.

### **Morphological and molecular implications for the ateline adaptive radiation.**

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The ateline New World monkeys constitute as certain a monophyletic group as there is among primates. The group is intriguing because while their adaptive

radiation is well understood and their monophyly as a group is unquestioned, their phylogenetic inter-relationships remain controversial. Our study addresses two aspects of ateline phylogenetic history: 1) incongruity of the molecular and morphological evidence; 2) relevance of the fossil record.

Traditional morphological comparisons isolate *Alouatta* from the atelins, and group *Ateles* and *Brachyteles* as a sister group to the exclusion of *Lagothrix*. In contrast, several recent molecular studies point to a closer relationship between *Brachyteles* and *Lagothrix* than between *Brachyteles* and *Ateles*. There is no obvious resolution here. Rather, we apply these opposing arguments to a new set of questions, such as the polarity of similarities between the nucleotide sequences of these taxa and the implications of positioning *Ateles* as the most morphologically derived atelin.

Resolving ateline phylogeny must consider the fossil record, which in this case doubles the number of taxa for study. Molecular approaches can consider only the four living genera, and in each published study only one individual per species is used. This is similar to the limitation that attends the use of fossils in cladistic reconstructions. Three ateline fossils are especially pertinent here. We interpret *Paralouatta* as a Quaternary alouattin, *Caipora* as an example of how the *Ateles* lineage derives away from the atelin morphotype, and we evaluate the likelihood that the remarkable anatomy of *Protopithecus* evidences the roots of both lineages.

#### **A comparison of microwear analysis and stable carbon isotope ratios to reconstruct Fremont subsistence.**

M. Hatch, S.A. Novak. Dept. of Anthropology, University of Utah.

Through scanning electron microscopy, dental microwear patterns on the occlusal surface of molars are able to lend insight into the subsistence strategies of prehistoric and modern animals and humans. Stable carbon isotope analysis is another technique frequently used to help reconstruct diet. Whereas microwear techniques are nondestructive, isotope analysis requires that a sample be destroyed. This study compares intertooth microwear patterns on individuals with known carbon-13 isotope ratios. The Fremont Complex (2100-500 B.P.) of the Great Basin has exhibited varying levels of nomadic foraging and maize agriculture depending upon the region and time period under scrutiny. The actual impor-

tance of maize, a C<sub>4</sub> plant, to their diet has been under debate by many Great Basin researchers (e.g., Berry 1974; Jennings 1978; Madsen 1989). If a nondestructive technique, such as microwear, can be applied to determine approximate amounts of C<sub>4</sub> plant consumption, museum specimens can be preserved for future study.

High-resolution epoxy casts are taken from first, second, and third mandibular and maxillary molars from ten prehistoric Fremont skeletons. Scanning electron microscope images are collected at a magnification of 500X. Each image is analyzed using Microwear Version 4.02 (Ungar 2002), which is currently the predominate software used to quantify microwear features. To test the accuracy of a new imaging software, these results are then compared to findings obtained using Image-Pro Version 4.5 (Media Cybernetics, Silver Spring, MD). The results of these microwear analyses are graphed and correlated with the individual's known δ<sup>13</sup>C‰ value (Coltrain 1993, 1999).

#### **The influence of dental wear on Neandertal mandibular morphology.**

K. Hattman, J.L. Thompson. Dept. of Anthropology, University of Nevada, Las Vegas.

Several mandibular morphological attributes have been used to assess population and/or species level relationships between Neandertals and early modern humans. For example, a decreased gonial angle, shorter dental arcade, retromolar space, and mental foramen positioned below the posterior teeth, are features used to differentiate between them. In contrast, the presence of a mental eminence in some Neandertal specimens and modern humans has been used as evidence of a close phylogenetic tie between them, as a symplesiomorphy, or the result of gene flow.

The dental and orthodontic literature reveals that, over an individual's life, the mandible is capable of considerable morphological change as a result of dental wear. Occlusal wear is associated with continuous eruption of the tooth root from the alveolus. Bone resorption results in gracilization and possibly an *incurvatio mandibulae* at the anterior corpus. Interproximal wear is associated with lingual tipping resulting in more vertical orientation of the anterior teeth and an accentuated projection of the inferior anterior corpus. It also causes mesial drift, resulting in reduced anterior arch length, alignment of the mental foramen with the posterior teeth, increased retromolar

space, and reduced gonial angle. In this paper we investigate the hypothesis that heavy dental wear, seen in adult Neandertals, may provide a functional explanation for mandibular morphological features used to characterize Neandertals, as well as features sometimes shared between Neandertals and modern humans. Thus, the effect of dental wear on tooth position and mandibular shape provides a means of testing evolutionary relationships between these two populations.

#### **Death in a mill town: Mortality in emergent industrial cities of New England.**

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The Connecticut Valley Historical Demography Project (CVHDP) has hypothesized that the widespread emergence of New England mill towns and the stressful environments and economic uncertainties of such rapidly growing industrial communities may have contributed to persistent high mortality during the 19<sup>th</sup> century. While conditions in these communities may have elevated mortality, developing infrastructures offered possible amelioration. Using individual-level linked census and death records from two emerging urban industrial towns in Massachusetts, Holyoke and Northampton, we first present the correlates of mortality, focusing on the relationship of wealth and community to infant and childhood mortality. With the addition of spatial data for individuals and public health infrastructure, the effects of developing infrastructure are then explored for one town. Analyses of age and cause-specific mortality within neighborhoods, in conjunction with evolving sewer systems in Northampton, demonstrate the mortality effects of industry and open sewers and the mitigation of these effects by subsequent sewer improvements. Our findings suggest that perhaps neighborhood environmental effects could be one mechanism through which wealth affected mortality. This work adds to a substantial and growing body of European and North American historical case studies of public health infrastructures in the cultural and physical mortality environments of newly emerging industrial communities of New England during its mortality plateau and eventual decline.

**Genotype-by-age effects on bone mineral density in the spine and forelimb in baboons: Possible implications of mechanical usage.**

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Though it is well known that both genes and advancing age contribute to risk of low bone mass and osteoporosis, genotype-by-age (G×A) effects on variation in this risk are little understood. We conducted statistical genetic analyses of DEXA-acquired areal bone mineral density (aBMD) measures in the spine, radius, and ulna in 692 pedigreed baboons (*Papio hamadryas*) to identify G×A effects in this nonhuman primate model for age-related changes and pathology in bone. We modeled G×A interaction for aBMD by defining the additive genetic component of the variance as a function of age. We also modeled the genetic correlation between relative pairs at different ages as an exponential decay function across age values. Through numerical maximization, we simultaneously estimated these G×A interaction terms plus the mean effects of sex, body weight, crown-rump length, and spinal arthritis severity, on each measure of aBMD. Likelihood ratio tests disclose G×A effects in the spine and ulna, but not in the radius. Genetic variance decreases with age in the spine ( $p=0.000783$ , anterior-posterior projection;  $p=0.002432$ , lateral projection). Genetic correlation between aBMD at different ages differed significantly from 1.0 in the spine ( $p=0.028354$ , lateral projection) and in the ulna ( $p=0.000194$ ). These results imply that the magnitude of genetic effects changes with age, as do the genes or suite of genes involved. Because the radius bears more weight (load) during baboon locomotion than either the spine or the ulna, we postulate that non-genetic effects related to functional biomechanics may obscure/override G×A interactions on BMD in the radius.

**The browridge: Pleistocene body armor?**

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Functional explanations for supraorbital torus morphology in fossil hominids have been varied. Many approaches have considered the torus as a functional re-

sponse to strain, presumably from mastication. Russell (1986) suggested that strain was magnified in crania with a marked angulation between the face and frontal squama, and browridge size does appear to be related to this angulation among both living and fossil samples. However, direct measurements of the forces created by mastication have shown only a weak strain in the supraorbital region, making hypotheses related to chewing appear less likely. It has frequently been suggested, notably by Weidenreich (1951) but also by others, that the system of cranial tori, including the supraorbital torus, may protect the skull. For the supraorbital, it would seem likely that the eyes were the primary object of this protection. The appearance of cranial wounds accompanied by marked cranial thickening in Lower Pleistocene *Homo* would seem to substantiate this explanation. However, an adaptive explanation focusing on protection should also account for the reduced browridges of many recent human populations, and possibly for the distribution of supraorbital morphology among other primates.

This study uses three-dimensional morphometric data to evaluate supraorbital form among fossil hominids and investigate possible protective mechanisms. This work included three-dimensional simulation modeling of impacts of various sizes of missiles and bludgeons upon the supraorbital region. It is found that the supraorbital area provides minimal protection to the superior face and eyes in the range of impact velocities and projectile shapes available to early humans. This minimal protection is greatly improved by the presence of a substantial supraorbital torus. In contrast, crania with relatively more vertical frontal squamae already provide substantial protection to the upper face and eyes; these do not benefit markedly from anteriorly projecting supraorbital development.

**The ecology of mammalian orbit orientation.**

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Primates are characterized by similarly facing, or convergent, orbits and associated binocular field overlap. Hypotheses explaining the adaptive significance of these traits often relate to ecological factors, such as arboreality, nocturnal visual predation, or saltatory locomotion in a complex nocturnal, arboreal environment. Allman and Pettigrew suggested that orbit convergence accrued functional ad-

vantages to nocturnal animals by both improving image quality and image brightness in the field of binocular overlap. To date, although the nocturnal visual predation hypothesis is the consensus explanation for primate orbit convergence, it is not universally accepted.

This study re-examines the ecological factors that are associated with high orbit convergence. Orbit orientation data were collected for over 250 extant taxa from twelve orders of metatherian and eutherian mammals. These taxa were coded for activity pattern, diet, and substrate preference. Nocturnal and cathemeral taxa have significantly more convergent orbits than diurnal taxa (excluding anthropoids), both within and across orders. Arboreal and aerial (i.e., megachiropteran) taxa also have significantly higher orbit convergence than terrestrial taxa. Interestingly, faunivorous taxa (both nocturnal and diurnal) do not have significantly more convergent orbits than non-predatory taxa. However, when considering nocturnal and arboreal taxa alone, faunivores do have significantly higher orbit convergence. These results suggest that multiple advantages of high orbit convergence exist, and these are not limited to nocturnal visual predators.

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**Mass migrations or mere movement of morphemes? A dental morphology investigation of post-Neolithic south Asian population history.**

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Recent assessment of DNA variation among members of various castes in modern India has rekindled controversies over the appearance of Indo-Aryan languages and spread of Vedic culture. Current theories include the Aryan Invasion Theory, the Out of India Model, and the Early Intrusion Model. Unfortunately, studies based solely on living individuals cannot distinguish between these models. This is because they encompass different expectations for the timing and patterning of phenetic relationships among prehistoric and living ethnic groups in south Asia.

Dental morphology provides a basis for comparison of phenetic variation among past and present populations. This study compares 17 tooth-trait combinations among 1451 individuals of 16 different prehistoric and living populations from central Asia, the Indus Valley (IV), and peninsular India that span from 6000 B.C. to the present. Samples are com-

pared with Mahalanobis generalized distance ( $d^2$ ) and patterns of phenetic affinity are assessed with cluster analysis, multidimensional scaling, and principal coordinates analysis.

This analysis provides no support for the Aryan Invasion Theory or the Out of India Model, but yields results consistent with the Early Intrusion Model. A substantial biological break occurs among IV populations between 6000 and 4500 B.C. This schism is echoed by the phenetic separation between living western and central Indians, and inhabitants of south-east India. Hence, it appears likely that the introduction of Indo-Aryan languages and Vedic culture was more a socially grounded movement of morphemes and ideas than a biologically grounded mass migration of Indo-Aryan speakers and Vedic proselytizers from outside the Indian subcontinent.

#### **Sexual dimorphism in the face and palate of the orang-utan.**

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The orang-utan is widely recognized as a highly dimorphic species. An ontogenetic approach to the study of sexual dimorphism assists in understanding both where and when these differences develop. In this study, 357 orang-utans from Borneo are divided into five developmental stages representing infancy to mature adulthood. 3-D coordinate data from 19 landmarks representing the face and palate are analyzed using Euclidean Distance Matrix Analysis, a quantitative method for the comparison of forms.

Results indicate that dimorphism in the face and palate can be localized in infancy and traced throughout all age intervals. Males and females are similar in facial dimensions related to the width of the orbits, face, nose and premaxilla and in the projection of the snout. They maintain these similarities throughout development. However, they differ in the height of the cheek, nose and premaxilla from the earliest stages into adulthood. The face broadens and zygomatic bone flares dramatically in adult males. In the palate, the sexes are similar in most dimensions representing width throughout all age intervals. Males exceed females in the length of the palate and tooth row in infancy and maintain this distinction into adulthood where they also exhibit a deepening naso/oropharynx and projecting premaxilla in mature adult stages.

The method used here was especially helpful in identifying both global and local form differences throughout the

development of the orang-utan face. These age-group comparisons also allow identification of potential trends in dynamic growth patterns in the craniofacial complex and suggest future directions of research.

#### **Magnetostratigraphy of the South African hominid palaeocaves.**

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Palaeomagnetic investigations have been undertaken at the South African Australopithecine palaeocaves of Makapansgat, Sterkfontein, Gondolin and Gladysvale. Other work was also undertaken at the faunal locality of Buffalo Cave and the archaic human site of the Cave of Hearths. Makapansgat is the oldest locality dating between 4.29 and 2.1 Ma. *The A. africanus* remains date to between 2.58 and 3.04. Sterkfontein dates between 4.18 and 1.07 Ma with Stw 573 dating to a period before 3.0 Ma, the main *A. africanus* assemblage dating to between 2.15 to 2.58 Ma and the Sts 5 fossil represents the youngest of the *A. africanus* fossils at a date of 2.2-2.0 Ma. The later deposits containing *P. robustus* and early *Homo* date to somewhere between 1.07 and 1.77 Ma. The main fauna from Gondolin dates to between 1.77 and 2.14 Ma with deposits as old as 2.58 Ma. Buffalo Cave dates to between 1.77 and 0.78 Ma, the main faunal deposits dating between 0.78 and 0.94 Ma and as such represents a period when few faunal localities are known worldwide. Currently the work at Gladysvale is ongoing and dates of younger than 0.78 Ma and as old as 1.77 Ma are suggested for the upper stratigraphy. As such these sites, taken together with other palaeocaves such as Swartkrans, Coopers and Kromdraai represent a relatively uninterrupted sequence of Plio-Pleistocene faunal and hominid fossil localities in South Africa.

#### **Sexual dimorphism in Meroitic, X-Group and Christian populations from Sudanese Nubia.**

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The transition from Meroitic (0 CE-250CE), X-Group (350-550 CE) and Christian Period (550-1350 CE) resulted from political economic changes that significantly affected the adaptation of populations inhabiting Nubian lands along the Nile. The Meroitic Kingdom, with its

central polity far to the south, unified groups along the length of the Nile and even into the adjacent areas of the Near East. The collapse of the Meroitic kingdom resulted in the rise of local groups that characterize the X-Group period. The populations in the Wadi Halfa area were reunited under the Christianity, whose central authority was in Nubia. Previous studies using a number of stress indicators reveal that the localized populations during the X-Group period were experiencing less stress than those of the Meroitic or Christian period. In this paper, we examine the degree of sexual dimorphism as a measure of adaptation during these periods of transition. Using the maximum length of the femur, the percent of sexual dimorphism in Meroitic is 5.0 % increasing to 6.9% in the X-Group population and decreasing to 4.5% in Christian period. Maximum femur length of males increases about 1.3% from Meroitic (N=57) to X-group (N=135) and decreases 6.1% in the Christian population (N=45). There is a slight decrease (-.4%) from the Meroitic to the X-group period females with a greater decrease in the Christian females (-3.8%). The decrease in sexual dimorphism in the Christian population results from the greater reduction in Christian males femur length. These results suggest that Christian population was experiencing considerable stress that differentially affected the sexes.

#### **Biological pattern changes in a French medieval population: Implications to reconstruct health status and dietary behaviour.**

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In order to evaluate the health status and the dietary behaviour of the medieval population buried in the Saint-Laurent de Grenoble Church (France), a paleoepidemiological analysis of osteological, dental and isotopic criteria is conducted. Probable links between the health status and diet are appreciated according to the three chronological phases of the studied period (XIIIth c., XIVth c., XVth c.) and the historical and environmental context. The anthropological series consists of 252 adults of equal proportion of males and females, young adults and old adults.

All results agree for a modification in the biological pattern during the late medieval period. The pattern of degenerative, traumatic and infectious lesions shows changes during the XIVth c. For the same period, the linear enamel hypoplasias frequencies argue for hard conditions of life probably due to the Plague (1348 AD) in association with bad climatic conditions. The both decreasing tooth wear and increasing dental pathologies and nitrogen isotopic compositions ( $\delta^{15}\text{N}$ ) from the XIIIth century to the XVth century are interpreted as a modification of the diet with a less important consumption of vegetal and fish food and a more important consumption of sweetened and/or consistent food and animal proteins. Therefore, the increase of stature and its degree of sexual dimorphism between the XIIIth and XVth c. could argue for an improvement of living conditions at the end of the late medieval period.

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#### **Late Pliocene climatic change and faunas in the Tugen Hills, Kenya.**

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The Tugen Hills, in the Rift Valley of Kenya, preserve a relatively unbroken succession of vertebrate faunas ranging in age from around 16 million years (Ma) to recent times.

One of several current interests of the *Baringo Paleontological Research Project* is the period between 3 Ma to 2 Ma, a time range of considerable significance for the origin and divergence of certain hominin lineages, such as *Homo* and *Paranthropus*. Global climate change, linked to astronomical factors, has been suggested as a possible element in faunal evolutionary shifts, particularly in the origin of these hominin lineages. However, there have been scant empirical data showing that astronomical forcing has a significant effect, or is detectable, at the equator in the interior of continents.

Exposures of the Chemeron Formation in the Barsemoi River, west of Lake Baringo, reveal a sequence of five major diatomites. Single-crystal <sup>40</sup>Ar/<sup>39</sup>Ar determinations show they occur between 2.66 Ma and 2.56 Ma, and reflect depositional cycles of 23, 24, 25 and 27 thousand years

(ka). This agrees well with the 23 ka Milankovitch precessional periodicity. Other data strongly suggest these cycles reflect global climatic change rather than local tectonics.

Over 35 fossil sites, ranging between 2.89 Ma and 2.43 Ma, can be correlated into this section. Three localities incorporate hominins, including one with the earliest known member of genus *Homo*. This situation provides an opportunity to determine whether the climatic fluctuations demonstrated in this sequence have a significant evolutionary effect on the late Pliocene fauna.

#### **Developmental instability and skeletal phenotypes in Down syndrome.**

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Two mouse models for Down syndrome (DS), Ts1Cje and Ts65Dn, are trisomic for segments of mouse chromosome 16, which correspond with portions of human chromosome 21. These segments share genes so that 108 genes are at dosage imbalance in Ts65Dn, while Ts1Cje has 79 of those genes at dosage imbalance. It is hypothesized that trisomy of multiple genes leads to increased developmental instability (DI), ultimately resulting in DS phenotypes. Evidence for this hypothesis comes from the observation of increased variability for individual complex traits. Morphological integration (MI) has been proposed as a measure of DI, in which lower integration patterns indicate increased DI. This study analyzes MI patterns of two mouse models for DS, in order to test the hypotheses of decreased MI as an explanation for the DS phenotype.

Twenty-two linear distances of the postcranial skeleton were collected from Ts65Dn euploid (N=22) and aneuploid (N=12), and Ts1Cje euploid (N=12) and aneuploid (N=13) mice. Linear distances are analyzed using MANOVA and MI-Boot, a bootstrap method for comparing MI patterns (© TM Cole III). Despite increased variation of individual measurements in the aneuploid skeletons, comparison of aneuploid and euploid littermates indicates stronger MI in both aneuploid samples. Our results indicate that increased variability of individual traits is not necessarily a reliable measure of developmental instability, and that

the postcranial skeleton in aneuploid individuals may be subject to differing developmental constraints, compared to euploid individuals.

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#### **Tooth size variation and dental reduction in Europe, the Middle East and North Africa between 120,000 and 5000 BP.**

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A reduction in tooth size is believed by most researchers to have occurred throughout the entire evolutionary history of *Homo*, but it appears to have been particularly marked in Neandertals and anatomically modern *Homo sapiens*. Most previous studies have used comparisons of mean measurements to show this reduction, and little is known about the variability of tooth measurements within groups of fossils because heavy tooth wear greatly reduces the number of measurable specimens. The present study, which has been in progress for more than two years, incorporates cervical measurements of tooth size which are taken at the neck of the tooth crown with specially constructed calipers. These measurements are much less influenced by occlusal and approximal attrition, and have made it possible to include a larger number of specimens than has been possible before.

In the most recent phase of the work, the total number of teeth measured has been brought up to over 6000, from sites in Portugal, France, Belgium, United Kingdom, Denmark, eastern Europe, Israel and North Africa. In general, most of the results confirm that there is an overall trend through the period studied towards reduction in average tooth size, but there is considerable variation within groups of specimens, and their ranges of variation overlap. There are also differences between teeth, between sites within the regions of the world studied, and between the regions themselves. It is as important to explain this variation as it is to explain the average trends in tooth size.

#### **Foot kinematics of *Hylobates lar*, *Ateles geoffroyi*, and *Macaca fuscata* during locomotion on arboreal and terrestrial substrates.**

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Since the foot performs a pivotal role in the interaction between body movements and substrate condition during locomotion, its form and motion should be closely related to the habitat in which the animal lives. In this study, we measured foot movements in detail in a gibbon (*Hyllobates lar*), a spider monkey (*Ateles geoffroyi*), and two Japanese macaques (*Macaca fuscata*) to obtain quantitative information about terrestrial or arboreal adaptation of foot kinematics in these species. Measurements were made using a 3-D video-based motion analyzer (ELITE, BTS) while the subjects walked on the ground or on a horizontal pole (diameter: 9 cm). The features that characterized the foot kinematics of the gibbon and spider monkey were a relatively plantar-flexed tarsometatarsal joint, a small range of motion of this joint, and an out-toed foot position. By contrast, the tarsometatarsal joint of the Japanese macaques was dorsiflexed during terrestrial walking. This may be related to the digitigrade-like walking of this species. During arboreal walking, however, the foot kinematics of the Japanese macaque were similar to those of the two arboreal species. This supports the hypothesis that the above-mentioned characteristics (plantar-flexed position and small range of motion at the tarsometatarsal joint, out-toed foot) are all related to branch grasping by the foot during arboreal locomotion. The spider monkey and gibbon, which are highly adapted to arboreal life, retain those characteristics when walking terrestrially, whereas the foot of the Japanese macaque seems to be designed to deal with both terrestrial and arboreal substrates.

#### **The relationship between size and shape in baboon molars.**

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For almost a century paleoanthropologists have studied the complex relationship between size and shape, allometry. Recent developmental genetic experiments are making the first steps in its clarification. We investigated the relationship between size and shape in baboon molars ( $n > 230$ ). The orientations of the mesial and distal lophs were measured as angles from the perpendicular mesiodistal axis of the tooth for RM<sub>i</sub>, LM<sub>i</sub>, and RM<sup>1</sup>. The coefficient of variation (CV) for these angles centers on 3 in this population. This is low compared to the CV for size measurements, which range between 5 and 6. We then tested for correlations between the mesial and

distal loph angles within the same tooth crown, between teeth on the same tooth row, across the arch, and between arches via Pearson Correlation coefficients. The mesial and distal lophs correlate significantly on all teeth ( $p = 0.01$ ), though the maxillary correlation is higher than for the mandible. The mesial and distal lophs are correlated across the mandibular arch (mesial = 0.42, distal = 0.51,  $p=0.01$ ). Only the mesial loph orientation is correlated between the maxillary and mandibular arches (0.23,  $p = 0.01$ ). The correlations between loph angles and standard size metrics are low ( $< 0.24$ ) or insignificant.

These results have important implications for understanding the sources of variance underlying the cusp positioning of molar crowns. The varying levels of correlation potentially indicate different levels of shared genetic and nongenetic effects in the patterning mechanism. Evolutionary implications will be discussed.

#### **The tale that tail bones tell about the antiquity of the human disease brucellosis.**

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Brucellosis, as a pathogen to humans, is a disease that is caused by three bacteria in the genus *Brucella* and is passed to humans through a variety of intermediate hosts including many animals. *Brucella melitensis* is the species that primarily affects goats, which are thought to be the second oldest domesticate (domesticated ca. 9,000BP), and is passed to humans through the consumption of milk. Today brucellosis is endemic in many Middle Eastern countries, but little is known about the origins of brucellosis as a pathogen to humans or about the dispersal patterns of brucellosis in the past. To better understand these concepts we reviewed clinical literature and observed radiographs of modern cases of brucellosis to determine the skeletal manifestations of the disease. Next we evaluated 184 sacra and 288 innominates for signs of sacroilitis (one manifestation of brucellosis) from five different Middle Eastern human samples. These samples included: two from Egypt (Egypt 12<sup>th</sup> dynasty 1991-1782 BCE, Egypt 25<sup>th</sup> dynasty 747-657 BCE), one from Jordan (Bab edh-Dhra 3,150-3,000 BCE), and two from Bahrain island (Bahrain 2,300-2000 BCE, Bahrain 2000-1700 BCE). We then radiographed seven innominates that showed

possible signs of brucellosis. We found that one female out of 19 individuals from the 25<sup>th</sup> dynastic Egyptian collection has sacroilitis that could have been caused by brucellar infection. This is a prevalence of about 5.2% of Egyptians in this 25<sup>th</sup> dynasty site and is a rate close to what would be expected in a sample where the disease is endemic.

#### **Craniofacial remodeling during adulthood: The supraorbital region.**

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Variation of the supraorbital region has been tied to sex, population, and childhood growth, but few studies have attempted to document changes in this region during adulthood. In this study, we examined the pattern of supraorbital change throughout adulthood in a sample of 110 human crania. Forty-five of the crania were of known age at death and sex. Age at death and sex were osteologically determined for the remainder of the sample. Age at death in the sample ranged from 16 to >70 years. After dividing the sample into 11 age groups, we employed an incremental resampling method (modified from Lee and Wolpoff, in press) to test the following hypotheses: 1) no portion of the supraorbital region changes during adulthood, 2) supraorbital change through adulthood is gradual and is not characterized by any spurts, and 3) males and females do not differ in their pattern of adulthood supraorbital change.

Our results falsify the hypothesis of no supraorbital change during adulthood. Lateral and midorbit supraorbital thickness increases significantly with age ( $p < 0.05$ ). Our results also show that supraorbital change during adulthood is, for the most part, not gradual. The most significant changes occur between the twenties and thirties and between the fifties and sixties. Finally, males and females exhibit significantly different patterns of adulthood supraorbital change. Females only exhibit significant change during from the forties to the sixties, while males exhibited significant change only from the twenties to the thirties.

#### **Fruits, fingers, and form: Functional significance of Meissner's corpuscles.**

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Meissner's corpuscles (MCs) are specialized mechanoreceptors found exclusively in the papillae of glabrous skin. They are confined largely to cutaneous pads of the extremities and respond to transient, phasic, or vibratory stimuli. Though absent in most eutherian taxa, including *Tupaia*, MCs are reported in all primates studied, being most developed in modern humans. The location of MCs between the internal ridges of the epidermis indicates that they are well situated to detect friction or deformation at the external surface. Accordingly, MCs are hypothesized to provide primates generally with an enhanced tactile perception. However, despite the importance of increased somatosensory acuity during hominid evolution, surprisingly little attention has been devoted to the functional and evolutionary ecology of primate MCs.

I report here on the comparative morphology and distribution of MCs measured from primate specimens available at the University of Chicago (N = 32 individuals of 28 species). For each animal I collected 45 mm of dermal tissue from between the interphalangeal crease and distal tip of both the thumb and index finger. Tissue samples were paraffin blocked and mounted onto slides for trichrome staining.

Results show that MC density varies as a function of diet. I discuss the importance of these findings to our understanding of anthropoid evolution. Specifically, I evaluate how these findings contribute to our reconstruction of Eocene diet, when anthropoid perception of fruit edibility was likely based principally on texture.

#### **Computer tomographic analysis of growth and development in juvenile adapiform primates from the Eocene of North America.**

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Developmental data are rare in the fossil record due to the relative scarcity of juvenile remains. Newly identified subadult and juvenile specimens of the middle Eocene North American notharctids *Notharctus* and *Smilodectes* were

examined to understand growth patterns in early euprimates. Radiographic techniques including CT scanning were applied to determine growth and developmental patterns in specimens of the modern Malagasy strepsirrhines *Lemur* and *Propithecus* of known age. CT scans of dentitions, crania, and postcrania of juvenile and adult notharctids were compared with the control study. Evidence suggests that *Notharctus* and *Smilodectes* follow divergent developmental patterns. A precocial pattern in *Notharctus* is indicated by replacement of the milk dentition and complete fusion of the mandibular symphysis prior to symphyseal fusion in the postcrania. Adult *Smilodectes* retains such neotinous cranial characters as unfused dentaries, small adult canines, the absence of a sagittal crest in males, and the retention of a more juvenile pattern in the coronal suture. *Smilodectes* is characterized by a muted expression of sexually dimorphic characters while *Notharctus* displays profound dimorphism. The divergent developmental pathways seen in these two fossil genera can be traced to precocial versus altricial character states in the newly described juvenile specimens. By comparing the physiology and social behavior of modern strepsirrhines to that of Eocene genera, it is hypothesized that we can reconstruct behavioral/ecological patterns for the fossil taxa.

#### **Dental microwear of mandibular molars of Japanese monkeys.**

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Scanning electron microscopic (SEM) analyses of dental microwear have revealed features on the occlusal surfaces of teeth (Hojo, 1989; 2000, 2002). In this study high resolution impressions were made of molars of Japanese monkeys from Takasakiyama, Western Japan. The sputter-coated epoxy resin casts made from the impressions were analyzed at the magnification ranging from 7X to 500X. Many microstriations on mandibular molars were measured using Microwear Image Analyzing Software Version 2.2β (Ungar, 1996), and varieties of microstriations among various occlusal surfaces of these molars were studied. The food of these Japanese monkeys mainly consisted of sweet potatoes and others, and dental microwear patterns of these samples were mainly thick about 5 to more than 10 microns. Many microstriations might be related with micrograins in mud with their sweet potatoes. These results indicate that many and thick microstriations

are observed on the occlusal surfaces of the prehistoric teeth of Japanese (e.g. Hojo, 2002).

#### **The effects of epiphyseal shape on metacarpal diaphyseal proportions in hominoids: Implications for long bone growth.**

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It has long been recognized that bone tissue will adapt itself during its lifetime to any mechanical loadings that have been placed upon it. For many years, physical anthropologists have been reconstructing behavior in fossil animals by modeling long bones as beams, using conventional beam theory while assuming that the distribution and amount of bone reflects patterns of stress and strain. However, Ohman and Lovejoy (2001) have argued that the morphological characteristics of adult long bones are not a reflection of those stresses. Instead, diaphyseal form does not necessarily reflect one's activity pattern. This research tests Ohman and Lovejoy's hypothesis by analyzing a series of external measurements on the metacarpal.

We hypothesized that shaft proportions near the metacarpal growth plate would reflect the shape of the metaphyses themselves rather than activity patterns, while the midshaft proportions would vary more with intensity of activity. Data were collected on human, chimpanzee, and gorilla metacarpals (n = 102). Dorsopalmar and mediolateral diameters of the proximal, middle, and distal portions of each metacarpal diaphysis were measured, and compared to the same dimensions of the distal end.

There is little correlation between the shape of the distal end and the shape of the midshaft. In addition, there is no correlation between the shape of the distal and proximal diaphyses. These results suggest that the shape of the distal shaft is more greatly influenced by growth plate dimensions than are the middle and proximal portions, which may be influenced by other factors, such as activity pattern.

#### **The utility of the lateral meniscal notch in distinguishing taxa of early hominins.**

T.W. Holliday, J. Dugan. Tulane University.

Senut and Tardieu (1985) explored the taxonomic utility of a proximal tibial notch representing the lateral meniscus'

posterior attachment. They pointed out that modern humans have two lateral meniscal insertions, differentiating them from apes and many earlier hominins. As the attachment is visible on dry bone, they also used it to differentiate fossil taxa, claiming two Plio-Pleistocene hominin taxa can be delimited using this feature – one fully modern (*Homo*), the second, more chimpanzee-like (*Australopithecus*). We test this feature's taxonomic utility using 57 human tibiae, reasoning that if some modern humans lack the notch, then its absence cannot be used to exclude a fossil tibia from *Homo*. The notches were scored by each author as: 1) clearly present, 2) possibly present, 3) possibly absent, or 4) clearly absent.

Twenty-one tibiae (36.8%) were scored differently by each author. However, most of these differences were of degree, not kind. Only in 2 (3.5%) cases did one author code a notch as clearly present while the other coded it as clearly absent.

The majority (77.8%) of our sample clearly evince a meniscal notch. However, a sizeable minority (8.3%) were judged by both authors to lack it. Adding those cases in which there *may* be no notch increases the number of exceptions to ca. 19.4%.

These data demonstrate that *some* modern humans lack the meniscal notch. Thus, the presence of the notch cannot be used to distinguish tibiae belonging to members of the genus *Homo* from those of *Australopithecus* (or, presumably, any other hominin genus).

#### **The lunate sulcus and early hominid brain evolution: Toward the end of a controversy.**

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Ever since Dart's original 1925 claim that the Taung brain cast showed a posteriorly located lunate sulcus (LS) and thereby a reorganized brain, there has been controversy surrounding two aspects: (1) where exactly was the LS located, i.e., either in a pongid anterior position or in a more human-like posterior position, and (2) when in the course of human evolution did this occur relative to brain enlargement. Both Keith, and later Falk, placed the LS in an anterior macaque-like position. LeGros Clark, Tobias,

and the first author regarded the LS as not readily visible, while Schepers was convinced that it was in a posterior position. Since the LS is the anterior boundary of primate visual cortex (area 17 of Brodmann), a posterior position would mean that there was a relative expansion of posterior parietal association cortex, often associated with complex cognitive behavior, and that *Australopithecus africanus* had a brain re-organized toward a more human, rather than ape, pattern.

With the discovery of the Stw 505 cranial remains from Sterkfontein, the controversy is thankfully at an end. There is a strong, undeniable presence of a LS, and, yes Virginia, it is in a posterior position. The early hominid brain was indeed reorganized prior to brain enlargement, or, rather, to be a purist, at least this fossil had such a brain.

#### **New *Loveina sheai* (Primates: Oromyidae) and implications for washakiin relationships.**

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Washakiin oromyids, a group known from the early to middle Eocene of North America, have been interpreted as derived from anaptomorphine oromyids, as closely related to tarsiids, as a sister taxon to anthropoids, and as a monophyletic tribe within a monophyletic Oromyinae. Most of these hypotheses have been based on the morphology of the better known, later-occurring species. Knowledge of the oldest taxa assigned to the group, species of the genus *Loveina*, is very poor, and the alpha taxonomy of the earliest species has been muddled by frequent reassignment to other species and genera. New material of the washakiin oromyine *L. sheai* from the early Eocene Wasatch Formation of the Green River basin in western Wyoming permits a revalidation of this species and provides the first evidence of the phylogenetically important premolar dentition. Analysis of this material in a broader comparative context permits the testing of several hypotheses regarding the ancestral morphology of washakiins and character polarities associated with the hypothesized relationships of the group.

*Loveina sheai* exhibits the most primitive premolar morphology of any known washakiin, having less molarized and relatively smaller p3-p4 and lacking the enamel crenulation and styler development seen in later washakiins. In these features, it shows similarities to the slightly older oromyin *Steinius vesperinus* and may approximate the primitive

omyinid morphotype. *L. sheai*'s morphology is not consistent with derivation of washakiins from anaptomorphines or with a sister taxon relationship to either anthropoids or tarsiids to the exclusion of other oromyines.

#### **Digital imaging of the pubic symphysis: A comparison of 2D and 3D approaches to assessing age-related changes.**

R.D. Hoppa, M. Sitchon. Dept. of Anthropology, University of Manitoba.

The principal source of data for understanding life expectancy in past populations is mortality statistics derived from skeletal remains. Most methods are based on gross morphological changes to the skeleton. Inadequacies associated with visual scoring include the inability to accurately distinguish discernible aging features in older adults. Image analysis techniques have the potential to identify discernible morphological changes related to age in more detail than is possible with the human eye alone. The increased comparative capability of image analysis software addresses the issues associated with estimating the age of older adults by recognizing age-progressive traits overlooked by visual scoring. The ability to more precisely correlate such changes with true age would greatly improve our ability to accurately reconstruct demographic profiles from past populations, and more readily address the known issues of older adult under-enumeration. This study compares methods of quantifying age-related changes from 2D versus 3-D imaging of the pubic symphysis. Implications for web-based training and virtual reference collections are discussed.

#### **Behavioural differences in the early to mid-Pleistocene: Were African and Chinese *Homo erectus* really that different?**

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When discussing differences between African and Asian *Homo erectus*, investigators commonly focus their attention on anatomical characteristics. The anatomical variation between these groups has sparked a long debate over whether the African and Asian populations should be assigned to separate species. This paper serves to add more information to this intellectual puzzle, not from an anatomical perspective, but from a behavioural one.

I examined several early to mid-Pleistocene sites from Africa and China in order to understand the behavioural differences between these populations, in both a spatial and temporal context. Information about stone tool type, raw material, transportation distance from raw material source, and site distribution were recorded for six time periods. These data, interpreted within a palaeoenvironmental context, were analysed to identify any statistically relevant behavioural differences between the African and Chinese populations. The pattern that emerges is one of a higher degree and rate of behavioural change, combined with closer group networking, in Africa. Although both regions underwent changes, those in China were never as drastic as in Africa. These differences potentially result from the paleoenvironmental context of each region. In Africa there was a higher degree of competition for resources because of the presence of large predators. Also the co-existence of up to three hominid species in the same region resulted in competition for similar resources. These interactions, combined with a changing environment, would have forced populations of *Homo erectus* to find more efficient ways of exploiting resources, leading to a more expanded tool kit, and greater social networks.

**Preliminary molecular analyses of individuals from a single multiple burial at the Neolithic Boisman II site of the Russian Far East.**

K.A. Horsburgh. Dept. of Anthropology, Indiana University, Bloomington.

The Neolithic Boisman II site (~5,300-6,000BP), located south of Vladivostok, represents the earliest evidence of a significant maritime adaptation in the Russian Far East. Presented here are preliminary findings of a long-term multi-allelic genetic study of individuals found at the site. Molecular markers amplified using ancient DNA techniques were utilized to describe patterns of biological relatedness among seven individuals interred together, adding an additional dimension to a debate of long standing among Russian scientists about the patrilineal or matrilineal structure of Far Eastern Neolithic societies. Additionally, molecular data are used to identify the sex of the four juveniles, and confirm the results of morphological sexing on the three adults in the burial. Ultimately this research program is designed to address questions of relatedness at each of several hierarchical levels. On the regional scale, hypotheses based on archaeological simi-

larities between the inhabitants of the Boisman II site and their Korean and Japanese contemporaries will be tested. Additionally, population movements within prehistoric Siberia, particularly those involving the Koryaks, Itel'men and the Chukchi will be investigated. Further, these data will be used to address issues in New World prehistory, specifically the relationships between the Eskimo/Aleut peoples and the Siberian Chukchi, with whom the inhabitants of Boisman II have a morphological affinity.

**Forelimb forces during gouging and other behaviors on vertical substrates in common marmosets.**

P.E. Hourani, C.J. Vinyard, P. Lemelin. Duke University Medical Center.

Claw-like nails distinguish callitrichids from other primates. Primatologists have suggested that claws allow these primates to cling to relatively large tree trunks. Among callitrichids, marmosets have more pointed, sharper claws (Hamrick, 1998) and may spend more time on large trunks. To better understand the functional role of claws in marmosets, we examined forelimb forces in *Callithrix jacchus* during various behaviors on vertical substrates.

We measured forelimb forces from two common marmosets during three behaviors: clinging, licking, and gouging. We recorded forces from each behavior on three vertical substrates: a 9 cm diameter pole, a 35 cm diameter pole, and a flat board. Each was coated with sand and polyurethane to allow claws to engage. A small section of each substrate was attached to a force platform. Forelimb forces during behaviors were recorded and analyzed using Peak Motus 2000.

Across substrates, average peak forelimb force during gouging ( $\approx 3.6$  N) was significantly greater than average force during clinging ( $\approx 0.7$  N) or licking ( $\approx 1.5$  N). The direction of the resultant force in each behavior was such that it could not have been created only by volar friction. This result suggests the claws were engaged during all behaviors, linking claws to behaviors on large tree trunks. Moreover, the significantly higher forces during gouging suggest that claw shape in marmosets evolved as part of a functional complex specifically for tree gouging.

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**Primate exploitation and bushmeat marketing in Liberia, West Africa.**

R.A. Hoyt, J.M. Frayne. Conservation & Science, Philadelphia Zoo, Philadelphia, PA.

The bushmeat trade in Liberia has been extensive for many decades, but the impact upon non-human primate populations is poorly known. Retaining nearly 40% of its original tropical lowland forest cover, Liberia may represent the best opportunity for preventing the extinction of many species unique to West Africa. However, a seven-year civil war, which resulted in the death or displacement of 40% of the human population, has left the country in economic and social ruin. Since the war's end, an over-dependency on natural resources and a reduced management capacity have resulted in a rapid expansion in the poorly regulated harvest of both timber and wildlife resources. A growing network of logging roads through formally isolated forest blocks has created new hunting grounds and shorter market routes. In addition, a general lack of employment opportunities in urban centers has fueled an entrepreneurial surge in the bushmeat trade that was greatly reduced through the war years. This paper will summarize off-take, market, and species preference data collected from both rural villages and urban centers that relates to the exploitation of non-human primates such as the sooty mangabey (*Cercocebus atys*), mona monkey (*Cercopithecus mona*), Diana monkey (*Cercopithecus diana*), and chimpanzee (*Pan troglodytes verus*), among other species. General trends within the bushmeat market of Liberia, and economic and social factors that affect the harvest and consumption of non-human primates will be discussed. Conclusions about future trends in bushmeat harvesting in Liberia, and recommended actions to mediate the crisis will also be addressed.

**Neandertals in Europe: The weight of climate.**

J-J. Hublin. Laboratory of Anthropology, University of Bordeaux 1, France.

The evolutionary processes of the Middle and early Late Pleistocene European populations resulted in the emergence of the Neandertals, a group of archaic humans that remains unknown outside of Western Eurasia. A series of derived cranio-mandibular features are operational in distinguishing the Neandertal specimens and their occurrences mark the milestones of the Neandertal emergence.

An incipient but clearly Neandertal morphology started to develop in the middle of the Middle Pleistocene and was followed by a process of accretion leading to the establishment of a fully Neandertal morphology at the beginning of the Upper Pleistocene. This timing is now documented by a rich fossil record and is consistent with the first available paleogenetical data. The process results from an increase of the frequency of derived conditions. This statement clearly discards the typological views on the Neandertals and makes difficult the definition of sharply defining grades. The spectacular climatic and geographic changes that Europe witnessed during this period deeply influenced the physical evolution of humans, not only in terms of biological adaptation. They also strongly influenced the distribution and size of the human groups. Severe reductions of the populations and possible resulting bottle-necks are suggested by the paleontological, archaeological and paleogenetical evidence, as well as by the comparative animal models. The replacement of Neandertals by modern populations at the end of OIS3 appears to be a complex process also partly driven by environmental changes.

**Fisher's Fundamental Theorem and the maintenance of genetic variation in life history traits.**

K.A. Hughes. Dept. of Animal Biology, School of Integrative Biology, University of Illinois, Urbana.

Viability, fertility and other fitness-related traits (life history traits) usually show substantial levels of genetic variation of within animal populations. Fisher's "Fundamental Theorem of Natural Selection" is often interpreted to mean that traits under strong selection ought to have little or no heritable variation, unless some form of "balancing" natural selection actively maintains it. However, results from recent quantitative-genetic studies suggest that most genetic variation within populations is probably due to non-adaptive forces such as mutation. Estimates of genetic variance for life-history traits are remarkably similar in animals. For example, the average coefficient of additive genetic variation (CVA) for life history traits in *Drosophila melanogaster* is about 10%, and in mammals is about 19% (18.9% in mice and 18.5% in humans). A recent study in olive baboons provides an estimate of genetic variation for age at first reproduction in this species: CVA=13.5%. Based on measures of genomic mutation rates in humans and other organisms, at least

half of this variation can be accounted for by mutation alone. An important implication of these studies is that only a small portion of phenotypic variation in life-history traits is likely due to genetic polymorphism actively maintained by natural selection. The remainder is either non-genetic, or due to non-adaptive forces such as mutation and gene flow.

**Basiscranial flexion and cranial vault architecture: Variation and structural relationships.**

P. Hughes. Dept. of Anthropology, Colorado State University.

Basiscranial flexion (BCF) has been used to support hypotheses regarding encephalization and the evolution of speech capabilities among the homininae. Methodologies employed to quantify BCF vary. Traditionally, internal BCF has been measured with the use of lateral skull radiographs while external BCF has been quantified via linear measurements taken from the base of the exocranial vault. The degree to which these two areas are related requires further evaluation.

The aim of the present study is three-fold. First, this research assesses the range of variation in BCF within a small sample (n=40) of modern humans known to be phenotypically diverse. The sample is comprised of adult males and females recovered from burial sites in eastern Uzbekistan spanning the late Bronze Age to the middle 16<sup>th</sup> Century. Second, it examines the extent to which the two independent methods of quantifying BCF used in this study are statistically correlated. And third, this research evaluates the capability of these measures to predict a structural inter-relatedness between BCF and cranial vault height, length, and width. Preliminary analysis using Pearson's correlation coefficient and bivariate regressions indicate that only specific aspects of internal and external BCF are correlated and that these correlated areas equivalently predict other dimensions of the cranial vault. These results suggest a structural inter-relatedness of the cranial vault and basicranium in modern humans that may inform interpretations of archaic human cranial morphology.

**A comparison of cranial integration through development in four primate species.**

J.H. Hunt. Dept. of Anthropology, Yale University.

Morphological integration has been examined commonly in an endeavor to

determine causality of the covariation of characters. Integration indicates one or more developmental, functional and genetic mechanisms, each of which may result in a module of character integration. However, modules of integration overlap, challenging the discernment of causality.

Unfortunately, many such studies are limited to adults of a single taxon, although influences on morphology change through development. If we seek to determine causality of integration, a proper study of morphological integration ought to take into consideration changes in the patterns of trait correlation through ontogeny, as well as the possibility that these patterns may differ by sex and by species. More closely related taxa ought to exhibit more similar patterns of morphological integration than distantly related taxa.

Evolutionary changes in patterns of integration cannot be well understood unless such differences are quantified.

This study explores patterns of morphological integration in four species of primates at five stages of ontogenetic development. In over 500 crania of four primate species, *Macaca mulatta*, *Hylobates lar*, *Pan troglodytes* and *Homo sapiens*, 80 homologous landmarks were captured using a 3D digitizer from fetus to adult. A variety of statistical tools are used to explore the similarities and differences in patterns of morphological integration at each ontogenetic stage for each sex and in each species. The hypothesis that patterns of morphological integration are more similar for closely related taxa than distantly related taxa, or for sexes of the same taxon than different taxa, is tested.

**Humeral and femoral head diameters in a contemporary ethnic Albanian population.**

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Evaluation of sexual dimorphism in humeral and femoral head diameters dates back to the late 19<sup>th</sup> century, when Dwight (1894), Dorsey (1897), and Pearson and Bell (1919) demonstrated the utility of using articular head diameters to determine sex from the skeleton. Later work by Thieme and Schull (1957), Stewart (1979) and others established standards that are currently used by many anthropologists working in prehistoric, historic and forensic contexts. Humeral and femoral head diameters are especially useful in cases involving fragmentary

remains lacking more sexually diagnostic criteria — particularly pelvic morphology. Consequently, new standards are being developed as anthropologists work with populations from which no data have been collected.

This preliminary study examines the range of variation found in the femoral and humeral heads of contemporary ethnic Albanian males. We compare these data with those of Stewart's (1979) to determine whether his conclusions may be applicable to human rights work currently underway in the Balkans. Data were collected during fieldwork investigating possible war crimes in Kosovo. Maximum femoral and vertical humeral head diameters are recorded for 50 individuals with sexually unambiguous pelvises.

For both the humerus and femur, the left side was not significantly different from the right; values for the right side were used when the left was unavailable ( $n = 48$ ). Results for  $t$ -tests (paired two-sample for means) comparing Stewart's data with the current study show no significant differences between the two samples for both humeral and femoral head diameters (humerus:  $t = -1.195$  / femur:  $t = -1.370$ ; critical rejection  $> 1.645$ ). These preliminary data suggest that Stewart's "sectioning points" may be useful for determination of males within this population when humeral and femoral head diameters are greater than 45 mm.

**Convergence of the "wishboning" jaw-muscle activity pattern in anthropoids and strepsirrhines: The recruitment and firing of jaw muscles in *Propithecus verreauxi*.**

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Symphyseal fusion in primates is likely to be a structural adaptation to strengthen the symphysis during chewing. Support for this hypothesis comes from mandibular bone strain analyses and EMG analyses of jaw-muscle behavior in several anthropoids, ring-tailed lemurs and thick-tailed galagos (Hylander et al., 1998, 2000, 2002; Vinyard et al., 2000). The EMG analyses demonstrate that anthropoids recruit relatively more muscle force from the balancing-side deep masseter (BSDM), and peak activity of this muscle occurs late in the power stroke. These recruitment and firing patterns cause the anthropoid mandibular symphysis to "wishbone" during mastication,

resulting in relatively high levels of symphyseal stress. Although BSDM recruitment and firing patterns are very similar in the above two strepsirrhines, both of which have highly mobile symphyses, we test the hypothesis that those living strepsirrhines with robust, partially-fused rigid symphyses (e.g., sifakas) have recruitment and firing patterns more similar to those of anthropoids.

We analyzed EMG activity of the jaw-closing muscles in 2 adult male and 1 adult female sifakas (*Propithecus verreauxi*). Both the recruitment and firing patterns of the BSDM of sifakas are similar to those of anthropoids, and quite unlike those of galagos and ring-tailed lemurs. These data provide additional support for the hypothesis that increasing symphyseal strength in primates is linked to "wishboning." Furthermore, as the BSDM firing patterns of galagos and ring-tailed lemurs likely represent the primitive mammalian condition, these data provide compelling evidence for the independent evolution of the "wishboning" firing pattern in strepsirrhines.

**Mycenaean mega-bones: A study of excessively thick cortical bone from Late Bronze Age central Greece.**

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A detailed bioarchaeological examination of Late Bronze Age Mycenaean skeletons is in progress and represents the first large-scale sample of human remains from this time period and geographic area subject to analysis. The burials were derived from twenty-nine rock-cut chamber tombs in the East Locris region of Central Greece and were recovered by the Greek Archaeological Service during rescue excavations. Osteological analyses indicate that the remains represent a minimum of 244 individuals of all age ranges and both sexes. Health and disease levels within each of the tombs are being assessed and analysis of pathological features within the collection is currently underway. This poster describes and illustrates a skeletal anomaly that has been discovered among tomb groups located near the coast, as opposed to those located inland. The anomaly is excessively thick cortical bone, and is present in several adults and subadults. While environmental factors are considered, all other indicators suggest that this trait was genetically inherited and, thus, provides valuable direct evidence in support of Late Bronze Age Greek chamber tombs as family sepulchers.

**Chimpanzee ant-dipping tools from West Cameroon: Geographical variation.**

E.J. Ingmanson. Dept. of Anthropology, College of William and Mary.

The extent of diversity in chimpanzee behavioral patterns is one of the most important findings to result from field research on chimpanzees (*Pan troglodytes*) during the last two decades. Tools for ant-dipping, for example, have been found at some sites in both east and west Africa, but are conspicuously absent from others. Where they are used, the size and form varies. Possible explanations for this variation include ecological factors, such as the presence of raw materials, or group traditions. During 1994, ant-dipping tools were found at a site near Ntale, southeast of Nguti, in the Southwest Province of Cameroon. Seven individual tools were found at an active driver ant (*Dorylus* spp.) nest, with clear indications of very recent use by a chimpanzee. All had been left inserted into the nest, with four of them in a single hole. They ranged in length from 41-80 cm, and were approximately 2.5 cm in circumference. The last 23 cm of each stick had been formed into a brush end. These measurements are similar to those from Guinea but are considerably longer than reported for the Ivory Coast. Though this is a single observation, it is the first report from this region and thus extends the known geographic range for this form of chimpanzee tool use.

This research was supported by a Faculty Research Grant from Dickinson College.

**Morphometric variation in African ape lumbar vertebrae.**

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Understanding the range and patterning of lumbar morphological variation in living organisms is key to making informed interpretations of function and phylogeny based on the shape of fossils, such as *Morotopithecus*. *Pan* and *Gorilla* are two very closely related genera that differ greatly in adult body size; thus, they are an ideal system for examining the patterns of growth of lumbar vertebral morphology and correlated function across a broad size range. In this study, we examined 1) how different parts of lumbar vertebrae change with increasing body size during growth in *Pan* and *Gorilla*; and, 2) whether or not *Pan* and *Gorilla*

*rilla* lumbar vertebrae share similar growth trajectories for their bony dimensions.

A suite of linear measurements was taken from digital photographs of *Pan troglodytes troglodytes* and *Gorilla gorilla gorilla* lumbar vertebrae. Ordinary least-squares regression analysis was used to describe growth trends, and analysis of covariance was used to test for differences between *Pan* and *Gorilla* in growth patterns. Results indicate that for both *Pan* and *Gorilla*, dimensions of the neural canal do not correlate with increasing body size. In contrast, the remaining vertebral dimensions change with increasing size, with most variables scaling isometrically. However, spinous process length increases with positive allometry in both genera. For interspecific comparisons, *Pan* and *Gorilla* are not ontogenetically scaled for most vertebral dimensions examined. Generally, the growth trajectories of *Gorilla* are shifted downward from the growth trajectories of *Pan*. The biomechanical and functional correlates of behavior related to this variation will be discussed.

**Ancient teeth and modern humans: Additional dental evidence for an African origin of *Homo sapiens***

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Previous work by the first author suggested that, relative to six modern comparative samples, sub-Saharan Africans are least derived dentally from an ancestral hominin state and, hence, may have the greatest time depth of all living world populations. This conclusion, together with other dental evidence, was judged to be supportive of an African origin for modern humans. In the present study, we expand upon this research by using: 1) primary dental data from African Plio-Pleistocene hominins, rather than published trait frequencies, 2) a single morphological scoring system (ASU Dental Anthropology System) with consistent breakpoints, and 3) data from larger, more varied modern comparative samples. The Mean Measure of Divergence was again used to estimate phenetic affinities among modern humans and fossil hominins. Principal Components Analysis was also employed on trait frequencies across samples. Both methods yielded similar results that support and bolster the previous findings. Of 14 modern samples, sub-Saharan Africans again exhibit the closest affinity to the

hominins, in their shared prevalence of complex crown and root traits. The fact that the Africans express these plesiomorphic characters, along with evidence of divergence from other modern groups, intra-population heterogeneity, and a world-wide dental cline emanating from the sub-continent, provides more definitive support for an Out-of-Africa origins model.

The first author's comparative data were collected through funding by NSF (BNS-9013942), the ASU Research Development Program, and the American Museum of Natural History. The second author's hominin data were collected via funding by an OSU seed grant and the Leakey Foundation.

**Kinematics of vertical climbing in hominoids: Which type is more preadaptive for bipedalism?**

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Vertical climbing has been proposed as being preadaptive for habitual bipedalism in early hominids. The kinematics of vertical climbing in hominoids, however, have never been quantified previously. This study presents 3D-kinematics of flexed-elbow vertical climbing in various captive hominoids (*Pan paniscus*, *Gorilla gorilla gorilla*, *Pongo abelii* and *Hylobates gabriellae*), including adult males, females and juveniles of each species. In total, 474 climbing sequences containing 3399 limb cycles have been analyzed.

Juvenile apes show more diverse gait patterns and a lower duty factor than adults. The body center of gravity is kept further away from the substrate in juveniles and limb joint excursions are thus less pronounced. Vertical climbing kinematics of adult males and females are most distinct in species with a large sexual size dimorphism. Besides such intraspecific variation, analyses reveal substantial interspecific differences in speed modulation, footfall patterns and angular excursions of the limb joints. Gorillas and bonobos climb similarly, although the climbing of bonobos is more diverse in speed and gait patterns. In orang-utans, the range of motion of the major limb joints is larger than in African apes. Gibbons abduct the arm more and the thigh less during climbing than any of the great apes. The maximum degree of hip extension, however, does not differ between the hominoid species studied. In an ancestral hominid, flexibility in the performance of climbing such as that observed in extant bonobos could have led to new locomotor habits.

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**Environmental change and the evolution of gibbons.**

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Molecular evidence suggests that gibbons originated sometime after the ancestors *Homo* and *Pan* diverged, or about 6-7 myr ago. This estimated date places their origination after the height of the radiation of the Asian hominoids, 10-13 myr ago, and at the end of a sustained period of species turnover in south Asia between 10.7 and 5.7 myr ago (Barry *et al.* 2002; *Paleobiology* **28** (Suppl. 2): 1-72). This evidence suggests that gibbons evolved from a Late Miocene stock of Asian hominoids, and that their evolutionary success was due primarily to their smaller body mass and access to the resources of the high forest canopy.

Apes were severely affected by the environmental changes of the late Miocene and Pleistocene because of their protracted reproductive schedules, requirements for higher quality foods (especially ripe fruits), and large body sizes. Gibbons were able to exploit tropical and more seasonal subtropical forests in Southeast Asia because of their smaller body size, energy-efficient mode of suspensory locomotion, and social organization that allowed more efficient foraging for plant resources in smaller territories. This explains why gibbons tend to occur at lower densities in forests of higher altitude and increased seasonality.

Siamangs, with their diet composed of somewhat more leaves and less fruit than smaller gibbons, have evolved the most monkey-like gut adaptations of the hominoids. Their larger body evolved *pari passu*, being related to lower food quality and the need for longer gut retention times. This may have been related to their use of higher altitude forests.

**Male dominance and reproductive success in white-faced capuchins (*Cebus capucinus*).**

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We investigate the relationship between dominance and reproductive success in two groups of white-faced capuchins (*Cebus capucinus*) in Santa Rosa National

Park, Costa Rica between October 1993 and January 2000. Paternity was determined using DNA extracted from non-invasively obtained hair and fecal samples and amplified using PCR. 25 infants were born into the two study groups during this period, although six of these infants died or disappeared before samples were gathered and paternity exclusion was unsuccessful for an additional four of the infants. Of the 19 infants sampled: we could not exclude one or more possible fathers for four infants in the sample (21%) (Note: the alpha male could not be excluded as a potential sire for all four of these infants); three (16%) were sired by subordinate males within the group (all beta males in groups containing =3 adult males) and; 12 (63%) were sired by alpha males. Within one of our long-term study groups, the alpha male has experienced an unusually long tenure (1993 to present) and he sired all of the infants (seven of nine) that we were able to sample from this group during his tenure. Although our sample size is small, these data clearly indicate that within our study groups there is a reproductive advantage to being alpha male.

**Variation in morphology and musculoskeletal stress marker expression of the first dorsal interosseous muscle in catarrhines.**

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Variation in the morphology and skeletal marking of the first dorsal interosseous muscle in catarrhines is examined to build a framework for assessing this marking on fossil hominin first metacarpals. Electromyographic (EMG) studies have shown the first dorsal interosseus (D1) to be very active during experimental stone tool manufacture and use. The muscle was measured during dissections and a system for measuring and scoring the skeletal marking was developed. The pollical belly of D1 has a more distally extensive origin in humans than in other catarrhines. The difference in origin area is reflected in the skeletal marking, which is on average longer and more robust in human specimens. Correlations between muscle origin length and D1 musculoskeletal stress marker (MSM) length facilitate inferences of muscle morphology from isolated skeletal and fossil samples. The development of a long and robust attachment scar for the first dorsal interosseus may be an indicator of strong recruitment of the thumb in repetitive and powerful grips.

The AL 333w-39 first metacarpal from Hadar, attributed to *A. afarensis* and not associated with stone tools, shows no muscle marking development and is unique in multidimensional space from any modern comparative catarrhine. The SK 84 and SKX 5020 specimens from Swartkrans, of less certain taxonomic affinity, both show a marked development of the first dorsal interosseus marking and fall within the range of human specimens in a multidimensional analysis. These specimens have been found in deposits containing both bone and stone tools.

**The effects of age and ethnicity on daily stress hormone variation in employed women.**

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Women employed in urban settings must adapt to the stresses of changing daily microenvironments. The pattern and extent of stress hormone responses to these changes may depend upon age and ethnic background. The purpose of this study is to evaluate the effects of age and ethnicity on the daily variation of urinary norepinephrine, epinephrine, aldosterone and cortisol excretion across work, home and sleep microenvironments in 95 women (38 European-American, age=35.4±7.4; 28 African-American, age=33.4±7.9; 12 Asian-American, age=36.7±9.3 and 17 Hispanic-American, age=31.6±10.9) employed as secretaries, technicians and managers in New York City using a repeated measures ANCOVA with age group (trichotomized) and ethnicity as fixed factors and body fat and mass as covariates. The results show that for norepinephrine, work and home excretion rates are substantially higher than sleep rates ( $p < .001$ ). Women in their 20's have significantly lower excretion rates than than women over 30 ( $p < .04$ ). There are significant ( $p < .04$ ) ethnic differences in norepinephrine output with Asian-American women having the lowest and African-American women having the highest rates. The rates of epinephrine and aldosterone excretion have a similar pattern across the microenvironments as norepinephrine excretion ( $p < .05$ ), but there is no age effect. There are significant differences in the rates of aldosterone excretion by ethnicity, with European-American women having the highest rates, and African-American and Asian-American women having the lowest ( $p < .05$ ). There is no significant variation in cortisol excretion with age or ethnicity. These results suggest that age and ethnicity have varying effects on different stress

hormones. Supported by NIH grant HL45740.

**A preliminary study of travel routes and spatial mapping in mantled howler monkeys (*Alouatta palliata*).**

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Studies of primate foraging and ranging behavior indicate evidence of goal-directed travel and relatively straight-line movement between sequential feeding sites. In the case of mantled howlers (*Alouatta palliata*) on BCI, Panama, Milton (1980) has argued that group members center their feeding, resting, and ranging activities on a small set of pivotal trees that are visited several times daily. The degree to which this pattern is adopted by mantled howlers at other sites remains unclear.

In this study we present quantitative data on travel routes taken by mantled howlers and address questions concerning howler goal-directed travel and spatial mapping. Data were collected during July and August of 2002 on a group of *A. palliata* inhabiting a dry tropical forest on Isla de Ometepe, Nicaragua. Over the course of 15 days and 104 hours of observation, all trees the howlers were observed to travel, feed, and rest in were marked (N=299), and distances and angles between trees were measured and mapped. Travel routes were identified by following a focal individual for 6-8 hours per day.

During the course of our study, howlers traveled between 185.5 to 659.5 meters per day. An analysis indicates that whereas 5 paths were reused frequently and accounted for 33% (37/111) of all travel route segments, 43% (48/111) of route segments were used only on one or two occasions. The results suggest that travel in Nicaraguan mantled howlers is characterized by evidence of both route-based travel and the use of varied pathways to reach previously visited feeding and resting sites. Additional relationships between mantled howler ranging, activity patterns, and use of spatial information are discussed.

### **An estimation of the heritability of cranial nonmetric traits in a tamarin sample (*Saguinus oedipus*).**

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While many of the differences observed in an individual's skull could be attributed to age, sex, and ancestry, much of the remaining variation is idiosyncratic and manifested as accessory bones, grooves or foramina. The conventional descriptor of these traits is "nonmetric", which implies that the characteristics are difficult to measure on an interval scale. The differing frequencies of skeletal nonmetric traits have been used to investigate familial relationships and biological distances between populations. The underlying assumption of such studies is that much of the nonmetric variation has a genetic etiology, but few extensive studies have been conducted to test this assumption. This paper attempts to illuminate the heritability of cranial nonmetric traits using a sample of tamarin crania (*Saguinus oedipus*) of known sex, age and parentage.

A sample of adult cotton top tamarin crania were obtained from the Oak Ridge Association Universities' (ORAU) Marmoset Research Center collection, housed at the University of Tennessee, Knoxville. The presence or absence of 22 cranial nonmetric traits was recorded, although only four traits displayed sufficient variation for analysis. Heritability was estimated using regression, in certain appropriate cases, and Falconer's method of heritability of liability for dichotomous variables. The number of accessory foramina present was not especially heritable, suggesting that some environmental covariate is primarily responsible for their manifestation. Incidence rates of 33.3 and 42 percent for the divided hypoglossal canal trait produced heritability estimates of .494 and .839 respectively.

### **Growth and life history in chacma baboons.**

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The social environment is a key feature influencing primate life histories. Chacma baboons (*Papio hamadryas ursinus*) are a female bonded species with a strict linear dominance hierarchy. In this species, the allocation of energy to competing demands of growth and reproduction is hypothesized to vary as a function of competitive ability, which in turn increases with social rank. Since growth

rate is a major component of life history models, measures of age-specific growth were used to analyze variation in life history traits across social ranks. Weights of 42 immature baboons were obtained without sedation or baiting from a troop of well habituated chacma baboons in the Okavango Delta, Botswana. Through a combination of nonparametric lowess regression and piece-wise OLS regression utilizing demographic and weight data from this wild population, five main findings emerged. 1) Weight for age and growth rate of infant and juvenile females is positively associated with maternal rank. 2) Male growth is not influenced by maternal rank. 3) Female growth shows smaller variation across feeding conditions than male growth. 4) Low ranking adult females continue investment in offspring until they reach a weight comparable to that of high ranking infants. 5) The benefit of rank to reproductive success, as a function of variation in immature growth rates, shown in this study is 0.83 additional offspring. Other mediating factors such as birth seasonality are examined through a multivariate hazard analysis.

### **Natural and anthropogenic influences on lemur population structure in southeastern Madagascar.**

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Efforts to preserve Madagascar's rapidly dwindling endemic fauna are hindered by a shortage of data on population structure on a regional scale. Accordingly, we present a synthesis of primate censuses conducted in the southeastern rain forest region from 1995-2000. We compare population densities in eight day-active lemur species: *Eulemur fulvus*, *E. albocollaris*, *E. collaris*, *E. rubriventer*, *Haplemur aureus*, *H. griseus*, *Propithecus diadema* and *Varecia variegata*. In addition, we examine relationships between lemur abundance and both anthropogenic (e.g., fragmentation, protected status) and natural (e.g., altitude, latitude gradient) site characteristics. Censuses were conducted using standard line-transect techniques in twenty locations within five protected areas and eight

unprotected forests. Our results indicate great variation in density both within and among lemur taxa. The brown lemur complex (*E. fulvus*, *E. collaris*, *E. albocollaris*, and hybrids) is the most abundant (up to  $45.6 \pm 10.9$  per ha.); although this group varies markedly in density, it is present in nearly every site. However, one member of this group, *E. albocollaris*, is both sparse ( $7.2 \pm 4.8$  per ha.) and patchily distributed – as are *V. variegata* and *H. aureus*. Within the 0-1550 m sampling range, altitude has inconsistent effects on lemur abundance (although *V. variegata* density differs sharply according to elevational zone). Similarly, density and distribution differ greatly among taxa according to location on the north-south gradient. Forest fragmentation (irrespective of legal protection status) has the most consistent and significant impact, reducing the number of lemur species and/or the densities of those present.

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### **Twinning in relation to fertility and other reproductive outcomes in Blackfoot women.**

S.L. Johnston. West Chester University.

Rates of twinning and other multiple births vary among human populations. From an evolutionary standpoint, multiparous births may increase the fitness of a given mother by increasing her total reproductive performance. On the other hand, these births also carry higher risks for fetal, infant, and maternal mortality, which may reduce reproductive fitness. This study explores twinning in relation to fertility and other reproductive outcomes in one Native American population, the Blackfeet of northern Montana.

As part of a larger study, complete reproductive histories were obtained by direct interview of a probability sample of 150 Blackfeet women, ages 18-93 years, living on a reservation in Montana in 1995-1996. In the total sample, 10 of 132 women (7.6%) who ever had been pregnant reported a biparous pregnancy (none reported higher multiples). Of the total 558 births, 20 (3.6%) were twins, with 18 of 549 (3.3%) livebirths. Mothers of twins had significantly higher total livebirths (6.2) compared with mothers producing only singletons (3.99),  $p=.01$ . Among women with completed fertility (women

50 yrs and older), 10 of 158 (6.3%) births were twins, with 9 of 154 (5.8%) live-births. Mean maternal age at twin births in this group was 30.9 yrs.

Blackfeet women as represented in this sample have a higher rate of twinning than some populations previously described and evidence of differential fertility in mothers of twins versus mothers of singletons. Additional data concerning rates of fetal and offspring mortality are presented. Implications for fitness are discussed.

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### **Testicular size, developmental trajectories and male life history strategies in four baboon taxa.**

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Theoretical and empirical studies have related relative testicular size to social behavior and reproductive patterns, predicting greater relative testicular size in adults with polyandry and consequent sperm competition. Among baboons (*Papio* sp.), previous work has shown adult testes to be relatively smaller in hamadryas, which are predominantly monandrous, than in so-called "savanna" forms that are polyandrous within single reproductive cycles. Here we report testicular size data for substantial samples of juveniles and subadults as well as full adults of four of the recognizable "forms" of extant *Papio*: yellow, anubis, Guinea, and hamadryas baboons. Among wild-caught Ethiopian animals, anubis have, as predicted, much larger testes and somewhat greater body mass as full adults than hamadryas, the consequence of a growth spurt immediately before emigration. Among hamadryas, which are both monandrous and male-philopatric, little increase in body mass or testicular size separates subadults from full adults. Juvenile hamadryas apparently tend to begin testicular enlargement earlier, perhaps a correlate of precocious sexual development and "follower" behavior. Wild-caught yellow baboons have a developmental trajectory similar to that of anubis, with a late growth spurt, but at all ages testicular size is small relative to body mass. Our Guinea baboon data are fewer and derived from zoo animals, but suggest a hamadryas-like trajectory lacking a late growth spurt. This finding predicts that the social behavior of Guinea baboons in the wild – still largely un-

documented – will be found to include male philopatry, and perhaps male-female bonding behavior that reduces sperm competition due to polyandry.

### **Locomotor character evolution in fossil and extant ateline primates.**

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Current hypotheses propose that the ateline's last common ancestor was either an agile, quadrupedal climber like *Lagothrix* or a cautious quadruped like *Alouatta*, and that climbing ability improved in the lineage leading to the (*Lagothrix*, (*Ateles*, *Brachyteles*)) clade with brachiation evolving in the common ancestor of *Ateles* and *Brachyteles*. In the last decade, several lines of evidence have emerged that challenge this interpretation of ateline character evolution. For example, new ateline fossils possess an unexpected combination of characters, such as *Alouatta*-like howling cranial adaptations paired with a brachiating body in *Protopithecus*, suggesting that all atelines, not just *Ateles* and *Brachyteles*, may have had a brachiating common ancestor. By examining the platyrrhine postcranial skeleton using new character reconstruction algorithms, fossils and evolutionary trees, this study tests traditional hypotheses of the evolution of brachiation in atelines and generates new hypotheses.

Postcranial characters that may be correlated with brachiation, hindlimb suspension and prehensile tail function were measured in over 350 platyrrhine skeletons and fossils *Cebupithecia*, *Protopithecus* and *Caipora*. The evolution of these characters was reconstructed using two recent platyrrhine phylogenies and maximum parsimony, maximum likelihood and generalized least squares algorithms. This study will aid paleoanthropologists who study the evolution of brachiation and forelimb suspension in hominoids to understand the origins and precursors of hominid bipedality by using studies of atelines as a comparison.

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### **Permanent molars and shifting landscapes: Elemental signature analysis of natality at the New York African Burial Ground.**

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Excavation of the 18<sup>th</sup> century New York African Burial Ground (NYABG) yielded skeletal remains of over 400 individuals, including 26 adults with modified dentitions. Multiple chemical methods are being used to address African versus Diasporan natality, including elemental signature analysis (ESA) with laser ablation inductively coupled plasma-mass spectrometry (LA ICP-MS).

The purpose of this study is to test Handler's (1994) interpretation of 18<sup>th</sup> century ethnohistorical data: that dental modification in the Americas indicates African birth and childhood. ESA was applied to first molar crowns from 14 modified NYABG adults, 19 non-modified NYABG subadults, and two individuals excavated near Elmina, Ghana. Third molars were also sampled from 4 modified NYABG adults. Since mature human dental enamel resists chemical adjustment, first molar crowns that calcify early in life should reflect natal environment, while third molars develop later as evidence of migration or occupational exposure.

Results support Handler's hypothesis, as well as bioarchaeological adoption of ESA. Modified and Ghanaian teeth differ from non-modified teeth in non-essential (i.e., not actively regulated physiologically) trace element concentrations. High lead concentration in particular may be a specific signature of non-African natality. Hierarchical cluster analysis reveals intra- and inter-individual tooth variation, and with a few possible exceptions, separates presumably natal from non-natal Africans. Methodological refinement may further distinguish Caribbean natality. This study suggests Handler correctly interprets dental modification as a cultural expression of African birth among colonial-era enslaved Africans.

### **Familiarity breeds disease: Human-macaque pathogen transmission in Asia.**

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The global HIV pandemic, recognized as an international public health and political issue, has focused attention on the role of nonhuman primates (NHPs) in the transmission of emerging infectious diseases. Perhaps less well recognized are the effects of endemic human pathogens on naturally occurring NHP populations. Data characterizing pathogen exposures among both human and NHP populations in areas where the two come into contact can be used to assess which pathogens pose the greatest risk to humans and NHPs and to develop hypotheses regarding the likely routes of transmission. In parts of Southeast Asia humans and NHPs have lived commensally for hundreds of years, presenting opportunities to investigate cross-species pathogen transmission in a variety of contexts including hunting and trapping, bushmeat consumption, NHP pet ownership, and "monkey forests." Our research group has studied bi-directional pathogen transmission between humans and macaques in Indonesia using a multidisciplinary approach that combines serological, molecular, epidemiological and ethnoprimate data to describe both the pathogens involved and the mechanisms by which they are transmitted. To date, our work on Sulawesi and Bali has yielded evidence that infectious agents enzootic in NHPs are being transmitted to humans who come into contact with macaques. We have also produced evidence that natural populations of NHPs are exposed to endemic human pathogens such as measles virus and *Mycobacterium tuberculosis*. These data have important implications for efforts to conserve NHP populations and prevent the emergence of nonhuman primate-borne zoonoses.

#### **Neighbours or sisters? Testing models of cultural transmission in the Pacific using phylogenetic methods.**

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Increasingly, phylogenetic methodologies from biology are being employed to explore adaptive hypotheses of human biocultural and cultural evolution. Accurate estimation of the mode of bio/cultural

trait transmission is necessary for the proper application of the comparative method. Many explanations for cultural evolution assume vertical (phylogenetic) trait transmission, while others indicate a horizontal or reticulate mode of transmission. Few reports quantitatively investigate which models best characterise particular aspects of culture. Here we present the results of a series of investigations into mode of cultural transmission in the Pacific, using ethnographic data and linguistic phylogenies developed using formal phylogenetic methods. Individual traits are tested for associations with phylogenetic versus geographical nearest neighbour. Correspondence analysis and Mantel tests are used to further identify appropriate models for groups of cultural traits, and the results are discussed in the context of Pacific prehistory, ethnography and environment.

#### **Common components of growth in the postcranium of African apes.**

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This study examines "ontogenetic scaling" in the postcranial skeleton of African apes. More specifically, it evaluates the degree to which gorillas can be modeled as ontogenetically scaled-up versions of the common chimpanzee and bonobos as ontogenetically scaled-down versions of the same. Flury's hierarchical approach to comparing the logged dispersion matrices is the statistical method employed in the assessment of similarity between multivariate growth patterns. Nine variables (lengths of the humerus, radius, femur, tibia, clavicle, scapula, ilium, pubis and ischium) were measured in samples of wild-collected, nonadult skeletons (gorillas, N=40; chimpanzees, N=48; bonobos, N=26).

Despite similarity in aspects of multivariate allometry, equality (and proportionality) of the growth matrices was rejected for both gorilla-chimpanzee and chimpanzee-bonobo comparisons. However, permutation tests of the significance of matrix correlations between these same var/cov matrices suggested significant overall similarity. The chi-square test for underlying common principal components rejected this model for the gorilla-chimpanzee comparison but accepted it for the bonobo-chimpanzee contrast. The Akaike Information Criterion (as well as the ratio of the chi-square to degrees of freedom) suggested that the gorilla-chimpanzee growth matrices are best described as unrelated, whereas chim-

panzees and bonobos can be described as sharing common principal components (i.e., the eigenvectors are similar despite differing eigenvalues). Total variance in growth of the smaller-bodied bonobo is indeed smaller than that observed in the larger common chimpanzee, but patterns of relative growth are sufficiently similar between the two to model the former as an ontogenetically scaled-down version of the latter, at least in the postcranium.

#### **Primitive dento-gnathic morphology of Javanese *Homo erectus*.**

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The age of the oldest Javanese hominid is debated hotly. The arguments so far, however, include little morphological basis of the fossils. The Early Pleistocene hominid collection from Java is often regarded as a single population of *H. erectus*, but its within-group variation has not been examined through a sufficiently large sample. Furthermore, only a limited number of specimens have been systematically compared with African fossil hominids, and this particularly makes the phylogenetic position of the Javanese hominid vague.

Our analysis of a dento-gnathic sample from Sangiran, which includes most of the existing mandibles and teeth from the Lower Pleistocene of Java, shows that (1) there are distinct morphological differences between chronologically older and younger subsamples, (2) the older subsample exhibits some features that are equally or even more primitive than the earliest Pleistocene *H. erectus* of Africa (*H. ergaster*), and (3) the younger subsample shows affinities with the Middle Pleistocene *H. erectus* from China as far as preserved portions are concerned.

The primitive morphology of the oldest Javanese dento-gnathic remains supports the view that the first dispersal of hominids into eastern Eurasia was close to the time of emergence of *H. erectus (sensu lato)*, although the age of the Javanese hominids themselves is yet to be resolved.

### **The relationship between sexual dimorphism and male-female dietary niche separation in haplorhine primates.**

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Body mass plays an important role in shaping an individual's ecology, especially with respect to dietary composition. Larger animals tend to consume higher quantities of low quality foods. In contrast, smaller individuals, with higher metabolic rates require a high quality diet. Therefore, species that exhibit high amounts of sexual dimorphism in body mass should also display high levels of male-female dietary differentiation. This study investigates the relationship between body mass dimorphism and dietary behavior dimorphism across several haplorhine species.

Assuming that leaves are a low quality food item and invertebrates are a high quality dietary resource, it is expected that male/female body mass should be positively correlated with 1) male/female percent of leaves in the diet, and 2) male/female time spent feeding, but negatively correlated with 3) male/female percent of invertebrates in the diet. To test these predictions, Pearson's correlations were conducted using the phylogenetic independent contrasts calculated from the male/female body mass and dietary raw data.

Body mass dimorphism was significantly correlated with invertebrate feeding dimorphism ( $r^2 = .954$ ,  $p < .01$ ,  $n = 9$ ) and leaf feeding dimorphism ( $r^2 = .790$ ,  $p < .01$ ,  $n = 11$ ). Body mass dimorphism was not significantly correlated with feeding time ( $r^2 = .407$ ,  $p = .149$ ,  $n = 14$ ).

These data suggest that more sexually dimorphic species exhibit greater male-female dietary niche differentiation than do monomorphic taxa. Such information has important implications for aspects of primate ecology, primate conservation, and extinct hominid behavioral ecology.

### **The structure of the tibia in bipeds.**

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Although a large number of primate taxa engage in facultative bipedalism, habitual bipedalism in primates is much more unusual and is only witnessed in humans and our closely related hominid relatives. Many of the anatomical corre-

lates of this unique form of locomotion relate to the interplay between the stance and swing phases of stride, where stance accounts for majority of the duration of stride. The effect of stance means that the leg can be modeled as a weight-bearing column under axial compression. We provide here a detailed study of this idea for the lower leg by using high-resolution X-ray CT (HRXCT) to quantify the tibia's cross-sectional shape and area (both of which contribute to compressive strength) and its degree of curvature in humans, and compare these results to similar measurements for quadrupeds including the baboon and chimpanzee.

A comparative approach to this general question is found in an examination of the anatomical correlates seen in a second group of bipeds, the birds. Here, bipedalism is married to flight, but several different taxa from across a range of body sizes are committed terrestrial forms, with some exhibiting a striding rather than a hopping gait. The roadrunner (*Geococcyx californianus*) and several ratites including the ostrich and emu are examined with HRXCT and the results of this study are compared with those of from the primates noted above. Together this comparative approach provides a robust test of the idea that the leg acts as a weight-bearing column during stance.

### **Y-chromosome evidence on the origins of the Balinese and the "Indianization" of Bali.**

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For more than fifty years prehistorians have debated whether the spread of Indian culture influence to the islands of Java and Bali was associated with a movement of people or simply cultural diffusion. R.C. Majumdar postulated wholesale colonization by Indian exiles, while J.C. van Leur argued that "Indianization" was wholly initiated by Southeast Asians who summoned Brahmins to visit their courts, creating merely a "thin and flaking glaze" of Indic language and customs. But until now there has been no evidence as to whether Indians actually visited the island.

Here we present Y-chromosome evidence that supports genetic ties between India and Bali. We studied single nucleotide polymorphisms (Y-SNPs) and short tandem repeats (Y-STRs) on the non-recombining portion of human Y chromo-

some. A set of 66 Y-SNPs and 10 Y-STRs was genotyped in 551 Balinese and in 1,041 males from several Southeast Asian and Pacific populations. The two most frequent (76%) Y chromosome haplogroups in Bali, O-M95 and O-M119, are both characteristic of mainland Southeast Asia and Taiwan. Only a small fraction (2.2%) of the Balinese paternal heritage seems to be associated with the original Pleistocene settlers in Indonesia/Melanesia. A notable fraction (9.6%) of Balinese Y chromosomes are common in India. Moreover, these Indian signature haplogroups are absent from Island Southeast Asia and the Pacific. Preliminary network analyses of the Y-STR data from Bali and India indicate close affinities. Additional analyses using YSTRs will be carried out to estimate the timing of gene flow from the Indian subcontinent to Bali.

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### **Rates of predation by diurnal raptors on the lemur community of Ranomafana National Park, Madagascar.**

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Predation has been a major topic of debate for anthropologists interested in understanding the origins and maintenance of social behavior in primates. The most direct method to understand how predation structures primate groups, populations, and communities and favors particular patterns of social behavior is to conduct studies of the predators themselves. Continuous research since 1999 of the nesting and feeding ecology of the Madagascar Buzzard (10 nests, 647 hours observation), Madagascar Harrier-Hawk (5 nests, 478 hrs.), and Henst's Goshawk (5 nests, 943 hrs.) in Ranomafana National Park, Madagascar have identified the Harrier-Hawk and Goshawk as significant lemur predators while Buzzards have never been observed to feed on lemurs. Both Harrier-Hawks and Goshawks have been observed feeding on *Haplolemur griseus* and *Microcebus rufus* while Henst's Goshawks have also fed frequently on *Eulemur sp.*, *Cheirogaleus major*, and *Avahi laniger*. Lemur kills are most frequent during the courtship and pre-fledgling stages of the raptor nesting cycle. A combination of raptor prey profiles, feeding rates, and density with lemur demographics has allowed a quantification of the annual predation rate by diurnal raptors on lemurs in RNP. These data demonstrating that the

Henst's Goshawk is the major raptorial predator of the lemur guild corresponds with playback experiments of predator vocalizations that show lemurs exhibit the most intense anti-predator behaviors to calls of the Goshawk. These predation rates will be contrasted with other known sources of lemur mortality to emphasize the potential significance of predation in lemur life history evolution and behavior.

#### **Using fish to test the expensive-tissue hypothesis.**

J.A. Kaufman. Dept. of Anthropology, Washington University.

According to the expensive-tissue hypothesis, dietary changes during hominin evolution led to a reduction in the size of the GI tract which helped to accommodate the growing energy demands of a relatively large brain. If this is true, and physiology remains unchanged, then the coevolution of diet and brain size would imply reciprocal changes in the size of the respective organ systems. In effect, any increase in relative brain size should be associated with a concomitant decrease in relative GI size, or reduction in some other organ system. This co-hypothesis is tested here by analyzing an exceptional teleostean fish, the elephantnose *Gnathonemus petersi*. The elephantnose fish has a relatively large brain for a teleost, accounting for two percent of its body mass. Moreover, the relatively large brain of this small fish is responsible for approximately 60% of its total body O<sub>2</sub> consumption, compared with 20% for humans. In this study, the body composition of *Gnathonemus*, a nocturnal carnivore, is compared with that of two other nocturnal teleosts: the algae-eater *Plecostomus*, and the carnivorous *Chitala* - a close relative to *Gnathonemus*. As expected, the algae-eating *Plecostomus* has a much larger digestive tract than either of the two carnivorous species. The large-brained elephantnose has a lower relative GI mass than the ecologically similar *Chitala*, a result that supports the expensive-tissue hypothesis. I conclude that tissue trade-off, based on organ mass, is significantly associated with encephalization in *Gnathonemus*. These results provide the first independent corroboration of the expensive-tissue hypothesis.

#### **Cranial evidence for the timing of the platyrrhine-catarrhine divergence.**

R.F. Kay, T.R.T. Mitchell. Duke University.

The timing of the relationship between the SA platyrrhine radiation and Eocene/Oligocene anthropoids is debated. Platyrrhines first appear in the late Oligocene in South America (~26 Ma). The catarrhine record is acknowledged to include Propliopithecidae from the African early Oligocene (<=34 Ma). But are there earlier representatives of either group in Africa? Specifically, are any late Eocene catarrhines, platyrrhines, or stem anthropoids?

We review the cranial evidence for the phylogeny of Eocene and Oligocene anthropoids in relation to extant catarrhines and platyrrhines. We evaluated 85 cranial characters for 41 taxa of primates. Three extant catarrhine genera and 16 extant platyrrhine genera were included. We examined the five oldest anthropoids for which crania are known (Eocene/Oligocene *Aegyptopithecus*, *Proteopithecus*, *Catopithecus*, *Simonsius* (= *Parapithecus*) and *Apidium*) and three of the oldest known platyrrhine crania (Miocene *Dolichocebus*, *Tremacebus*, and *Homunculus*). Fourteen outgroup taxa were examined including Eocene omomyids and adapids and extant lorises, lemurs, and *Tarsius*.

Using PAUP, a parsimony analysis program, we constrained the analyses with a 'backbone' option based on molecular data so as to produce platyrrhine monophyly and to recognize an unresolved cebid-pitheciid-atelid trichotomy. The relationships among other taxa, including all fossils, were decided by parsimony. Cranial evidence indicates that propliopithecids (represented by *Aegyptopithecus*) are the sister group to extant catarrhines. Thus, the catarrhine-platyrrhine split had occurred by 34 Ma. However, *Catopithecus*, *Proteopithecus*, *Apidium*, and *Simonsius* do not link with platyrrhines or catarrhines but instead are stem anthropoids. Thus, we find no cranial evidence for a platyrrhine-catarrhine split among late Eocene taxa.

#### **The health effects of Wari imperial control: Rates of enamel hypoplasia and carious lesions in prehistoric Nasca populations.**

C.M. Kellner. University of California, Santa Barbara.

During the beginning of the Middle Horizon (750-1000 AD), Nasca populations on the Peruvian south coast were conquered by the highland Wari empire. The health effects of this imperial incursion on local populations are not well known. Based on shared characteristics in ceramic iconography and proximity to the

Wari empire's capital near Ayacucho, researchers have surmised that the Nasca held a special, perhaps privileged, place in the Wari imperial sphere.

Dental pathology has been shown as a good indicator of the general health of a population. An analysis of linear enamel hypoplasia (LEH) and carious lesions in the dentition of Nasca populations helps determine what the health effects were of Wari imperial conquest in the Nasca region. Over 137 individuals from the Julio C. Tello Nasca skeletal collection were examined for evidence of LEH and carious lesions. The imperial period population exhibits an individual LEH frequency of 20.3%, while earlier Nasca time periods display a much lower rate of 12.1%. Individual frequencies of carious lesions are also higher (54%) during the imperial occupation period than earlier periods (46%). These data on LEH and carious lesion rates in these Nasca populations suggest that oral health deteriorated during imperial conquest, perhaps due to the detrimental health effects of living in large, aggregated settlements. This indicates that the Nasca may not have held such a vaunted place within the Wari empire as previously believed.

#### **Tackling (some of) the vagaries of ancient DNA work.**

B.M. Kemp, D.G. Smith. Dept. of Anthropology, University of California-Davis.

When extracting ancient DNA (aDNA) from skeletal remains, researchers are plagued with multiple complications that make this type of research difficult. Two of the most prevalent complications are contamination and PCR inhibition. Our study provides protocols for tackling these common problems.

DNA originating from modern sources can provide false positives and out-compete the degraded aDNA in PCR amplification. It is of the utmost importance that researchers working with aDNA provide evidence that the DNA extracted from an ancient source is genuine, and, therefore, free of modern contaminants. Many aDNA researchers have reported the use of bleach (in various diluted concentrations) for decontaminating bone surfaces, but it is unknown to us whether a systematic study has provided evidence of its effectiveness. We show that a 1:3 dilution of bleach to water is an effective decontaminating solution.

PCR inhibitors are often present in ancient skeletal remains and are co-extracted during DNA extraction. These inhibitors can be visualized as a yellow to brown coloring in the final solution con-

taining the extracted DNA. We present a protocol using PTB (N-phenacylthiazolium bromide) during DNA extraction that is effective in avoiding the co-extraction of PCR inhibitors. Our protocol uses a modified incubation temperature and concentration of PTB from those protocols reported in the literature, which we found ineffective. We also report the use of sodium hydroxide as an effective means of PCR inhibitor removal following DNA extraction. Our sodium hydroxide protocol is a modified version of one suggested for use in forensics.

### **Global population relationships based upon multiple haplotype loci.**

J.R. Kidd, A.J. Pakstis, K.K. Kidd. Dept. of Genetics, Yale University.

As part of an ongoing study to examine the patterns of linkage disequilibrium at multiple regions of the genome, we have collected data on over 2000 individuals from 38 populations distributed across all major regions of the globe. Data are available on all populations for more than 20 haplotyped loci involving three to seven single nucleotide polymorphisms (SNPs); about half also contain a short tandem repeat polymorphism (STRP). In addition, several independent SNPs are available for the same populations. Genetic distance analyses give an extremely robust framework for the global population relationships. When compared to geography-based "migrational" distances between populations, there is a clear correlation between genetic similarity and geographic proximity. However, compared to those "migrational" distances, the genetic data show greater variation among populations in the same geographic region and less variation between geographic regions. The patterns of gene frequency variation and linkage disequilibrium both provide strong support for an out of Africa model with both increasing genetic distance and increasing linkage disequilibrium as populations are further from Africa, with some notable exceptions. For example, the Druze from Israel cluster genetically with other European populations but tend to show more linkage disequilibrium. An African-American sample shows genetic distances clustering with other African populations but displaced toward Europeans; the average level of linkage disequilibrium, however, is the same or less than that seen for most sub-Saharan African populations and considerably less than that seen for European populations. Supported by GM57672, MH62495, and NSF BCS-9912028.

### **ALFRED - the ALlele FREquency Database - an update.**

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ALFRED (<http://alfred.med.yale.edu>) is designed to be a resource to the genetic anthropology and population genetics communities by providing a central curated resource for allele frequency data for DNA-based polymorphisms typed on defined population samples. It is hoped that it will help the research community fill in the missing cells in the largely empty population-polymorphism matrix. Most of the effort during the past year was put towards increasing the quantity and quality of data in ALFRED. Currently, frequency tables (one population typed for one site) involve 672 polymorphisms and 228 populations and have increased from 3561 (September, 2001) to 6301 (September, 2002). The staff are now systematically extracting gene frequency data from recent issues of major human genetics and physical anthropology journals. Curatorial software tools to ensure data accuracy and consistency were developed and we are in the final stages of migration of the existing ALFRED data from a Microsoft Access database to a more robust and powerful Oracle database. An improved Web-based search and retrieval system is being developed. As part of that effort a Document Type Definition (DTD) has been developed for importing and exporting ALFRED data in XML format. We are now beginning to accept data directly from researchers. While XML data or a spreadsheet are preferable, we can also accept data in most any electronic form if the descriptive information is submitted in parallel.

(Ongoing support of ALFRED is provided by NSF grant BCS-0096588)

### **The Dali cranium in the context of human evolution in China.**

J.H. Kidder, A.C. Durband. Dept. of Anthropology, University of Tennessee, Knoxville.

The Dali cranium, discovered in Shaanxi Province in 1959 is central to the understanding of later hominid evolution in China. This find is mostly complete and is dated to approximately 209

ky BP. The phylogenetic interpretation of this fossil is problematic, but most authors maintain that it has a mix of characteristics that place it either intermediate between *Homo erectus* and later *Homo sapiens* or within the range of the latter (Wu 1959, 1981; Wu and You 1979; Zhang *et al.* 1982; Brace *et al.* 1984; Wu and Poirer, 1995).

For this study, Mahalanobis distances are generated to test the morphometric position of the Dali cranium using 43 archaic and early modern fossils as a comparative sample. The Howells modern sample is used to calculate a stable covariance matrix. Mahalanobis distances are computed for the fossil samples after Jantz and Owsley (1999). Once these distances are calculated, the fossil crania are compared to one another by the use of random expectation statistics.

The results suggest that the Dali cranium exhibits a morphometric pattern similar to the Zhoukoudian *Homo erectus* crania. These findings corroborate earlier work by the current authors that indicates a potentially unique evolutionary history for the Chinese hominid assemblage.

### **Surviving scarcity: Remarks on the physical anthropology of a Neolithic population from the Oman Peninsula.**

H. Kiesewette. Institute for Pre- and Protohistory, Tuebingen University.

Until recently little was known about the Neolithic inhabitants of the Oman Peninsula living on the verge of the Rub Al Khali (Empty Quarter). The graveyard discovered at Al-Buhais 18 is so far the first located in the interior of the United Arab Emirates to be dated in the early 5<sup>th</sup> millennium BC. With over 400 individuals recovered from the site, the skeletal material provides valuable information on the demography, health, and diet of the Neolithic population and contributes to the understanding of subsistence strategies in a barren environment.

Archeological investigations suggest that the people from Al-Buhais 18 were living as nomads, depending on sheep, goat, and cattle. It is remarkable that - in contrast to the Bronze Age and Iron Age populations recorded from the Oman Peninsula - only few of the Neolithic skeletons from Al-Buhais 18 show signs of malnutrition. Even more interesting is the relatively high number of individuals exhibiting evidence of inter-personal violence. Paleopathological analyses reveal injuries caused by blunt force in 11.9 % of the examined skulls. Most of the indi-

viduals with violence-related unhealed fractures were male and less than 40 years of age. In comparison with other Neolithic populations from the Near East the demographic profile shows a reduced percentage of survivalship among males aged between 20 and 40. These results provide compelling evidence of interpersonal or intergroup aggression. The violent behavior can be explained by the need to protect the herds on which the population highly depended against foreign aggressors.

### The "Mysterious Cemetery" of Frankfort Kentucky: Letting the bones speak!

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On March 11, 2002, Construction workers uncovered the first human remains of some 265 individuals at the future site of a state office building in Frankfort, Kentucky. The Kentucky Archaeological Survey and the Kentucky Heritage Council took charge of the recovery effort for the Kentucky Finance Cabinet. Northern Kentucky University assisted with recovery and the skeletal analysis. In the late nineteenth century several buildings were placed over the cemetery and it became lost to history. Several hypotheses on the origin of the cemetery have been put forth. These propositions include that the cemetery is associated with a State Penitentiary; the cemetery results from one or more cholera epidemics; the cemetery is affiliated with African Americans and the lower class of Frankfort; the cemetery is for the first settlers of Frankfort and finally the resting place of a Lieutenant Governor of the State of Kentucky. Who is buried in the Frankfort Cemetery?

Of the 265 individuals recovered 179 are adult individuals of which 80 are complete. The remaining individuals are sub-adults, most of which are incomplete. A wide range of pathologies and occupational stress markers are observable including arthritis, osteoporosis, TB, Rickets and Paget's disease. Basic demographics of the first hundred individuals analyzed will be described as well as the distribution of the pathologies and occupational stresses will be presented. The distributions and population characteristics will be used to evaluate the proposed origins of this cemetery.

### Semi-automatic assembling of skull fragments.

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When reassembling a fossil from fragments, one first typically finds the fragments, then places them in rough alignment (using cues such as surface curvature, vessels, or textures) and finally decides what to glue and what to plaster. This paper introduces an algorithm that aids at this third stage, by changing to a virtual setting where the fragments are given as CT-scans, and by optimally fitting those fragment outlines.

We present the following aspects of the assembling problem: In order to find this optimal alignment, each fragment outline is divided into segments. Then for each segment, a feature vector is computed, and the feature vectors are classified using a clustering algorithm. The resulting clusters correspond to 'letters'. Thus the fragment outlines are translated to 'words', and the skull fragments are adjusted to optimize their alignment which is measured by a Hidden Markov Model of this generalized string matching problem. This is a familiar problem in the field of bioinformatics, where string matching tasks with insertions, deletions and mutations are considered. In reassembling fossil skulls, however, geometric information can be incorporated, too, to help to measure the error: in millimeters, not in base pairs.

We show how the performance of the algorithm depends on (simulated) abrasion and present the results for two fragments of a broken recent skull of a modern *Homo sapiens* specimen that was CT-scanned twice, before and after the breakage. Further work on the rough alignment problem will be presented elsewhere.

This work was supported by the Austrian Science Foundation (PNo. P-14738).

### A new hominin skull from Hadar: Implications for cranial sexual dimorphism in *Australopithecus afarensis*.

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In 2000 a fragmentary but well preserved adult hominin skull was recovered from the lower Kada Hadar member (~3.1

mya) of the Hadar Formation at Hadar, Ethiopia. The specimen, A.L. 822-1, includes a virtually complete mandible plus much of the calvaria, maxilla, zygomatics, and most upper and lower teeth. Distortion and breakage necessitated considerable reconstruction, the preliminary results of which are described.

We assign the skull to *A. afarensis* based on apparent autapomorphies in the supraorbital, zygomatic, and nasal regions. It also evinces the prevalently primitive suite of characters known in *A. afarensis* specimens such as the A.L. 417-1 and A.L. 444-2 skulls and the A.L. 333 material. Dentally, A.L. 822-1 is moderately large (in 8/20 postcanine metric comparisons it exceeds Hadar means), but the small maxillary canine crown points to female status. This is supported by delicate zygomatic arches, thin supraorbitals, and the absence of sagittal and compound temporal/nuchal crests. Mandibular and maxillofacial size closely shadows that of A.L. 417-1, diagnosed as female by canine size.

A.L. 822-1, the first complete female *A. afarensis* skull, permits systematic assessment of morphological sexual dimorphism in this species' cranium. Females show consistent circumnasal, infraorbital, palatal, and occipital morphology relative to males, irrespective of absolute size. Thus, A.L. 822-1 and A.L. 417-1 differ characteristically from the similar-size A.L. 333-1 male, which, in turn, resembles the much larger male A.L. 444-2. These comparisons underscore the taxonomic unity of the Hadar *Australopithecus* sample and raise questions about appropriate models for early hominin craniofacial sexual dimorphism.

Supported by NSF and NGS.

### A pilot study to assess paleodietary change in northeast Thailand using stable isotopic analysis.

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A pilot study of stable isotopic analysis on prehistoric human bone from the archaeological site of Ban Chiang, northeast Thailand (n=33) was conducted to determine 1) whether isotopic data can be obtained from archaeological human remains from mainland Southeast Asia, and 2) whether secular changes in diet could be detected using carbon and nitrogen isotopic analysis. Results of the pilot study confirmed the methodology was viable and also suggest that dietary changes occurred.

The levels of  $\delta^{15}\text{N}$ ,  $\delta^{13}\text{Cco}$ ,  $\delta^{13}\text{Cca}$ , and  $\Delta^{13}\text{Cca-co}$  found in the pilot study all sug-

gest the diets of these individuals were highly mixed, with both terrestrial and aquatic proteins. The narrow range of variation in carbon and nitrogen values over time suggests little dietary change. However, analyses of by sex differences within each time period are statistically significant for each carbon and nitrogen values. This may represent differential access to food resources based on status, sex, or both. Stratified wealth is well documented in northeast Thailand but to date no studies have tested differential access to food resources.

Additional research utilizing isotopic values of plant and animal samples collected in northeast Thailand and additional human archaeological samples will refine our interpretation of these dietary changes. From this it may be possible to make trophic level distinctions to assist in explaining the subtle variations in isotopic values found in mainland Southeast Asia.

**Sources of variability in modern East African herbivore enamel: Implications for paleodietary and paleoecological reconstructions.**

J.D. Kingston. Dept. of Anthropology, Emory University.

Characterization of biogeochemical cycles that mediate the distribution and pathways of light stable isotopes in the biosphere have contributed substantially to reconstructions of ecological and climatic parameters in the past. These approaches have been important in documenting ecological shifts, habitat heterogeneity in space and time, dietary regimes of fossil terrestrial communities, and the effect of climatic perturbations and oscillations on terrestrial ecosystems. Application of stable isotopic approaches to paleoenvironmental and paleodietary reconstructions in East and South Africa utilizing fossil tooth apatite has provided valuable independent data relevant to interpreting early hominin environments and diets. Interpretations of these data, however, have been limited by an incomplete understanding of patterns of isotopic variability in terrestrial ecosystems. Research focusing on mapping out this variation, either empirically or theoretically, has revealed extensive, analytically significant intra- and inter-tooth variability related to isotopic variability of food items and water sources, and possibly developmental physiology, during enamel formation. In addition, significant variation between members of a population or between populations has been documented. This variability can ultimately be

linked to factors such as differential distribution of isotopes across microhabitats, biased transmission of biochemical markers through trophic levels, heterogeneity within plant assemblages and individual plant components, seasonality or climatic shifts, migratory patterns, dietary shifts related to life history patterns, and feeding niche partitioning. Utilizing carbon and oxygen isotopic analyses of modern herbivore tooth enamel sampled in East Africa, this variability is mapped out and assessed in the context of habitat and environmental heterogeneity.

**On the relationship between visual specialization and encephalization – a comparative analysis of relative optic foramen size.**

E. C. Kirk. Dept. of Biological Anthropology and Anatomy, Duke University.

Visual specialization has long been assumed to play an important role in primate brain evolution, but quantitative data to clarify the nature of this relationship have only recently been published. In 1998, Barton (*Proc. Roy. Soc. B* 265: 1933-1937) provided evidence that relative brain size in 14 primate species is highly correlated with the number of parvocellular neurons in the LGN. These data suggest that increases in neural "input" associated with high-acuity vision have led to increases in relative brain size among primates.

In order to test the hypothesis that visual specialization has influenced encephalization in primates and nonprimate eutherians, data were collected on optic foramen size and endocranial volume for 101 primate, 72 carnivoran, 50 sciurid, and 15 scandentian species. Optic foramen area is highly correlated with the number of optic nerve fibers, and may thus be used to estimate the total number of visual "input" channels to the brain.

Analyses using multiple regressions, partial correlations, and independent contrasts indicate that the relative quantity of estimated visual input (EVI) is not significantly correlated with relative brain size in carnivorans, sciurids, scandentians, or strepsirrhines. Among haplorhine primates, relative EVI and relative brain size are positively correlated, but EVI explains only a small proportion of the total variation in relative brain size. These results suggest that total visual input has little effect on relative brain size among eutherian mammals, and that the high degree of encephalization shared by living anthropoids is primarily the result of non-visual factors.

**MHC diversity in captive western lowland gorillas.**

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The major histocompatibility complex (MHC) is a tightly linked cluster of genes responsible for functions including immune responsiveness and disease resistance. MHC loci are highly polymorphic and this extensive diversity is important for resistance to infectious disease and reproductive success. Although a substantial body of literature describing the MHC of the great apes has accumulated over the past decade, this information has not been effectively applied to the conservation of captive or wild gorillas. To assess MHC diversity among captive western lowland gorillas, MHC-DRB alleles were identified in 81 individuals using the polymerase chain reaction (PCR), denaturing gradient gel electrophoresis (DGGE) and direct sequencing. Subjects included 33 wild-born founders and 48 captive-bred animals. The analysis revealed concordance with previous smaller-scale studies of MHC-DRB genes in gorillas and captive management strategies appear to be successfully maintaining much of the genetic diversity of founder gorillas. However, a high degree of similarity between all gorillas in captivity, including unrelated and wild-caught individuals, was observed. Overall, wild-born founder gorillas possess more unique genotypes and exhibit a significantly lower degree of allele sharing than captive-bred gorillas. Additionally, MHC-DRB variability was found to decrease throughout successive captive generations. The loss of rare alleles and fixation of common alleles was also observed. Integration of these results with genome wide data will be critical in successfully monitoring and supporting viable populations of gorillas and other primates both in captivity and in the wild. (Supported by Morris Animal Foundation and US Fish & Wildlife Great Ape Conservation Fund.)

**Integrating research and education for orangutan conservation in Gunung Palung National Park, Indonesia.**

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Gunung Palung National Park is one of the world's last refuges for endangered wild orangutans. Here we report on techniques and research findings from our efforts to protect orangutans and their habitat. Accurate estimation of orangutan density is generally accomplished through nest surveys. We describe results from our long term monitoring of nest viability and present data on population-specific measures of mean nests built/day. A new method of nest transect recounts, greatly increasing accuracy, is presented.

We describe GIS mapping to monitor orangutan range movements, providing critical information on orangutan range and habitat requirements. Habitat viability and the effects of disturbance are assessed through combining long-term follow data on orangutan dietary and nutritional requirements with GIS mapping, pH soil testing, and density measurements of orangutan plant resources. Orangutans reproduce at an extremely slow rate, with fecundity closely linked to energy availability. Minimum caloric requirements for successful conception, obtained from measurement of urinary hormones and nutritional analysis, are presented. These data indicate that fecundity is compromised and inter-birth intervals lengthened in degraded habitats.

Finally, we discuss and evaluate our methods used to disseminate these research findings to the local population. Education and awareness efforts include study site field trips, teacher workshops, an environmental education center, lesson plans, educational pamphlets, volunteer and ranger training, billboards, radio programs, newspaper articles, films, puppet shows and theatre presentations.

Principle supporters are: US Fish and Wildlife Great Ape Conservation Fund, National Geographic Society, Leakey Foundation, BOS-USA, Conservation, Food and Health Foundation, NSF, WCS, and Margot Marsh Biodiversity Fund.

**Payoffs, community relations, and vocational training: Implementing local conservation in Ecuador's Yasuni National Park.**

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Yasuni National Park is a nearly one-million hectare rainforest reserve located in eastern Ecuador. Over the last decade, petroleum development has led to road-building and increased colonization in portions of the park by two indigenous tribes. Even cursory examination reveals that these colonists are having a significant, detrimental impact on the forest and its fauna, principally along the main road accessing the park. In this region, areas cleared for agriculture are steadily increasing, and faunal surveys hint at a marked impact of subsistence hunting on the densities of large-bodied mammals, particularly primates.

We have been involved in two major efforts to mitigate some of these impacts. One began in 1994 as an expedient response to a direct hunting threat. At that time, we started providing a small economic incentive to a set of indigenous families in exchange for not hunting in a portion of their territory where a site was being established for studying comparative primate socioecology. As the community has grown, the payoff per family has decreased, but community members continue to refrain from hunting in the site (where primate populations now thrive). The second, more formal program began in 2001 and provides education and training in vocational skills (e.g., sewing, carpentry, auto mechanics) to several indigenous communities, with the goal of making it possible for them to have other sources of income so that they can rely less directly on the forest for their subsistence. The success of these programs is made possible by – and is contingent upon – continuing efforts to foster good relationships between researchers and locals.

**The effects of alcohol abuse on the skeleton.**

S. Kohn. Dept. of Anthropology University of New Mexico.

Skeletal remains of thirty-five males curated at the Maxwell Museum of Anthropology, University of New Mexico, are examined to identify the effects of chronic alcohol abuse. Each is known to have a history of ethanol abuse and to have died either directly from ethanol poisoning, or from alcohol-related causes such as accidental or violent trauma. The alcoholics (n=16) are compared to a sample of non-alcoholics (n=19) in a similar age range in order to detect statistically significant

differences in a series of expected skeletal and dental pathologies. Expectations for chronic alcoholics include 1) increased incidence of osteoporosis due to deficient diet, disturbances in nutrient absorption, and in rates of bone remodeling caused by ethanol ingestion, 2) increased evidence of trauma due to violent as well as accidental causes, 3) higher incidence of systemic and localized infection related to a deficient immune system and lack of medical care, and 4) increased frequencies of dental pathologies including caries, abscesses, gingival infection, tooth loss, and calculus accretion due to poor dental hygiene and lack of dental care. Preliminary results indicate that alcoholism is associated with malnutrition (p=.039) as noted at the time of autopsy, presence of periodontal disease (p=.011), and number (p=.004) and location of fractures. The frequency of total fractures among alcoholics was 117% higher than among non-alcoholics including a significantly greater number of fractures located on the skull and thorax. Further analyses will confirm or repudiate significant differences in rates of osteoporosis and infection.

**Paleodemography of the Averbuch Site (40DV60).**

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During the last decade paleodemography has undergone a resurgence fueled by the development of new analytical methods. Where the field once included little more than the calculation of life tables based on "age determinations," modern paleodemography now incorporates the use of hazard models and aging methods that admit imprecision in age estimation. While these methodological developments have been fairly rapid, applications of the new methods have been slow to materialize, primarily because of the stringent data requirements. In this paper we report on one of the first applications of these modern paleodemographic methods.

The Averbuch Site is a late prehistoric Native American palisaded village with associated cemeteries, from which more than 800 individuals were recovered. As part of a routine inventory project, information on "age indicators" was collected from all available skeletal remains. Comparable indicator information was collected from 792 known-age individuals from the Terry Anatomical Collection and 360 known-age males from the McKern and Stewart Korean War Dead data. The

known-age data are used to fit both a full multivariate probit and an accelerated failure time model for ectocranial suture closure, pubic symphyseal development, and auricular surface development. This reference sample information is then used to estimate a stationary Gompertz-Makeham model of mortality for individuals fifteen years old or older at time-of-death. The results show that while early adult mortality was quite high, an appreciable proportion of the population from the Averbuch Site did live to extreme old age.

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### **Craniometric variation among medieval Croatian populations.**

D.V. Kopp. Dept. of Anthropology, University of Utah.

This study examines craniometric variation among a series of medieval Croatian skeletons to determine if the populations inhabiting the coastal (Dalmatian) and continental (Pannonian) regions are morphometrically dissimilar. Differing historical population movements in the regions provide possible evidence for genetic, ethnic, and cultural dissimilarity between the Dalmatian and Pannonian regions. Cranial measurements from three coastal and three continental medieval Croatian sites are subjected to multivariate analyses to assess craniometric variation among the groups. Canonical variates analysis and distance matrix comparisons are completed for male and female mean data separately.

Plots of the first two canonical axes derived from the canonical variates analysis reveal no clear distinction between the coastal and continental sites for either sex. The plot of the male data does indicate a distinction between the late medieval site of Nova Raca and the other earlier Croatian sites. This dissimilarity is likely a result of not only temporal differences, but also increased ethnic diversity in the population of Nova Raca from intensified migrations of other central European peoples into the region beginning in the twelfth century.

Matrix comparisons of biological distance with geographic and temporal distances indicate that there is no significant correlation between any of the matrix pairs for both male and female data. Fairly high  $F_{st}$  values estimated from R matrices, however, indicate genetic heterozygosity (differentiation) between the populations. Based on these analyses it is suggested that there is differentiation between the groups studied, but no sig-

nificant patterning between the coastal and continental populations of medieval Croatia.

### **Implications of dental arch form on the maxillary sinus size in *Macaca nemestrina*.**

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The knowledge about the influence of craniofacial growth on the paranasal sinuses is still incomplete. It has been suggested that in contrast to hominoids, maxillary sinus size (MSS) of adult macaques is closely related with the form of the palate (Koppe et al., 1999, *Ann. Anat.*, 181: 77-80). Therefore, this study explores this relationship further by focusing on the association between the size of the maxillary dental arch and MSS in *M. nemestrina*.

Whereas maxillary sinus measurements of 25 female and 25 male were obtained from lateral cephalograms, which were collected longitudinally over a period of eight years, maxillary dental arch measurements were achieved from dental casts using sliding calipers. Reduced major axis analysis suggests that in both sexes maxillary sinus length grew postnatally faster than the height. In addition, sexual dimorphism in maxillary sinus length appeared earlier than in height, and male sinuses tended to grow over a longer period than females. The dental arch length grew in both sexes faster than the width. A significant sexual dimorphism in maxillary arch length was already observed in infant monkeys.

Partial correlation coefficients revealed for both sexes a close association between MSS and dental arch length but not with dental arch width. The finding, however, that the maxillary dental arch length of both sexes developed postnatally faster than the length of the maxillary sinus may be related to the fact that in contrast to hominoids, the maxillary sinus of macaques is restricted to the region of the maxillary molars.

### **Felsőtárkány, a middle Miocene catarrhine locality in central Hungary.**

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Felsőtárkány is a middle Miocene locality described by Schreter in 1913. Subsequent researchers recovered small samples of vertebrates, invertebrates and plant fossils. Felsőtárkány was listed in a compendium of Hungarian Miocene fossil localities (Kretzoi, 1982). *Pliopithecus* was included in the short faunal list, without further detail.

New excavations, faunal analysis, survey and analysis of the primate specimen provide the first glimpse of middle Miocene primate paleobiogeography in Hungary. Older collections and new fossils (Hír, et al. 2001) indicate a middle Miocene age, MN 7/8, or about 12 Ma by most estimates. Survey revealed a sequence of fossiliferous and radiometrically datable sediments possibly also amenable to magnetostratigraphic analysis, a rare combination in the region. Continued work should confirm the potential to establish Felsőtárkány as an important tie-point locality in the assessment of the absolute age of MN 5-7/8, the middle Miocene terrestrial vertebrate sequence in Europe and the focus of considerable debate. The primate specimen is a complete proximal phalanx, probably from the foot. It is smaller and less robust in secondary shaft characters and transverse dimensions than pliopithecoid phalanges from Rudabánya, (late Miocene, Hungary) (*Anapithecus*), and closer to those of Devínská Nová Ves ("Neudorf Spaltze"; middle Miocene, Slovakia) (*Epipliopthecus*). Felsőtárkány is located between Rudabánya and Devínská Nová Ves, but relatively close to both. Other localities of middle to late Miocene age in the same general region (Austria, Poland) suggest an epicenter of pliopithecoid evolution in central Europe. Funded by NSERC and OTA.

### **Life history and folivory in primate species: The importance of juveniles.**

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Correlations between diet and life history in primates are poorly understood. Some elements of life history may bear a relation to diet, but mortality, particularly infanticide, may impact life histories. This analysis investigates the relations between diet and a range of life history variables, with the expectation that diet and life history covary.

Data regarding life history variables, degree of folivory and infanticide rates for anthropoid primates are derived from literature. These data are subjected to regression analyses. Partial correlations

are applied to control body size and independent contrasts provide phylogenetic control.

Correlations between folivory and life history variables are apparent for the entire sample, but infanticide rates are uncorrelated with life history variables. A more limited set of correlations is recorded within anthropoid superfamilies. However, independent contrasts indicate a lack of statistically significant correlations for all variables except growth rates. Furthermore, contrasts point to correlations between some measures of infanticide and life history variables.

These results reveal a complex set of correlations between diet and life history in anthropoids. Specifically, diet is uncorrelated with measures of life histories in adults, but correlations between life history variables, growth, and infanticide rates may reflect diet and life history correlations during the juvenile period. Faster early growth rates could indicate riskier infant periods for folivores, possibly in relation to higher rates of infanticide (among other potential causes of juvenile mortality). These results also show that a focus on juveniles may be important in explaining the evolution of primate life histories.

#### **Paleodiet and the peopling of Sundaland: Modeling early human subsistence using stable isotopes of carbon.**

J.S. Krigbaum. Dept. of Anthropology, University of Florida.

Excavations at Niah Cave's West Mouth (Sarawak, East Malaysia) provide a large sample (N=39+) of human skeletal remains that date to the terminal Pleistocene/early Holocene period. Isotopic data, based on  $\delta^{13}\text{C}$  values derived from tooth enamel apatite (structural carbonate) demonstrate important patterns of subsistence. This paper builds on the growing isotopic database for Niah Cave remains and other penecontemporaneous faunal and human skeletal material from the Southeast Asian subcontinent of Sundaland. At Niah, early human burial 'types' grouped together show  $\delta^{13}\text{C}$  values that currently average  $-14.4\%$ , significantly more negative than later Neolithic individuals at the site.  $\delta^{13}\text{C}$  values range from  $-15.7$  to  $-12.2\%$ , suggesting differential foraging patterns for otherwise inferred "broad spectrum" foragers.

Ongoing isotopic studies of modern ecosystems in Sarawak allow more refined partitioning of these data with respect to differential patterns of subsistence. Developed models will allow ques-

tions to be raised and predictions formulated with respect to generalized foraging pattern (e.g., coastal vs. terrestrial, closed vs. open forest). Various tropical/subtropical subsistence regimes are presented based on prehistoric case studies and the ethnographic literature and interpreted with respect to dietary breadth and microhabitat utilization. The early human remains and fauna recovered from Niah Cave provide important ecological correlates towards better understanding the inferred subsistence pattern of the early modern humans that peopled the region some 80-60 thousand years ago.

#### **Modeling juvenile robust australopithecine faces.**

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No complete juvenile facial remains have been found for robust australopithecines. However, Euclidean Distance Matrix Analysis techniques can be used to create hypothetical juvenile forms that allow us to make predictions about what robust australopithecine juvenile fossils might have looked like, and to test hypotheses about hominoid facial growth patterns.

3-D coordinate data were collected from 8 landmarks on the face and palate of KNM-ER 406, OH 5, KNM-WT 17000, SK 48, Sts 5 and Taung, and from extant comparative samples of juvenile and adult humans (N=21, 141), gorillas (N=11, 115), common chimpanzees (N=13, 65), and bonobos (N=27, 23). A "reverse growth matrix" (consisting of the ratios of the juvenile to adult comparison for all unique linear distances between landmarks) was created for each extant species and for *A. africanus*. Hypothetical juvenile forms were then created for each extant species, *A. africanus*, and the robust australopithecines by multiplying the mean adult form by the "reverse growth matrix" of different species.

Hypothetical robust juveniles are very similar to Taung and the hypothetical *A. africanus* juveniles when the zygomatic arch is excluded from analysis. However, when the zygomatic arch is included, the hypothetical robust juveniles differed markedly from all other species, including *A. africanus*. These results suggest that robust australopithecines shared certain elements of facial growth with the extant species and with *A. africanus*, although other elements of growth (particularly relating to the zygomatic arch) were dis-

tinctive. Such developmental differences may relate to unique robust australopithecine dietary adaptations.

#### **Material and structural properties of human and African ape cortical and cancellous bone: Implications for the evolution of bipedality.**

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An upright, habitual striding form of bipedalism distinguishes modern humans from all other extant terrestrial mammals. A comparative analysis of *Homo sapiens*, *Pan troglodytes*, and *Gorilla gorilla* distal tibiae indicates that humans have adaptively altered the architecture of cortical and cancellous bone within the metaphysis (Kunos, 1997). Given that the muscular mechanisms responsible for load attenuation are severely compromised in erect bipeds, the unique architecture of human tibial metaphyses may be related to impact attenuation especially during heel strike.

Human and African ape cortical and cancellous bone demonstrate no significant difference in mineralization or mineral ash density. Under compression, the elastic moduli of human and African ape bone within the tibia do not differ significantly. Similarly, there are no differences in apparent density or porosity of cortical and cancellous bone. Structural differences in the human tibial metaphysis allow structural dampening of applied compressive loads. In African apes, peak strain amplitude coincides with peak force amplitude. In humans, peak strain amplitude occurs later than the registration of peak force. A phase lag between peak force and peak strain indicates load attenuation.

Given the anatomical specializations of the modern human metaphysis, the unusual structural distribution of cortical and cancellous bone likely serves as an additional mechanism by which humans, and our hominid ancestors, insulate themselves from peak locomotor loads engendered during single limb support.

Kunos, CA. 1997. Distal Metaphysis of the Tibia: Implications for the Evolution of Bipedality. *Amer J Phys Anthropol Suppl* 24: 147-148.

### **Tooth root morphology and masticatory muscle force pattern in humans and nonhuman primates.**

K. Kupczik, F. Spoor, M.C. Dean. Evolutionary Anatomy Unit, Department of Anatomy & Developmental Biology, University College London.

The few studies that have investigated root morphology in the primate dentition are based on linear measurements such as root height and mesio-distal diameters. Here we present a three-dimensional (3D) analysis of root morphology and surface area to explore the functional hypothesis that root surface area varies along the tooth row according to the muscle force distribution.

A high-resolution CT-scanner was used to make scans at 0.5mm intervals of 157 isolated teeth of modern *Homo sapiens* as well as the complete dentitions of 2 *Gorilla gorilla*, 2 *Homo sapiens*, 2 *Papio anubis*, 4 *Pan troglodytes* and 2 *Pongo pygmaeus*. 3D-imaging software (VOXELMAN) was used to reveal and examine root morphology and conduct a metric study of the roots.

When canines are excluded the root surface areas were found to peak at lower M1 and upper M2 in *Homo*, lower and upper M2 in *Gorilla*, lower and upper M1/M2 in *Pongo*, lower M2/M3 and upper M2 in *Papio*, but in maxillary I1 and mandibular P4/M1/M2 in *Pan*.

The distribution of root surface areas along the tooth row in humans, with a peak at M1/M2 and both a decline in more mesially and distally positioned teeth, concurs with findings from theoretical and experimental studies on masticatory muscle force activity along the tooth row. Although at present the experimental and biomechanical data are unavailable to confirm this relationship for the remainder of the sample, such a relationship could prove a good indicator of muscle activity pattern in fossil and other living primates.

### **Prenatal influences on leptin levels in adolescent Filipinos.**

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Fetal growth and maternal pregnancy nutrition have been shown to predict metabolic traits in offspring, yet little is known about the role of the fetal environment on the adipose-tissue derived hormone leptin. This paper investigates this problem in a sample of 600+ Filipino

adolescents enrolled in the Cebu Longitudinal Health and Nutrition Survey, a one-year birth cohort study begun in 1982-1983 (Cebu City, the Philippines). We investigated the relationship between leptin measured 15-16 years after birth (1998-9) and 1) maternal third trimester dietary fat intake (1983-4) and 2) birth weight, controlling for the child's adiposity, current fat intake, and other potential confounding factors.

Triceps SF is the strongest predictor of leptin levels in both sexes ( $r = 0.63$  and  $0.55$  in males and females, respectively). BMI (mean  $18.5 \pm 0.15$  and  $18.8 \pm 0.14$ ) and leptin levels (mean  $0.78 \pm 0.05$  and  $3.56 \pm 0.13$ ) were low relative to US or European adolescents. In multivariate models, the child's and mother's fat intake during pregnancy were independently and positively related to leptin in females. In males there was a significant interaction between maternal and offspring fat intake: Leptin increased with increasing child fat intake, but only among offspring of mothers with a higher fat intake during pregnancy (median split). In male offspring of lower fat intake mothers, leptin levels decreased with increasing fat intake in adolescence. These relationships were independent of the child's birth weight, which was unrelated to leptin in either sex. Our findings suggest sex-specific effects of maternal dietary composition during pregnancy on leptin metabolism in offspring.

### **Comparison of patterns of shape dimorphism with interspecific scaling trends in the elbow and knee of cercopithecoids.**

M.R. Lague. Dept. of Anthropology, George Washington University/

An understanding of variation in the fossil record is potentially complicated by the fact that intraspecific body mass differences may incur shape differences in the supporting skeleton as a means of maintaining comparable joint stress among individuals. Cercopithecoids are well-suited for research into the effects of body mass on skeletal design because of their uniformity in body plan and gait, as well as frequent body mass dimorphism (BMD). Based on previous analysis, limb joint size increases allometrically both interspecifically and intraspecifically. This study examines the extent to which conspecific sexes also differ in joint shape and tests the hypothesis that patterns of shape dimorphism resemble interspecific scaling trends.

Landmarks of the distal humerus and distal femur were quantified for 14 taxa exhibiting a range of BMD. Linear regres-

sion was used to examine interspecific scaling of various joint dimensions, as well as their associated degrees of dimorphism. A number of geometric morphometric techniques were used to test the null hypothesis of shape similarity between conspecific sexes and to examine any shape differences.

Although most cercopithecoid species exhibit joint size dimorphism beyond the isometric expectation (for a given degree of BMD), the majority of sampled species do not exhibit significant shape dimorphism. Nevertheless, several size-dimorphic taxa (i.e., *Nasalis*, *Cercopithecus*, *Papio*) exhibit significant sex-based shape differences that are reminiscent of interspecific scaling patterns and may reasonably be linked to the biomechanics of weight-bearing. The observance of significant joint shape dimorphism within extant taxa must be considered when interpreting variation in the fossil record.

### **Communities of frugivores: the relative role of anthropoids in seed dispersal.**

J.E. Lambert. Dept. of Anthropology, University of Oregon.

Primates constitute the bulk of arboreal mammalian biomass in many tropical forests. Because they also can be highly frugivorous, primates are increasingly recognized for their roles as seed dispersers. However, evaluations regarding the impact of primate dispersers are commonly made without reference to the wider frugivore community. This shortfall hinders a full understanding of plant-frugivore and forest regeneration dynamics.

Here, I evaluate the relative role of primates in fruit removal from three common tree species in Kibale National Park, Uganda. Focal trees of *Ficus exasperata* ( $n = 30$ ), *Uvariopsis congensis* ( $n = 6$ ) and *Celtis durandii* ( $n = 6$ ) were observed for 12 days/month, June 2001 - June 2002. Data were collected on frugivore visitation (frequency, duration), feeding rates, fruit-processing and seed removal. In addition to non-primate mammals and birds, particular attention was paid to fruit-removal by anthropoids: *Pan troglodytes*, *Lophocebus albigena*, *Cercopithecus ascanius*, *C. mitis*, *C. lhoesti*, *Procolobus badius*, *Colobus guereza*.

Preliminary analysis of a sub-set of 1,150h of observational data indicates that primates removed more fruit than birds as a consequence of greater frequency and duration of visitation and faster feeding rates. Cercopithecines

were the most common visitors, followed by chimpanzees and colobines. *C. ascanius* was the most reliable frugivore, in part due to their high relative density. These preliminary results have implications for interpreting community structure and forest-wide patterns of seed dispersal. Moreover, given that primates are particularly vulnerable to population decline, these findings have conservation implications for forest regeneration in the face of declining seed dispersers.

**Severe enamel hypoplasia in a 19th century cemetery sample from North Carolina: Possible causes.**

P. Lambert. Utah State University.

Two individuals in a sample of 18 skeletons from a small, 19th century cemetery in North Carolina have disfiguring enamel defects throughout the dentition. One is a child of seven, the other a young adult male of 21 years. The lesions variously appear as multiple, deeply incised bands, notches, and malformed tooth crowns. The cause of these dental lesions is not clear, although the two cases bear striking similarities that suggest a common aetiology. Medially bowed fibulae and remodeled periosteal lesions of the tibiae in the older individual may provide clues concerning the cause(s) of childhood morbidity that led to the formation of defective tooth enamel in these individuals. The purpose of this paper is to explore possible causes of enamel hypoplasia in these and several other individuals from the Eatons Ferry Cemetery, and by proxy, health conditions in rural North Carolina during the 19th century.

**Fetus to infant in biomedical perspective.**

M. Lampl. Dept. of Anthropology, Emory University.

One of the primary biomedical issues of our time is the nature of the developmental process during fetal life, and the challenges presented by the transition to the postnatal environment. A central biosocial concern is matching technological support with the maturational needs of the gestational fetus. This is a challenge to scientific interventional strategies at a time when cultural values identify the midgestational fetus as a viable infant. Significant theoretical debate has engaged notions that physiology is programmed during fetal development and biological destiny is determined in terms of adult health profiles. Scant longitudinal data have contributed to our under-

standing of normal fetal development in response to environmental conditions.

Fetal ultrasonographic data from forty-nine fetuses collected weekly during the second and third trimesters permit intensive study of the growth patterns of the heart, kidneys, torso, limb and head. Multivariate longitudinal analysis identifies distinctive growth patterns by sex and in the fetuses of smoking mothers. Body growth patterns in the limbs and head reflect fetal blood flow patterns, and smoking alters the growth patterns of the heart and kidneys. These data suggest influences unique to fetal growth and the timing differences between males and females may contribute to the observation that boys seem to be more sensitive to negative influences. These studies identify the importance of longitudinal studies of normal growth to the goals of biomedical constructions of normal development.

**The phylogenetic co-variation of anthropoid colour signalling.**

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Co-variation of certain primate characteristics may indicate a causal evolutionary relationship between one characteristic and the development of retention of another characteristic. This is the case for three different forms of colour signalling in the Anthropoids. We have demonstrated co-variation in the development and retention of estrus colouration, male genital colouration, and natal coat colouration. The correlations describe a bidirectional influence among all three characters, particularly between male genital colouration and natal coat colouration. These correlations suggest a causal relationship and a possible evolutionary 'feedback loop'. Phylogenetic reconstruction suggests the presence of contrasting male genital colouration and natal coat colouration in the ancestral Anthropoid species. The age of these characters and the strength of the correlations between them suggest that the development of one or both of these characters may have been a key event in the later development of estrus colouration. Additionally, colour changes indicating pregnancy have been reported for a few primate species including Patas monkeys (*Erythrocebus patas*) and baboon species. Presence and correlational influence demonstrated between other forms of colour signalling indicate that it is likely that other primate species display colour pregnancy signals that have gone unobserved. The demonstration of correlations between different forms of Anthropoid colour signalling

elucidates the causal link between these forms of signalling and suggests the presence of other forms of Anthropoid colour signalling.

**Limb compliance during walking: Comparisons of elbow and knee yield across quadrupedal primates and in other mammals.**

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It has been suggested that primates utilize a compliant gait to help reduce peak locomotor stresses on their limbs (Schmitt, 1994, 1998, 1999). However, the components of such a gait, i.e., increased step length, prolonged contact time, and substantial limb yield, have only been documented for a handful of primate species. In order to explore the generality of this claim, elbow and knee angles during walking were documented at touchdown, midstance and liftoff in a sample of primates, carnivores, marsupials, rodents, and ungulates, all under 25 kg. Limb yield was calculated as the change in angle from touchdown to midstance and re-extension as the change in angle from midstance to liftoff for both forelimbs and hind limbs.

Use of a compliant gait (as reflected in significant limb yield) in primates was confirmed for both forelimbs and hind limbs. However, there was variability within primates with prosimians displaying the greatest amount of limb yield, and catarrhines the least. Surprisingly, marsupials were found to exhibit almost as much elbow yield and even greater knee yield than primates. Carnivores and rodents display a modest amount of limb yield during walking, while ungulates display the stiffest gait. These data are consistent with the suggestion that the use of a compliant gait to attenuate peak stresses may have facilitated the primate invasion of a small-branch niche. However, limb compliance (as reflected by elbow or knee yield) does not appear to be exclusive to the primate order.

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**History of behavior and lifestyle in the Western Hemisphere: Osteoarthritis and skeletal robusticity.**

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Osteoarthritis and skeletal robusticity are strongly influenced by the mechanical environment. Using these variables, the purpose of this study is to assess and interpret workload in particular and activity in general, especially in addressing hypotheses about lifestyle and major adaptive shifts in the past.

Using the Health and Nutrition in the Western Hemisphere database, this study analyzes prevalence and pattern of osteoarthritis and degree of skeletal robusticity of the adult Native American component of the database. We examined frequency of osteoarthritis (marginal lipping and articular surface erosion) and robusticity (femoral midshaft index, total subperiosteal diameter) for the following parameters: temporal period, age, sex, elevation, settlement pattern, subsistence mode, and proximity to coast.

The following primary findings were made: Osteoarthritis is more common in (1) older adults than in younger adults, regardless of habitat, subsistence mode, or location; (2) farming populations than in foraging populations (although the difference is slight and nonsignificant); (3) mobile populations than in sedentary populations; and (4) in contact-era populations than in precontact or early contact populations. Skeletal robusticity (especially the midshaft index) is greater in (1) males than in females; (2) foragers than in farmers; and (3) mobile than in sedentary populations. This study reveals that variation in both osteoarthritis and robusticity is influenced by lifestyle, especially with regard to age and mobility.

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**Genetic population structure in a wild lemur population, the white sifaka (*Propithecus verreauxi verreauxi*): 1992-2002.**

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Gene flow within and between social groups is contingent on behaviorally-mediated patterns of mating and dispersal. To understand how these patterns affect genetic structure of primate populations, long-term data are required. In this study, we analyze ten years of demographic and genetic data from a wild lemur population (*Propithecus verreauxi verreauxi*) at Beza Mahafaly Special Reserve, Madagascar. Our goal is to specify how patterns of mating and dispersal determine the distribution of kinship and

genetic diversity among animals in the population. Specifically, we use microsatellites and census data to obtain estimates of genetic subdivision, non-random mating, relatedness, and reproductive skew within and among social groups in the population. We analyze different classes of individuals (i.e., adults, offspring, males, females) separately in order to discern which classes most strongly influence aspects of population structure. Together, these data reveal that offspring are consistently more heterozygous than panmictic expectations and offspring cohorts within groups are more substructured than adults. Female relatedness within groups is positively correlated with the degree of genetic divergence among social groups. The ability of a resident male to sire an offspring in his group is negatively related to adult sex ratio (females/males) within groups, and offspring retain more heterozygosity as extra-group siring decreases. These data are interpreted within the context of female philopatry, male dispersal, exogamy, and offspring sex-ratio. Our analysis illustrates the basic idea that where animals move and with whom they mate will ultimately influence gene dynamics and genetic diversity in this lemur population.

**Preliminary report on the natural history of brown titi monkeys (*Callicebus brunneus*) at the Los Amigos Research Station, Madre de Dios, Peru.**

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The Los Amigos Conservation Area, created in July, 2001, protects approximately 140,000 hectares of Amazonian lowland moist forest in the Los Amigos watershed. This preliminary study is based on a 30-day visit to the research station in July and August, 2002.

At least seven groups and one lone male were found within 200 meters of the research station. Six of the groups consisted of one adult male, one adult female, and zero to three juveniles. The seventh group may have included a second adult-sized male, who was observed performing a long call to which the adult pair responded. In 21 days, one group used an area of 1.4 hectares, considerably less than the home ranges of 6 to 12 hectares reported for the species at Cocha Cashu. Fruits eaten included *Cecropia* (Cecropiaceae), *Bellucia* (Melastomataceae), *Inga* (Fabaceae), *Stryphnodendron* (Fa-

baceae), *Virola* (Myristicaceae), and *Annona* (Annonaceae).

Four other primate species were sympatric with the titi monkeys in the study area, and sometimes found in apparent association. Interspecies interaction ranged from coordinated travel to apparent avoidance. On one occasion, a *Cebus* attacked and killed a female titi.

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**A new hominin calvaria from Ileret (Kenya).**

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In 2000 the Turkana Basin Research Project of the National Museums of Kenya resumed field work at sites in the Koobi Fora Formation, east of Lake Turkana. New hominin discoveries from Ileret include a well preserved calvaria KNM-ER 42700. The specimen was found in situ, almost fully embedded in a matrix of coarse sandstone and carbonates. Consequently, it attained nearly no damage due to postdepositional erosion, and extensive preparation has now resulted in one of the best preserved hominin cranial fossils from the east Turkana region. The specimen derives from strata 1.5-2 m below a tuff which is compositionally very similar to a tuff in the Koobi Fora Tuff Complex in Area 103, so the age is most likely between 1.5 and 1.6 Ma.

The calvaria is complete, with the exception of a small area of the vault around bregma. The frontal is slightly dislocated. The sphenoccipital synchondrosis is mostly fused suggesting that it concerns a subadult or young adult. Its overall vault shape, and characters such as frontal and parietal midline keeling are most similar to those seen in *Homo erectus*. However, the specimen differs from calvaria traditionally assigned to this species, by a significantly smaller size, and by the absence of both prominent supraorbital tori and supratatorial hollowing. It shares these characteristics with the D2700 specimen from Dmanisi (Vekua et al. *Science* 297, 85-89, 2002). The morphology of KNM-ER 42700 will be described and comparisons will be made with the African and Asian Plio-Pleistocene hominin fossils.

### **Ancestry determination using mesiodistal measurements of deciduous teeth.**

L.R. Lease. Dept. of Anthropology, The Ohio State University.

Until recently, ancestral patterns of metric variation in the deciduous dentition has been neglected. Often it is considered that the pattern of variation in the deciduous dentition is the same as in the permanent. The lack of first hand information stems primarily from the difficulty in gathering information from a large variety or quantity of deciduous dentitions.

Using four different samples, measurements of 20 deciduous teeth were taken on dentitions from 187 historic English and modern European Americans, and 211 historic and modern African Americans. Mesiodistal and buccolingual measures were tested for normality and equivalence of variances within and between samples. While both types of measurements are univariate and multivariate normal, buccolingual measurements were found to have unequal covariance matrices among the samples. The data from the mesiodistal observations were thus used to develop two discriminant functions that can be used to estimate the ancestry of an unknown individual. The discriminant function using all of the samples produced an error rate of 14% using jackknifed evaluation. A discriminant function using only the modern European American and African American samples has a similar error rate of 12%. The resulting discriminant functions were subjected to a test, using dentitions from individuals of known African American or European American ancestry yielding the correct allocation in 80% of 10 cases.

### **Detection of mycobacterial DNA in Andean mummies.**

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The identification of genetic material from pathogenic organisms in ancient human tissues provides a tool for diagnosis of infectious diseases in historic populations. Several recent reports describe isolation of *Mycobacterium tuberculosis* in ancient human remains. We performed polymerase chain reaction using DNA from genital tissue samples of twelve ancient mummies from South America in

order to detect the presence of mycobacteria, Leishmaniasis, and sexually transmitted diseases. Dried tissue samples were obtained from the genital area of twelve naturally mummified adult human remains housed at the American Museum of Natural History. Archaeological findings and radiocarbon dating estimate that the mummies date before 1460 AD. The tissue samples were in dried form from histologically confirmed skin samples in the pelvic region. Positive controls for *Mycobacterium tuberculosis*, *Neisseria gonorrhoea*, *Mycobacterium leprae*, *Treponema pallidum*, *Leishmaniasis*, *Herpes simplex virus*, *Human papillomavirus*, and *Human T-cell lymphotropic virus* type 1 were used. PCR was carried out and was repeated for some of the target diseases. To confirm that DNA in mummy tissues is still intact after hundreds of years and can be detected from the dried samples, glyceraldehyde 3 - phosphate dehydrogenase (GAPDH) gene was used as a marker for DNA.

Our results show that DNA was efficiently isolated from mummy tissues and was adequate for PCR amplification; GAPDH DNAs were detected in all twelve specimens. In two specimens, both from Charassani, one dating to 140 AD and the other to 990 AD, DNA was detected by PCR, using primers specific for *M. tuberculosis*. DNA from nonpathogenic mycobacteria was also detected. DNA from other organisms was not identified.

### **Looking at the small picture: Using cranial and dental nonmetric traits to determine the origins and sources of admixture for the Caddo, a frontier Mississippian culture.**

C. Lee. Dept. of Anthropology, Arizona State University.

The Caddo are important to the understanding of Native American population history as they were located on the Mississippian frontier, with the nomadic Plains cultures to the North and West. The Caddo were a Mississippian based culture, but their language was related to Plains tribes (Arikara, Pawnee). The objectives of this study were to determine the homogeneity of the Caddo through time, identify an originating culture, and sources of outside genetic admixture.

Cranial and dental nonmetric traits were collected from 635 individuals. The Caddo were divided into five archaeological/geographical subgroups to test population homogeneity. For comparative purposes, non-Caddo data were obtained from published sources. The mean meas-

ure of divergence statistic was used to assess biological distance.

All Caddo subareas exhibited local population continuity through time. The Caddo were more homogeneous between subareas during the early (800-1200 AD) and late periods (1600-1800 AD). The middle period (1200-1600 AD) had some subareas possibly experiencing genetic drift. Population interaction was not based on geographical proximity, with evidence of long distance travel. Among the Caddo/non-Caddo comparisons, the Caddo were found to be closer to themselves than to outgroups, with one exception. The Cooper Lake population was indistinguishable from the Caddo. This group was suspected to be a Caddoan population who adopted a Plains lifestyle. The Caddo were found not to have originated from the Fourche Maline, or Mississippians (Quapaw). Sites with possible outside admixture were not located as expected on the Caddo frontier, but in densely populated central Caddo subareas.

### **The Late Pleistocene human species of Levant.**

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The human remains from the Late Pleistocene Mousterian sites in modern day Israel raised the issue of variation for the first time in the history of paleoanthropology. Their current interpretation is still problematic, in that the sources of their variation remain unresolved, and attempts at resolution reflect the currently accepted philosophy of paleoanthropologists as strongly as they reflect the nature of the data. In this paper, we examine the question of whether the observed pattern of cranial variation reflects species differences in the remains from Amud, Qafzeh, Skhul, and Tabun. We try to refute a single-species hypothesis, and suggest new approaches for examining this phylogenetic question. We report on the distribution of a testing statistic based on the standard error of the slope of regressions relating large number of measurements common to pairs of specimens (standard error test, or STET). Previous studies have shown that this method is powerful in rejecting the hypothesis of single species for other animals. Using measurements taken on the original specimens by the authors, we show that this method has the power to reject the null hypothesis for significant

hominid taxonomic differences, but does not reject it for the Levant remains.

**Tooth enamel remains a virtually closed system for stable light isotope and trace element archives in fossils.**

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Studies based on a number of Pliocene hominid sites have demonstrated that stable carbon isotope signals from fossil enamel is very reliable, and that stable oxygen isotope patterning in the carbonate component from the same fossils is very promising. These conclusions are drawn both from first principles, and from extensive comparisons with isotopic patterning in modern fauna. Furthermore, predictable differences in strontium isotope and trace element values have been extracted from some fossil tooth enamel samples, and in some cases from bone. It seems clear, however, that the observed isotopic and perhaps trace element fidelity exists in spite of crystallographic changes accumulated during the course of fossilisation. Using examples drawn from the sites of Makapansgat and Swartkrans, I suggest that this apparent contradiction is likely related to the nature of fossilisation processes occurring in karstic sites. Under these conditions, alkalinity and high calcium concentrations may buffer early chemical changes and favour processes in which the chemical signals are 'locked in' rather than changed through exchange or recrystallisation or other mechanisms.

**Ecogeography of primates in Guyana: Species-area relationships and ecological specialization.**

S.M. Lehman. Dept. of Anthropology, University of Toronto.

Compared to our understanding of primate social systems and diet, we know relatively little about the ecological biogeography of primates. The effects of area and ecological specialization on species richness are an integral part of biogeographic studies. It has been suggested that species that exploit a wide range of resources (generalists) are locally common and widely distributed whereas species that exploit a narrow range of resources (specialists) have a limited distribution and are locally uncommon. To test this hypothesis, I used data from 2108 km of primate surveys conducted from 1994-

1997 in Guyana. Geographic ranges were estimated for each species using a GIS system. Geographic range size is a major determinant of the number of sightings of the eight primate species. Interfluvial area is the strongest correlate to primate species diversity in Guyana. Geographic range size is positively correlated with habitat breadth but not dietary breadth for the eight primate species in Guyana. Contrary to models of species-area relationships, generalist species are more likely than specialist species to be found in small, rare habitats such as swamp woodlands. Moreover, specialists may require a more diverse diet than generalists because Guyanese forests have: (1) low nutrient levels and (2) low levels of floral diversity and abundance of plant families that are valuable food resources for primates. Although the species-area relationship is considered the closest thing to a rule in ecology, researcher should be wary of too readily applying and accepting the model at all scales in biogeographic studies.

**Ontogeny, life history, and maternal reproductive strategies in baboons.**

S.R. Leigh, R.M. Bernstein. Dept. of Anthropology, University of Illinois, Urbana.

Optimal foraging analyses of wild baboons (*Papio*) suggest that foraging proficiency early in the juvenile period is inextricably tied to lifetime reproductive success. Links between morphological development and acquisition of foraging skills may be important components of baboon life histories. Therefore, the present analysis conducts ontogenetic comparative analyses of baboons and other papionin primates in order to evaluate correlations between behavioral and morphological development.

Analyses investigate brain, dental, and somatic development in baboons and other papionins. Data are derived from museum specimens and measurements of captive specimens, focusing on comparisons between *Papio* and *Cercocebus atys* (sooty mangabeys). These data are subjected to a variety of regression analyses.

Brain development in papionins is highly variable. Baboons reach relatively large adult brain sizes, but show high fetal brain growth rates, and appear to cease brain growth very early in the postnatal period. Other papionins may devote substantial portions of the postnatal developmental period to brain growth. Comparisons of dental and somatic development show distinctions in patterns of maturation among taxa. Comparative analyses suggest that early brain growth

in baboons may entail extraordinary maternal metabolic costs. These costs may be structured differently among papionins. Baboons partially offset these costs by deferring dental, reproductive, and body size maturation relative to other papionins. These results may reflect high investment in baboon offspring quality, with substantial maternal investment increasing an offspring's chances of attaining foraging proficiency at a very young age. The implications of these findings for primate life histories are discussed.

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**The effect of body mass variation on the locomotor dynamics of *Cheirogaleus medius* A natural experiment.**

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The fat-tailed dwarf lemur (*Cheirogaleus medius*) is unusual among primates in storing large amounts of fat in its tail prior to hibernation (Hladik et al., 1980). In doing so, this lemur augments its body mass by more than 50%. This seasonal increase in mass provides a unique opportunity to examine relationships between body mass variation and locomotor forces. As body mass increases, it is expected that the limbs will be subjected to greater forces during quadrupedal walking. Since most of the weight gain is caudal to the pelvic girdle, it is also expected that the weight borne by the hindlimbs will be greater than that of the forelimbs as body mass increases.

To test this hypothesis, we recorded substrate reaction forces on four adults of *C. medius* walking quadrupedally on a 28-mm pole attached to a force platform. Peak vertical substrate reaction forces ( $V_{pk}$ ) were analyzed using Peak Motus 2000 and compared for a range of body masses (180 g to 300 g) representing different stages of tail fatness. Forelimb and hindlimb  $V_{pk}$  were positively correlated with body mass ( $P < 0.001$ ), with hindlimbs  $V_{pk}$  always higher than forelimb  $V_{pk}$ . Also, the rate at which  $V_{pk}$  increased relative to body mass was significantly higher for the hindlimb than the forelimb ( $P < 0.05$ ). These relationships between seasonal variation in body mass and locomotor forces may explain the unusual variation in long bone strength parameters observed in cheirogaleids

compared to other prosimians (Demes and Jungers, 1993).

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### **Comparative energetics of human and primate locomotion.**

W.R. Leonard, M.L. Robertson. Dept. of Anthropology, Northwestern University.

There continues to be much discussion about the potential importance of energetics to the evolution of human and primate locomotion. Human bipedal walking is relatively economical compared to the locomotor costs for other animals of the same size, whereas human running appears to be relatively energetically expensive. Based on re-analyses of data presented by CR Taylor and colleagues, this paper examines the relative locomotor economy of human bipedal walking and quadrupedal movement of non-human primates in comparison to other animals. These analyses show that non-human primate species, as a group, expend relatively more energy for movement than an "average" animal of the same size. Of the 8 primate species that have been studied, 7 have locomotor energy costs higher than expected for an average animal of the same size, with the mean residual from the overall regression being between +0.60 to +0.80 standard deviation (SD) units ( $P < 0.05$ ). In contrast, human bipedal walking is relatively economical, falling 1.4 SD units below the overall regression. Non-human primates thus expend more energy on locomotion than an average animal, whereas human walking is quite economical. Differences in ecology and body composition between primates and other mammals are examined as potential correlates of the differences in energy costs of locomotion.

### **Regional variation in dental attrition rates of Chalcolithic populations in Israel.**

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In this study we compare dental wear rate and pattern between two Chalcolithic samples in Israel, one from the Judean desert (Wadi Makoch) and the other from the northern Galilee (Peqi'in). Dental wear is scored for mandibular molars using scales devised by Scott (1979), and standardized for age in each sample separately using subadult specimens in whom age could be assessed from tooth development and eruption. The dental wear

index shows that attrition rates are significantly higher in the Wadi Makoch sample for the nonparametric Kolmogorov-Smirnov test ( $p < 0.05$ ). Using the nonparametric one-way Kruskal-Wallis test, no significant differences have been observed between the groups in the slope of the occlusal plane, suggesting similar chewing patterns.

Archaeological evidence points to subsistence based on mixed farming in both populations and does not indicate any major adaptational differences between these geographical regions at that time. The increased dental attrition recorded for Wadi Makoch may have been caused by still unknown dietary differences, but is more likely due to the arid and sandy environmental conditions of the Judean desert. This hypothesis is supported by recent epidemiological studies carried out in Israel on living populations of known age which showed that despite similar dietary patterns attrition rates in Bedouins from the Negev were significantly higher than those of farmers dwelling in non-desert areas. This study stresses the importance of non-dietary factors in interpreting the significance of attrition scores, as well as the importance of assigning population specific attrition scores for age assessment in adults.

### **Sex differences in scent-marking in sifaka: Mating conflict or males services?**

R.J. Lewis. Dept. of Biological Anthropology and Anatomy, Duke University.

Male and female interests can either be in conflict or serve as a basis for exchange. Communication is thus an important aspect of intersexual relationships. White sifaka (*Propithecus verreauxi verreauxi*), like many prosimians, use chemical signals as one form of communication. The goals of this study were to determine (1) if males and females exhibit differences in their scent-marking behavior and (2) if scent-marking is an example of mating conflict or cooperation. All-occurrence of scent-marks, scent-mark context, and scent-mark style were collected on 23 sifaka in the Kirindy Forest of western Madagascar for 7 months (September 2001-March 2002). Scent-mark rates were collected using continuous focal animal sampling from November 2000-March 2002. Home range data were collected using monthly censuses and instantaneous focal sampling throughout the 17 months. Socioecological pressures seem to have shaped scent-marking in sifaka: the sexes exhibited significantly different scent-marking behavior. Fe-

males scent-mark to advertise their presence and mark their resources. Males could be divided into 2 groups (clean chests, stained chests). Clean-chested males use scent-marks as between group communication to advertise their presence, whereas stained-chested males use scent-marks as a form of olfactory mate guarding. Scent-marking cannot be a service that males provide to females because overmarking limits female communication rather than adding to the overall number of scent-marks. Scent-mark behavior is a crucial aspect of the mating conflict and for understanding intersexual relationships in sifaka.

### **Quantitative analysis of femoral neck shape and loading environment in robust australopithecines.**

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Robust australopithecines (*Australopithecus robustus* and *A. boisei*) have been characterized as having anteroposteriorly compressed femoral necks when compared to primates in general, and to other hominids in particular. The degree of this anteroposterior compression, however, has never been quantified. To remedy this deficit, we determined the cross-sectional aspect ratios of the femoral necks of fossil hominids, as well as those of eight extant human femora. Cross-sectional properties (such as area moment of inertia) are also evaluated and used with estimates of body mass in order to examine the loading environments to which these hominids were exposed. Cross-sectional properties can inform about the loading environment that the individual experienced, as well as the typical environment seen by the species, because bones respond to applied load (by increasing bone concentration in areas of high load) and are shaped through natural selection. Our data show two trends in hominid evolution: substantial anteroposterior compression of the femoral neck and less intense loading environments in the robust australopithecine lineage, and limited anteroposterior compression of the femoral neck and more intense loading environments in *A. afarensis* and *Homo*. The results may indicate that the morphology of the robust australopithecine femoral neck is a character with functional significance, and that additional study of the proximal femur of robust australopithecines is necessary to understand the locomotor behavior of these species.

**Comparing Neanderthal and modern human long bone loading history from cross-sectional geometry.**

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We evaluate here efforts to compare archaic and modern human limb loading from long bone cross sections. Recent studies find that cross sectional properties ( $I$ ,  $J$ ,  $Z$ ) calculated from second moments of area (SMA) are similar in Neanderthals and early modern humans when adjusted for body mass and limb length, but differ in cross-sectional shape (e.g.,  $I_x/I_y$ ). These results suggest the two taxa had similar magnitudes but different patterns of locomotor loading. Such interpretations, however, assume that long bones are deformed like long, straight beams in pure bending, with neutral axes (NA) that run through the cross-sectional area centroids. We test this assumption experimentally using exercised sheep with rosette strain gauges mounted at three locations around the midshaft of the tibia and metatarsal. Calculation of normal strain distributions at the midshaft indicate that the NA does not run through the area centroid, largely because of the combined effects of bending and compression. In addition, orientation of the centroidal axes around which maximum SMAs ( $I_{max}$ ) are calculated are unrelated to the planes in which the bones bend. Because SMAs are fourth-power functions, cross-sectional properties that assume the NA runs through the area centroid yield substantial errors in magnitude (up to 100%) compared to cross-sectional properties calculated around experimentally-determined NAs. The polar moment of area,  $J$ , is least subject to error. Applying these analyses to the hominid fossil record indicates that SMAs neither support nor refute the hypothesis that Neanderthals and early modern humans had different magnitudes or patterns of loading.

**Declining fitness of race in the American Journal of Physical Anthropology: 1918-1996.**

L. Lieberman. Central Michigan University.

Fitness, defined as the frequency of papers using the race concept in successive years of the American Journal of Physical Anthropology (AJPA), declines from 1918 to 1996. Criteria developed by Cartmill were modified and odd number

years were examined (plus 1918 and 1996). The frequency of the use of the race concept by 50 percent or more of articles per year declined in three periods: 1918-1931: 88%; 1933-1963: 63%; 1965-1996: 24%. Also compared were the number of papers using race as a percent of the number of members in the American Association of Physical Anthropology, indicating an even sharper decline. The social and scientific context as well as alternative interpretations are discussed.

**Human social issues, disease, and sympatric apes in the Central African Republic.**

A.A. Lilly. Dian Fossey Gorilla Fund International, Kigali, Rwanda.

The Central African Republic is a country of 3.5 million people in an area of 650,00 square kilometers, making it one of the least populated countries in Africa. However, the fragmentation of the population and the underdevelopment of the infrastructure have led to isolated pockets of dense human habitation and lack of basic medical care. In 1997, a project was started in the southwest region of the country to monitor intestinal parasites in the great apes and the local people. The southwest region includes part of the Dzanga-Ndoki National Park and the Dzanga-Sangha Reserve. Around the Reserve are several villages comprised of Bantu agriculturalists and Ba'Aka hunter-gatherers and a logging concession. Unemployment, malnutrition and disease, especially for the Ba'Aka, are common. The Ba'Aka and Bantu villages are frequented by gorillas and chimpanzees foraging for fruit and other commodities. Data collected during the project suggest that the Ba'Aka are carrying higher prevalences of intestinal parasite species than the Bantu; gorillas and chimpanzees living deep within the Dzanga-Ndoki National Park are carrying lower prevalences of intestinal parasite species than the groups living in proximity to the human villages; and around one village in particular, gorillas, chimpanzees and Ba'Aka are infected with a protozoal parasite in the invasive stage. Potential reasons for these differences will be discussed, as well as possible solutions to the problems of: 1) cross-transmission of pathogens between humans and apes; and 2) lack of health care in local people living in proximity to endangered species of apes.

**Ancient DNA study of the San-Pao-Chu site, Tainan, Taiwan.**

H-M. Lin, A.C. Stone. Dept. of Anthropology, University of New Mexico.

In the South Pacific, modern populations are culturally, linguistically, and biologically variable. Many attribute this to the fact that more than one migration occurred during the colonization of Oceania. Archaeological, linguistic, morphological, and molecular evidence have been used to suggest that Austronesian-speaking peoples originated from either Southeast Asian Islands, including Taiwan, or further east; however, the ancestral homeland of Austronesian-speaking populations still remains unknown.

To address this question, we are examining ancient DNA (aDNA), specifically the 9 base-pair deletion and the Hae III restriction site of mitochondrial DNA, from skeletal remains from the prehistoric Taiwanese archaeological site, San-Pao-Chu (SPC), dated to the Late Neolithic period (2,500-3,000 BP). The SPC site was chosen because it has a large skeletal sample and it dates approximately to the time of the initial colonization of Oceania.

Preliminary results have been obtained from nine human skeletal samples. Of nine samples tested for the 9bp deletion, seven (77.8%) amplified successfully and none has the deletion. Of four individuals tested for the Hae III site, two were successfully amplified and neither has the restriction site. This preliminary examination of remains from the archaeological site of SPC suggests that DNA preservation is sufficient to conduct a larger aDNA analysis. The results of this research will considerably enhance the body of knowledge regarding the peopling of Oceania. It can also offer information to evaluate the SPC within-site social organizations. Moreover, it may contribute data to estimate the population structure during the initial population expansion.

**3D data acquisition using Tuned-Aperture Computed Tomography, TACT(r).**

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Tuned-aperture computed tomography, TACT(r), is a method for extracting 3D information from sets of 2D images. Developed originally for use in radiographic imaging, TACT uses known geometric

relationships between fiducial points in each image to co-register images to a common view and synthesizes a stack of slices that individually approximate a narrow focal plane at specific levels in the imaged volume. In practice, one can record x and y coordinates from the imaging plane to which images are co-registered and the z coordinate from the height above the plane at which a feature of interest comes into focus in the synthesized slices. When applied to optical images, the method could be a flexible and cost-effective tool for 3D digitizing.

Such a system would address many of the shortcomings associated with dedicated 3D digitizing hardware. For instance, TACT resolution is limited only by the optical imaging system and the images provide an archive that admits future data collection without access to the original specimens. This poster provides a more detailed explanation of the geometry and mathematics underlying the technique and preliminary tests using skulls of cynomolgus macaques (*Macaca fascicularis*). The results show the precision of landmarks digitized in 3D using TACT are comparable to data collected by traditional methods. With further development, TACT-based software could provide a viable alternative to hardware solutions for 3D data acquisition and extend the opportunities for 3D morphometric analysis to many more students and researchers.

#### **Worldwide variation in tooth formation and eruption.**

H.M. Liversidge. Queen Mary's School of Medicine and Dentistry, University of London.

The aim of this study was to review published reports of tooth formation and eruption (excluding M3). The criteria for inclusion was the use of cumulative statistical methods. For clinical emergence this consisted of 27 studies of deciduous teeth and 75 of permanent teeth. Comparisons were made between regions: Europe and descendants, Africa and descendants, Asia and the Americas, Indo-Mediterranean and Australia/ Pacific Islanders. All results of deciduous teeth were less variable than permanent teeth. The median timing of emergence showed some variation between groups, with a few outliers for individual teeth but no clear pattern between regions. The timing of alveolar eruption of permanent teeth from three studies was compared. Data from longitudinal studies were similar and earlier than the cross-sectional study. Tooth formation data from two deciduous and seven permanent tooth reports were

compared. Small differences were noted in deciduous teeth, with some variation apparent in permanent teeth. Direct investigation of ethnic differences between groups for permanent teeth was available from six studies of clinical emergence and five of tooth formation. Children of African ancestry were 3 to 6 months advanced in emergence. Root formation of late forming teeth appears to differ relative to other teeth between groups. This review highlights the gaps in knowledge and suggests areas of future research.

#### **Morphological differentiation among great ape subspecies, as indicated by geometric morphometric analysis of temporal bones.**

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In recent years, systematic diversity among great apes has been investigated primarily from a genetic perspective, the main conclusion being that subspecies differentiation is pronounced. In some cases, these conclusions are consistent with observed morphological differences, while in others, genetically distinct populations do not appear to exhibit substantial morphological differences. To evaluate the fit between patterns of morphological and genetic differentiation, and to provide analogues for evaluating variation in fossil hominoid samples, we studied 3D landmark data from temporal bones of all commonly recognized great ape subspecies. Principal components analyses were conducted on residuals from generalized procrustes analysis of landmark data. These principal components were subsequently examined by the use of canonical variates and cluster analyses. Males and females were studied separately, because of shape dimorphism in most groups.

Results for either sex reveal levels of differentiation among great ape populations that correlate closely with genetic distances and allow near-perfect discrimination of subspecies. The degree of difference between gorilla and orangutan subspecies is similar to or greater than the difference between chimpanzees and bonobos, a finding which contributes to evidence that *Gorilla* and *Pongo* contain multiple species. Differences among chimpanzee subspecies are less pronounced, with *Pan troglodytes verus* representing the most distinct group. This study highlights the power of geometric morphometrics in species-level taxonomy. Moreover, it shows that, when studied

with consistent methods across hominoids, results from morphological data are consistent with levels of differentiation indicated by genetics.

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#### **Analysis of DNA sequences under unequal evolutionary rates.**

J.C. Long<sup>1</sup>, K. Hunley<sup>1</sup>, R.A. Kittles<sup>2</sup>. <sup>1</sup>University of Michigan, <sup>2</sup>Howard University.

Genetic diversity is measurable by the probability that two randomly chosen copies of a locus will differ, and the number of nucleotide differences between them. Many simple statistics for measuring genetic diversity, such as *F<sub>st</sub>*, are of limited value because: (1) they confound demographic and mutational processes by ignoring the total number of mutational differences between two sequences, and (2) they are biased by invalid assumptions, such as all populations have the same effective size and are evolutionarily independent. Following the work of Excoffier (Genetics, 131:479) and Urbanek (MBE, 13: 943), this paper provides a linear statistical model and estimation procedure that unifies the probability that two copies of the locus will differ with the number of differences between them. It allows for differences in effective size and hierarchical structure.

The method is demonstrated by performing an analysis to reveal the relative importance of population hierarchy, unequal effective population sizes, and mutational differences. A sample (N=1676) of mtDNA D-loop sequences drawn from 21 populations with worldwide distribution was used. First, each morph was treated as a unique allele and standard F-statistics were computed. This failed for all population structure models because mtDNA morphs are too variable within groups to reveal patterns of variation between groups. Next, analyses were conducted by incorporating the number of nucleotide differences separating mtDNA morphs. These analyses demonstrate important variability both within and between groups. However, very different patterns of population relationships emerge by making different assumptions about effective sizes within and between groups.

#### **Early *Homo* remains from Georgia (Southern Caucasus).**

D. Lordkipanidze. Georgian State Museum, Tbilisi.

The site of Dmanisi (Southern Caucasus, Republic of Georgia) brings new evidence and opportunities to address several critical questions concerning the earliest human dispersal out of Africa. The paleontological, archeological, geochronological, and paleomagnetic data from Dmanisi all indicate a Pleistocene age of about 1.7–1.8 MYA. The skeletal remains from Dmanisi thus represent the oldest undisputed hominid remains outside Africa. The hominid sample is now represented by six cranial remains: three crania and three mandibles, accompanied by rich faunal collections and simple stone tools. The Dmanisi fossils are the first hominid remains discovered outside of Africa to show clear affinities to Early African *Homo* rather than to a typical Asian *H. erectus* or any of the Lower-Middle Pleistocene European hominids. This is the first good physical evidence we have for the identity of the initial emigrants out of Africa as the Dmanisi finds expand the known geographic range of the African *Homo*. Thus morphologically and temporally these fossils seem to represent the “missing link” connecting Africa, Asia and Europe.

**Dispersal, philopatry, or something in-between? Behavioral patterns and dominance relationships amongst males in a population of semi-free ranging long-tailed macaques (*Macaca fascicularis*) at the Padangtegal Wanara Wana in Ubud, Bali, Indonesia.**

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Over a five year period we recorded adult male social behavior, dominance hierarchies, and dispersal patterns in a population of semi-free ranging long-tailed macaques (*Macaca fascicularis*) at the Padangtegal Wanara Wana in Ubud, Bali, Indonesia. This population is comprised of three multi-male, multi-female groups and ranged in size from 139 to 204 individuals. A total of 21 adult males were followed, with eight being present, as adults, for the entire study period.

Here we present data on adult male behavior patterns and the relationship between status and access to contested resources and activity budgets. Adult males varied in their behavior patterns and activity budgets across rank and group and within rank and group. Adult males in high rank positions also varied significantly in their frequencies of ob-

served copulations and their patterns of aggression towards females. A majority of the males do not leave this population at subadulthood resulting in a high number of subadult and adult males (currently exceeding 15% of the overall population) and increasing the frequency of male-male fighting. Adult males do shift to neighboring groups, possibly to increase their access to contested resources and/or decrease their level of received aggression. Over the five years, two adult males died from wounds received and one died of old age. Two adult males successfully immigrated into the population and at least five emigrated out of it. Our results suggest that in a semi-free ranging environment male macaques exploit both philopatric and dispersal strategies with varied results.

**Iron deficiency in infancy: A rhesus monkey model.**

G.R. Lubach, C.L. Coe. Harlow Primate Laboratory, University of Wisconsin, Madison.

Iron deficiency anemia (IDA) is still prevalent in many parts of the world. IDA continues to affect 30-80% of infants worldwide, and low iron levels have been linked to cognitive deficits in older children. Previously, we undertook a pilot study with iron-deficient and iron-sufficient multiparous rhesus females, to investigate a possible cause of IDA. Iron status was monitored during pregnancy, and through 6 months post-partum. The infants were similarly assessed through 6 months of age. At parturition, serum ferritin levels were significantly different ( $p < .0005$ ) in the two groups of females. Infant ferritin and iron levels reflected the iron status of the mother. In addition, the hematologic status of the infants over the first 6 months of life was a reflection of their iron stores at birth. We have continued this research with additional subjects, some of which are now over one-year of age, and we have increased our experimental measures. Birth ferritin levels are still predictive of the later iron status of the infants. Iron levels in cerebrospinal fluid, as well as serum levels, may reflect brain development. We are assessing the infants with auditory and somatosensory evoked potentials to test this. In addition, cognitive studies are being conducted when the infants are between 8-18 months of age. Our preliminary data are in line with our previous pilot study. The new measures, though still being analyzed, are providing additional evidence for the importance of adequate iron in early infancy.

**Dental morphometrics of Early Holocene India: A comparison of Indus and Ganga Valley samples.**

J.R. Lukacs. Dept. of Anthropology, University of Oregon.

The Indo-Gangetic Plains of India provide two early-mid Holocene samples: Neolithic Mehrgarh (MR3; Baluchistan, Pakistan) in the Indus Valley and the Mesolithic Lake Culture Complex (MLC; Uttar Pradesh, India) in the middle Ganga Valley. Dental morphometrics of MLC sites (Damdama, Mahadaha, and Sarai Nahar Rai) in the middle Ganga Valley are described and compared with contemporary samples from Mehrgarh to answer questions of population affinity and biological adaptation. Do the Indus and Ganga Valley samples represent distinct genetically isolated populations? In dental dimensions, how do the MR3 and MLC samples compare? Standardized protocols for classification of dental morphology (Turner et al., 1991) and measurement of crown dimensions (Kieser, 1990) were followed.

Tooth size at Mehrgarh (1258 mm<sup>2</sup>) is significantly smaller than the value for Lake Culture sites (1365 mm<sup>2</sup>). The 107 mm<sup>2</sup> difference (7.8%) in total crown area may reflect differences in subsistence and food preparation. Apportionment of dental size across tooth classes reveals greater differences in anterior (I-C) than in posterior teeth (P3-M3). MR3 and MLC samples displayed similar trait frequencies for UI1 and UI2 shoveling, UI2 interruption groove, LM2 Y-groove pattern, accessory cusps (C-6, C-7), yet exhibited differences in UC shovel, UM1 Carabelli trait, UM1 and UM2 metaconule, UI and UC *tuberculum dentale*, and five cusped LM2. These variations are compared with other prehistoric South Asian samples.

**“Give us your tired, your poor”... An analysis of postmortem medical use of underprivileged individuals from the Albany County Almshouse skeletal sample.**

K.A. Lusignan. Dept. of Anthropology, University at Albany, SUNY.

During the 19th and early 20th centuries, the socially and economically underprivileged were used as a source of medical research. Preliminary skeletal analysis from the Albany Almshouse Cemetery (1826-1926) yielded individuals with cranial and post-cranial cutmarks, indicating postmortem medical procedures performed by the Albany Medical College. Analysis of these individuals provides

insight into the social and historical aspects of medical research on the poor.

Thirty-five individuals possess cuts either to the crania and/or to long bones, comprising 7.7% of observable individuals (n= 451). The skeletal ages of individuals range from 8 to 50+ with the majority (31.4%) in the 30-40 age group. Many cranial cuts are V-shaped, running vertically through the frontal bone and horizontally through the occipital, indicating removal of the brain during autopsy. Postcranial cuts are varied, but commonly consist of transverse cuts of long bones. Twenty-three of 239 males (9.6%) exhibit postmortem cutmarks, with three having cutmarks only on the postcrania. Ten of 155 females (6.4%) exhibit cranial cutmarks, three of which have additional cuts on the postcranial skeleton.

Archaeological, osteological, and historical analyses on the individuals provide an understanding of medical autopsy practices of that time. Analyses of sex, age, ancestry, trauma, and infection on the skeletal collection yield no significant reasons as to why these individuals were chosen for autopsy, aside from the fact that they were from the underprivileged class of Albany County.

#### **Whose life is it anyway? Maternal investment and life history strategies in baboons.**

J.E. Lycett. L. Barrett. University of Liverpool.

Female mammals' reproductive success is primarily constrained by access to resources, which limits both the rate at which offspring can be produced and the level of investment that can be provided to each offspring. Consequently, any factors that affect a female's ability to acquire resources will have very significant effects on reproductive behaviour and life history patterns. In group-living species, like baboons, these differences in female life-history parameters and maternal investment patterns have significant knock-on effects for the future demographic structure of the group and, consequently, on the social behaviour displayed. Here, we use data on maternal investment levels, inter-birth intervals and mortality rates from two populations of chacma baboons living under different ecological conditions to demonstrate how differences in individual female quality can produce different life-history patterns and behaviour even though females may be following the same overall reproductive strategy.

#### ***Australopithecus* or *Paranthropus*: "Robust" australopithecine taxonomy based on analogy.**

P.J. Macaluso Jr. Dept. of Anthropology, Binghamton University (SUNY).

The taxonomic status of the "robust" australopithecines is evaluated by use of analogy. It is argued that if the australopithecines, treated collectively, do not display significantly greater variation in their morphology and ecology than do species of *Macaca* then generic separation of the "robust" species as *Paranthropus* is not warranted.

To assess the morphological variation present within the australopithecines and modern monkeys, 24 craniofacial, mandibular, and dental measurements are compared using Coefficient of Variation (CV). A Wilcoxon two-sample test is used in conjunction with the CV to determine whether the null hypothesis is supported. The modified FK weighted scores test is applied to determine if the degree of relative variation in the fossils is significantly greater than in the reference sample. Also, four observations describing the formation of cranial suprastructures are recorded and compared for the two samples. In addition to the morphological evidence, the ecological or dietary adaptations of both genera are considered. The evidence for "robust" australopithecine monophyly, which is essential for generic status, is reviewed as well.

Results of the Wilcoxon test, FK test, cranial observations, and ecological comparison fail to reject the null hypothesis and demonstrate that modern species of macaques, which are not separated at the generic level, display an equivalent if not greater degree of variation in their morphology and ecology than do the australopithecines. Therefore, even though monophyly is the most likely explanation for the morphological similarities of the "robust" species, generic distinction is not warranted. The "robust" australopithecines should be classified as *Australopithecus*.

#### **Behavioral interactions between small juvenile and adult male white-faced capuchin monkeys (*Cebus capucinus*) in Costa Rica.**

K.C. MacKinnon. Saint Louis University.

This paper examines the broad range of behavioral interactions between small juvenile and adult male white-faced capuchin monkeys (*Cebus capucinus*) in northwestern Costa Rica. I report findings from an 11-month study carried out

in the Area de Conservación Guanacaste. Data were collected on two habituated groups of capuchins using a variety of sampling techniques.

Small juveniles spent approximately 35% percent of their overall time budgets engaged in social behaviors, and up to 10% of their time interacting with certain adult males. The vast majority of interactions I observed between juveniles and adult males were affiliative in nature. The clear trend that emerges from the small juvenile and adult male interactions in this study is that juveniles favor strongly the alpha male. Within the adult male age-class, several behaviors (e.g. "watch") were performed exclusively towards the alpha male when small juveniles were the actors during focal sampling. Although the alpha male received the majority of attention overall, individual variation will also be discussed. Play, although infrequent, did occur between juveniles and adult males, and agonistic behaviors were rare.

Small juvenile interactions with adult males occur across a wide variety of contexts. Possible reasons for social interactions between these age/sex classes are plural and not mutually exclusive. Kin recognition is not the primary reason for such interactions (i.e. genetic relatedness, or lack of it, doesn't adequately explain certain behavioral patterns). Adult male dominance rank and the juvenile's familiarity with certain adult males are likely more important in the formation of such relationships.

#### **Patterns of surface shape in great ape endocasts.**

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Virtual endocasts of chimpanzees, orangutans, and bonobos were deformed to the shape of a modern human reference endocast and to each other using a voxel-based elastic deformation procedure in order to detect the regions of the surface of the brain that differ most markedly. All endocast volumes were normalized, and regions that had to contract or expand to meet the reference shape were colour coded according to degree of voxel deformation.

In all three great ape endocasts the orbito-frontal cortex and the ventral parafloccular lobules (tonsils) of the cerebellum must increase in order to conform to the modern human shape. However, each genus shows a particular pattern when

warped to the modern human endocast, implying that each genus underwent its own brain shape evolution, however modest. Chimpanzees and orangutans are more similarly patterned to each other in their warps to humans than are bonobos, which appear closest to the modern human pattern of the three. The right and left hemispheres show differences when the three genera are compared, with particular asymmetries in ape surface shapes.

These deformation fields add the dimension of shape to the understanding of the evolution of the brain in the great ape genera. The regions of the cerebral and cerebellar surface that diverge from the reference endocast can be correlated with functional anatomical maps, and hypotheses generated as to the meaning of these shape differences.

#### **Across-cultural study of consanguinity dispensations.**

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The institution of marriage is of interest to biological anthropology in part because it impacts population structure. Marriage rules to some extent determine the level of consanguinity in a population. Here we test the hypothesis that Catholic Church marriage rules were applied in the same manner cross-culturally. We compare data collected in Escazú Costa Rica (1800-1900) with data from other Catholic communities. The sources are not cited for space considerations.

In Escazú from 1800-1900 there were 2,071 marriages, of which 227 included a dispensation. Of these 227, 167 involve consanguinity. The types of consanguineous dispensations were: C12= 1 (0.006%), C22=35 (0.21%), C33=34 (0.2%), C44=31 (0.185%), C23=34 (0.2%) and C34=32 (0.19). Excluding the one uncle-niece (C12) mating, the frequencies of the other types were not significantly different, indicating that no specific type of cousin marriage was favored ( $X^2 = 0.32$ ,  $df=4$ ,  $p>0.05$ ). These frequencies contrast sharply with those reported in Spain during roughly the same time period, which show a preference for first cousin mating and a high frequency of niece-niece marriages (Calderón et al., 1993). Other reports in Spain collected during the latter part of this time frame demonstrate a clear preference for C12 marriages.

Although the Catholic Church passed laws governing the levels of consanguinity that required dispensations, and these laws were in principle universal, a cross-

cultural study of dispensations indicates that the laws were not applied uniformly. The data indicate that local cultural practices were more important impacting the mating patterns of different Catholic communities than were Church-proclaimed guidelines.

#### **Assessment of trabecular architecture parameters of catarrhine calcani using high resolution microCT scanning.**

M. Maga, J. Kappelman. Dept. of Anthropology, University of Texas at Austin.

Trabecular bone is a complex biomaterial with substantial heterogeneity and anisotropy, consisting of meshwork of plate and rodlike structures. Current understanding suggests that the alignment of these structures and biomechanical parameters conform to the principle mechanical loads acting on the bone. Coupled with ever-increasing computing power, microCT scanning provides new opportunities for investigating trabecular architecture. Here we undertake a comparison of trabecular architecture in the calcaneus of male chimpanzees, humans, and baboons, which encompass a wide range of locomotor behaviors.

During the scanning process, the calcaneus is coronally scanned along the long axis. From each specimen at least one stack of images from the posterior aspect of the calcaneus is acquired. In addition to posterior, central and anterior stacks are also extracted from selected specimens. The scans produced images with slice thickness of 0.050 millimeters, and inline pixel resolution of 0.043 millimeters. The number of serial slices in each stack varied from 150 to 171 depending upon the length of the specimen. A region of interest (ROI) is defined by maximizing the overlapping area on the most posterior and anterior slice in each stack. Then, the exact ROI is extracted from each slice within the stack. For the chimpanzee, these settings produced trabecular cubes between 7.5-8.5 mm in each dimension. Trabecular parameters are calculated using in-house software (QUANT3D), which employed the star volume distribution method. Initial results of the posterior cubes from male chimpanzees indicate a strong primary material orientation of trabeculae from superoposterior to inferoanterior direction.

#### **Lives forgotten; Morbidity and mortality in the late 19<sup>th</sup> Century Colorado Insane Asylum.**

A.L. Magennis. Colorado State University.

Burials exhumed from an unmarked cemetery associated with the original Colorado Insane Asylum in Pueblo, Colorado offer the opportunity to integrate information from historic documents, archaeology, and human skeletal remains. Excavations in 1992 yielded 135 burials and an additional 31 individuals were exhumed in 2000. Historical documents and artifacts indicate that the cemetery was used between 1879 and 1898. Records summarizing patient admission-discharge beginning in 1879 until 1900 paint a picture of those nearly 2000 people sent to the asylum. Residents were poor laborers, miners, farmers, and domestics, a third of whom were immigrants. They were admitted to the institution for a variety of conditions including, among others, intemperance, ill-health, syphilis, or epilepsy. Most of the listed conditions would leave no skeletal trace.

Admission records indicate that 506 individuals died at the institution during this time period. The majority were male (78%), although this is only a slightly higher proportion than the male population of Colorado in 1880. The demographic profile of the cemetery sample mirrors that of the admission records except in the oldest two decades. Of the 31 individuals exhumed in 2000, contrary to expectation there is little skeletal evidence of infectious disease, although Hoffman (2002) reports that nearly 50% of the sample excavated in 1992 does. Traumatic injury is common, and at least partly reflects a life of manual labor as well as interpersonal violence; however, harsh treatment while at the asylum cannot be ruled out.

#### **Ancient antibiotics: Tetracycline in human and animal bone from the Dakhleh Oasis, Egypt.**

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Two decades ago, archaeologists in northern Africa discovered evidence that an antibiotic was somehow included in diet of ancient peoples, possibly affecting the health of the population. In addition to its bacteriocidal effects, Tetracycline has been shown to limit bone formation *in utero* and to hinder bone resorption due to degenerative disease. It has been proposed that the causative organisms are

*Streptomyces aureofaciens* - ubiquitous, mold-like, tetracycline-producing bacteria that could have contaminated grain products. Upon consumption, tetracyclines are incorporated into developing or remodeling bone, remaining observable under ultraviolet light for thousands of years. The current project focuses on an analysis of Roman-Egyptian human and animal bone from the Dakhleh Oasis in southwestern Egypt (100 BC to AD 360). Confocal Laser Scanning Microscopy (CLSM) is used to determine whether or not the population had been exposed to antibiotics, taking advantage of tetracycline's natural fluorescent properties. Results show that, though nearly every sample shows fluorescence as described in previous literature, bone from the Kellis 1 and Kellis 2 cemeteries display distinct differences in fluorescent patterning. CLSM allows three-dimensional viewing and high-resolution imaging, lending new perspective and increased accuracy to the analysis. Further investigation could have implications that overflow their archaeological context due to the multiple uses modern science has for tetracycline therapy.

**Human dental microwear during the development from a hunter-gatherer to an agricultural economy in northern Israel.**

P. Mahoney. Research School for Archaeological Science, University of Sheffield.

The hunter-gatherer to agricultural development in Israel is arguably one of the most heavily researched prehistoric dietary developments. Yet, much that is known about human diet during this period has been inferred from archaeological and environmental evidence. This evidence has provided insights into the food that was available for consumption, and not necessarily the food that was consumed. This study investigated the microscopic marks on prehistoric human dental tissue from the period of dietary development. These marks are a permanent record of what was actually consumed. Microwear analyses may therefore contribute further insights into the dietary adaptation.

Dental microwear was investigated in hunter-gatherers (Natufian) and agriculturalists (Neolithic) from northern Israel. Dental microwear at the bottom of facet 9 on the 2nd mandibular molar (n=60) was examined with a Scanning Electron Microscope at 500x. Several significant differences were detected between the hunter-gatherers and agriculturalists. The agriculturalists had significantly

larger dental pits, based on length ( $t(60) = -2.032, p = 0.047$ ) and width ( $t(60) = -2.502, p = 0.016$ ) measurements. Discriminant Function Analyses also indicated that the increasing frequency and width of dental scratches were important predictors ( $x^2(2) = 14.577, p = 0.001$ ) for separating the agriculturalists from the hunter-gatherers. The dental microwear pattern may indicate that the development from a hunter-gatherer to an agricultural economy in northern Israel led to an increase in the consumption of hard and abrasive objects, and a corresponding decrease in the amount of tooth-on-tooth wear during mastication.

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**Test for selection on *ALDH2* in a Southeast Asian population.**

R.S. Malhi, K. Hunley, J.C. Long. University of Michigan Medical School.

*Aldehyde dehydrogenase 2* (*ALDH2*) and *alcohol dehydrogenase 1B* (*ADH1B*) are involved in multiple biochemical pathways in humans, including ethanol and Vitamin A metabolism pathways. The *ALDH2\*2* and *ADH1B\*2* alleles are absent in most populations worldwide, except in Southeast Asia, where populations exhibit these alleles in unusually high frequencies (>30%). Researchers have attributed this peculiar distribution of *ADH1B* and *ALDH2* alleles to the effects of natural selection. However, the effect of these alleles in the ethanol metabolism pathway is an increase in the concentration of acetaldehyde in the body. This increased concentration of acetaldehyde produces an unpleasant physiological response and the evolutionary benefit of such a high concentration of this chemical in the body is unclear. In addition, *ALDH2\*2* is a recessive allele and should only be under selective pressure in the homozygous state. In this study, we sequenced over 5000 base pairs of *ALDH1* and *ALDH2* of two chimpanzees. We apply the HKA test for natural selection to Japanese and chimpanzee *ALDH1* and *ALDH2* DNA sequence data since these sequences diverged from a common ancestor.

**The palaeoenvironmental interpretation of the Plio-Pleistocene locality of Gatarakwa, Central Kenya, and its significance in understanding hominid evolution.**

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Fossil fauna recovered from Plio-Pleistocene deposits at Gatarakwa in Central Kenya during preliminary fieldwork in April, 1999, offers new evidence of highland occupation by species like *Nyanzachoerus* cf. *kanamensis*, Gomphotheriidae (*Anancus* cf. *kenyensis*), Rhinocerotidae (*Diceros* sp.), Denotheriidae, Rodentia, Bovidae and other large mammals. The short tooth crowns in the proboscideans and *Diceros* sp. indicate browsing as opposed to grazing as a way of food procurement. These findings suggest the presence of a closed habitat, but not necessarily dense forest.

Gatarakwa is also the first site with palaeontological significance known beyond the Rift valley system in East Africa. The presence of *Nyanzachoerus* sp. suggests an age of 52 Ma for the site. This time period is known for high diversity of hominin genera and species. Sites of similar age range are known at Lothagam, Kanapoi, Chemeron, Kanam East, Omo Mursi Formation, lower Kaiso Formation and the Sangatole Formation of the Middle Awash. All these sites have yielded similar fauna including hominids.

The vertebrate fauna from Gatarakwa points to a highland adaptation for several species. This evidence makes it likely that hominins were also present outside the Rift valley and may support the fact that our ancestors, like other mammals forming the Gatarakwa ecosystem were also closed habitat - highland dwellers, and not restricted to the more open African savanna. A recently discovered hominid from Chad, Central Africa also supports an extra-Rift valley distribution of hominins. Gatarakwa may soon offer the first test for determining whether hominins lived beyond the rift system even in East Africa.

**Geometric morphometric analysis of the human burial series from Niah Cave, Borneo.**

J. Manser. New York University, NYCEP.

The human burial series from the West Mouth of Niah Cave provides a unique osteological sample from island Southeast Asia that spans the terminal Pleistocene and Holocene. The biological affinities of the inhabitants of this cave site, as well as of neighboring sites, are important to understanding later stage modern human population movements through this region. This study looks at coordinate data in 3-dimensions for 350 specimens from 20 recent Asian, Melanesian, Micronesian, Polynesian and Australian human populations and the West Mouth sample. The 15 landmarks examined are standard

anatomical landmarks of the human cranium with the facial skeleton as the primary focus. Specimens are superimposed using the generalized least-squares Procrustes superimposition method in GRF-ND. The aligned coordinates of the resulting superimposed specimens are analyzed by PCA and ANOVA with Bonferroni adjustment in order to look at group distinctiveness.

Preliminary results indicate group differences on PC1 between the West Mouth sample and Australian, Polynesian, and Melanesian samples. The landmarks loading most heavily on this PC are related to facial height and upper facial projection. The West Mouth sample is separated from the Australian and Tasmanian groups on PC2 and PC3 with lateral mid-facial and medial mid-facial landmarks affecting each PC respectively. These results demonstrate how geometric morphometrics can be used effectively to study incomplete specimens, to describe craniofacial shape variation and to explore the biological affinities of an archaeological sample with recent human populations.

**Europeans at the Early-to-Middle Pleistocene boundary and their role in assembling a scenario for the subsequent evolution of the Genus *Homo*.**

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The boundary between the Early and Middle Pleistocene (ca. 780 kyr BP) represents a frontier in contemporary paleoanthropology. Events and processes occurring at this time are crucial to our understanding of the evolution of the genus *Homo* throughout the remainder of the Pleistocene. At the present time, the best candidates to represent the ancestry of subsequent Europeans, and more unexpectedly for Africans as well, are found in Europe. This fossil evidence derives from both Italy (Ceprano) and Spain (Atapuerca TD6), and independent sources of data indicate affinities between this material and African Middle Pleistocene hominines and/or modern humans (*H. sapiens*). It is puzzling that these affinities are closer to the Africans than to European Middle-to-Late Pleistocene hominines (including Neandertals). This paper examines cranial data from a phenetic perspective with the goals of recognizing affinities between individual specimens, identifying possible taxa, and reconstructing a plausible phylogenetic

interpretation. The data demonstrate that a distinction between African specimens often assigned to *H. ergaster* and the Far Eastern representatives of *H. erectus* does exist and that Middle Pleistocene hominines from Africa and Europe, attributed by some scholars to *H. heidelbergensis*, are actually phenetically distinct. The possibility of the existence of more than one single Afro-European species during the late Early and Middle Pleistocene is also considered.

**The Chimpanzee Cultures Website: An online tool for research and teaching**

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In 1999, Whiten et al. (*Nature*, 399:682-685) published comparative analyses of 65 behavioral patterns from 7 African field sites. In 2001, this database was expanded to 9 sites (Whiten et al., *Behaviour*, 138: 1481-1516). These are the published products of a research collaboration, the Chimpanzee Cultures Project, which includes all long-term studies of wild chimpanzees as studied by African, American, Asian and European researchers. However, the first stage of CCP barely scratches the surface, as data from over 40 sites have been collected and need collating. The Chimpanzee Cultures Website seeks to do so, and is the only such resource based on primary data. It can be found at <http://culture.st-and.ac.uk/chimp>

The collective database is huge, and so affords the potential for ethnological analyses. Key aspects of the Chimpanzee Cultures Website include: Behavior Definition and Distribution (presence and extent, by pattern and site), Behavior Example (text and images, from drawings to video, by pattern), Study Location and Site Report (biotic and abiotic characteristics, by site), Graphical Display (dynamically generated matrix display of pattern distribution across Africa), Active Cross-Referencing (interconnections of all the above). Thus, one can ask such questions as: In how many populations is leaf grooming customary? Are West African chimpanzees culturally different from East African ones? Is the grooming-hand-clasp similar in details of performance at Mahale (Tanzania) versus Kibale (Uganda)?

The Chimpanzee Cultures Website is supported by the Centre for Social Learning and Cognitive Evolution at the Uni-

versity of St. Andrews, Scotland. Expanding and extending it is an ongoing project.

**Stunting and obesity in the land of plenty: Children of migrant laborers in New Jersey.**

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To examine growth and development in a cross-sectional sample of the children of migrant Hispanic agricultural workers in southern New Jersey (N=525), their BMI/age and height/age were compared with the NHANES III. Of the sample, 10.5% were found to be stunted, 22.8% were classified as "at risk of overweight," and 22.3% were overweight, exceeding the frequency of these conditions both in the general U.S. population and among settled Mexican Americans. Additionally, boys were more likely than girls to be stunted ( $p > X^2 = 0.0205$ ). Over the 6 years of the study, prevalence of overweight has climbed steadily while stunting has remained stubbornly the same.

Interviews with 52 families revealed that children left alone or cared for by several different caregivers were more likely to be stunted ( $p > X^2 = 0.0004$ ). Years of mother's education (mean: 6.0) were negatively correlated with their children's BMI for age ( $p < 0.0380$ ). The following were positively correlated with the likelihood of overweight: having a private kitchen ( $p > X^2 = 0.0306$ ), being cared for in parents' absence by a grandmother or aunt ( $p > X^2 = 0.0032$ ) and eating at fast food restaurants ( $p > X^2 = 0.0049$ ). As families migrated less frequently and children were enrolled in local schools, high-calorie additions to the diet occurred while cooking methods remained the same, dramatically increasing children's daily caloric intake. Of note was that children between the ages of 2 and 6 were as likely as older children to be overweight. This information has important implications for planned interventions to diminish the incidence of overweight and the subsequent risk for type 2 diabetes.

**Dynamics of molecular genetic diversity in the East Midlands, England.**

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The main aims of this investigation were 1) to establish the database of minisatellites (VNTRs), AMP-FLPs, microsatellites (STRs), and ALU Insertion allele frequencies for the regionally subdivided populations of the East Midlands, which is suitable for population genetic, forensic and evolutionary studies, 2) to determine if Caucasian sub-population heterogeneity exists within the UK, Europe and World Caucasian and racial populations at these loci and 3), whether settlement patterns of various continental European populations have left any detectable genetic imprints in the East Midlands populations. Blood samples (500) were collected at random from the five Caucasian East Midlands populations. We analysed the variation at MS1, MS31, YNH24, MS43a, D1S80, APO-B, and YNZ22 VNTR; HUMTHO1, F13A, F13B, FES, LPL, VWA31 and CSF1PO STRs; and ACE, TPA, D1, PV92, APO and FXIIB Alu polymorphisms. While overall pattern of allelic distribution was within the ranges observed for Caucasian populations. We observed significant inter-population/regional differences for a number of loci. As expected the heterozygosity levels for DNA loci were much higher than conventional blood groups. The  $F_{ST}$  values were also higher for DNA loci (average 0.018) compared to blood groups and serum proteins (0.005). The implications of observed genetic diversity in urban contemporary populations are evaluated in the light of settlement patterns of continental European populations. The Caucasian population heterogeneity and its implications for disease mapping, forensic and paternity investigations are presented to evaluate the effectiveness of these markers.

#### **An analysis of lorisid phylogeny using morphological and molecular data.**

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Evolutionary relationships among the four or five lorisid genera have been the subject of contention for some time. The family has alternately been described as polyphyletic (whereby the African and Asian taxa developed their shared specializations independently, and one or other group is more closely related to the

galagids) and monophyletic, wherein virtually all conceivable relationships among taxa have been proposed at some time. In this study we analyzed a morphological data set comprising 36 craniodental characters as well as a molecular data set made up of approximately 400 bp of the 12S rRNA gene, both separately and in combination. Outgroups included two galago taxa and the gray mouse lemur. The morphological and molecular data sets proved to be significantly incompatible, indicating that combining them was not advisable. When they were combined, they yielded the same result as did the molecular data alone. Using the combined or molecular data sets and including all three outgroups, the African lorises grouped with the galagos to the exclusion of the Asian lorises. When only the galagos were included, a lorisid clade was recovered. The morphological result was not dependent on the inclusion of exclusion of the mouse lemurs. The craniodental data defied geography, grouping the robust-bodied and gracile forms, with the gracile clade being the first to diverge. Both the molecular and morphological data sets apparently contain high levels of homoplasy. Molecular clock estimates deriving from the 12S data set were completely at odds with the fossil record.

#### **Subspecific variation in the crania of *Cebus capucinus*.**

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This study examines subspecific cranial variation among adult specimens of three subspecies of *Cebus capucinus* (*C. c. capucinus* [n = 43], *C. c. imitator* [n = 62], and *C. c. limitaneus* [n = 34]) by means of ANOVA, Tukey's multiple comparison test, multivariate discriminant function analysis, and multivariate cluster analysis. The analyses are based on 23 linear variables. Each specimen is assigned to a subspecies according to its location of capture. Geographic ranges for each subspecies are taken from published sources.

Results of the Analyses of Variance indicate that the subspecies are significantly different in nine of the 23 cranial variables. Tukey's tests indicate that *C. c. capucinus* and *C. c. imitator* possess significantly larger dental arcades, increased facial width, and larger cranial size compared to *C. c. limitaneus*. Discriminant function I differentiates the subspecies by overall size. The larger subspecies (*C. c. capucinus* and *C. c. imitator*) are differentiated from *C. c. limitaneus* by variables related to the dental arcade, facial width, and neurocranial

shape. Function II further differentiates the larger subspecies from each other by variables related to facial height, facial width, and neurocranial shape. Cluster analysis illustrates that *C. c. capucinus* and *C. c. imitator* join first, and then are joined by *C. c. limitaneus*.

All analyses indicate *C. c. limitaneus* is the morphologically distinct subspecies. These results, in conjunction with molecular and morphological analyses examining the relationships both within and among the other capuchin species, support the proposal that the taxonomy of *Cebus* needs some revision.

#### **Inventoring through the lens: anthropometric photography and racial categorization before 1945.**

K. Matiassek, M. Teschler-Nicola. Natural History Museum Vienna / Dept. of Archaeological Biology and Anthropology, Vienna.

Like anthropology, photography had its origins in the 1840s and was viewed as a medium that would enable nature to spontaneously represent itself in a faithful record of reality. Thus suspending the responsibilities of an authorship, the photograph itself was readily taken as evidence. With examples from the photographic collection of the Vienna Natural History Museum, the practice of photography in physical anthropology is presented from its advent up to 1945, leading from a merely *optical* to a complete and possibly remote *numerical* assessment of individuals. Successive anthropometric image types - from the well known standardized mug shots to stereophotogrammetric images that allow for a reconstruction of three-dimensional body measures from the flat photographic surface - are discussed in the light of racist constructions and popularizations of the time. They are perceived to consequently illustrate a growing quest for a numerical inventory of man according to preconceived racial categories: in a circular argument, previously selected human types were photographed and then scientifically verified with these very images. This trend of inventoring through the lens as reflected in increasing numbers of both photometric techniques applied and actual photographs taken, is shown to have culminated in unequaled excesses of anthropometric photography during the Nazi era.

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**The commensal model continues - *Rattus exulans* mtDNA variation from Island Southeast Asia through to Polynesia - Implications for human settlement of the Pacific.**

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Previously, we reported on mtDNA variation in *Rattus exulans* in Polynesia as a model for human settlement of the Polynesian triangle (Matisoo-Smith 1995, 2001). Briefly, we have argued that because *R. exulans* were transported by prehistoric peoples as they settled the Pacific, they are an ideal proxy for human mobility in the region. We have extended the geographical range of our sampling and now present evidence for mtDNA variation in *R. exulans* populations from Island Southeast Asia and across the Pacific. Approximately 400 bp of mitochondrial DNA from over 100 archaeological and museum bone samples of *R. exulans* was analysed. Our results strongly suggest: 1) multiple introductions of *R. exulans* to the Pacific and 2) a Wallacea origin for Remote Oceanic *R. exulans* populations. These results are discussed in relation to human molecular, linguistic and archaeological evidence from the Pacific and suggest a complex history for the human origins, settlement, and interaction in the Pacific.

**Vocal communication at sleep trees by spider monkeys (*Ateles geoffroyi frontatus*).**

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Spider monkey "whinny" vocalisations have acoustic characteristics enabling individual recognition. Whinnies are usually associated with coordination of subgroup movement and feeding episodes. The social organisation of spider monkeys, whereby the community fissions into smaller subgroups which may fuse together at feeding and sleep tree sites, means that individual recognition through whinnies may be important in assessing who is present in the subgroup, particularly after fission or fusion occurs. This study was undertaken on a large community of spider monkeys in Santa Rosa National Park, Costa Rica. Subgroups were followed from first encounter during the day until nightfall on 32 occasions between May 2000 and December 2001. On four occasions fusion of sub-

groups occurred during the hour preceding arrival at the sleep trees, and on a further four occasions fusion occurred at the sleep trees. Whinnies were recorded before and after arrival at the sleep trees. Although subgroup size correlates significantly with whinny rate per hour both before and after arrival at the sleep trees, the correlation disappears when we control for the number of individuals present. When comparing whinny rates per individual per hour at the sleep trees we find that rates are higher when fusion occurs than when it does not. This difference is especially significant when only cases in which fusion occurred at the sleep trees are included in the analysis. This result may suggest that spider monkeys use whinnies to assess who is present at the sleep trees after a fusion event when approaching darkness reduces visibility.

**Topographic variation of the enamel thickness in the human anterior deciduous dentition.**

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Dental enamel thickness (ET) variation is used as an indicator of dietary habits and of (paleo)environmental/ecological conditions, and, more importantly, as a diagnostic feature for taxonomic assessment and phylogenetic reconstructions. Nonetheless, a purely qualitative estimate is usually given ("thin" vs. "thick" enamel; at times, the term "intermediate" is used). This typology bases on observations realized on permanent teeth only (mostly, on cheek teeth). In addition, currently available reference database for ET in primates (including *Homo*) do not incorporate information on the cross-sectional (and sex-related) variation.

Our research project is designed to quantitatively detail (by means of histological and/or noninvasive  $\mu$ CTs techniques) patterns of ET topographic variation of the primary and secondary dentition in a number of extant primate taxa. The human anterior deciduous dentition has been preliminarily considered. Two dental samples have been investigated: (i) the *Fatina* collection, representing 104 healthy individuals known for sex and clinical history, and (ii) the *SCR* collection, representing 94 individuals from the Imperial Roman cemetery of Isola Sacra. Distinctly for the labial and the lingual aspect, ET has been measured on histological sections at intervals of 200  $\mu$ m along the DEJ. On average, 80 measure-

ments have been taken for each crown, allowing the reconstruction of specific profiles of variation. In both samples, remarkable differences have been detected within each tooth-type and among all the teeth. In both upper and lower dentitions, thickening is shown in mesiodistal direction. *Fatina* and *SCR* show overlapping patterns of size variation. No statistically significant sex-related difference has been recorded.

**Longitudinal assessment of quantitative and qualitative age-related change in the dental pulp chamber: An expert system approach using dental radiographs.**

D.G. McBride. Dept. of Anthropology, University of Missouri.

Pulp chamber measurements taken from dental radiographs provide a useful and non-invasive alternative method of individual age estimation. To address questions of individual variation, longitudinal data were collected from archival dental radiographs of 37 individuals for three time periods each, spanning an average of 13 years.

Results show significant ( $p \leq 0.05$ ) cross-sectional correlations of pulp dimensions with age that range between -0.3 and -0.7. The longitudinal data reveal considerable individual variation in pulp chamber size and rate of change. While pulp chamber dimensions do tend to decrease for most individuals, the most substantial age-associated differences are qualitative, resulting from increased radiodensity, which obscures and reshapes the pulp chamber as secondary or tertiary dentin is formed. Size differences may be minimal over time and measurements are difficult to standardize due to image variation in tooth size and shape from different equipment and radiographers' techniques. By incorporating expert knowledge of qualitative criteria into a deductive, rule-based system, some of these problems are mitigated.

Results of quantitative analyses are compared with a qualitatively phrased expert system model using deductive decision rules. The process of building an expert system resulted in a usable qualitative method for age estimation and suggested how changes in the quantitative models might lead to improved estimation with them.

**Phylogenetic implications of Miocene hominoid premaxilla length, with special reference to *Dryopithecus* from Rudabánya.**

M.L. McCrossin. New Mexico State University.

Few craniodental complexes are as diagnostic of hominoid phylogenetic affinity as the subnasal pattern. Fossil great apes are identified by their possession of a true incisive canal. Cohesiveness of the Asian great ape clade derives largely from the constricted incisive canal and convex nasalveolar clivus shared by *Sivapithecus* and *Pongo*. The earliest evidence of an African subnasal pattern is seen in a middle Miocene kenyapithecine, *Nacholapithecus* (Kunimatsu et al. 1999).

Several authorities have noted that *Dryopithecus* from Rudabánya (RUD 12) retains a primitive subnasal pattern, unlike that of living great apes. In fact, the posterior pole of the subnasal alveolar process manifestly does not overlap the anterior pole of the palatal process of the maxilla. Nevertheless, Kordos and Begun (2002) claim that Rudabánya *Dryopithecus* exhibits an African subnasal pattern. Despite the patent absence of an incisive canal in RUD 12, they report that an index of premaxilla length demonstrates a *Gorilla*-like condition for *Dryopithecus*.

I indexed premaxilla length (alveolare to incisive foramen) against the square root of first maxillary molar area for a large sample of anthropoids. Contrary to Kordos and Begun (2002), substantial overlap exists between extant lesser apes (especially *H. syndactylus*) and great apes in terms of premaxilla length. Moreover, many ceboids and cercopithecoids exhibit so-called "great ape" index values. Determination of this index for Rudabánya *Dryopithecus* is rendered problematic by the incomplete preservation of RUD 12 and RUD 44/47. The best estimate of premaxilla length for Rudabánya *Dryopithecus* falls within the ranges of ceboids, cercopithecoids, and hominoids.

**Locomotor adaptations reflected in contrasting muscle proportions in gorillas and orangutans.**

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Gorillas and orangutans are the largest-bodied primates. Both live in forests, but gorillas frequently travel and feed on the ground, whereas orangutans confine their activities almost exclusively to the trees. The anatomy of the two species reflects

these divergent behaviors. In proportions gorillas have less massive forelimbs than orangutans, more massive hindlimbs, and more overall muscle tissue.

We analyzed the muscle weights of 6 adult male gorillas and orangutans. We found that within the limbs, proportions of flexor to extensor muscle groups show similarities in the distal segments (forearm, leg) between the two species, but marked differences in proximal ones (arm, thigh). Muscle proportions in the arm and thigh segments differ in opposite directions. In gorillas, the elbow flexors (*biceps brachii*, *brachialis*) are 1.4 times heavier than the extensors (*triceps*), whereas in orangutans, the ratio is 2.2. In the thigh, gorilla *quadriceps femoris* are 1.6 times heavier than the hamstrings, whereas in orangutans, they are only 0.7 times as heavy.

Elbow and knee extensors are more prominent in gorillas. In orangutans, heavier flexors in the arm segment facilitate elbow flexion and rotation in manipulating branches to forge pathways through the trees. Orangutan hamstrings function as knee rotators in clambering through the canopy. In contrast, gorilla hamstrings function for propulsion on the ground. In limb proportions, relative mass segments, and in proportions of muscle groups, gorillas vary in the direction of humans, reflecting the terrestrial component of their locomotion as well as their closer shared ancestry with humans.

**Bone histological features in catarrhines: implications for life history and paleobiology.**

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Examinations of hard tissue "signatures" of catarrhine life history have largely focused on anatomical features formed during dental development. However, investigations of other vertebrates demonstrate that microscopic features in bone constitute another important source of information about life history and organismal (paleo)biology. Here we examine the potential of bone for such studies in catarrhines, including ontogenetic series of *Cercopithecus aethiops*, *Hylobates lar*, and *Pan troglodytes*. If confidence in this approach is established, we can build upon the current foundation for extending investigations to fossils.

Variability in bone microstructural features is examined on ground plane parallel 100µm thick thin-sections from the midshaft femur. Primary bone tissue types, vascularization, and growth arrest lines (LAGs) reflect variability in skeletal growth rates as individuals pass from one growth stage to the next, and as they experience seasonal variability in their environments. Features are assessed with respect to traditional developmental measures (known body weight, bone length, dental eruption) and mechanically relevant changes in bone microstructure (e.g., remodeling).

Results show marked variability in bone microstructure through ontogeny. Highly vascular less-ordered tissues are characteristic of infants, while increased proportions of less vascular lamellar tissues reflect declining growth rates during later ontogeny. Sex and species differences are interpreted within the context of life history. LAGs are observed in most taxa, although individual and sex differences suggest their interpretation is more complicated than commonly proposed. Our observations indicate the subtlety with which bone histology records aspects of primate life history.

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**Variations in stable isotope composition in *Propithecus diadema edwardsi* from disturbed and undisturbed rainforest habitats in Ranomafana National Park, Madagascar.**

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Approximately one third of Ranomafana National Park's 43,000 hectares was affected in varying degrees by selective logging prior to the formation of the park in 1991. Habitat disturbance is predicted to affect patterns of energy flow through trophic levels in rainforest ecosystems as a result of changes to the canopy and understory vegetation. We compared the carbon stable isotope (δ<sup>13</sup>C) and nitrogen stable isotope (δ<sup>15</sup>N) composition of *Propithecus diadema edwardsi* from three sites in Ranomafana that vary in extent of human disturbance: 1) Talatakely (heavily logged in the 1980s); 2) Vatoharanana (selectively logged in 1986 and 1987); and 3) Valohoaka (undisturbed). In 2000 and 2001, *P. diadema edwardsi* were captured from these sites and hair samples collected and processed to determine δ<sup>13</sup>C and δ<sup>15</sup>N values. Average δ<sup>13</sup>C in *P. diadema edwardsi* from Talatakely was –

23.4‰ (± 0.2); average  $\delta^{15}\text{N}$  was 2.1‰ (± 0.2). Average  $\delta^{13}\text{C}$  in *P. diadema edwardsi* from Vatoharanana was -23‰ (± 0.1); average  $\delta^{15}\text{N}$  was 3.3‰ (± 0.2). Average  $\delta^{13}\text{C}$  in *P. diadema edwardsi* from Valohoaka was -22.8‰ (± 0.2); average  $\delta^{15}\text{N}$  was 3.2‰ (± 0.2). *P. diadema edwardsi* samples from Talatakely are the least enriched in  $\delta^{13}\text{C}$ , with Vatoharanana and Valohoaka successively more enriched. Vatoharanana and Valohoaka are both  $\delta^{15}\text{N}$  enriched relative to Talatakely. Previous analysis suggested approximately a half step difference in trophic level between *P. diadema edwardsi* from Talatakely and Vatoharanana. New data from Valohoaka indicate an even greater difference in trophic level between disturbed and undisturbed rainforest habitat.

**Strain gradients in the colobine mandibular symphysis: Assessment of the reliability of morphometric proxies for biomechanical strength and rigidity.**

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Comparative study of primate jaw morphology has long sought to relate the mechanical demands of diet to size and shape of the mandible. In sympatric colobines, predicted differences in mandibular morphology attributable to diet are not observed; structurally weaker symphyses are associated with more obdurate diets (*Int. J. Primatol.* 22:1033-1055), a finding which undermines the premise of a functional linkage between diet and morphology.

One explanation for these results is that linear measures used to infer biomechanical performance poorly estimate bone behavior. We explore this possibility by comparing predicted levels of strain with those observed experimentally in 6 mandibles representing *Colobus polykomos* and *Procolobus badius* under lateral transverse bending loads, the major source of masticatory stress in anthropoid symphyses. We treat the mandible as a curved elliptical beam and also directly section specimens to calculate area properties.

Our results depict differences in labial and lingual strains that are below the disparities predicted by mathematical formulae for curved beams, and labial strain gradients vary in both steepness and direction. These observations indicate that substantial errors are associated with morphometric models, but these

errors may only partially account for the poor fit between jaw form and diet among closely related species. Supported by NSF BCS-0096037.

**Geometric morphometric analysis of palatal morphology in extant and fossil hominoids.**

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Much of the known diversity among Miocene hominoids is preserved in craniodental specimens, including a number of palates, hemi-palates, and tooth row fragments. Here I present results of a three-dimensional geometric morphometric analysis of hominoid palatal morphology. Included in the analysis were specimens from all extant hominoid genera plus several non-hominoid "outgroups." The fossil sample comprised three well-preserved palatal specimens attributed to *Proconsul* (KNM-RU 16000), *Morotopithecus* (UMP 62-11), and *Sivapithecus* (GSP 15000). The aim of this study was twofold: 1) to quantify and analyze patterns of variation among extant hominoids, and 2) to use these extant models to determine the affinities of fossil specimens.

The results generally confirm three distinct groups of anthropoids: ceboids, cercopithecoids, and hominoids. Among the apes, *Gorilla* and *Hylobates* are closely linked and cluster with the more generalized cercopithecoids. *Pan* and *Pongo* are separately distinct from these, with some similar features. *Homo* is nearly equidistant from *Hylobates* and *Pan*. The fossil specimens are all confirmed as hominoids, with *Proconsul* and *Morotopithecus* closest to *Hylobates*, while *Sivapithecus* is most similar to *Pongo*, but only slightly farther from *Hylobates*. Projected onto a consensus phylogeny, these results suggest that the overall palatal morphology of *Gorilla* is conservative—rather than derived—among hominoids. This generalized pattern is shared by the early Miocene specimens. The *Sivapithecus* palate seems derived in the direction of *Pongo*, but still retains much of the conservative pattern.

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**Vitamin D deficiency and mortality: Impaired immune response in infants and elevated cancer risk in adults.**

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The skeletal deformities of rickets and osteomalacia are regarded by many to be artifacts of the historic past where the condition was considered more a source of morbidity than mortality. However, recent immunochemical and oncological research has shown that vitamin D3 is manufactured in a variety of tissues where it plays important roles in modulating immune response, cell differentiation, and cell proliferation. Specifically, studies show that impaired immune response and elevated risk of serious infections (principally of the lower respiratory tract) are an early consequence of hypovitaminosis D in infants and young children. And, while hypovitaminosis D in adults is now recognized as a dominant and costly source of musculoskeletal morbidity among the elderly, recent research has established links between vitamin D deficiency, cancer risk, and cancer survival rates. In particular, studies have linked vitamin D status to breast, prostate, colon and rectal cancers.

This study examines associations between vitamin D deficiency and cause of death among Hamann-Todd Collection infants, children, and adults. The findings are concordant with relationships described above where 83% of HTC children with rickets died of an infection (72% respiratory tract, and 61% bronchopneumonia/pneumonia specifically). Among adults, 75% with breast/ovarian cancer and 67% with prostate cancer displayed one or more osteomalacia pseudofractures at time of death. No individuals with colon/rectal cancers exhibited bony evidence of hypovitaminosis D. Results are discussed as they relate to cultural behaviors which give rise to the nutrient deficiency in modern human societies.

**Late Holocene archaeological remains from chimpanzee and human sites in the rainforest of Côte d'Ivoire.**

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We report sequential data obtained through archaeological excavation showing chimpanzee occupation levels superimposed on prehistoric human settlements in Taï National Park, Côte d'Ivoire. Archaeological excavation techniques have recently been used to recover a chimpanzee record of occupation at a

*Panda oleosa* nut-cracking site known as 'Panda 100'. Here we report the preliminary results of an excavation conducted at a *Coula edulis* chimpanzee nut-cracking site. The *Coula* site, named 'Loukoum', focused on several anvil systems associated with two nearby *Coula* trees. The archaeological data retrieved indicate an occupation sequence in which Stone Age humans were followed by Iron Age people, then chimpanzees into the present. The anthropogenic remains include stone artifacts, ceramics, iron, and charcoal. The chimpanzee behavioral remains comprise stone pieces interpreted as fragments of nut-cracking hammers. The evidence unearthed in the African rainforest demonstrates that there is a buried record of chimpanzee nut-cracking activity, and that this record is detectable through conventional archaeological techniques. Moreover, the data support the need to look at rainforests as places where new clues of human and non-human primate ancestry could be found.

**Subadult skeletons from the North African Epipaleolithic: Clues to patterns of growth found in the subadults from Afalou and Taforalt.**

J.D. Merriman. Binghamton University.

Cranial and postcranial dimensions were recorded for subadult skeletons from the North African Epipaleolithic sites of Afalou and Taforalt in order to compare development in these populations with that of a modern (16th-17th C. Montenegro) group. There are no complete individuals; crania and mandibles were aged according to dental eruption stage, and postcranial elements were placed in developmental categories based on diaphyseal lengths and state of unfused diaphyseal articular surfaces. Biplanar radiographic views of the humerus and femur were taken to assess cortical growth patterns and load bearing and bending strength as calculated by Runestad et al (1993: Radiographic estimation of long bone cross-sectional geometric properties. *Am J. Phys. Anth.* 90:2;207-215). The North African samples are fragmentary but yield interesting hints as to variation in human development present just prior to the onset of the Neolithic in western North Africa. Of particular interest are size differences between the North Africans and the Montenegro group. North African adults show a high degree of cranial robusticity relative to more modern people, and subadult craniodental dimensions are greater than those of the comparative sample, particularly in length of the mid-

vault, basioccipital size, chin height, and dimensions of the primary dentition. Humerus and femur cortical thicknesses from Afalou, Taforalt and Mistihalj (Montenegro) show growth disruption relative to 20th C. children, indicating nutritional and/or disease stress during development. There are no significant differences in strength. This result underscores the difficulty in studying interpopulation differences among subadults. The plastic response of growing bones to environmental perturbation may easily mask subtle differences in growth patterns occurring during the evolution of modern humans.

**Mitochondrial DNA variation in Afghanistan.**

D.A. Merriwether. Dept. of Anthropology, University of Michigan.

We examined mtDNA D-loop sequence variation in 131 unrelated Pashtoon speaking residents of Gawargin village in the Helmand Valley of Southern Afghanistan. The samples were collected in 1971 before the Soviet invasion and occupation, the Taliban period of rule, and the US invasion of Afghanistan. These villagers migrated from Laghman Province East Afghanistan in the 1950s. This sample represents a unique snapshot in the genetic history of the Afghan people. We sequenced spanning nts 16000-00430 encompassing HVS1 and HVS2 of the human mtDNA genome. We observed 59 haplotypes among the 131 sequences. We compared the sequences to various worldwide populations of mtDNA sequences, and found many exact matches with Europe and India, and only a few with Asia. We present a Bandelt Median Joining Network to show the relationships and distributions of these mitochondrial lineages and to estimate the ages of the haplogroups in this population.

**Preliminary studies of the demography and genetics of the Boruca of Costa Rica.**

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Boruca is an indigenous reservation of about 14,000 hectares. It is located in the Zona Sur (Southern Zone) of Costa Rica. Historical evidence suggests that the town of Boruca has been inhabited for at least 500 years. It was reportedly one of

the larger native towns when the Spaniards arrived in 1516. However, by 1569 the "town" of Boruca was composed of about 250 individuals. Apparently the population remained relatively stable because by 1802 there were about 236 individuals residing in 41 households. By 1883 the households had increased to 60 along with an increase in population to 326. Today the area is comprised of three main villages, Boruca (about 1,400 inhabitants), Rey Curre (about 400 people), and Maiz (about 200 people). Approximately 1,500 people live in the countryside, making the total native population of the area about 2,500 individuals.

Historical records indicate that about twelve family names were present among the Boruca for at least two centuries, and probably longer. These twelve names continue until about the 1970s. Today the number of family names has been reduced to ten. These findings suggest the possibility of high levels of endogamy and the potential for high levels of inbreeding. Most Boruca have traditionally married other Boruca, and levirate and sororate were practiced in the past. Fieldwork began last summer by collecting extensive genealogies and tracing as many families back to the 1880s as possible. Families are large and complex entities with ties extending throughout the community. Temporal changes in family types, composition, and sizes and other household measures and characteristics will be documented and discussed.

We also collected blood samples from a few individuals for typing. Markers on the Y chromosome were scored on male samples in order to determine (1) evidence of admixture with European and/or African groups, and to detect how many male lineages are represented in the community and if males with the same surname share identical, or very similar, Y haplotypes. Preliminary results after scoring seven males from the community for Y chromosome markers show that there are different Y-haplotypes, with at least 3 alleles at locus DYS393 and 2 alleles at locus DYS392. These results do not suggest very close relationships and will be discussed as they relate to the limited family names shared in the community. This research was supported, in part, by a General Research Fund grant from the University of Kansas.

**A new technique for reconstructing the vocal anatomy of fossil humans.**

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Previous reconstructions of fossil human vocal tract (VT) anatomy have primarily been based on single skeletal indicators such as basicranial flexion or hyoid morphology. These studies have produced conflicting results. A few reconstructions have used combinations of indicators to predict VT morphology, but these have employed relatively subjective methods. In an attempt to better understand fossil human VT anatomy, we developed a new predictive technique that uses relationships between VT landmarks and associated skeletal landmarks of living humans as the basis for reconstruction. We believe that the use of these landmarks is more likely to produce reliable results than any single indicator, and that our method of analyzing relationships between skeletal and soft-tissue anatomy is less subjective than previous techniques. Using the software package C2000cépha v.2.1.B, we collected two large sets of landmark data from a sample of human clinical CT scans provided by the Clinique Pasteur in Toulouse, France. The first consisted of skeletal landmarks located on the basicranium, vertebral column, dentition, mandible, nasopharynx, nasal cavity, and nasal aperture. The second consisted of soft-tissue landmarks located along the VT. Through the combined use of generalized procrustes analysis, principal component analysis, and multiple regression, we derived multiple formulae that allow us to predict the position of soft-tissue VT landmarks based on associated skeletal landmarks. Preliminary work indicates that this technique facilitates a working 3-D approximation of the supralaryngeal VT from skeletal landmarks, and that it holds promise for the reconstruction of VT soft-tissue anatomy in Neandertal and other fossil specimens.

#### **Cannibalism and Sample Size: The New Remains from Navatu, Fiji.**

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The recognition of cannibalism in the osteoarchaeological record is an important component of bioarchaeological research. One methodological aspect of such studies that merits attention is the dependency of these identifications on the size of the

skeletal sample analyzed. We consider here the influence of sample size on the recognition of cannibalism using skeletal remains from the site of Navatu, Fiji. This site was initially excavated by E. W. Gifford, and yielded a large sample (2,188 analyzed specimens) of human and non-human skeletal remains. The subsequent taphonomic analysis of these remains provided strong support for the inference of cannibalism (DeGusta, 1999, AJPA 110:215). Recently, Clark initiated renewed excavations at Navatu, which have so far yielded a much smaller skeletal sample from the same midden. The taphonomic analysis of these materials is compared here with the similar analysis of the Gifford sample to illustrate the ways in which sample size and sampling effects can influence the reconstruction of prehistoric behaviors, especially cannibalism.

#### **Social and spatial aspects of male subgrouping in a community of wild chimpanzees.**

J.C. Mitani, S.J. Amsler. Dept. of Anthropology, University of Michigan.

Strong social bonds typically develop between dyadic pairs of male chimpanzees. These bonds are manifest in several contexts, including association, grooming, and proximity. Here we demonstrate that bonds exist at a higher level of organization among males living in an extremely large community at Ngogo, Kibale National Park, Uganda. An analysis of over 2,500 hours of observation of 35 individuals (22 adults, 13 adolescents) reveals two distinct subgroups of male chimpanzees. Males that compose each subgroup can be identified on the basis of their tendency to associate in temporary parties. Matrix permutation tests indicate that subgroup membership affects patterns of spatial proximity and participation in territorial boundary patrols. Males in each subgroup also tend to range in different areas. Despite this social and spatial segregation of males, community integrity appears to remain intact with low levels of aggression between individuals of different subgroups. After controlling for the effect of association, significantly more aggression occurs within compared to between subgroups. We compare our findings with those from other study sites and discuss their implications for understanding the unusual demography of the Ngogo chimpanzee community.

#### **Is the bonobo growth trajectory the ancestral one for the *Hominoidea*?**

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We collected a total of 96 traditional landmarks and semilandmarks on the face and cranial base of 268 adult and sub-adult crania for a geometric morphometric analysis of five different hominoid species—*Homo sapiens*, *Pan paniscus*, *Pan troglodytes*, *Gorilla gorilla* and *Pongo pygmaeus*.

The standard relative warp (RW) morphospace was sheared so that pooled within-group size allometry, the axis assumed to express the "common" ontogenetic shape change, lies horizontally. In the resulting analysis there are differences in size-adjusted mean forms—these appear in sheared RW's 2,3, ...—and there are also differences in the within-taxon ontogenetic trajectories (which appear as within-group correlations of RW's that must, per definition, be uncorrelated in the pool). When visualized, both correspond to regionalized shape differences. The shape differences associated with the second sheared RW, which separates *Homo* from *Pongo* and the African apes, are already manifest in the youngest forms we have. These ape ontogenies seem parallel, but the vector for *H. sapiens* is different ( $P=0.002$ ). Shape features of the third component, which distinguishes among the African apes, develop during postnatal ontogeny, and thus express actual divergence of ontogenies. Assuming that *Hominoidea* is monophyletic, the average growth trajectory is a reasonable estimate of the ancestral ontogeny. This trajectory is closest to those observed in our two samples of chimps, particularly to that for bonobo. In the second and third dimensions, furthermore, the bonobos lie nearly at the grand mean. We suggest therefore that bonobo is a particularly good model species for speculations about hominoid ancestral ontogeny.

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#### **Occlusal shape changes with wear: A comparison of chimpanzee and gorilla molars.**

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Tooth shape is often used to infer diets of fossil primates. Such studies depend on associations of dental functional morphology with diet in extant taxa. This

project applied a 3D dental topographic approach to the functional analysis of variably worn chimpanzee and gorilla teeth. High resolution lower M2 casts of wild-shot *Gorilla gorilla gorilla* ( $n = 48$ ) and *Pan troglodytes troglodytes* ( $n = 56$ ) were scanned at 0.025mm resolution in 3D using a Surveyor 500 laser scanner (Laser Design, Inc). ArcView 3.2 GIS software (ESRI Corp) was used to model occlusal surfaces, and measure slopes and angularities of individual cusps. Wear level for each cusp was scored using Scott's (1979) method. Resulting data for each variable were ranked and analyzed using 3-way ANOVAs with species, cusp, and wear stage as the factors.

All three factors showed significant differences, and there were no interactions for the slope study. Further, there were significant differences for cusp and species but not wear stage for the angularity study. Again, there were no significant interactions. Gorillas had steeper sloped cusps and more angular surfaces than chimpanzees regardless of wear stage. Lingual cusps were significantly steeper and showed more angularity than buccal cusps. While slope decreased with wear in both species, differences between taxa did not change through the wear sequence. Species also differed in angularity, despite no changes with wear. These results demonstrate significant differences between chimpanzees and gorillas in the functional morphology of worn molars analyzed in 3D.

Supported by the LSB Leakey Foundation.

#### Tracing prehistoric activities.

P. Molnar. Archaeosteological Research Laboratory, Department of Archaeology, Stockholm University.

In this study, 41 adult individuals from *Ajvide*, a Middle Neolithic (2750-2300 B.C.) burial ground on the island of Gotland in the Baltic Sea are analysed. The material culture of the site includes bone arrowheads, fishhooks and harpoons. Intensive fishing and sealhunting strategies suggest that both archery and the use of boats were every-day events at *Ajvide*. The aim is to verify alleged activities, such as archery and kayaking from muscle attachment data as well as to investigate details concerning age and gender related consequences on skeletal markers associated with physical activity.

Altogether 64 muscle and ligament attachment (*Musculoskeletal Stress Markers, MSM*) sites are scored on 13 bone elements using Hawkey & Merbs (1995) method (with modifications). Focus

of the investigation is placed on muscles associated with the mentioned activities. Additionally, using straightforward descriptive statistics, comparisons are made between age groups, as well as males and females.

Diverging patterns of habitual activity in males and females as well as age-related differences show that levels of activity, rather than specific activities can be traced. However, attachment sites for muscles used in more specific (known) activities, as archery and kayaking, show no obvious signs to substantiate these activities. Assessment of prehistoric physical activity patterns by studying muscle and ligament attachments as well as other traces of activity, can be useful in a broad sense to compare levels of activity between different populations and between groups.

#### Occupational activity level in relation to bone strength.

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This study examines the differences in torsional second moment of area (J) and cortical area (CA) of bone in the midshaft of the humerus and femur of individuals whose occupations required different levels of activity. The sample studied consists of 28 cadavars (15 females, 13 males) of individuals whose occupations, age, stature and weight were known. The physical activities that may have been pursued by these individuals outside of their occupations was not known. The occupations of the individuals in the sample were divided into "active" (construction and manual labor) and "sedentary" (office work) categories. Sections of the midshaft of the right humerus and femur were collected from each individual and photographed. The cross-sectional properties were calculated with Matt Warfel's moments macro for NIH Image. Values for CA were standardized for body mass, and values for J were standardized for body mass and stature.

Humeral properties exhibited sex differences, with males having 64% and 38% higher adjusted J and CA, respectively. Among males, the active group ( $n=4$ ) had significantly stronger humeri with 60% and 35% higher adjusted J and CA, respectively. Femoral differences, although higher in active males, were less pronounced and non-significant (38% and 33% higher adjusted J and CA, respectively). Although the division regarding levels of activity were relatively crude, the results from the calculations done with Matt Warfel's moments macro for

NIH Image indicate there is an apparent difference in the bone strength of individuals whose occupations are "active" (construction and manual labor) and "sedentary" (office work).

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#### The mineralization, preservation and sampling of teeth: Strategies to optimize comparative study and minimize age-related change for lead and strontium analysis.

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Increasingly, studies analyse concentrations and isotope ratios of lead and strontium in archaeological tooth mineral to obtain dietary and mobility information. Unfortunately, there is little data on the fundamental behaviour and homogeneity of lead and strontium in teeth and how this impacts on sample selection and preparation. This study uses core enamel and co-genetic primary crown dentine, neither of which model nor remodel *in vivo*, from modern and archaeological teeth to investigate lead and strontium behaviour and so inform future sampling strategies.

Results demonstrate that isotope ratios of modern enamel and co-genetic crown dentine remain indicative of childhood origin with no evidence for post-eruptive uptake. However, resorbing deciduous roots are dynamic, facilitating lead and strontium incorporation and consequently sensitive to post-formation residence change. Enamel samples from the same tooth, from antimeres and from co-genetic teeth replicate extremely well in modern and archaeological teeth. In particular, enamel strontium reproducibility can surpass that of the analytical standard.

Macromorphological tooth preservation is no guide to biogenic strontium or lead isotope integrity. Mature, but not immature, enamel is resistant to diagenesis whether well preserved or not. Dentine is highly susceptible to diagenesis irrespective of preservation state. Formation, mineralization and subsequent ante- and post-mortem behaviour of dentine and enamel are very different; within each tissue there exists age and exposure-dependent changes that, if sampled, may invalidate comparisons between adults and juveniles. Core enamel (all surfaces and enamel-dentine-junction removed) from the histologically simple tooth wall

of fully mineralised molars is recommended as the standard archaeological sample.

**Recent human mental foramen ontogeny: Its significance for craniofacial growth theory and phylogenetics of Pleistocene *Homo*.**

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Mental foramen ontogeny plays a significant role in the delineation of mandibulofacial growth theory. Phenotypic variation in foramen expression also figures in taxonomic-phylogenetic analyses of fossil *Homo*. Whereas the mental foramen is considered significant, available ontogenetic studies lack sufficient resolution. Therefore, we detail foramen ontogeny in recent humans, discuss the impact of these data on growth theory, and reconsider the foramen's role in phylogenetics.

Our sample (N= 429) comprises mandibles with ages from 6 months *in utero* to adult which are seriated in one-tenth year intervals. We measured seven dimensions and tabulated both the foramen's position relative to the developing dentition and its direction of opening.

We observed: 1) less change in regions inferior to the foramen than superior to it and low correspondence between these regional changes; 2) the direction of foramen opening to vary and to rotate from anterior to posterior during the first year as opposed to continuously throughout growth; 3) neither corpus height nor breadth at the foramen to be correlated with the direction of opening; and 4) foramen position relative to the dentition to change abruptly during growth, especially in the 2.0-4.0 year-old age range. We found a disjunction between the timing of change in direction of foramen opening and its position relative to the dentition. Opening direction appears related to early mandibulofacial relationships whereas foramen position change is related to dental eruption timing. Given these results, we clarify the foramen's role in both models of mandibular growth and phylogenetic studies of fossil *Homo*.

**Limb proportions, climatic adaptations and Neandertals.**

W.L. Moore. University of Tennessee, Knoxville.

Several researchers have stated that Neandertals show extreme distal forelimb shortening relative to proximal limbs (Holliday 1995, 1997; Trinkaus 1981; and Porter 1999). This view of Neandertal "hyperpolar" body proportions has supported the idea that Neandertals were an unlikely candidate for a modern human ancestor because their proportions were outside the modern human range of variation. However, regression equations derived from a modern human sample can predict Neandertal long bone lengths with 95% confidence (Moore 2000). The purpose of this paper is to test the hypothesis that European Neandertals were "hyperpolar" in their limb length proportions.

Long bone measurements (maximum lengths of femur, tibia, humerus and radius), both raw and logged, from samples of geographically and climatically widespread adult modern humans (N = 939) and adult Neandertals (N = 5) are used in bivariate plots of femur/tibia and humerus/radius to initially examine upper to lower limb ratios. Plots of an internally defined body size variable calculated by both Darroch and Mosimann's method and Burnaby's method are then plotted against the logged lower limb segments for all sample groups to examine limb to body size ratios. Using World War II and Arikara samples with "known" stature estimates, classic regression equations are calculated. Each Neandertal will then have its long bone lengths estimated. Those estimates are tested using R, which is an inconsistency diagnostic that measures the departure from allometric scaling (Brown 1993, Konigsberg et al. 1998). Initial results indicate that Neandertals are well within modern human ranges of variation in limb proportions.

**Cranial variation in a Bronze Age skeletal series from Cyprus: A study of population dynamics in the eastern Mediterranean.**

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Past investigations of temporal and spatial variation among archaeological populations in Cyprus have yielded unique and sometimes conflicting results concerning the origins, and composition of the island's prehistoric people. Following its initial settlement, the island of Cyprus experienced increasing trade through an expanding network of communication and population movement in the region. Several studies point to traffic and population movement into the island of Cyprus especially during the Bronze Age and later times, either from the Levant to the east

and/or from the Mycenaean civilization and eastern Europe in the north and northwest. The present study specifically addresses questions about the variability in cranial morphology among Cypriot archaeological skeletal series from between ca. 2,400-1,000 B.C.E. In contrast to traditional uses of indices and strictly qualitative typological approaches, the present study employs quantitative data obtained directly from complete and fragmentary cranial samples representing Cypriot skeletal collections from several sites across the island. Up to 65 measurements were recorded for each cranium using traditional standards of Martin (1956) and Howells (1970). Data on age, sex and specific temporal and spatial associations were also recorded. Published cranial metric data from throughout the eastern Mediterranean region were also assembled for the purpose of a regional assessment of the relative affiliation of the Cypriot cranial sample. Both univariate and multivariate procedures are applied to the cranial data to discern patterns of homogeneity and heterogeneity within and among skeletal series from Cyprus and across the surrounding region.

**Baby's first steps: The development of cortical bone in the human femur.**

M.M. Moran. Dept. of Anthropology, Western Michigan University.

This study aims to improve our understanding of the function and development of the hip in relation to bipedalism. Rafferty (1997) has shown that cortical thickening on the medial border of the femur is directly related to the loading of the hip in bipedal walking, and this makes it the most diagnostic bipedal feature. Thus one would expect that the thickening of the medial border of the femoral neck during growth would correlate with the development of bipedal gait in children. This in turn would allow for a new means to assess bipedal locomotion in the fossil hominid remains. To test this hypothesis femurs (n=91) from the Dickson Mounds site housed at the Illinois State Museum, were sorted into age cohorts (neonatal to 60 years at time of death), measured, x-rayed, and graphed for cortical bone thickness. Results revealed that medial cortex of femoral necks become thicker during the years when most children begin to walk and continues long after this point through the age of 10. This strongly supports the contention that bipedal gait is a major factor in the thickening of the medial border in children ages 1-3.

### Genetic effects on brain neurotransmitter function and mood.

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Despite current advances in characterization and nosology, major depression remains a symptom-based construct representing a rate-limiting step in the identification of susceptibility genes. Psychiatric geneticists have proposed an evolution from traditional syndromic diagnosis to the study of discrete entities such as consistent clinical or laboratory findings that would be more supportive of an etiological approach to classifications. Acute nutritional depletion of tryptophan (TRP), lead to a decrease in brain serotonin (5-HT) availability and the experience of transient depressive symptoms in certain subgroups of depressive patients. We investigated the relationship between these depressive symptoms and a functional polymorphism of the promoter region of the 5-HT transporter gene (SLC6A4). Forty-three subjects in remission from a major depressive episode who underwent TRP depletion were genotyped. DNA was extracted from blood lymphocytes or from cheek cells. The two common alleles are designated long ("L") and short ("S"). Depressive symptoms were measured with the 25-item Hamilton Depression Rating Scale (HDRS). There was a significant association between the "L" homozygous genotype and the depressive response to TRP depletion, with a significant main effect of time ( $F = 8.763$ ,  $DF = 3, 38$ ,  $p < 0.001$ ), and time x "L" homozygous allele interaction ( $F = 3.676$ ,  $DF = 3, 38$ ,  $p = 0.02$ ). The use of trait markers such as TRP depletion in combination with genetic approaches may help identify genetic markers by reducing the heterogeneity of the condition, ultimately facilitating our understanding, prediction and treatment of an important subgroup of depressives.

### Genetic history of hunting and gathering populations of Tanzania.

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The genetic relationship of hunting and gathering populations within East Africa to one another and to surrounding populations remains unknown. Within Tanzania, two of these groups currently speak languages belonging to the Khoisan linguistic family (Sandawe and Hadzabe). The relationship of Khoisan-speakers to other hunter-gatherers of different linguistic affiliation (e.g. Dorobo and Akie) remains unclear. It is likely that Khoisan speakers were once spread throughout much of eastern and southern Africa, making these groups the original inhabitants of the region. Anthropological and linguistic data indicates successive waves of migration into Tanzania, first by Cushitic-speaking people ~5000 ya, followed later by migrations of Nilotic speakers, and Bantu speakers.

A large Tanzanian panel comprised of ~300 individuals from populations that currently (or recently) practice hunting and gathering subsistence (Hadza, Sandawe, Dorobo, and Akie), in addition to several hundred samples from neighboring populations (Burunge, Gorowa, Iraqw, Maasai, Datog), were analyzed for a set of genetically informative mitochondrial DNA and Y chromosome markers. The primary goal of this work is to determine the relationship of hunter-gatherer groups to each other and to surrounding groups, in order to infer long-term population size, levels of population substructure and degrees of admixture between groups. These data help clarify existing interpretation of patterns of migration within Tanzania and East Africa, as well as having direct implication to current understanding of the evolutionary history of hunting and gathering societies within a dynamic population setting. Funded by NSF grant No. 9905396 to ST and NSF IGERT grant No. 9987590.

### Scaling of muscle mass in primates.

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Physiologists and evolutionary biologists have erected a variety of equations to describe and explain size-related and size-required aspects of biology. Surprisingly, relatively little attention has been paid to the scaling of muscle mass with body size, or how ecology and phylogeny might confound such relationships. Body composition varies dramatically among mammals, even in closely related species. Differences in body composition are important in influencing variation in metabolic energy requirements, given differ-

ences in mass-specific metabolic rates across tissues. Currently there are few published data on muscularity in primates, and no data are available on Malagasy strepsirhines or tarsiers.

Here we present preliminary data on relative muscularity in a variety of primates. All animals were collected from the Duke Primate Center. Strepsirhines in our sample include African, Asian, and Malagasy forms. Also included is *Tarsius syrichta*. Using captive weight records we document significant variation in 'adult body weight.' We develop equations to describe the relationship between overall body size (mass) and total muscle mass within strepsirhines, and more generally, within primates using a literature-based sample of metatherians and eutherians.

Our results indicate a pervasive pattern of isometry when scaling total muscle mass to body mass. However, we find differences between the percent muscularity of arboreal and terrestrial species within mammals. We discuss the implications of this, and other findings, with regard to current hypotheses of depressed metabolic rates in strepsirhines.

### Evidence of subadult scurvy from Kagamil and Shiprock Islands, Alaska.

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The purpose of this study is to present evidence for subadult scurvy in skeletal remains from Kagamil and Shiprock Islands, Alaska. Scurvy is a metabolic disease caused by vitamin C deficiency. Although evidence for scurvy has been observed in skeletons worldwide, no cases have been described from the Aleutian Islands.

The study sample includes subadult remains from two burial caves, including 43 individuals from Shiprock Island and 20 from Kagamil Island, Alaska, between 0-19 years of age. These remains are housed at the National Museum of Natural History and were collected by Aleš Hrdlicka from 1936-1937. The temporal context for the remains from both islands is likely post-Russian contact.

Diagnostic skeletal changes attributed to scurvy include porous lesions of the sphenoid, which are often accompanied by other specific cranial lesions (Ortner and Erickson, 1997 and Ortner et al., 1999). Using these indicators, four probable cases of scurvy were identified in the Kagamil remains and five probable and four possible cases were identified from Shiprock. All of the affected individuals were

under 6.0 years and the majority were under 2.5 years. The presence of scurvy in this young age range may indicate increased stress during nursing due to frequent or prolonged periods of famine. These results suggest that the previous lack of data on scurvy in Aleutian remains may be attributed to the relatively recent development of diagnostic criteria and not its rarity in Aleutian populations.

#### **Allelic variation at alcohol metabolism genes and alcohol dependence in an American Indian population.**

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Investigation of allelic variation in the alcohol metabolism pathway can improve our understanding of the mechanisms by which alcohol dependence develops. Alcohol metabolism in humans is mediated by two gene families, alcohol dehydrogenase (*ADH*) and aldehyde dehydrogenase (*ALDH*). Allelic variants have been identified that alter metabolic rates and influence disease risk. Specifically, *ADH1B\*47His* and *ALDH2-2* have been shown to confer protection against alcoholism, presumably through accumulation of acetaldehyde in the blood and a resultant 'flushing response' to alcohol consumption.

In the current study, variants at *ADH1B*, *ADH1C*, and *ALDH2* were assayed in DNA extracts from participants belonging to a Southwest American Indian tribe (N=490). This population was chosen because its members lack alleles *ADH1B\*47His* and *ALDH2-2*, yet have a high prevalence of alcoholism suggesting the existence of additional alleles that affect disease risk. Each subject underwent a clinical interview for diagnosis of alcohol dependence, as well as evaluation of intermediate phenotypes such as binge drinking and flushing response. Detailed haplotypes were constructed and tested against alcohol dependence and related intermediate phenotypes using both association and linkage analysis. *ADH* and *ALDH* variants were also assayed in one African and three Asian populations (no clinical data) to provide an evolutionary context for the haplotype data. Both linkage and association analysis identi-

fied several *ADH1C* alleles and a neighboring microsatellite marker that affected risk of alcohol dependence and were also related to binge drinking. These data strengthen the support for *ADH* as a candidate locus for alcohol dependence and suggest further productive study.

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#### **Laetoli Pliocene environments revisited: Stratigraphic and taphonomic context of Upper Laetolil Bed fauna at Localities 8 and 9.**

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The depositional environments, geological and stratigraphic interpretations of Pliocene Upper Laetolil Beds have always been associated with dry, savanna-like environments characterized by grassland, shrubs, and isolated trees. Revised stratigraphy and taphonomy of Upper Laetolil Bed at Localities 8 (NE of the hominid footprints), and 9 (NW of the waterfall) indicate an existence of complex depositional environments than that previously predicted for Laetoli. Fossil faunal remains from Upper Laetolil Bed are represented by a highly variable number of skeletal parts dominated by heavily fractured and or modified distal, proximal and midshaft fragments of varying sizes, cranial-dental fragments, and isolated teeth. The parentage of most abundant skeletal parts, bone modification and weathering conditions within the assemblage not only provides information on the agencies responsible for bone accumulation, but also furnish us with depositional conditions that may be used in environmental interpretations. Unlike marine fossil deposits, which furnish thick sections with rich fossil accumulations of invertebrates, Laetoli deposits are most commonly composed of low-density accumulations with terrestrial faunal assemblage that differ significantly from its modern counterpart. Observed changes in faunal compositions at Laetoli have been noted, especially between the Lower and Upper Units, but their cause has not been established. It is unclear

whether these faunal changes through time were caused by tectonic, taphonomic, or climatic factors.

#### **Morphology of the axial skeleton of *Nacholapithecus* from the Middle Miocene of Kenya.**

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We describe morphology of the axial skeleton of *Nacholapithecus* from the Middle Miocene of Kenya, based on the KNM-BG 35250 skeleton and a few additional specimens. Vertebral specimens of KNM-BG 35250 are; fragmentary atlas and axis, a well preserved mid cervical vertebra, 10 thoracic vertebrae including the transitional and a post-transitional vertebra, and six lumbar vertebrae. Almost all specimens are badly deformed. Cervical vertebrae are generally large relative to the presumed body weight (ca. 22kg), suggesting a heavy head with large jaws and developed neck muscles. The atlas retains the lateral and posterior bridges over the course of the vertebral artery, unlike living apes. Thoracolumbar vertebrae are proportionally smaller (female *Papio* size) although precise metric comparison was impossible due to the bad preservation. On the other hand, their zygapophyses and muscular processes are very robust. Especially, one lower thoracic vertebra has an extremely thick spinous process with a very large dorsal tubercle. The lumbar vertebral body is cranio-caudally long with a well-developed median ventral keel. Transverse processes arise from the dorsal margin of the body. These lumbar features are common with *Proconsul nyanzae*. However, *Nacholapithecus* lumbar vertebrae are unique in their more caudally positioned spinous process base relative to the postzygapophyses. Functional meaning of this feature is unclear. Similar morphology is observed in lorises and *Pongo*. We recently collected one specimen of the first coccyx of *Nacholapithecus*. Its morphologies clearly indicate that *Nacholapithecus* had not external tail. Supported by Grant-in-Aid from the JSPS (#12440245).

#### **The effects of epiphysis shape on femoral diaphyseal proportions in hominoids.**

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It has long been recognized that bone adaptive tissue will react to mechanical forces placed upon it. Knowing this, researchers have reconstructed behavior in fossil animals by modeling long bones, especially femora, as beams using conventional engineering beam theory. They predict that the amount and distribution of bone in the femoral midshaft reflects patterns of strain to which that bone had been subjected. Recently however, Ohman and Lovejoy (2001; AAPA Supplement 31; p. 115) challenged this view by stating while connective tissue cells are acutely sensitive to mechanical stimuli, the morphological characteristics of an adult bone shaft are not a simple reflection of those stresses as is often assumed. Rather, they argue, long bone diaphyseal form merely reflects shape and size of the closest physeal plate. If so, it would not reflect an individual's particular behavior. If it is growth plate rather than activity pattern that determines diaphyseal geometry, then our ability to infer the habitual activity of an individual from bone diaphyseal geometry is compromised. This hypothesis compares external measurements of the middle femoral diaphyses to neck and distal metaphyseal dimensions in chimpanzees, gorillas and humans. No significant correlations were found for most comparisons, suggesting that midshaft diaphyseal shape is independent of femoral neck dimensions and distal metaphyseal shape. Instead, the variation observed support the hypothesis that other factors, such as mechanical environment, are a stronger determinant of diaphyseal form in these hominoids.

#### **Sex determination from the human hip bone: A response to Bruzek.**

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Volume 117, Issue 2 (February 2002) of the *American Journal of Physical Anthropology* included a research contribution entitled *A Method for Visual Determination of Sex, Using the Human Hip Bone* by Jaroslav Bruzek. Although potentially very accurate, the technique is cumbersome and shows similarities to methods that are already commonly employed in osteological research. This study evaluates the utility of Bruzek method and the degree of concordance between this new method and standard techniques utilized by human osteologists. A sample of 110 individuals recovered from the Nubian site of Kulubnarti were examined during the study. Of these, ten individuals were of known sex and 100 were of unknown

sex. All individuals were tested using both the Bruzek method and standard sexing techniques. The results of this study indicate that the Bruzek method produces results that are consistent with other techniques in the majority of cases and provides few advantages over procedures already in use.

#### **Cranial base sexual dimorphism: Size and shape and their taxonomic significance.**

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This study tested the null hypothesis that patterns of sexual dimorphism in the cranial base are consistent within the living members of the *Pan/Homo* clade. The sample comprised 329 adults from *Pan troglodytes*, *Pan paniscus* and four groups of modern humans from Africa, China, Europe and Australia. Twenty seven linear measurements and angles were taken from radiographs or directly from the specimens. The size of the individual was based on the geometric mean of 54 linear variables from the base and face. Within *Pan troglodytes* there was significant sexual dimorphism in the overall size of the cranial base, and to judge from the residuals of the individuals from the geometric mean, there were also sexual differences in shape. This contrasts with the effective lack of both size and shape sexual dimorphism in the cranial base of *Pan paniscus*. Within the sample of modern humans there was significant sexual dimorphism in size. Approximately half of the shape differences were size related, the remainder being independent of size.

These preliminary results suggest that within the living representatives of the *Pan/Homo* clade there is no single pattern of sexual dimorphism. If this finding is substantiated by further analysis it will complicate attempts to interpret cranial base variation in fossil hominins. Supported by NSF IGERT Grant No. 9987590.

#### **Inter-tooth distribution of linear enamel hypoplasia in non-human primates.**

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Examinations of the inter-tooth distribution of enamel hypoplasia in humans have provided consistent evidence regard-

ing which teeth are most affected. Goodman and Armelagos (1985), Duray (1992), Mack and Coppa (1992), and Al-Abbasi (1997), among others, found the highest frequency of defects in the maxillary central incisors, followed by the mandibular canines. Following this pattern, recent analyses of linear enamel hypoplasia (LEH) in non-human primates have often focused on the maxillary incisors and mandibular canines (e.g., Eckhardt 1992).

The present research examines the suitability of this restricted focus for studies of LEH in non-human primates. Data were collected from the full dentitions of 3,375 wild-caught specimens derived from 117 taxa. LEH frequencies are calculated for each tooth, within each species. To determine inter-tooth frequency differences between taxa, average frequencies are calculated for each tooth in larger taxonomic groups. While these analyses indicate that the tooth classes most often affected by LEH are distinct across non-human primate taxa, in contradistinction to humans, canines and premolars have the highest frequencies of LEH for the order. Of equal importance, at all taxonomic levels, mandibular teeth have significantly higher frequencies of LEH than maxillary dentition ( $p < .001$ ). Because of the differential manifestations of LEH observed between teeth, between jaws, and between taxa, this research includes an examination of the factors, both physiological (e.g., timing and duration of crown development) and structural (e.g., size and shape of crown), that may contribute to an explanation of these disparities.

#### **Social and historical factors for clay pipe smoking among residents of a late nineteenth and early twentieth century almshouse.**

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The Albany County Almshouse skeletal sample is an invaluable source for determining the health and behavior of the poor during the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. One common practice was clay pipe smoking, evident from semicircular wear facets on the dentition. This is a demographic and historical analysis of tobacco smoking habits among the underprivileged residents of Albany County.

Out of 325 observable individuals, 39% exhibit pipe stem wear, with the majority of wear facets on the canines and premolars. The minimum age that wear is observed is 18, with individuals 30-49 exhibiting the most wear, followed by individuals over 50. The difference in the occur-

rence of wear between age groups is not significant, but the degree of wear is proportionally higher in older individuals. There is no significant difference between the sexes, with 42% of males and 34% of females exhibiting pipe stem wear.

Since the majority of the skeletons date between the 1870's and the 1920's, the high rate of pipe smoking among females is remarkable considering tobacco was generally disused by women in the later part of the 19<sup>th</sup> century. Almshouse records reveal that many residents were immigrants from Europe, where pipe smoking was still common in the late 19<sup>th</sup> century. The high rate of pipe smoking in both sexes may also be attributed to poverty- pipe tobacco was inexpensive compared to cigarettes, which were more fashionable. Pipe smoking may have been additionally facilitated by the Almshouse administration, which purchased large amounts of smoking tobacco yearly.

#### **Using history to explore controversial topics in physical anthropology courses.**

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This paper focuses on the advantages of using historical case studies as a strategy for dealing with controversial topics in physical anthropology courses. Introductory-level and general education physical anthropology courses inevitably deal with a variety of topics that are controversial for at least some students. The idea that humans are animals, that humans are the evolutionary product of a variety of natural processes, that human natural history spans millions of years, that the earth itself is unimaginably old, that more conservative interpretations of religious writings very familiar to most students are contrary to modern scientific conclusions regarding the origin of the world and humans and that the biological race concept is virtually impossible to apply to humans represent some of the more obvious topics that generate some degree of negative student reaction in our courses. Incorporating the historical development of many of these controversial ideas into a course has several advantages for dealing with ideas that can be both emotionally laden and intellectually challenging for students. Helping students understand the historical context in which many of these ideas developed and some of the controversy and criticism they generated in the past actually serves to deflate some of the emotion associated with them. Using historical case studies that mirror objections and criticisms still being made

today often enables students to better distance themselves from those objections and criticisms and consider them more objectively. This paper suggests some examples of such historical case studies.

#### **The anterior pillar of *Australopithecus africanus* - A mechanical support?**

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The anterior pillars are well developed bone columns on both sides of the nasal aperture, described by (1) in *Australopithecus africanus* and *Paranthropus robustus*. It is commonly accepted that the anterior pillars support the anterior portion of the palate during occlusal load. This hypothesis is not supported by biomechanical investigations. Based on CT-scans of Sts 5 (*A. africanus*), we determined the maximal stress in maxillary cross sections through the anterior pillar at different levels and angles. The maximal stress corresponds to the sum of direct compression and bending stress exerted by maximal symmetrical bite and muscle forces (medial pterygoid, (2)). In order to rate the mechanical purpose of the anterior pillar, we compared it with two simulations of reduced pillars (anteriorly reduced, and hollow/posteriorly reduced). The anteriorly reduced pillar provides the highest stress (maximally 14 MPa), 1.3-2 times as high as the intact pillar stress (5-7 MPa) during incisor bite. The stress reduction by a factor of two is favouring the formation of a pillar; however, the yield stress of cortical bone is about ten times higher than the observed. Thus, this safety factor is not used up by the simulated reduction of the bone. This result questions the function of the anterior pillars as supportive structure during maximal load on the teeth.

(1) Rak Y (1983) *The Australopithecine Face*. New York: Academic Press, (2) Fuss F. K., Niegl G. (2001) *IFMBE Proceedings*, Vol. 1, Part 2, pp. 608- 611. Eds. Magjarevic R. et al. Croatian Medical and Biological Engineering Society, Zagreb.

#### **3D geometric morphometric analysis of hand joint surfaces and visualization of Neandertal thumb and index finger movements.**

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Human hand joints are difficult to analyze because they have few natural landmarks. A grid is projected onto Late Pleistocene human (including Neandertal) and recent human carpometacarpal joint surfaces to provide identifiable landmarks for digitizing. The 3D landmark coordinates are used in the Morphologika software program (O'Higgins & Jones, 1998) for a Procrustes superposition of the landmarks and a principal components analysis of Kendall's tangent space coordinates (Kendall, 1984). The principal components scores are analyzed to test the null hypothesis of between-sample equivalence of joint shapes. Morphed 3D Procrustes mean joint shapes identified by the principal components analysis are visualized with the Morphologika software. The identification of functionally significant between-sample differences in joint shapes and/or orientations can yield important behavioral inferences (Niewoehner, 2001).

Modeling the range of possible Neandertal finger and thumb movements requires 3D visualization. Laser scans of casts of the La Ferrassie 1 Neandertal right thumb (trapezium, metacarpal, and phalanges) and index finger (metacarpal and phalanges) are used in a 3D authoring/animation computer program (Maya Unlimited). The scans are moved into their anatomical positions and a center of rotation is assigned to each joint using the software's animation tools. Assigning flexion/extension and abduction/adduction values to each joint controls thumb and finger movements. Using conservative values for joint range of motion results in tip-to-tip contact of the thumb to the index finger, indicating Neandertals were physically capable of modern human-like precision grips.

This research is supported by the L.S.B. Leakey Foundation, the N.S.F., and CSU-SB.

#### **Arbovirus surveillance in free-ranging howling monkeys, with a case study of the seroepidemiology of vesicular stomatitis virus.**

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Virologists have hypothesized that "persistent" viral infections--those that have co-specified with, are well-adapted to, and asymptomatic in their reservoir host species--represent potential emerging infectious diseases (EIDs) in tangential hosts like humans. Recently, it has been suggested that field studies of nonhuman primates can play an important role in understanding cross-species transmissions. This paper reports on an arbovirus

surveillance study of free-ranging howling monkeys (*Alouatta palliata*) in Costa Rica. Immunoassays for mosquito-borne flaviviruses (dengue fever serotypes, yellow fever, West Nile virus, St. Louis encephalitis), alphaviruses (eastern, western and Venezuelan equine encephalitis viruses), and a rhabdovirus (vesicular stomatitis virus: VSV) are employed to explore the genetic epidemiology and immunology of concurrent arboviral infections.

This paper reports preliminary data on the seroepidemiology of VSV in a well-studied howler population. Serologic and demographic data are utilized to examine risk factors and evaluate hypotheses, e.g., that the New Jersey strain of VSV occupies an endemic ecological zone in riparian forests. These data were collected in 1992-3 and again in 2001 on many of the same individuals. Demographic and ecological parameters include: age, sex, parity, reproductive status for females, weight, forest type, and season of capture. Like human populations in endemic VSV areas, a high percentage of the monkeys are infected. Interestingly, females are more likely to be seropositive and to have higher antibody titers. The value of such studies for understanding local human disease incidence, the synecology of arboviral pathogens, and for addressing issues in primate conservation will be discussed.

#### **Correlation of fecal testosterone levels with age in white-faced saki males (*Pithecia pithecia*).**

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Intraspecific variation in pelage color follows two developmental patterns in primates. Infants may exhibit a different color than adults and attain the adult pattern after weaning or the sexes may gradually diverge during development so that they are phenotypically distinct by adulthood. The proximate mechanism leading to sexual dichromatism in males is presumably triggered by increasing levels of testosterone (T) during development, however male white-faced sakis exhibit the trait well before sexual maturity. We report developmental fecal testosterone (fT) profiles and adult fT levels for six white-faced saki males (*Pithecia pithecia*) housed at Pittsburgh Zoo and Aquarium. Fecal samples were collected weekly for 10 months on three males < 13 months of age. Samples were also collected opportunistically from three adult males rang-

ing in age from 40 to 144 months. While the literature suggests that T levels should increase briefly postnatally and then decline until puberty, the young saki males showed a gradual increase in fT levels (range: 1.5 to 80.4 ng/gm). Age and fT levels were significantly correlated for the three young males (Spearman  $r_s = 0.34$ ,  $p < 0.01$ ,  $n = 125$ ) and for all six males ( $r_s = 0.65$ ,  $p < 0.01$ ,  $n = 201$ ), but not for the three older males > 30 months of age ( $r_s = -0.09$ ,  $n = 76$ ). We have yet to correlate the development of the white face with T levels, but these preliminary results suggest that progressive increases in T may underlie both the process of changing facial coloration and explain individual variation in the development of the trait.

#### **Human skeletal remains from a third century Roman CAVE necropolis in Croatia.**

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The cave site of Bubijeva Jama is located near the town of Karlovac, in continental Croatia. The 1999 excavation revealed scattered and commingled human remains, coins, iron keys, a bronze fibula, a silver pin, pottery sherds, and faunal remains (Perkić 2001). The coins indicated a minimum date of A.D. 259, corresponding to a time when this region was part of the Roman province of Pannonia Superior. During the Roman period, cremation and inhumation were the primary mortuary practices, and thus the burial context of the Bubijeva remains was inconsistent with traditional Roman funerary practices. The anomaly of the grave led to hypotheses of mass killings, plague, and disposal of slaves.

Our subsequent analysis of sampled human remains identified 477 bones/fragments and 325 teeth from adults and subadults, for a MNI of 35. The majority of the remains were from young adults, followed by old adults, and finally subadults. The sex ratio was nearly equal, with only a slightly higher number of males than females. Pathological analysis indicated no evidence of perimortem trauma or infectious disease, and degenerative conditions were limited. There was a positive correlation with age for the number of dental caries and ante-mortem tooth loss. Given these findings, the hypothesis that the remains were

those of slaves was rejected by the nature of the grave artifacts. Our skeletal analysis rejected the hypothesis of a mass killing, although we could not reject the hypothesis that the individuals died of plague, which ravaged the area from A.D. 250 to 270.

#### **Diagenetic alterations in archeological human skeletal remains via light microscopy and their implications.**

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Compact bone is the preferred study material for isotope and chemical analyses to reconstruct paleodiet and paleoenvironment. As discussed in the literature, the results of such analyses can be hindered due to diagenetic alterations caused by dissolving and recrystallization phenomena. Although post-mortem alterations of buried bone have been carefully studied in these last few years, they are still not very well understood. The aim of the present study is the quantification of microstructural features in light microscope images of histological cross sections of compact femur bone by using an image analysis software package (KS 300 ZEISS).

The samples were taken from skeletal remains buried in three different sites in eastern Austria. They are characterized by different repository materials and originate from different culture periods (loess in the Neolithic site Schletz; river gravel in the Early Bronze Age site Franzhausen; humus in the Medieval site Gars). A total of 71 midshaft femur bone samples were investigated. The histological cross sections were analyzed for their collagen structures using polarized light and regions of putative microbial activities (appearing as dark spots with blurred boundaries). The microstructure changes thus determined differ considerably depending on the repository material and the bronze from grave goods (whenever present). These identified collagen features have been chemically analyzed so as to quantitatively determine the histological content.

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### **Obstetrics and pelvic dimensions in prehistoric Inuits.**

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Cephalo-pelvic disproportion is a major cause of complications during parturition, frequently leading to stillbirths and maternal death. In traditional societies where modern medical services are not available, such disproportions are considered a strong selective agent against women with small pelvic dimensions. The obstetric literature suggests that cephalo-pelvic disproportion affects short women more frequently than tall women. However, attempts to link pelvic dimensions with osteological correlates of stature and body size do not necessarily yield high correlations.

This study examines pelvic dimensions and nonpelvic measures of body size in a sample of 100 prehistoric Inuit skeletons. These Inuit remains, from Point Hope, Alaska, are associated with the Ipiutak and Tigara cultures. The earliest components of this collection date to approximately 300 B.C., with later components dating to the pre-contact period of Arctic Alaska.

Previous osteological studies have used several skeletal measurements as proxies for overall body size and mass in examining their relationships to female pelvic dimensions. Comparative analyses in this study used clavicular length as a proxy for transverse chest diameter, and femoral-head diameter cubed is used for body mass. Preliminary results suggest that there is a positive allometric relationship between transverse chest diameter and the pelvic midplane in females, but the relationship between these variables in males is not statistically significant. Additionally, in females there is a strong correlation between femoral-head diameter cubed and the pelvic midplane, but not in males. These results suggest that larger females had some obstetric advantage over smaller females in this particular population.

### **Sociality and infectious disease in wild primate populations.**

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Natural populations of primates harbor an amazing diversity of parasites and infectious diseases, yet little is known about host traits that influence the evolution and ecology of parasite communities.

To examine the role of disease in primate mating and social systems, we tested the relative importance of four sets of host traits that have been forwarded to explain differences in parasite community diversity: (1) social factors that influence the probability of transmission and infection, specifically population density, group size, and mating behavior, (2) host body mass and life history, under the assumption that hosts are "island habitats" for parasites, (3) trophic transmission of parasites, particularly among primates that consume insects, and (4) habitat diversity, using data on host geographic range size, home range size, and day journey length. To test hypotheses, we compiled a data set on the parasites of primates that includes 941 host-parasite combinations involving 231 parasite taxa and 101 primate species. Our analyses controlled for confounding variables, including sampling effort and phylogeny. Parasite species richness was associated with body mass, indicating that larger hosts provide larger or more diverse habitats for parasite colonization. However, these results were non-significant after controlling for host phylogeny. Among the other host traits, population density was significantly associated with overall parasite species richness and the diversity of helminths, protozoa, and viruses, and these results remained significant after controlling for phylogeny. Our results therefore demonstrate the essential role of social contact in understanding disease risk, as predicted from basic epidemiological models.

### **Warriors of the clouds? Inferences and interpretations of trauma from Chachapoyas, Perú.**

K.C. Nystrom<sup>1</sup>, J. W. Verano<sup>2</sup>. <sup>1</sup>University of New Mexico, <sup>2</sup>Tulane University.

Characterized by their conquerors as strong and powerful, the Chachapoyas of northern Perú have come to us cast in the role of fierce warriors. Assimilated into the Inka Empire 60 years before the arrival of the Spanish and the written word, the description of the relationship between the Inka and the Chachapoyas comes from the victors, and as such, may represent a tainted view. Are these historically applied appellations accurate, or do they represent the revisionist history of conquerors? In this study, we examine craniofacial trauma and trepanation rates from two different sites in the Chachapoyas region. The first site, Kuelap, has a long history of archaeological interest largely due to its impressive 'fortifications'. Out of a sample of 104, 17%

of the individuals suffered craniofacial trauma, while an additional 8% displayed evidence of trepanation. The second site, the more recently discovered Laguna de los Cóndores, exhibits only an 8% craniofacial trauma rate, while trepanation appears to be absent. These 'warrior' populations are compared to roughly contemporaneous samples from the central highlands, which exhibit much higher frequencies of craniofacial fractures and trepanations. The results from this research are discussed in light of ethno-historical evidence, contributing to our growing understanding of Chachapoyas bioarchaeology.

### **A preliminary investigation of wildlife, domestic and human use of the Sinya Mine Water Pools in Tanzania.**

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Presently, when protecting endangered species or habitats, humans and their domestic animals are usually excluded despite the fact that humans and wildlife have lived along side each other for centuries, but can wildlife exist along side with humans? Between 1956 and 1980 there was an active open-pit mining project in Sinya (northeastern Tanzania). When the mining ended, the pits filled up with water due to the high water table of this region. The pools now serve as year round water sources for wildlife and domestic animals. Sinya, a semiarid acacia scrub habitat, is occupied by traditional Maasai pastoralists, and is the site of a tourist concession that provides local Maasai with a significant tourist income.

A preliminary investigation of the mine pool habitat was conducted in June-July, 2002. Five of nine pools were observed for 87 hours. The focus was to identify the use of the pools as a sustainable water resource by both domestics and wildlife. Seventeen wild mammalian species, 35 species of birds, and five domestic species used the pools regularly. We identified the drinking cycles of domestic and wild species and the number of individuals observed drinking from the pools. These novel fresh water sources sustain a large number of individuals. Preliminary observations and interviews of local Maasai and tourist operators suggest that wildlife populations are increasing (from both high fecundity rates and emigration into the area) despite the presence of domestic animals. Pool use data indicate a complex, articulated and interactive pattern of drinking activities.

### Evolution vs./and creation: Do students have to choose?

B.H. O'Connell. Hamline University.

In a famous talk in 1959, C.P. Snow described the "two cultures" that divide the sciences and the humanities. In a 1984 essay, John Maynard Smith argued for the value of science and myth. In a 1997 essay, Stephen J. Gould used the concept of "nonoverlapping magisteria" to create a rapprochement between scientific and religious views of origins. Still close to half the American public rejects evolution. In addition, students enter introductory courses in physical anthropology and human evolution with a dichotomous view of knowledge and misconceptions about the practice of science. Some science educators (Alters & Alters 2001) believe the rejection of evolution is based on specific misconceptions about evolutionary science.

An introductory course on human evolution that fulfills the natural science general education requirement at a small liberal arts college is discussed. A series of laboratory and lecture assignments are described that introduce the scientific method by utilizing a survey, "Ideas About Humans," that assesses general knowledge about science, evolution and the nature of humans. Students develop hypotheses, collect survey data and test the relationship among various variables using chi-square tests. Students then read and attempt native exegesis of creation myths from various cultures. Finally, an exercise of application is described that involves writing a position statement regarding the teaching of evolution in the form of a letter to a school board or a legislator. The effective outcome of these exercises is discussed with reference to student response to specific knowledge questions and student evaluations.

### Asymmetry in the humeri of tennis players: 'Wolff's Law' or not?

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Some degree of left/right asymmetry should be expected between paired bones, but what is perhaps remarkable is that only minimal asymmetry is generally expressed given up to two decades of independent development. When marked asymmetry is noted among individuals

who exhibit a known behavior, that asymmetry is assumed, by invoking Wolff's Law, to be the direct product of the behavior. One example often cited as a demonstration of Wolff's Law is that of Jones, *et al.* (JBJS 59A: 204-208, 1977) who observed humeral asymmetry in a group of tennis players; that is, the playing arms of these tennis players were somewhat more robust as a result of the stresses placed upon them. Given the data provided by Jones, *et al.*, the cross-sectional areas of the playing humeri are greater, but the additional bone appears to be almost equally distributed between the periosteal and endosteal surfaces of the playing arm (in males, 25.7% greater periosteally versus 20.1% endosteally; in females 18.3% periosteally versus 17.6% endosteally). This does not conform to the Wolffian prediction of increased strength with economy of bone. For more than a decade, our growing knowledge of evolutionary developmental biology has contributed substantially to the virtual "demolition of the validity" of Wolff's Law (Currey, J.D., 2002, *Bones*; Princeton University Press; P. 159). We here explore alternative explanations of the "tennis player phenomenon."

### Forest degradation and demographic changes in *Ateles geoffroyi* at Estación Biológica La Suerte, Costa Rica.

T. O'Mara. Dept. of Anthropology, Grand Valley State University.

*Ateles* utilizes one of the largest community ranges in the Americas. Large ranges are necessary due to *Ateles'* high frugivory and the patchy, unpredictable nature of fruiting. Elimination of half of a community's range could be detrimental to *Ateles'* survival. Such a situation exists within the Large forest at Estación Biológica La Suerte, Costa Rica (EBLS). The EBLS forest (100 Ha) is divided into the 30 Ha Large Forest (LF), owned and managed by EBLS and the privately owned 70 Ha German Forest (GF) which is currently being logged intensively. This study compares Pruetz's (2000) baseline demographic data on *A. geoffroyi* with data collected since logging began. Line transect surveys were conducted over established trails within the LF and GF on a community of *Ateles geoffroyi*. Data were collected on group size, composition, diet, activity, and ranging, and then compared to Pruetz's (2000) baseline data.

Results are comparable to Pruetz's data, with slight increases in mean subgroup size and overall population density. Mean subgroup size was 3.18 with a

range of 1-8. Mode subgroup size was 2. At least 1 adult female was observed in 76% of subgroups. Male-only subgroups were observed 12% and solitary animals 5% of total observations. Minimum population size was 13 individuals. Population density estimated is at 13-18 individuals/km<sup>2</sup>.

Initial results suggest deforestation in greater than one-half of *A. geoffroyi's* possible range has had little effect on their demography and ranging patterns. However, deforestation is only in its first stages and further logging may well impact *Ateles* survival.

### Radiographic reconstruction of human long bone cross-sectional geometric properties: A test of two non-invasive techniques.

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Cross-sectional geometric properties (areas, second moments of area) have been used extensively for reconstructing the mechanical loading history of long bone shafts. In absence of a fortuitous break or available CT facilities, the endosteal and/or periosteal boundaries of a bone may need to be approximated. The present study tests whether cross-sectional geometric properties can be adequately estimated using two noninvasive techniques: biplanar radiography alone, using a simple elliptical model, and molding of the subperiosteal contour in combination with biplanar radiography, in which the medullary cavity is reconstructed using a simple ellipse. The results are analyzed against properties calculated from their digitized cross-sectional images.

50 individuals from the Pecos Pueblo, New Mexico site were selected from a previously analyzed sample (Ruff, 1981). Cortical areas (CA) and second moments of area (I<sub>x</sub>, I<sub>y</sub>, and J) were calculated for femoral midshaft and subtrochanteric sections and at tibial midshaft using each technique. Percent differences between techniques were calculated, and paired *t*-tests used to evaluate the significance of technique differences.

The biplanar radiographic technique significantly overestimated the true cross-sectional geometric properties for all variables ( $P < 0.0001$ , *t*-tests), with differences averaging 20-26% for CA and 25-51% for second moments of area. In contrast, the subperiosteal molding + radiography technique produced much smaller differences from true values, averaging 26%, with a majority non-significant ( $P > .05$ , *t*-

tests). Thus, while elliptical approximation of periosteal contours in irregular sections such as those of the present sample is unwarranted, periosteal molding in conjunction with endosteal approximation yields acceptable error magnitudes when compared to true values.

**Knuckle-walking anteaters? Testing the hypothesis of adaptation for purported knuckle-walking features using a non-primate model.**

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Appeals to features of the wrist shared by the African apes, early hominins and modern humans as evidence of a knuckle-walking ancestry for the hominin lineage rely on accurate interpretations of those features as adaptations to knuckle-walking locomotion. However, because *Pan*, *Gorilla* and *Homo* share a close common ancestor, the interpretation of such features is confounded to a degree by phylogeny. This study examines the evolution of a similar locomotor regime in New World anteaters (Order Xenarthra, Family Myrmecophagidae) and assesses the feasibility of using it as a convergence test of adaptation for purported knuckle-walking features.

Although not identical to locomotion of the knuckle-walking apes, observations of the terrestrial giant anteater (*Myrmecophaga tridactyla*) suggest that loads in stance phase are transmitted through flexed digits and vertical metacarpals, with hyperextension occurring at the metacarpophalangeal joints of the weight bearing rays. This differs from locomotion in smaller, arboreal anteaters, of the genus *Tamandua*, that walk on the sides of their hands with wrists extended. This allows for interpretation of features in *Myrmecophaga* that may be analogous to those of the apes thought to facilitate load transmission or limit extension of the hand and wrist. These include a pronounced dorsal ridge on the MC4 head, volar slant of the distal radius resulting in a distally extended dorsal ridge and expansion of the nonarticular surface of the dorsal capitae. Although *Myrmecophaga* has a fused os centrale, this trait is common to all xenarthrans and is not supported as an adaptation to knuckle-walking in myrmecophagids.

**A comparison of morphometric data and methods in classification.**

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Anthropologists have used Discriminant Function Analysis (DFA) of craniometrics to describe human variation and classify remains for several decades. FORDISC demonstrates the utility of DFAs of conventional craniometrics to assess ancestry and sex in a forensic context. DFAs using interlandmark distances (ILDs) contain more information and perform better than conventional measurements, especially on fragmentary remains (Mann and Ousley 2001). Geometric morphometric analysis (GMA) retains the most information from three-dimensional landmark coordinates but has been used primarily to explore shape variation among groups, ignoring size. In forensic anthropology, the practical value of DFA is measured by the accuracy of predicted classifications, rather than in assessing shape differences. This study compares the value of conventional measurements, ILDs, GMA, and GMA with size (GMA<sub>sz</sub>) in DFA.

Forty eight landmarks from 220 crania were digitized. Principal components (PCs) were extracted from the common set of landmark data in all data sets. Deviations from the mean form using GRF-ND were used for GMA. Using the PCs that represent 95% of the total variation, the four-way DFAs for sex and ancestry were ranked GMA<sub>sz</sub> (77% correct jack-knifed), conventional (75%), GMA (73%), and ILDs (67%); stepwise selection of PCs were ranked GMA<sub>sz</sub> (82%), conventional (80%), GMA (77%), and ILDs (75%); using the original variables and stepwise selection, GMA<sub>sz</sub> (91%), GMA (86%), conventional (85%), and ILDs (83%).

Data expressing both size and shape are necessary for correct classifications. Each of the data types has caveats in terms of multicollinearity, multivariate normality, noise, and recording size and shape differences.

**The influence of patch entry order on feeding priority in three prosimian species in southeastern Madagascar.**

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Erhart and Overdorff (1999) hypothesized that among Malagasy prosimian primates, females may be able to establish feeding priority over males by leading group movements and arriving to food patches first. Here, we present data on female dominance, group movements, and the possible feeding advantages gained by

entering a food patch first in three prosimian primates in southeastern Madagascar (*Propithecus diadema edwardsi*, *Eulemur fulvus rufus*, and *Varecia variegata*). The influence of order on feeding rate was compared in all three species from January-June 2002. Of these three species, *P. d. edwardsi* and *V. variegata* demonstrate clear female dominance; dominance patterns in *E. f. rufus* are less clear. In *P. d. edwardsi* and *V. variegata*, the dominant adult female in each study group was observed to enter food patches first more often than males. In contrast, an adult male and female *E. f. rufus* entered food patches first equally; these male and females were also each other's preferred partners. There was a trend that first arrival to a patch confers some benefit in terms of higher feeding rate in *P. d. edwardsi* and *V. variegata* ( $p < .06$ ). This trend reached statistical significance in *E. f. rufus* ( $p < .01$ ). We suggest that feeding priority can be facilitated either by female dominance (*P. d. edwardsi*, *V. variegata*) or by preferred partners (*E. f. rufus*). Differences in strategies used may be related to body size, reproductive differences between species, and/or degree of group cohesiveness.

We thank National Science Foundation and University of Texas-Austin.

**Dental anthropology of the prehispanic Canarian islandscape: Tracking population dynamics and lifestyle.**

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Previous dental morphology studies suggest both marked heterogeneity and marked homogeneity between Canary Island populations, while analyses of dental pathology indicate diversity in diet within the archipelago. However, dental anthropology's potential for addressing population history and lifestyle in ancient Canarian human groups has been insufficiently explored, as these studies lack temporospatial depth, are often restricted to single islands, and are independent of cultural context. A combined population-biology/life-history approach was therefore developed in order to provide a more refined review of population dynamics and lifestyle across the islandscape. This was contextualised within a temporal and cultural framework, designed to permit the testing of settlement hypotheses derived from archaeological remains, and also to overcome the effects of time averaging. 1134 jaws (MNI 625) were assessed using ASUDAS and the caries scoring

system devised by Hillson (2001). This analysis suggests that ancient Canarian populations occupied a position intermediate between complete isolation and full inter-island integration, that temporal variability in population biology was caused by sporadic migration between the islands and from Northern Africa, and that dental pathology and diet varied according to gender and island ecology. The study also indicates that traditional approaches to population history analysis are not always appropriate for the study of islandscapes, and that it is unwise to apply specialist methodologies without considering historical, cultural and environmental context.

**Ghosts of the past: Temporal muscles, fasciae and bones in some primates.**

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Fasciae are hard to dissect and therefore poorly known. In 16 monkeys and apes the temporal fascia attached above to the superior temporal line and covered a fleshy superficial temporalis muscle. In 365 humans, however, the temporal fascia was a multi-laminar structure arising from both temporal lines and the bone between, and covering the temporal muscle and its fan-shaped tendon. It seems to be a compound structure comprising the sheets on each side of a non-existent superficial muscle and on the existing muscle. In 35 of 400 cadavers, anomalous muscles were found within this fascia supporting the idea of superficial muscle loss. When, in human history, did the superficial temporal muscle disappear? Since fossil muscles are rare this cannot be answered directly. However, fascial attachments are reflected in bone surface features. In non-humans the region between the temporal lines is similar to other regions where fleshy muscles arise. In humans the vertical fibres in the fascia are bound down to the region between the temporal lines. The bone therefore shows fine vertical striae where a superficial muscle is absent.

If would be interesting to know if preservation of surface features is good enough to suggest which of australopithecine, habiline, erectus, Neanderthal, etc, fossils still retained or had lost the superficial muscle. The timing of its loss might relate to human developments in types of diet, mastication, food preparation, cooking, and other functions of the jaws. Thanks are due to Kenneth Chan and

James Moore. Supported by Australian Research Council funds.

**The role of morbidity in the mortality decline of the 19th century: Evidence from the Gibraltar garrison.**

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The 19th century decline of mortality has posed an intriguing problem for population scientists since McKeown hypothesised that modern medicine played no part in increasing longevity. His thesis was that industrialisation of the food supply, and the sequelae of lower prices and increased population nutrition, were the driving forces for population growth. McKeown, and those who disagreed with him, depended almost exclusively upon mortality figures to set out the logic of their conclusions. Evidence from the 19th century garrison of Gibraltar looks at morbidity, or the rates of admissions into hospital, in addition to deaths, to investigate the behaviour of mortality during the decline. Throughout the 82 years, total mortality and morbidity dropped, but at different rates. Furthermore, categories of diseases did not fall in concert and, in some categories, morbidity rose as mortality dropped. Regression analysis highlights the categories of diseases that were most influential in the decline of mortality. The data, coupled with analysis of reports by army medical officers, suggest that, in addition to sanitary improvements, changes in medical practice were effective in reducing the mortality of the men of the garrison of Gibraltar.

**Does hearing play a role in insect predation? An assessment of the relationship between external ear morphology and foraging behaviors in nocturnal prosimians.**

A.K. Palmer, M.N. Muchlinski. Dept. of Anthropology, University of Texas at Austin.

Various authors (e.g. Laskinsky, 1960; Schultz, 1969; Ankel-Simons, 2000) have noted differences in the external ear morphology of nocturnal prosimians in terms of relative size and shape, mobility, presence/absence of specific auricular structures (most notably cross-folds), and the presence/absence of fur covering the ear and/or the external auditory meatus. While hypotheses have been suggested, no systematic assessment of the functional significance of these differences have been undertaken.

In intrageneric comparisons among galagids, tarsiids, cheirogaleids, and lorises, Lemelin (1996:508) demonstrated that the more faunivorous taxa have relatively longer manual digit indices than their "more frugivorous closely related congeners." Our study uses a similar approach by computing an index of ear length to total head and body length for 140 primate taxa to determine if there are relative differences among them in ear length both taxonomically and dietarily.

Our results indicate that prosimians have relatively longer ears (higher ear to head and body length indices) than do anthropoids. However, faunivorous nocturnal prosimians have the highest indices among all taxa and exhibit intrageneric differences that appear to be associated with the percentage of invertebrate prey in their diet. For example, *Galago senegalensis* has a higher index than that of its more frugivorous congener *G. alleni*. Because it has been previously demonstrated that allometry and latitude do not affect prosimian ear length (Palmer and McCrossin, 1996), the current study suggests that an auditory component to insect foraging may influence external ear morphology in faunivorous nocturnal prosimians.

**'Friendship' behavior as a reproductive strategy in savanna baboons: Intraspecific variation.**

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A common feature of savanna baboon social systems is the close affiliative relationship between anoestrus females and adult males, commonly known as 'friendships.' The adaptive significance of these relationships for females remains unclear. It has been suggested that friendships enhance female reproductive success through anti-infanticide protection in chacma baboons. Current data, however, reveal that risk of infanticide varies considerably across baboon populations, suggesting alternative functions for friendships in other populations, such as discouraging harassment from young adult males or other female rivals. I present behavioral data from an ongoing comparative field study of the olive baboon (*P. hamadryas anubis*) in central Kenya and the chacma baboon (*P. h. ursinus*) in northern Botswana. In these two populations, the nature, temporal patterning, and mechanisms of this social relationship differ. For example, friendships in chacma baboons are generally more cohesive and arise through a greater invest-

ment of females in maintaining the relationship. The implications of interpopulation differences for evaluating alternative functional hypotheses for female friendship behavior will be discussed. Likewise, the reproductive significance of friendships for male partners is unclear. The "Parental Effort" hypothesis suggests that males are the fathers of their female friend's young, while the competing "Mating Effort" hypothesis argues that males are unrelated to their current friend's infant, but may sire her subsequent offspring through female choice. Preliminary genetic data addressing the paternity of females' infants are presented in order to address this question.

**Miners or mine owners- Do the Hallstatt skeletons reflect occupation and social structure?**

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Musculoskeletal Stress Markers (MSM) can provide information about habitual activities of past populations. The MSM result of occupational hyperactivity and appear as pittings on the bony cortex where a muscle, tendon or ligament inserts. They are also known as "stress lesions" or "enthesopathies". MSM were recorded on the skeletons from the Hallstatt (Austria) cemetery, dating 800-400 B.C., located on a mountain next to the salt mines. There is no proof whether the people buried there with wealthy grave goods also worked in the mines. 34 muscle and ligament sites on the 99 skeletons (48 male, 24 female, 27 unsexable adults) were examined for occupational stress markers type and severity according to Hawkey (1995).

The results show a specifically strong MSM score pattern in the Hallstatt skeletons, indicating a laborious lifestyle of the population examined. The ranked MSM scores show, that the Hallstatt males used their *triceps brachii*, *pectoralis major* and *latissimus dorsi* heavily, muscles that are needed, for example, in wood chopping. This movement is likely to resemble closely mining salt with a bronze pick. Interestingly, the Hallstatt females showed higher scores in muscles important in lever arm movements, like the *biceps brachii* and the *brachialis*. This could indicate the women having carried heavy loads. A division of labour could possibly be interpreted here. This combination of heavy working people and rich grave goods is in contradiction to modern conventional views that miners cannot be

wealthy. Accordingly, we should be more careful with identifying social structure solely by burial goods.

**Franchthi Cave, Greece: The human population from the Upper Paleolithic to the Final Neolithic.**

A. Papathanasiou. Ephorate of Speleology and Paleoanthropology, Athens.

Franchthi Cave located on the coast of the Argolid peninsula in southern Greece was investigated from 1967 to 1979. The cave and the surrounding settlement were occupied from 25,000 to 5,000 B.P., extending from the Upper Paleolithic until the Final Neolithic Age. The site yielded well preserved but fragmentary human osteological material dating from 10,000 to 5,000 B.P. The Franchthi population consists of formal burials and scattered bone yielding a minimum number of 60 individuals including two Paleolithic, thirteen Mesolithic, 25 Early and Middle, four Late, and fourteen Final Neolithic, as well as two recent individuals. Of these individuals, 38 are subadults (seventeen are under one year of age), and 22 adults of which six have been identified as probable males and six as probable females. The mean adult age is 32.5 years.

The observed pathological conditions include high incidence of cribra orbitalia (45%, 10/22), porotic hyperostosis (20%, 14/71), trauma (15%, 9/60), industrial wear of the front teeth (12% 16/131), pre-mortem tooth loss and osteoarthritis, and relatively low incidence of dental caries (2.4% 11/458), LEH (6.8% 31/458) and infection.

A paleodietary reconstruction has been performed, using carbon and nitrogen stable isotope analysis of human bone collagen and carbonate apatite on eighteen individuals. The results point to a terrestrial, predominantly C3 diet focused primarily on plant resources with only occasional or periodic exploitation of animal and marine protein resources despite proximity to the sea. Both analyses suggest that the site was occupied by agriculturalists with a land-based subsistence and strenuous lifeways.

This study was supported by a research assistantship from the Wiener Laboratory of the American School of Classical Studies at Athens.

**Copulatory plug displacement: Further evidence for sperm competition in *Lemur catta*.**

J.A. Parga. Dept. of Anthropology, University of Texas at Austin.

In primates, sperm competition (Parker, 1970) is most commonly inferred from large testes size relative to body size (Harvey and Harcourt, 1984). Among strepsirrhine taxa, ringtailed lemur (*Lemur catta*) males have the largest relative testes (Kappeler, 1997), and additionally have ejaculate which coagulates in the female vaginal tract to form a copulatory plug (Evans and Goy, 1968). Copulatory plug formation and *displacement* (plug removal) by subsequently-mating males has been hypothesized to function in sperm competition in *L. catta* (Sauter, 1991; Sauter and Sussman, 1993; Sauter et al., 1999), although actual copulatory plug displacement has heretofore not been witnessed in this species.

This study is the first to document and describe copulatory plug displacement by male ringtailed lemurs. Data were collected during Oct.-Nov. 2000 and 2001 on two groups of free-ranging ringtailed lemurs on St. Catherine's Island, USA. Copulatory plug displacement was witnessed nine times in twenty-two observed mating bouts; plugs were expelled by the mating male's fully erect penis during deep vaginal thrusting. In every case of plug displacement observed, the male displacing a previous male's plug mated to ejaculation with the estrous female. Variation in displaced plug size indicates inter-individual differences in male ejaculate volume. Because coagulated ejaculate conforms to the dimensions of the female vaginal tract (Dixon, 1998), variation in displaced plug shape suggests that different males were intromitted at different depths upon ejaculation. Frequent removal of copulatory plugs by subsequently-mating males calls into question the effectiveness of plugs as barriers to future insemination.

**Getting beyond the warm fuzzies: Teaching the real reasons why there are no biological human races and why it's so important.**

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That human subspecific groups do not exist on a biological level would seem among the least controversial things we teach, yet many students come away still thinking the reason for the nonexistence of biological races has less to do with actual biology than with its seeming support for the philosophical premise of racial equality. In other words, they accept the idea because it makes them feel good. This way of thinking is also true of some colleagues who accept the concept un-

questioned because it seems to jibe with an important moral belief.

The problem with this thinking is two-fold. First, it can bring about a misunderstanding of the scientific data, especially data that indicate differences among populations. Second, so powerful is our folk wisdom coupled with our drive to create categories within sets of variables that, if we only accept the nonexistence of biological races on a philosophical level, we may not have confidence in its literal truth. After all, we still, despite sound scientific data, commonly speak of human variation as if it, indeed, must come assorted into discrete units. The paper discusses these problems and suggests one approach to ensuring that the evidence for the nonexistence of biological races is accurately conveyed and understood.

#### **Skin pigmentation and admixture in five populations with Native American ancestry.**

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We present data on constitutive and facultative skin pigmentation in five populations with Native American ancestry. We measured pigmentation in the upper inner arm and the forehead using a narrow-band reflectometer (Dermaspectrometer) in the following samples: a sample of females primarily of Aymara ancestry from Bolivia, a sample of males and females primarily of Quechua ancestry from two locations in Peru (Lima and Cerro de Pasco), a sample of males and females from the State of Guerrero in Mexico, composed of individuals primarily of Nahua, Tlapanec and Mixtec ancestry, and a sample of Puerto Rican females from New York. We also present data on skin pigmentation in a sample of Hispanic males and females from San Luis Valley in Colorado. In this sample, pigmentation was measured only in the upper inner arm, using a Photovolt model 575 spectrophotometer.

We describe the observed distribution of constitutive and facultative skin pigmentation, and discuss sex-differences in pigmentation. In numerous anthropological studies, skin pigmentation has been

often used as a proxy for admixture. We have genotyped these samples for a panel of ancestry informative markers and we have estimated individual admixture using the program STRUCTURE (Pritchard, Stephens and Donnelly, 2000). We report the relationship of constitutive pigmentation and individual admixture, and discuss its implications for admixture studies. A significant correlation is generally observed between skin pigmentation and individual admixture (estimated with the panel of informative genetic markers), particularly in the samples in which there is a high admixture level.

#### **Nutrition behavior change in Mali: A biocultural model.**

C.F. Parvanta. Centers for Disease Control and Prevention.

Between 1988 and 1995, the "Nutrition Communication Project (NCP)" was implemented in 4 rural areas of the country where the Government of Mali and non-governmental organizations (NGOs) ran "Child Survival" projects. Ethnographic research allowed us to focus on specific behaviors, including 'active' child feeding, and aggressive recuperative feeding techniques. NCP used interpersonal communication to teach new skills, and mass media to affect community norms.

The evaluation used a quasi-experimental design with random assignment of villages matched for wealth and other factors to NCP (trial/high exposure) or "routine child survival activities" (comparisons/low-no exposure) within NGO project sites. Baseline (1990), midpoint (1993) and outcome (1995) surveys collected parental knowledge, attitude, reported behaviors and child anthropometric data. In 1995, sufficient data were collected on 712 women, 354 men and 845 children for analyses. Weight/age < -2SD was 29% in high NCP exposure villages compared to 44% in no/low exposure villages ( $p=0.0001$ ). When NCP media recall, child survival project variables, and wealth variables were included in logistic regression analysis, only NCP exposure was significant with an OR of 2.04, (1.52, 2.57,  $p=0.008$ ). Height/age > -2SD showed a stronger influence of NCP with an OR of 3.37 (2.8, 3.94,  $p=0.000$ ).

Nutrition communication can enhance growth outcomes in child survival programs. These effects can be obtained with inputs of staff training, simple visual materials and radio, which have minimal recurrent costs compared to supplementary feeding programs.

#### **The taphonomy of soft tissue preservation in anaerobic conditions - the Queen Street Mission crypt, Huddersfield, England.**

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In 1970, a recovery and exhumation was conducted of 83 mummified bodies interred in an early 19<sup>th</sup> century Victorian crypt cemetery in Huddersfield, England. Due to the high degree of soft tissue preservation, including skin and organs, forensic pathologists were able to conduct complete autopsies documenting disease states and causes of death. Unique taphonomic conditions of the sealed lead crypts had been produced by the combined factors of: an anaerobic environment, cloth burial shrouds, and oak bark shavings. From a sample of 27 of the best preserved bodies, this study consists of a retrospective review and analysis of the archived postmortem reports, notes and photographs to document the degree and pattern of soft tissue preservation, including adipocere and tanning and their association with types of interment materials and structures.

Results of the analysis indicated that 70% of individuals were well preserved, and adipocere was present on 60% of the adults, 33% of children and 50% of the infants. The most common locations for this were the head and face as well as the extremities. The presence of adipocere and the degree of skin tanning were assessed subjectively from the autopsy photographs and ranked on a 5-point scale. This analysis revealed that the presence of oak shavings is positively associated with skin tanning, based on mean tanning scores of 0.77 for individuals without oak and 3.34 out of 5 for individuals with oak, a highly significant result in a Wilcoxon ranked pairs test. Generally, tanning better preserved the skin but not the internal organs, while preservation of all soft tissues was greater when less oak bark and adipocere were present but when burial shrouds were used.

#### **Molecular systematics of lemurs.**

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This study examines the systematics of the lemurs of Madagascar (suborder Strepsirrhini). Evolutionary relationships within this prosimian group remain con-

troversial, despite a long history of previous investigations. In a multi-level approach, the study presented here uses sequence variation in mitochondrial genes to reconstruct phylogenetic relationships among families, genera, species and subspecies of the extant lemurs. To attempt this goal, ~2400 bp of the ND3, ND4L, ND4 genes and five tRNAs of a total of 131 lemurs from 12 genera, 25 species and 18 subspecies were sequenced. A variety of taxa were used as outgroups. Monophyly of the Malagasy lemurs, as well as the family status and monophyly of each of the five lemur families are strongly supported by the molecular data. *Daubentonia* (family Daubentoniidae) consistently groups as sister to a clade containing the other four lemur families. The sequencing data failed to reveal phylogenetic relationships among the four families Cheirogaleidae, Indridae, Lemuridae and Lepilemuridae. The genes clearly resolved phylogenetic relationships among subspecies, species and genera of most lemur taxa. Comparison of tree topology and genetic divergences allowed verification of monophyly and the taxonomic hierarchy of most units investigated. However, some currently recognized taxa could not be confirmed by our molecular data (e.g. *Eulemur fulvus mayottensis*, *E.f. sanfordi*, *Hapalemur griseus alaotrensis*, *Propithecus verreauxi coronatus*, *P.v. deckeni*, *P. tattersalli*) and several new taxa have been tentatively identified (*Cheirogaleus medius* ssp., *E. fulvus* ssp., *H. griseus* ssp., *Lepilemur* sp., *Microcebus* sp., *M. murinus* ssp., *Varecia variegata* ssp.).

#### **The comparative morphology of the oblique cord in non-human anthropoid primates.**

B.A. Patel. Interdepartmental Doctoral Program in Anthropological Sciences, Stony Brook University.

The oblique cord (OC), as observed in humans, is a ligament connecting the antero-lateral aspect of the ulna proximally to the postero-medial aspect of the radius distally, inserting just distal to the radial tuberosity. Its functional significance is uncertain, but it has been proposed to either limit the degree of supination and/or aid in resisting buckling failure in the curved radius. The OC in non-human primates has not been thoroughly investigated and there are no evolutionary implications for its presence. The goal of this study was to investigate the distribution and form of the OC in non-human anthropoid primates and to explore its possible functional significance.

Soft tissue dissections of diverse anthropoid taxa revealed the presence of an OC in both New and Old World monkeys, and lesser apes. The ligament was absent in *Pan* and in all Atelines dissected. Manipulation of the two forearm bones revealed that the OC becomes most taut in pronation contrary to the human condition. Also, larger bodied and habitually terrestrial primates have relatively larger OC areas when compared to total interosseous membrane area.

Isolated radii were subsequently analyzed, and it was observed that OC size and the point of OC insertion lack a significant relationship with bone curvature, thus contradicting the hypothesis of preventing buckling failure. However, there is an association between the site of radial insertion and habitat preference. Thus, the form and function of the OC in non-human anthropoid primates differs from modern humans and experimental investigation is warranted before any evolutionary implications can be made. Research supported in part by NSF Grant BCS-0109331.

#### **Postcranial reflections of climatic adaptation and habitual activity in Tierra del Fuego.**

O.M. Pearson, M. Millones. Dept. of Anthropology, University of New Mexico.

The people who lived on Tierra del Fuego at the time of European contact offer a remarkable opportunity to study the effects on the skeleton of long-term adaptation to climate and the short-term adaptation to habitual activity. The island provided one of the coldest habitats in South America. Two groups with different subsistence strategies occupied the island at contact: the Yamana (canoe-using marine foragers) along the southern and western coast and the Selk'nam (terrestrial hunter-gatherers) in the interior. The dissimilar subsistence patterns should predict that the two groups should have dissimilar robusticity and diaphyseal shapes of long bones in the upper and lower limb. Due to climate, both groups should show levels of limb and joint robusticity and body proportions similar to other cold adapted humans.

Skeletons of either group are rare in North America and Europe. Skeletons of Selk'nam (11 males, 3 females) and Yamana (7 males, 3 females) were measured at Museums in Argentina and Chile and supplemented with published data. Robusticity indices of the shafts and epiphyses of limb bones, relative bi-iliac breadth, and AP/ML midshaft ratios were calculated and compared. The results show

the Fuegians had very robust limb bones and relatively broad pelvises in common with the most cold-adapted recent populations. However, no significant differences existed in matched-sex comparisons of upper limb versus lower limb robusticity or in pilastric and platycnemic indices. The difference in ethnographically documented activity and lack of its skeletal manifestation argues for the use of caution in interpreting these traits.

#### **STDs in prehistory: Why they mattered.**

R.L. Pennington. Dept. of Anthropology, University of Utah.

Sexually transmitted disease (STD) can have high fitness costs for human populations. For example, antibiotics tripled the fertility of Herero pastoralists of the Kalahari over several decades, and I have argued that much of the low fertility of neighboring !Kung Bushman is due to endemic STDs. STDs have been implicated as a cause of infertility throughout Africa and the Pacific.

Theory predicts that STDs should increase host sexual activity, cause low host mortality, and have long infectious periods, and there is empirical support for these predictions in numerous plants and animals species including humans. Unlike other infectious diseases, STD epidemiology depends on numbers of sexual partners, not population size. Because of long infectious periods they can persist indefinitely in small populations. I discuss syphilis, gonorrhoea, human papillomavirus (HPV), chlamydia, and herpes in the context of this evolutionary theory.

I also examine fitness consequences of different mating strategies in the presence of endemic sterilizing STDs. Fitness costs of promiscuity should decrease as adult mortality increases, as fecundity increases, and as the prevalence of sterilizing pathogens increases. Both sexes benefit from promiscuity when the frequency of sterile partners is high. Inferences about human population history typically rely on anthropological surveys of human fertility that exclude populations affected by sterilizing STDs. But STDs and their consequences on population and social evolution in our species are not recent. HPV, for example, predates the continental dispersal of humans and may be several million years old.

### **The bioarchaeological evidence for intra-site class differences in the Roman Near East.**

M.A. Perry. Dept. of Anthropology, University of New Mexico.

Textual and material cultural evidence have provided the primary perspective on class-based differences in the Roman Near East. Biological substantiation of social stratification, on the other hand, is rarely included in historical and archaeological discourse. As data on health and quality of life can reflect within-group differential access to resources, intra-site bioarchaeological analyses of two communities provide additional evidence of Roman Near Eastern political-economic relations.

Burials from each site were separated based on historical observations and material culture. Individuals from a village cemetery and church were compared at the agricultural village of Rehovot ( $n = 96$ ). In addition, burials containing Greco-Roman artifacts were contrasted with other burials of pastoral nomads from Zabayir ( $n = 73$ ).

Assessment of bioanthropological variables such as non-specific indicators of stress, osteoarthritis, vertebral osteophytosis, and skeletal trauma quantified differences in health and activity between community subgroups. Individuals controlling local resources were expected to have better health and lower evidence of activity than the rest of the community. Interestingly, expected differences between the subgroups did not emerge. No differences in health existed between Rehovot or Zabayir elites and the general population (Fisher's Exact Mean Statistic,  $p > 0.05$ ). Furthermore, individuals buried in the Rehovot church actually had greater signs of activity than the general population (Fisher's Exact Mean Statistic,  $p = 0.0032$ ). Community relations with the Roman administration likely had a stronger impact on differential access to resources and activity patterns than local socio-economic dynamics or subsistence strategies. These bioarchaeological interpretations enhance historical narratives on Classical Near Eastern class-based differences.

### **Digastric groove morphology: A potential new criterion for sex diagnosis.**

T.R. Petersen. University of New Mexico.

This study proposes a new criterion for sex diagnosis: morphology of the digastric groove of the temporal bone. The sample

examined comprises 88 adult crania from the Maxwell Museum of Anthropology documented (known age and sex) skeletal collection. The study examined the diagnostic utility of a combination of groove border expression (presence or absence of an overhanging margin), width, depth, and visibility from lateral aspect. Each trait was scored in categories along a gradient from "strongly feminine" to "strongly masculine." The method involves summing numerical scores for categorical data on these variables. Approximately 95% of known-sex females exhibit either "intermediate" or "feminine" total scores, and 70% of known males exhibit either "intermediate" or "masculine" total scores. In this study, 68% of the individuals with "feminine" total scores were known females, and 91% with "masculine" totals were known males. In this sample, 31% had intermediate total scores. Fisher's exact test indicated that the sex-assignments were significantly better than random ( $p < 0.01$ ). Similar results are obtained when only individuals with mastoid sizes in the "feminine" or "intermediate" range are examined, indicating independence of the other traits from mastoid size. It should be noted that "masculine" scores are more likely to identify correctly males than "feminine" scores are to identify females. This criterion should not be used alone, but rather in conjunction with established criteria to enhance cranium-based sex diagnosis.

### **Comparison of methods for estimation of individual ancestry.**

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Understanding an individual's ancestry is important for genetic mapping and association studies. The presence of admixed individuals or undetected mixtures of subjects from genetically differentiated populations can violate key statistical assumptions made by these analyses. One approach to control for mixed ancestry is to estimate the contributions of ancestral populations to individuals using genetic marker data. Here we compare the accuracy of individual admixture estimates obtained using maximum likelihood (ML) and Bayesian methods for simulated data in which each individual's ancestry is known.

Data were simulated according to two models of population admixture, hybrid

isolation and continuous gene flow (Pfaff, et al., 2001). Each population was sampled at generations 0, 5, 10, 15, 20, and 25 following the initial admixture event. Each sample consisted of 300 individuals with genotypes at 62 ancestry-informative markers (i.e. ancestral allele frequency differential of  $> 30\%$ ).

For the samples simulated using a hybrid isolation model of admixture, the individual ancestry estimates obtained using the Bayesian method were both more accurate and more precise than the ML estimates for each sample. However, for the samples simulated using a continuous gene flow model of admixture, the ML method was more accurate than the Bayesian method for generations recently following the initial admixture event. For samples taken from later generations of admixture, the Bayesian method performed better. These results show that, for accurate inference of ancestry, it is important to consider the specific admixture history of each sample when choosing which method to use to estimate individual ancestry.

### **Dividing the dead: Bioarchaeological differentiation of sub-populations within the Albany County Almshouse Cemetery.**

M. Phillips, G. Hughes, M. Solano. Anthropology Dept. University at Albany, SUNY.

The Albany Almshouse Cemetery (Albany, New York), in use from 1826 to 1926, was the final resting place for almshouse residents, indigent Albany County residents, inmates from the local prison and Albany Medical College specimens. An analysis of the relationship between the biological and the cultural remains from this cemetery ( $N=681$ ) was performed using chi-square tests, with the goal of differentiating these subpopulations archaeologically and biologically. Archaeological variables include coffin shape (hexagonal or rectangular) and artifact inclusion (clothing, etc.). Biodemographic variables including age, sex, ancestry and pathological conditions are tested against these archaeological variables.

This analysis shows significant variation between those interred in rectangular ( $n=210$ ) versus hexagonal ( $n=471$ ) coffins. Rectangular coffins exhibited a higher frequency of clothing and other grave goods, while those in hexagonal coffins were frequently buried without personal effects. Traumatic injuries (including amputees) and autopsies were also more common among skeletons in

rectangular coffins. The age distribution in rectangular coffins favored those under five years of age and those above 30 years of age. Additionally, rectangular coffins were more likely to contain those of European ancestry as compared to African ancestry.

Cultural aspects of the mortuary program and the bio-demographic variables suggest various origins for those buried at the Albany Almshouse Cemetery. Based on coffin form and artifact distribution, almshouse residents appear to be interred in hexagonal coffins, while rectangular coffins likely originated from the Albany Medical College, the local penitentiary and residents of Albany County that could not afford burial elsewhere.

#### **The meaning of impacts on bones from several skeletal samples.**

C.M. Pijoan, J. Mansilla. DAF/INAH, Mexico.

The evidence of different rituals made with the bodies of the sacrificed has been determined in several prehispanic populations of Mexico. These rituals have been interpreted from the analysis of the cultural taphonomic alterations on the human bones. When studying the skeletal remains from burial No. 14 from Tlatelolco, D.F., we saw that almost all the long bones, as well as a number of vertebrae showed impacts or percussions on the epiphysis. This burial is constituted by the remains of at least 153 dismembered individuals. After analyzing these alterations we suggested that they were left when introducing some instrument into the articular capsule to help the dismemberment.

As these alterations had not been reported before, we studied several other populations to see if they also presented them. We analysed the skeletal samples from San Lorenzo Tenochtitlan, Ver. (1250-900 b.C.), Tlapacoya-Zohapilco, Mex. (1250-700 b.C.), Tlatilco, Mex. (1100-600 b.C.), Tetelpan, D.F. (600-300 b.C.) and Electra S.L.P. (350-800 a.D.).

We found the presence of impacts on all of these samples. However, their expression is somewhat different to those from Tlatelolco. We also found that these marks are found on those bones whose integrity was desired. This study shows that the use of the technique of introducing an instrument into the articulation to help in the dismembering of human bodies is very old in Mexico.

#### **Geographic variation in gorillas: *graueri* and *beringei* are dentally similar.**

V. C. Pilbrow. Dept. of Anthropology, New York University and NYCEP.

Dental morphology is commonly used in differentiating fossil species. In this study the utility of dental morphology in fossil species recognition is examined by using dental dimensions to study patterns of geographic variation in gorillas. 299 adult dental specimens were sorted into 14 populations representing gorillas throughout their distribution in equatorial Africa. About 200 dental characters were measured quantitatively and 200 characters were coded using discrete codes. The quantitative data were size adjusted using the Geometric Mean. Mahalanobis distance matrices and hierarchical clustering procedures were used to study the affiliations of the 14 populations.

The results of the analyses indicate that in dental morphology (1) the west African gorillas are clearly differentiated from the east African gorillas (2) gorillas from the Virunga mountains in Rwanda, commonly placed in the subspecies *Gorilla gorilla beringei* lie at an intermediate position between west African and other east African populations. (3) interpopulational distances between the Virunga gorillas and the Utu/ Mwenga-Fizi gorillas from eastern Democratic Republic of Congo (commonly referred to as *G. g. graueri*) are lower than that among other eastern populations.

These results run contrary to that reported by Groves (1970) using craniometric dimensions. In Groves study, Virunga gorillas were the most distinctive of the gorillas in mandibular and palatal features that reflected their dietary reliance on tough fibrous vegetation; the Utu/ Mwenga-Fizi populations occupied an intermediate position. The contrary results of this study have implications for the presumed correlation between dental morphology and diet, and are explained using arguments of phylogenetic inertia and drift.

#### **Sampling bias and the *cytochrome oxidase III* locus of mitochondrial DNA.**

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Sequence variation of human mitochondrial DNA (mtDNA) has provided extensive insight into our understanding of

human evolution. However, attempts to demonstrate general patterns of variation across human populations often mask more subtle patterns that exist at local or regional scales. Studies of human mitochondrial variation typically focus on either a small number of individuals from many populations or a large number of individuals from several focal populations. Here we compare these two sampling strategies using data from the *cytochrome oxidase III* locus of mtDNA in order to test the hypothesis that sampling design may lead to differing conclusions about human diversity. Currently we have examined six populations of fifty individuals each (two in Africa, four outside of Africa). Observations reveal that one African population (the Dogon of Mali) has relatively few segregating sites and the lowest nucleotide diversity ( $\pi$ ) of the six populations studied. However, when the two Africa populations are pooled, we observe greater diversity in Africa, and less diversity outside of Africa, congruent with results based on global sampling strategies. One of our non-African populations (the Baining of New Britain) shows a positive Tajima's D, consistent with stable population size. However, when pooled with the non-Africans there is a statistically significant negative Tajima's D, compatible with population expansion. These data indicate the great importance of local sampling in order to make inferences about growth and diversity of individual populations.

#### **The appearance and dispersion of the first farmers in Europe. A novel approach to an old debate.**

R. Pinhasi. Dept. of Biological Anthropology, University of Cambridge.

The appearance and dispersion of the first farmers in Europe has been the subject of heated debate among anthropologists, archaeologists, and geneticists for over a century. While each discipline focused on different aspects of this grand topic, the central point of contention is what may be regarded as the demographic nature of the process. There is lack of consensus regarding two main aspects (1) the extent to which the transition to farming was an indigenous process, involved some admixture between incoming farmers and local hunters, or a population replacement process; and (2) the historical pattern in terms of the timing and tempo of the dispersion events.

These issues are addressed through the combined analysis of archaeological and morphological data focusing on the following aspects: 1. Cranial variability within

and between past populations during the Mesolithic, Early Neolithic and Middle/Late Neolithic periods. 2. An analysis of the exact pattern of expansion of populations in Europe during the Early Neolithic Period. The expansion of these populations is assessed against corresponding changes in the settlement pattern and demography of the European hunter-gatherer groups.

A quantitative analysis of craniometric data was performed on an extensive sample of 1400 specimens from the Mesolithic, Early Neolithic and Middle/Late Neolithic periods from the Near East, Anatolia and Europe. Statistical methods were applied to a series of subsets from the total sample in order to assess intra and inter-population variability in relation to archaeological cultures, location and period.

Statistical results reveal a new and complex picture regarding morphological variability within and between populations in the three periods. Moreover the results indicate regional and temporal differences in the dispersion process and corresponding degrees of admixture with local hunting populations. Based on the results, a new detailed, region-specific, model was developed. This model explains the spread of farming in Europe as a series of varying dispersion processes, with the initial Neolithic population originating from Central Anatolia.

#### **Group size, sex ratios, and the contribution of male and female canine size to dimorphism.**

J.M. Plavcan. Dept. of Anthropology, University of Arkansas

Recent studies emphasize that sexual dimorphism is a function of variation in male and female traits. A number of comparative behavioral studies shed light on patterns of group size, sex ratios, and competition in primates that should help explain variation in dimorphism. Specifically, Janson and Goldsmith (1995) demonstrated that female resource competition is negatively correlated with group size in anthropoids. Others have demonstrated that male group size is negatively allometric with female group size in multi-male groups. If canine size covaries with operational sex ratios in males, and with competition in females, then it should parallel these findings.

Recent published data on male and female group sizes and sex ratios were gathered from the literature for 55 anthropoid species. Canine tooth size data were taken from Plavcan (1990). Phylogenetic contrast analysis was carried out on

size corrected data using the Smith and Cheverud (2002) phylogeny. Female canine size was adjusted for correlated response to male canine size. Female canine size and female group size are negatively correlated, corroborating Janson and Goldsmith's model. Male canine size is correlated with the sex ratio in multi-male, but not single-male species. Results identify single-male species as unusual in their expression of canine dimorphism compared to other species, lending support to Altmann's (2000) suggestion that male demographics may not accurately reflect reproductive skew in these species. Combining the results, canine dimorphism covaries predictably with the sex ratio and female group size. Supported by NSF SBR 9616671 and BNS 8814060.

#### **The effects of differential mechanical loading on articular surface area in miniature swine.**

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It is well established that bone responds to mechanical loading during growth, however the specific role of mechanical factors in determining articular surface area (ASA) is still unclear. Articular surface growth must follow a trajectory that allows mechanical loads to be passed through the surface without severe joint wear. Contact pressures from loads that are too great due to insufficient articular size can irreparably damage articular cartilage, allowing subchondral wear to occur. Clearly, the location and properties of each joint influence the manner in which loads are transmitted; hence the magnitude and direction of articular response may be joint dependent. Joints must be large enough to function under the required levels of stress and oriented in a direction to withstand efficiently that stress.

This study experimentally tests the hypothesis that a growth mechanism responsive to mechanical stresses allows articular surface area to adapt to its mechanical environment (Frost 1999; Hamrick, 1999). The hypothesis is tested through comparisons of exercised (n=28) and control (n=30) subadult pigs. These data support the hypothesis that ASA is responsive to differential loading during growth. ASAs at the proximal femur and proximal tibia are significantly greater in the exercised pigs relative to controls ( $P < 0.05$ ). The distal articular surface of the tibia, although larger in the exercised

group, is not significantly different. This suggests a trade-off between kinetic energy conservation during swing phase of locomotion coincident with distal limb tapering and higher cartilage contact pressures incurred by less plastic joint surfaces.

#### **Conditional independence modeling of neurocranial, facial, and masticatory integration in *Pan*, *Gorilla* and recent *Homo*.**

J. M. Polanski, R. G. Franciscus. Dept. of Anthropology, University of Iowa.

The possibility that hominin speciation involved growth alterations among functional matrices (F-sets) is widely acknowledged and is made more amenable to testing by posing explicit hypotheses. Franciscus (1997) rejected the null hypothesis that neurocranial, facial and masticatory F-sets were significantly integrated in recent humans using partial correlation analysis of Howell's (1989) craniometric database. This degree of cranial F-set "uncoupling" was unexpected and speculatively linked to anatomical modernity, but in the absence of a wider comparative baseline was difficult to interpret. In the present study, we have extended the sampling and analytical framework to explore further the evolutionary implications for this pattern.

A sub-set of 32 measurements divided among neurocranial, facial and masticatory F-sets from Howells' (1989) database were collected on 31 gorillas and 23 chimpanzees (all adult males). The same measurements were selected from Howells' complete data set for 30 geographically representative adult male recent humans. These measurements were used to calculate size and shape variables for each F-set that were subjected to tests involving conditional independence as described by Magwene (2001) in his study of integration levels in the Sewell Wright fowl data set.

The size results indicate that humans have the lowest overall level of F-set integration and gorillas have the highest. However, comparison of the integration levels between each functional unit dichotomizes human versus ape patterns. In terms of overall F-set shape, gorillas are the least integrated, perhaps due to masticatory specialization. These results are discussed further in terms of the broader issue of operationalizing anatomical modernity.

### Running in human evolution.

J.D. Polk, S. Psutka, S. Cote, D. Lieberman. Dept. of Anthropology, Harvard University.

When did human ancestors first start to run like modern humans? Carrier (1984) suggested that humans are well adapted to endurance running, and that the morphology of early *Homo erectus* may have been shaped by the mechanical constraints imposed by a running gait. Two of these constraints are the high magnitude impact force generated as the foot contacts the ground with each step, and the energetic consequences of the large vertical fluctuations in the body's center of mass (COM) during running. Impact forces frequently exceed four times body weight and repeated exposure to these impacts causes joint deterioration. Therefore, moderating these forces should be advantageous for running-adapted hominins. Running animals should also reduce their energy expenditure by smoothing the path of the COM. This study tests the hypothesis that trained human runners actively moderate impact forces through kinematic control of their vertical velocity at touchdown (in comparison to untrained runners), and that trained runners exhibit energy saving running kinematics of the COM. To test this hypothesis, 3D limb kinematics and vertical ground reaction forces were obtained for trained and untrained human runners moving at several speeds on a treadmill with an embedded force platform. While trained and untrained runners do not differ in their impact force magnitudes, trained runners have less vertical fluctuation in their body's center of mass and stiffer limb spring coefficients. These limb movements allow trained runners to move more efficiently than untrained runners and to delay fatigue. The lack of impact force damping should influence joint shape, and the joint surfaces of *Homo* may be enlarged to moderate joint stress.

### Climbing behavior and locomotor energetics in wild chimpanzees: Implications for hominin locomotor evolution.

H. Pontzer. Dept. of Anthropology, Harvard University.

What do anatomical comparisons of chimpanzees and early hominins reveal about the selection pressures shaping hominin locomotor anatomy? Little is known about wild chimpanzee climbing behavior or the specific selective pres-

ures shaping chimpanzee locomotor anatomy. This study tests the hypothesis that climbing adaptations in chimpanzees, though energetically costly during terrestrial locomotion, maximize overall energy efficiency by reducing the energy spent climbing. Locomotor behavior of wild chimpanzees in Kibale National Park, Uganda was measured to determine the amount of energy allocated daily toward knuckle-walking and climbing. Day ranges were measured using 153 nest-to-nest follows. Climbing was measured during 19 days over two months. Daily energy expenditure for knuckle-walking and climbing was estimated using published equations from the physiological literature. These estimates were compared with estimates of total daily energy expenditure (TDEE).

Chimpanzees allocate approximately 13-percent of TDEE to knuckle-walking and only 1-percent to climbing. Such a low percentage of TDEE spent on climbing suggests chimpanzee locomotor anatomy is selected for climbing safety, not energetic economy. Results of this study suggest that climbing adaptations shared by chimpanzees and australopithecines, though they support reconstructions of these hominins as adept climbers, do not indicate how much time australopithecines spent in trees, nor do they suggest a significant amount of energy spent on climbing. These results are also relevant to energetics-based arguments for the evolution of bipedalism in hominins. Finally, the effect of age on day range and climbing rates suggests an unexplored role for body size in determining ranging behavior in all hominoids.

### Social organization of wild groups of *Callimico goeldii* in northwestern Bolivia.

L.M. Porter. Dept. of Anthropology, University of Washington.

Although the social organization of many callitrichines has been well studied in the wild, there have been few comparable data available for *Callimico goeldii*. In northwestern Bolivia, behavioral data on wild groups of *C. goeldii* were collected from 1997-1998 and from 2001- 2002. Although *C. goeldii* groups with two breeding females were observed in the research area, the study groups observed during these field seasons contained single breeding females. These females gave birth twice a year to single offspring, at the end of the dry season and the end of the rainy season. Communal care of *C. goeldii* infants was observed, with group members helping to transport and share

food with infants. During observations in 2002, nearest neighbor distances were collected using 5 minute focal animal samples and all-occurrence data were recorded of mating and aggression. In addition, group membership data were collected during these studies and demonstrate that groups change rapidly in size and replenish slowly when membership diminishes. Together these data provide insights into the social organization of *C. goeldii* and allow comparisons of *C. goeldii* to other callitrichines.

### The evolution of lactase persistence in African populations.

K.B. Powell, H. Mortensen, S.A. Tishkoff. Dept. of Biology, University of Maryland.

Adult lactase persistence is the genetically determined ability to derive energy from lactose, a major component of milk. Previous studies suggest that high frequencies of lactase persistence are found in populations with strong traditions of milk drinking and/or cattle herding. In this sense, the trait is considered to be a rare example of culturally influenced genetic adaptation in humans. Lactose tolerance tests (LTT and/or LTTE) were performed on ~250 individuals representing 12 Tanzanian ethnic groups practicing different methods of subsistence. They include pastoralists (Maasai, Iraqw, Burunge, Gorowa), agriculturalists (Rangi, Mbugu, Mbugwe, and Pare) and hunter-gatherers (Sandawe, Hadza, Akie and Dorobo). Results indicate that patterns of lactase persistence do not always correspond to dietary tradition among East African groups. This is likely to reflect a history of extensive gene flow in this region. We are currently examining genetic variation among the tested individuals to ascertain additional information regarding the evolutionary history of lactase persistence and the genetic basis of adaptation in humans. Funded by NSF grant No. 9905396 to ST and NSF IGERT grant No. 9987590.

### Periosteal reactions as indices of health status.

M.L. Powell. University of Kentucky.

Paleopathological analyses of disease in past populations often include observations of osteoblastic activity visible on long bone shafts (periosteal reactions) as an indicator of population health. Using the Health and Nutrition in the Western Hemisphere database (7500 YBP to the early 20<sup>th</sup> Century), this study focuses on prevalence and pattern of periosteal reac-

tions reported in Native Americans, African-Americans, and Euro-Americans in North America. The data are analyzed by the following parameters: temporal period, age, sex, elevation, settlement pattern, subsistence mode, and proximity to coast. In all three groups, periosteal reactions are significantly more common ( $p < .05$ ) in adults than in subadults, regardless of ecological or cultural variables, a pattern owing in part to "the osteological paradox". For Native Americans, sedentary farming populations show a higher prevalence than do foraging populations, a trend also observed in the 20<sup>th</sup> Century in forcibly 'settled' hunting-gathering groups in Africa and South America. Males and females show no significant difference in prevalence for non-trauma related periosteal reactions in any time period, though the greatest differences appear in the post-contact Native American samples. For both African-Americans and Euro-Americans, rural population samples exhibit more skeletal pathology than their urban contemporaries, a reflection of lower rural socio-economic status and unequal access to adequate medical care.

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**New *Australopithecus boisei* specimens from the Kaitio Member, Nachukui Formation, Kenya.**

S. Prat. UPR 2147 du C.N.R.S., Paris.

New specimens of *Australopithecus boisei* are described from West Turkana in northern Kenya. These specimens come from two different sites: the new site of Naiyena Engol 9 and the archeological site of Kokiselei 1. They belong to the Kaitio Member (1.65-1.9 Myr) of the Nachukui Formation. The specimens from Naiyena Engol 9 comprise a composite skull, a mandible fragment, a parietal fragment, a molar fragment and a right femoral head (temporarily attributed to *A. boisei*). The composite specimen consists of eleven calvarial fragments. The morphology of these fragments (the sagittal and temporonuchal crests for example) is very close to KNM-ER 406. In the archeological site of Kokiselei 1, 526 stone tools and 244 faunal remains have been discovered *in situ* and 6 hominid teeth on the surface. These latter specimens are four complete teeth (upper left canine, first upper left premolar, third upper right molar and third lower left molar) and two molar fragments. They are attributed to *Australopithecus boisei*, on the basis of morphology, general crown size/shape and enamel thickness. These discoveries in-

crease the number of *Australopithecus boisei* specimens in West Turkana. The presence of these hominids, may be associated (but not verified in Kokiselei 1) with archeological remains, raises again the issue of the identity of stone tools maker or makers.

**Using genomics to identify human brain specializations.**

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Little is known about how human brain organization differs from that of other hominoids, in part because many widely used neuroscientific techniques involve invasive or terminal procedures and are therefore inappropriate for use with humans and apes. Structural and functional differences should be reflected by differences in gene expression, however, and the latter can be identified in post-mortem tissue samples using available genomic techniques. We used high-density oligonucleotide arrays, cDNA microarrays and quantitative RT-PCR to compare gene expression in different cortical regions of five humans, four chimpanzees and four rhesus macaques (all adults). Of 9700 genes interrogated by the arrays, ~50% were detected on average in human and chimpanzee cortex and 173 showed clear differences in expression levels between both species. We confirmed 36 of these expression differences by independent methods. When the rhesus data is considered, ~60% of the changes appear to be specific to humans and correspond to a wide diversity of functional classes, including genes involved in metabolic pathways, signal transduction, RNA and protein synthesis, intracellular transport, extracellular interactions, and many genes with unknown function. These results indicate the human brain is not merely an enlarged ape brain: such marked differences in gene expression suggest strongly that humans possess numerous specializations of the structure and function of cerebral cortex. Knowing the genes involved, these specializations can be characterized more fully with standing immunocytochemical and *in situ* hybridization techniques.

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**Investigation of stable Sr isotope ratios in prehistoric human bones and teeth using laser ablation ICP-MS.**

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The analysis of stable Sr isotope ratios in human skeletal remains has been shown to be an appropriate method for the reconstruction of paleodiets, paleoenvironments and human migrations of ancient populations. Although the technical and methodological prerequisites (instrumental setup, precision, online Rb-Sr separation) could recently be optimized, the difficulties of possible post-mortem influences on Sr isotope ratios due to possible diagenetic changes (such as dissolving and recrystallization phenomena), remained heretofore unresolved, especially when the usual invasive techniques (e.g., liquid nebulization ICP-MS) had been used.

In the present study, we apply and test the potential of a novel Laser Ablation ICP-MS (LA-ICP-MS) technique on transversal cross sections of femur compact bone and longitudinal sections of tooth samples, employing both its high lateral resolution and isotope ratio capabilities. The Sr isotope ratio measurements were performed with an instrumental precision of about 0.1 % RSD. Furthermore, the mineralized products ("Brushit") showed a significantly increased amount of Rb, indicating that they are exogenous. Teeth were analyzed for their Sr isotope ratios both in enamel and in dentine and reliable results could always be obtained. LA-ICP-MS therefore is the method of choice to analyze Sr isotope ratios in buried, diagenetically altered bone and teeth tissue. Moreover, with this new method only a small sample piece is needed; it can be as small as one single tooth.

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**Deformations of the Steinheim cranium revealed by electronic preparation help reassess sex attribution, cranial volume, and circumorbital form.**

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It has been difficult to assess much of the morphological and taxonomic information the Steinheim cranium has to offer because of its extensive encrustations and its considerable deformations. It is possible, though difficult, to remove the encrustations electronically from a CT-scan, thus revealing many interesting endocranial features, such as sella turcica and crista galli, as well as deformations that have implications for the interpretation of the external morphology. It appears that the facial complex of the cranium has been deformed in two different directions and that the frontal bone is broken above the browridges, considerably altering the cranium's facial morphology. When these deformations are accounted for, the individual appears to have been male. An internal analysis confirms the observation that the external vault is too low, because the basion is pushed inwards and upwards, resulting in a 'wrong' inclination of the clivus. A rough quantification of the deformations of the cleaned endocast of Steinheim implies that its volume is about 1140 cm<sup>3</sup>. Of further interest is the comparison with the frontal sinuses of Petralona and Broken Hill (Kabwe): the distinct differences in extent and morphology between the two European fossils and the African one suggest a re-examination of their neural-orbital disjunctions.

#### **Isotopic evidence of migration at the imperial port of *Portus Romae*, Italy.**

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O-18/O-16 ratios in teeth and bones reflect the source of water ingested by an individual. This ratio is mainly controlled by the  $\delta^{18}\text{O}$  of local precipitation and varies with geographical location. This study uses 138 1<sup>st</sup> and 3<sup>rd</sup> molars, as well as 43 molar/femur pairs to look for immigrants in the population from *Portus Romae*, Italy. The site of *Portus Romae* was an important economic center for the city of Rome during the first few centuries AD. Epigraphic evidence from the nearby necropolis (Isola Sacra) suggests that some of the people buried there were from the eastern Mediterranean region, particularly Greece; however, most individuals were buried without any 'biographical' information concerning place of birth. The results of isotopic analysis for this skeletal series are compared to data from

a sample (N=20) of deciduous teeth from modern Roman school children (average  $\delta^{18}\text{O} = -5.1 \pm 1.0\text{‰}$ ).

Teeth of ancient Romans give values of -7.6 to -3.1‰ (1<sup>st</sup> molars) and -7.6 to -2.8‰ (3<sup>rd</sup> molars). Compared to the modern Roman sample, about 27.5% of the individuals from the necropolis are greater than one standard deviation from the modern mean. The majority of individuals outside this range have lower  $\delta^{18}\text{O}$  values than modern Romans, suggesting that they came to Rome from northern Europe rather than from regions to the south of Italy (e.g., North Africa). In all but one individual  $\delta^{18}\text{O}$  of bone is greater than associated M1 values.

#### **Scrambling for a common resource: Chimpanzees, humans, and *Saba senegalensis*, in southeastern Senegal.**

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Chimpanzees (*Pan troglodytes verus*) at the Fongoli study site in southeastern Senegal were hypothesized to compete over the fruit, *Saba senegalensis*, with humans of the Bedik, Bassari, Malenke, and Diahanke groups based on preliminary observations of extensive gathering of *Saba* by local people in May-June 2001. Chimpanzees fed on both unripe and ripe *Saba* fruit from February-July and focused on this food resource during the driest, hottest months (May-June). *Saba* seeds were found in most (>69%) chimpanzee feces collected from April 2001-July 2002, with an average of 41 seeds found per sample throughout the study period (N=117). Chimpanzees may therefore be effective dispersal agents for this plant species. Given that *S. senegalensis* seems to be a keystone food source for chimpanzees here, an assessment of the role that the fruit played in the local economy of people in the area and how this might affect both the *S. senegalensis* and chimpanzee populations at Fongoli was conducted from May-August 2002. A key informant approach was used to determine the most significant participants in harvesting and marketing *Saba*. Women and children have recently begun to harvest wild *Saba* from surrounding woodlands for export to markets in larger cities such as Dakar and Bamako, Mali. The goal of this research is to better understand the dynamics among the human, chimpanzee, and *Saba senegalensis* populations in southeastern Senegal and to design a plan for the sus-

tainable harvest of a fruit species that is important to both humans and chimpanzees in the area.

#### **Mandibular corpora of *Australopithecus afarensis* and *Australopithecus africanus*: 3-D modeling and measurements.**

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This project describes a systematic methodology for taking height, breadth, and cross-sectional area measurements from 3-D models of *Australopithecus afarensis* and *Australopithecus africanus* mandibular casts. Many studies in 3D models and data acquisition provide quantitative descriptions of characteristics such as curvature, surface area, cross-sectional area and other characteristics useful in many areas of research — but particularly in research describing and assessing variation among fossil specimens.

Using software packages such as "ARI\_Project" (developed at ASU's PRISM lab) linear, 2-D data was collected from 3-D models of *Australopithecus afarensis* and *Australopithecus africanus* mandibles. This project shows these measurements are directly comparable to traditional measurements taken with calipers. In addition to developing two alternative methods for taking height and breadth measurements, this project also presents cross-sectional area measurements in order to illustrate the types of measurements possible with 3-D analysis.

The results of this project indicate that there are extremely low amounts of inter-observer error comparing the measurements from the 3D models with caliper measurements as well as extremely low amounts of intra-observer error present in the measurements of the 3-D models themselves. The low intra- and inter-observer errors indicate that the methodology generates reproducible measurement data that is consistent and comparable with published caliper measurements.

#### **Age variation in isotopic and histological profiles in the Kulubnarti R Group ( 1000CE – 1550 CE) from Sudanese Nubia.**

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thropology, University of Colorado, Boulder.

The Kulubnarti population provides a unique opportunity to develop isotopic profiles reflecting aspects of diet that can be assessed in a well established framework of life history patterns. Much of the previous work, however, has been limited to the adult segment of the population. In this paper, we have included subadults of the R-group population in our analysis. As childhood represents a vulnerable stage in the human lifespan, and overall childhood health has been found reflective of population success, analysis of individuals that did not survive this critical period can aid in a biocultural reconstruction of life histories. Collagen, isolated from ribs, was analyzed isotopically for both carbon and nitrogen isotopes. In addition, a thin section was prepared at the site of the original cut on each rib, and examined microscopically. The objectives were multi-faceted, to examine differences in isotopic ratios between age groups, and to examine isotopic differences matched with histological growth profiles. With the exception of a change in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  values associated with the weaning transition, preliminary analyses indicates that variation between age groups was statistically insignificant from variation within age categories. Histological analysis allowed for an examination of variation in bone growth, which would then be examined with respect to isotopic variation. Isotopic variation between diaphyseal and epiphyseal areas of the bone was also analyzed.

**Plio-Pleistocene mammalian migrations in the East Turkana Basin, Kenya: Testing the utility of stable strontium isotopes.**

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The Plio-Pleistocene mammalian assemblages of the East Turkana Basin in northern Kenya capture a critical period for the environmental context of early hominin ranging and dispersal behaviors. Unraveling the past movement of coeval mammals may provide insight into hominin land use and ranging and the impetus for dispersal from Africa by *Homo erectus*. Recently stable strontium isotopes ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) of bone and teeth have been used to elucidate mammalian ranging and migratory behavior in extant and extinct species. Sr ratios reflect the geologic substrate from which an animal obtained food and water and are incorporated into skeletal tissues during forma-

tion. Variable Sr isotopic ratios sampled from teeth with different eruption times are used to reconstruct movement across diverse geologic substrates.

The utility of Sr isotopic analysis for investigating mammalian movement depends upon quantifying the Sr ratio variability of the regional geology and mapping the Sr distribution on the paleosurface. Here we examine how Sr ratios vary throughout Plio-Pleistocene stratigraphic sequences of primary volcanic tephra and paleosols from the East Turkana Basin. Based on our results we propose that Sr ratios in pedogenic calcite nodules are precipitated from the parent material during soil formation and therefore may be used as a proxy for paleosurface Sr distribution. Differential paleosurface Sr has the potential to be applied to the analysis of mammalian Sr ratio variability in tooth enamel to illuminate patterns of ranging and migration in the past.

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**Molecular estimates of primate divergence dates.**

R.L. Raaum, K.N. Sterner, T.R. Disotell. New York University & NYCEP.

The consensus view of fossil and molecular data places the human-chimpanzee divergence at ~6 Ma and the hominoid-cercopithecoid divergence at ~25 Ma. Some recent molecular publications run counter to this consensus, suggesting that these divergences occurred substantially earlier. If true, these earlier dates would suggest a major reappraisal of the fossil evidence and require a recontextualization of these events in substantially different paleoenvironments. Date estimation from molecular data poses significant methodological challenges that have not yet been fully evaluated. Furthermore, there is no widely accepted methodology accounting for these challenges. Unfortunately, some recent publications relevant to primate divergence times have methodological shortcomings.

We performed extensive analyses of simulated and real sequence alignments to determine factors having the greatest impact on primate divergence date estimates. Our results show that the best results derive from (1) choosing a local calibration point - early primate divergence times incompatible with fossil findings often result from calibration outside the primates, (2) correction for rate variation across lineages - there is considerable variation across primate lineages and

between primates and other mammals, and (3) accounting for rate variation across nucleotide sites - variation across sites within a single locus and between loci produces substantial error if loci are concatenated. We have developed methods for the estimation of divergence dates from molecular data. We have evaluated the precision and accuracy of these methods. Reanalysis of recently published data following this methodology results in date estimates more compatible with current interpretations of the fossil record.

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**A strategy for the reduction of mechanical internal work in primates.**

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Quadrupedal primates have limbs shaped differently than most other mammals. Primates have muscle mass distributed distally on their limbs to control their grasping hands and feet. Most other quadrupeds have limb mass concentrated proximally, presumably to reduce the energy needed to move those limbs (mechanical internal work). Primates would therefore be expected to use more energy during locomotion compared to other mammals of similar body mass. Surprisingly, though, primates have similar energetic costs of locomotion compared to other mammals. This study examines the possibility that primates adjust their gait in order to mitigate the energetic consequences of their distally heavy limbs.

One possible determinant of energetic cost is stride frequency. Since primates differ from most other mammals by using lower stride frequencies at a given speed, this difference may relieve the negative effects of their limb shapes. A model equation for the prediction of mechanical internal work based on body mass distribution and gait characteristics was developed by Minetti (1998). Using this equation, the work done during walking was predicted for three groups: *Papio*, *Canis*, and *Papio* modeled with non-primate stride frequencies. *Papio* and *Canis* do not differ in their predicted mechanical internal work when walking naturally, but *Papio* walking with higher, non-primate stride frequencies does significantly more work than either *Papio* walking naturally or *Canis*. These results suggest that primates' lower stride frequencies counteract their distally distributed muscle mass and allow them to do similar amounts of work compared to other mammals, possibly accounting for their similar energetic costs.

### Neandertal facial morphology and increased jaw gape.

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Neandertals exhibit a large number of uniquely derived cranial and mandibular traits. For example, in the mandible, the tip of the coronoid process is substantially elevated *relative to the condyle* (Rak et al., in press). Our data also suggest that this configuration in Neandertals stems *not* from an increased height of the coronoid (the height relative to the occlusal plane is the same in both Neandertals and early *Homo sapiens*) but rather from the low position of the condyle. Whereas in *H. sapiens* the height of the condyle constitutes about 104% of the height of the coronoid process, that is, the condyle is on average about 4% higher than the coronoid, these values are substantially lower in Neandertals, with a mean of about 74%. Early *H. sapiens* specimens such as Skhul IV and Tabun C2 resemble those of modern *H. sapiens* in that the condyle is higher than the coronoid process.

The closer proximity of the condyle to the occlusal plane has an impact on the amount of maximum gape in Neandertals. Other typical Neandertal morphologies, such as an extended and hypertrophied lateral pole of the condyle, an enlarged retromolar space, anteriorly positioned premolars relative to the mental foramen, increased prognathism, more posteriorly positioned jaw muscles as indicated by postorbital bar morphology and the position of the anterior root of the zygoma, and the presence of a medial pterygoid tubercle, are all arguably functionally linked to a masticatory system designed to increase maximum jaw gape.

### Bone density differences in iliac crest samples from a modern and an archaeological Peruvian population.

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Modern and archaeological skeletal populations exhibit similar age-associated bone loss patterns, yet in paleopopulations there is minimal evidence for non-traumatic bone fractures. Exploring this difference is key to understanding biomechanical incompetence in osteopenic bone.

Biomechanical stress and nutrition influence trabecular bone density and distribution, and therefore susceptibility to non-traumatic fractures. However, the role of biomechanical stress and nutrition has yet to be fully investigated independent of genetics. The Chiribaya skeletal population, comprised of three genetically related groups with different subsistence strategies, provides an opportunity to examine further this relationship.

Histomorphometric analysis was conducted on a sample from each of the three Chiribaya subsistence groups. Iliac crest wedge biopsies were removed from the skeletal sample (n = 99) and histologically prepared. Cortical thickness, trabecular bone density, and trabecular connectivity were measured for each sample. The data were separated into decade age groups, as determined by gross skeletal indicators, and the groups were compared to each other and to modern clinical and cadaver data.

The Chiribaya groups with lower biomechanical stress and higher general nutrition were found to be more similar to modern clinical/cadaver samples in trabecular bone density and connectivity than those with higher biomechanical stress and lower general nutrition. These findings indicate that more severe age-associated osteopenia and its consequent increase in susceptibility for non-traumatic fractures in modern populations may be a result of decreasing biomechanical stress and over nutrition, relative to paleopopulations.

### Gene-physical activity interactions on cardiovascular and type 2 diabetes risk factors.

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The lack of regular physical activity has been recognized as a major risk factor for several chronic diseases, including cardiovascular diseases (CVD), type 2 diabetes and obesity. Regular exercise training has been shown to have beneficial effects on several risk factors of CVD and diabetes. However, it is also well documented that some people show more pronounced risk factor responses to endurance training than others, despite the identical training programs and similar initial risk factor levels. This kind of variation is an example of normal biological diversity and originates most likely from interactions with genetic factors. Data from genetic epidemiology studies indicate that there is a genetic component affecting inter-individual differences in both CVD and type 2 diabetes risk factor responses to

regular physical activity, with maximal heritability estimates ranging from 20 to 50%. Evidence from molecular genetic studies are scarce at the moment, but the first reports suggest that DNA sequence variation in the CVD candidate genes, such as angiotensinogen, also modify blood pressure responses to endurance training program. The current knowledge regarding the role of genetic factors in the modification of CVD and type 2 diabetes risk factor responses to endurance training will be summarized and discussed.

### Heterogeneous anisotropic elastic properties in a *Macaca fascicularis* mandible.

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This study characterizes the structure and heterogeneous anisotropic elastic properties of mandibular bone in an adult female specimen of *Macaca fascicularis*. We determine properties in alveolar, mid-corpus, and basal regions of buccolingual cross sections taken from multiple corpus and ramus locations. Within sections, we determine properties from endosteal, midcortical, and periosteal regions. The combined experimental techniques of reflected light microscopy and Knoop microindentation are used within the context of elasticity tensor transformation equations. Reflected microscopy enables the visualization of local principal material directions. Bone is sampled with a Knoop indenter, a diamond rhombohedral pyramid that creates an indentation with major and minor axes. Elastic constants are determined by varying the orientation of the indenter with respect to the material directions and applying the transformation equations. We find regional variations in bone structure, including bands of orthotropic circumferential lamellar bone at the endosteal and periosteal corpus base, angular region, and ramus. Transversely isotropic osteonal bone characterizes the midcortices of alveolar and basal regions, with many resorption spaces in alveolar regions. Regional variations in elasticity include stiffer bone with greater orthotropy in the endosteal molar regions compared to the periosteal angle region. Stiffness in-

creases posteriorly within the midcortical molar region, and is less in alveolar compared to basal regions. Considerable variation exists in structure and material properties on a highly localized scale, and such data provide for more realistic modeling of stress in structural models.

#### **On morphological variation.**

M.J. Ravosa, B.T. Shea. Dept. of Cell & Molecular Biology, Northwestern University Medical School.

The causes of, and constraints on, morphological variation remain central to systematic analyses of extant and extinct primates. The goal of our study is to integrate ontogenetic, in vivo and genetic heritability data with theoretical evidence so as to discuss and dispute a recent attempt to codify a series of generalizations regarding taxonomy and intra- and interspecific variation in skeletal features (Wood & Lieberman, 2001, *AJPA* 116:13-25).

These authors posit that: (1) "variables with lower than average...levels of intraspecific variation...are...more taxonomically valent than those with average or above average levels of intraspecific variation"; (2) "variables...subject to high strains from mastication have much greater levels of intraspecific variation"; (3) variance in loading levels is the major cause of intraspecific variation in masticatory variables; (4) their data on variance comparisons across measures and taxa are size-independent; (5) all variables are equally implicated in speciation; and (6) intraspecific variation is inversely related to heritability.

Analyses of cranial growth trajectories and adult CVs for *Alouatta*, *Macaca*, *Nasalis*, *Gorilla*, *Pan* and *Pongo* do not support #1-4. In two cases (#1, 2) it is incorrectly assumed that higher levels of within-species variance (due to environmental or allometric factors) necessarily swamp out between-species variation. We further illustrate why ecological features are differentially implicated in speciation events (contra #5). Lastly, heritability data indicate no support for #6. Thus, we do not view their guidelines as methodological improvements or an increase in our understanding of morphological variation.

#### **CAGD methods for physical anthropology.**

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The discipline of CAGD involves mathematically modeling curves and surfaces for engineering and architecture applications. CAGD algorithms are now commonly being applied to biological and anthropological 3D data. In this paper, we try to provide a brief overview of the current state-of-the-art of CAGD and its various applications to other research areas, such as physical anthropology. One of the recent developments in the field is to fit spline and subdivision surfaces to large data (e.g., fitting surfaces to point cloud data generated by 3D laser scanners). Automatic fitting of surfaces to such data, commonly referred to as Reverse Engineering, continues to be an area of research. Another important breakthrough involves the development of feature segmentation/extraction algorithms for polygonal mesh data. By varying certain parameters one can isolate local regions of interest on the generated surface. While data collection techniques and equipment are getting more sophisticated with time, geometric techniques and analytical tools must also continue to evolve to keep pace for researchers in other disciplines working with 3D data. Recent work at PRISM has focused on developing an intelligent archival system for 3D data such that a user can search based on features. We will also discuss the geometric interface requirements for a 3D sketch based system for initiating 3D queries.

#### **Community perspectives on fossil cercopithecoids from the Hadar locality, Afar Region, Ethiopia.**

A.L. Rector. Arizona State University.

The fossil primate community recovered from Hadar, Afar Region, Ethiopia, has been identified as representing between four and seven species (e.g. Ciochon, 1993). The habitats across time at Hadar are reconstructed as fluctuating open woodlands and bushlands, accompanied by gallery forests as well as floodplains. Extant primate communities in these types of environments generally consist of no more than two or three terrestrial or terrestrial/arboreal primate species. The primate community at Hadar was considered in terms of substrate use to explore whether the division of ecological space at the substrate level of the fossil primate community was similar to the pattern seen in extant primate communities in similar habitats.

The proximal and distal humerus and proximal ulna were measured to predict the locomotor and substrate repertoires of these fossil monkeys through comparison

with postcrania of extant primates with known locomotor behavior and substrate utilization. Measurements used have been previously correlated with locomotor patterns, and a wide variety of extant taxa were used for comparison in order to minimize possible phylogenetic effects. Principle components analyses were carried out to explore patterns of morphology with locomotor and substrate preference in both the extant and fossil primates. The analyses distinguished between primates with terrestrial and more terrestrial/arboreal behaviors. The fossil primate community at Hadar differs from extant primate communities in similar habitats.

#### **Allometry in the skulls of *Papio* subspecies: Alternative visualization techniques.**

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Recent work by Frost et. al. (in prep) has shown that one of the largest components of the shape variation of skulls in *Papio* is allometry. Landmarks and ridge curves (lines) were digitized on a large sample of baboon skulls using a Microscribe 3D and were subjected to generalized Procrustes alignment. Principal components of this alignment were correlated with scaling as represented by centroid size, and the resultant vector taken to represent allometry. Traditional methods of visualizing the thin-plate spline between forms, as between larger and smaller baboons in this case, either simply show the difference between the positions of the landmarks or use a projection of the thin-plate spline as represented by a deformed regular planar grid, which is movable along any (potentially oblique) axis. These visualizations require user familiarity and may be less suitable to elucidating the deformation of surfaces as versus landmarks, as the surfaces will obscure portions of the projection. As an alternative, we present a method of sectioning the thin-plate spline by a laser-scanned exemplar surface, allowing a much more compact and elegant display of the non-linear transformation of the spline. These visualizations are then assessed by their ability to focus attention on regional features of papionin scaling.

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**Evolution in the human primary visual cortex: Modifications of layer 4a.**

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The primary visual cortex (V1) receives inputs from two visual pathways, the magnocellular (M) and parvocellular (P) streams. How these pathways are organized within area V1 varies between anthropoid groups. Previous studies demonstrated the existence of human-specific compartments in cortical layer 4A, which can be visualized by staining for non-phosphorylated neurofilament (NPNF), thought to be enriched in the M pathway. Our recent analyses include a more detailed examination of these compartmental tissue bands, staining with monoclonal antibody Cat-301 and with a plant lectin, WFA, both of which are also thought to be specific M markers. Double-staining studies indicate that Cat-301 and WFA are localized in the same compartments that stain strongly for NPNF. Cat-301 and WFA stain similar populations of pyramidal and non-pyramidal cells. Three-dimensional reconstructions of compartments stained for NPNF reveal a highly distinctive neural architecture, which spans cortical layers 4B through deep layer 3. Mound-like clusters of multipolar and pyramidal cells in layer 4B give off dendritic bands that arch through layer 4A, extending horizontally into layer 3. These arches of stained tissue form narrow, elongated territories in layer 4A approximately 25-75  $\mu\text{m}$  wide, spaced at 100-250  $\mu\text{m}$  intervals, with frequent bifurcations and abrupt endings. The compartmental geometry that characterizes human V1 is unique among primates, and may represent a human-specific specialization related to visual motion perception.

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**Does size really matter? Investigations of moment arms in the fifth ray of catarrhines.**

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The size of certain skeletal elements, such as the hamate hook, has often been assumed to correlate with the size of the moment arm of muscles originating off of the element. This study assesses the accuracy of such an assumption by directly measuring both the moment arms and the skeletal elements associated with the attachment sites of ten muscles that cross the fifth carpometacarpal and/or metacarpophalangeal joints. The sample consists of twelve human, eleven baboon (*Papio anubis*), and three orangutan (*Pongo pygmaeus*) forearms. The dynamic moment arm for each muscle was calculated using the slope of joint angle and tendon excursion. Shape ratios generated from a regional surrogate for body mass were used to test for correlations using Spearman's Rho.

For the hamate, both flexor digiti minimi (FDM) and opponens digiti minimi (ODM) moment arms show a positive correlation with the size of the hamate hook. The extrinsic flexors as well as the common extensor show a positive correlation with the dorsopalmar depth of the metacarpal head. However, the size of the metacarpal head did not correlate with the moment arms for other muscles that flex the metacarpophalangeal joint. Although mixed, the results show some support for using the size of the skeletal element to predict the size of a muscle moment arm. The results warrant an expanded investigation that includes soft tissue measures such as the physiological cross sectional area of the muscles so that potential torque can be calculated.

**Ecological trends in the distribution of micromammals recovered from owl pellets in northern Tanzania: Using modern systems to calibrate paleoenvironmental analyses.**

D.N. Reed. IDPAS, State Univ. of New York, Stony Brook.

The search for ecological factors influencing hominid adaptation requires the precise and accurate assessment of paleoenvironment and paleoclimatic conditions under which our ancestors evolved. Microfauna and especially micromammals represent one component of a combined evidence approach that is the most powerful means of paleoenvironmental reconstruction, yet perilously little is known about the accuracy and precision of interpretations derived from microfaunal data. This paper reports on several large actualistic assemblages of micromammal remains derived from owl pellets across a diversity of habitats in northern Tanzania. These data are compared against a

physiognomic vegetation model derived from contemporaneous Landsat 7 ETM+ data. Micromammals are found to be informative about vegetation structure, including the density of woody and herbaceous canopy cover, and to a lesser degree soil substrate density and type. Given their accuracy under known conditions a method is presented for their use as predictive models against which to test hypotheses of habitat change over time, and methods for integrating micromammals with other data types into spatially explicit paleolandscape models are presented.

**Faunal comparison between the Middle Ledi and Hadar hominin sites, Ethiopia: Time, landscape, and depositional environment.**

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Landscape paleoecology integrates information about geographical variation in depositional environments with ecological inferences drawn from fossil animal and plant distributions. Such studies are necessary to determine how closely fossil fauna represent the environments in which they lived, and also to shed light on taphonomic processes and migration events. Landscape differences can be compared with temporal changes in species diversity to clarify questions of local and global species turnover in the Plio-Pleistocene.

Recent field research in the Middle Ledi region allows study of local variation in mammalian communities and paleoenvironment in the lower Awash basin. Fauna recovered from the youngest deposits (2.95-3.1 Ma) differ in taxonomic composition and/or species abundances from synchronous deposits at the nearby Hadar locality. Analyses of ecological diversity over 450 kyr at Hadar show alternating woodland type habitats accompanied by minor species fluctuations from > 3.4 - 3.18 Ma. The fluvially deposited Denen Dora Member (DD, 3.22 - 3.18 Ma) has yielded large numbers of reduncine bovinds that indicate the presence of edaphic grasslands. These species decline after their peak in the DD, and are not present at Hadar after ~ 3.18 Ma. In fluvial deposits of the Middle Ledi that are directly beneath a 2.95 Ma tuff, however, these same fauna are still abundant. Thus, depositional environment and faunal remains indicate both a localized landscape shift and species habitat pref-

erences. Comparing these results with similarity and cluster analyses of the total fauna across both sites indicates that a regional species turnover also occurred between 3.18 and 2.95 Ma.

#### **A model for human canine crown growth in a medieval urban cemetery sample.**

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The aim of this study was to create a model of crown development based on thin sections of mandibular canines taken from 33 individuals from Sortebrødre Torv (Black Friars Square), a medieval (mid-13<sup>th</sup> to 16<sup>th</sup> century) urban friary cemetery in Odense, Denmark. Given that published crown formation times are varied and in some cases based on modern clinical samples, a sample-specific approach to determining formation time was most appropriate.

Thirty-three thin sections measuring approximately 250-300µm in thickness (including adhesive) were examined for total number and distribution of lines marking the normal enamel growth front. Following Risnes (1986), cuspal thickness in three unworn canines averaged 760 µm, and the mean cuspal formation time was estimated at 291 days. Imbricational enamel striae counts in the teeth ranged from 148 to 188, resulting in imbricational formation times ranging from 1036 to 1316 days (assuming a periodicity of 7 days between adjacent striae).

An important function of the growth model is in translating locations along the external surface of the tooth into internal timing (to produce accurate external defect chronologies). A quadratic equation characterizes the relationship between striae as they intersect with the dentin-enamel junction and the external surface (after Simpson 1999). Interestingly, no significant statistical difference was found between the function for medieval Danes and that derived from a sample of native American mandibular canines from La Florida dating from AD 1 to AD 1704 by Simpson (1999). Given the differences in the groups in both time and space, the similarity of the equations is surprising.

#### **Using 87Sr/86Sr in teeth as clues to the life histories of enslaved Africans buried in New York City.**

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We have analyzed 87Sr/86Sr in tooth enamel and dentine in 31 eighteenth century enslaved Africans buried in lower Manhattan, as well as in two burials and local well water from near Elmina, Ghana a major slave shipment port serving NYC. Since bedrock 87Sr/86Sr is very high in ancient west African gneisses, 87Sr/86Sr in tooth enamel may distinguish New York-born from African-born individuals. Some of the 408 burials display decoratively filed teeth, an African custom generally repressed in the New World. Twelve individuals (most < 10 years old) lacking decorative modification show tightly clustered 87Sr/86Sr in dentine and enamel (avg: 0.71159 +/-0.00072). They are apparently native New Yorkers. Nineteen others with filed teeth show enamel 87Sr/86Sr ranging widely (0.7085 to 0.7275). Their dentine 87Sr/86Sr lies closer to their enamel to the NYC value. These dentines have crystallinity indices (IR reflection spectra) of 2.7 to 2.8, suggesting that the isotopic differences are not diagenetic but rather reflect "new" NYC diet. If so, life expectancy in NYC may be estimated from the proximity of the dentine 87Sr/86Sr to 0.71159 relative to the enamel value, using estimated ages at death to define a rate constant. The life expectancy of most African-born individuals was < 10 years. At 0.7355, the Ghanaian well water is our highest measured 87Sr/86Sr. Ghanaian dentines show 87Sr/86Sr closer to 0.7355 than their corresponding enamel, also suggesting that these individuals were not native to their place where they were buried.

#### **Learning from the ancestors: The value of skeletal study.**

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The Omaha Tribe of Nebraska and the University of Nebraska worked together in defining an analysis program for Omaha ancestors who died between 1780 and 1820. For the Omaha Tribe, this was an important historical period. It saw the transition from the Omaha as the major political and military power in the region to a lesser force that was dominated by other tribes. The analysis of the skeletons shows how lifestyles and health changed at the turn of the nineteenth century. Previous to 1800, the tribe was

led by Chief Blackbird. The skeletons document the equestrian nature of the tribe and its dietary dependence on the buffalo. The analyses also show how lead and mercury poisoning affected the tribe at this time from paints provided by traders. The analysis shows that the Omaha were biologically diverse. American Indians from other tribes and a caucasian woman were adopted into the tribe. After 1800, there are distinct changes in the Omaha life style. There was a decline in heavy metal poisoning. The skeletons show that the diets of men and women differentiated. They also show that women had distinct roles in the production of trade goods and had more access to high-status artifacts. Men also had distinctive activities, some of which left skeletal markers. These observations, and others, have been incorporated in efforts to control modern diabetes and alcoholism by educating Omaha about their traditional lifestyles. The application of this "ancestral knowledge" for the benefit of the tribe is summarized.

#### **Hominoids, hindlimbs and Hox: Implications for hominid evolution.**

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Hox genes act as growth regulators that contribute to the specification of appendicular skeletal proportions. The posterior (5') alleles of the HoxA and HoxD clusters are expressed in similar, although not identical, domains during forelimb and hindlimb development. We have previously suggested that the lengths of the hominoid distal forearm and manual digits II-V undergo co-evolution via up or down regulation of *Hoxd11* expression or its growth targets (Lovejoy et al., 2000, *AJPA Suppl.*30:214). Here we investigate whether a similar relationship exists in the hindlimb. We measured the lengths of the proximal and distal femur and tibia and the five metatarsals and proximal two phalanges of each ray as in previous analyses. In contrast to the forelimb, the femur and tibia show no evidence of co-evolution with the pedal digits. Although *Hoxd11* is expressed in the hindlimb autopod, evidence from loss-of-function analyses suggests that it has only limited effect on tibial growth. In fact, evolutionary changes in pedal digits more closely resemble those expressing *Hoxd11* in the forelimb. This may support previous hypotheses (Inouye & Lovejoy, 1998, *AJPA* 26:125; Webb & Fabiny, 2001, *AJPA*

Suppl.32:161) that selection on either the hand or foot has pleiotropic effects on the other. These data suggest that Plio-Pleistocene elongation of the hominid hindlimb may have occurred independently of digit reduction. Furthermore, since both hindlimb elongation and digit reduction occurred after the attainment of obligatory bipedality, neither is likely to be a locomotor adaptation.

**The biomechanics of warrior activity: Repetitive, strenuous unimanual activity and its role in skeletal adaptation.**

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Architectural adaptations to the humerus have been identified in battlefield casualties from the Battle of Towton (UK), 1461 AD. These adaptations include variation in humeral torsion and a lateral deviation to the distal humerus with bowing to the shaft. The nature of these and other architectural modifications in the humerus is analysed as evidence of the altered biomechanics observable within habitual, strenuous unimanual activity.

External bone dimensions are compared with CT images taken at 20%, 35%, 50%, 65% and 80% to assess cortical bone deposition. Asymmetry is apparent both in the thickness of the cortical bone and in the direction of deposition, demonstrating divergence between limbs in the forces of mechanical loading. Preliminary investigation of external shaft measurements demonstrates a distinctive pattern of contralateral bone deposition within the Towton population. Some individuals display thicker cortical bone deposition in the right proximal shaft, which then shifts focus to the left distal shaft. Additionally, some architectural anomalies occur at 20%, indicating the variations in biomechanical forces across the elbow region.

Comparison is made between the Towton population and a group of blade-injured males from the cemeteries of St. Andrew, Fishergate. These individuals are thought to have fought at either the Battle of Fulford or the Battle of Stamford Bridge, both dating to 1066 AD. Biomechanical analysis is employed to identify any unique signature of architectural and biomechanical accommodation to the upper limb typified in battle-injured contexts and to identify any change in combat technique or other activity variants during the medieval period.

**Paleopathology at Jamaica Beach in Galveston, Texas**

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This presentation reports on an analysis of skeletal pathologies from 19 individuals of the Jamaica Beach site (41GV5) in Galveston, Texas. For the purpose of this study, the skeletal remains were analyzed in 1997, which were excavated in 1962. This presentation provides the first complete osteological analysis of this prehistoric hunter-gatherer group of the Texas Gulf Coast. Information gathered from each individual includes age, sex, and pathological occurrence. The site is dated to AD 1200-1500. Currently, the skeletal collection is housed at the Houston Museum of Natural Science in Houston, Texas.

This aboriginal coastal population is assumed to be Karankawa. However, there are several groups that inhabited the Texas Gulf Coast at this time and this study reports that the remains could be that of the Akokisa, another group present along the Upper Texas Gulf Coast. This was also a hunter-gatherer population who subsisted on hunting, fishing, and food-gathering, just as the Karankawa.

The purpose of this study is to determine presence and frequency of the following pathological occurrences within this population: dental pathologies, periosteal infection, porotic hyperostosis, arthritis, and trauma. Although the remains of each individual are not complete, preservation is good. After reconstruction and analysis of the skeletal remains, results show minimal pathological occurrence within this skeletal population of Jamaica Beach.

**The sutura frontalis and frontofacial growth in Pleistocene to recent Homo.**

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Sutural morphology and obliteration timing directly impact cranial growth and shape change. We report on the life history of the *sutura frontalis*, potential mechanisms that induce or inhibit fusion, and the impact of these on cranial shape in recent humans. Given this information, we investigate their impact on our understanding of the ontogeny of frontofacial growth and shape change in Pleistocene-to-recent *Homo*.

Our recent sample comprises 128 infants (fetal-newborn to 3.0 years-of-age) and 35 juveniles and adults with suture

retention. We made 11 measurements of the frontofacial region, quantified the fusion sequence and sutural pattern, and compared the fused to unfused condition.

We found the closure sequence to begin endocranially in the mid-frontal region with ossification spreading ectocranially and then posterosuperiorly and antero-inferiorly. We recorded fusion in 55% of infants aged as fetal-newborn with increased frequencies in later age stages. Loss of sutural function co-occurs with a frontal expanding equally at its maximum and minimum breadths. Sutural morphology, in conjunction with curvature characteristics, indicates separate functional units within the suture. We conclude that: 1) normal fusion timing varies but can begin at or near birth; 2) frontal curvature-cranial base relationships are important in the initial location and sequence of fusion; 3) normal lateral expansion appears unaffected by fusion timing; and 4) the interaction of dural attachments, sagittal sinus configuration, and cranial shape characteristics results in a biomechanical inductor of fibroblastic growth factors and their product, sutural fusion. Given these results, we discuss their impact on ontogenetic differences in Pleistocene-to-recent *Homo*.

**Early hominin locomotion and the ontogeny of phalangeal curvature in primates.**

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Disagreements over how to interpret locomotion in early hominins is based in large part on the disagreement over how to best interpret primitively retained morphology, such as phalangeal curvature. In an effort to better understand this feature's significance, this study tests the hypotheses that curvature changes during growth in a predictable manner relative to changes in locomotor behavior, and that interspecific differences in growth patterns relate to variation in function rather than phylogeny.

Curvature was assessed by measuring the included angle of third manual proximal phalanges in ontogenetic samples of the following taxa: *Macaca mulatta* (n=169), *Hylobates lar* (n=81), *Pongo pygmaeus* (n=59), *Gorilla gorilla* (n=80), *Pan troglodytes* (n=46), and *Homo sapiens* (n=123).

In the nonhuman taxa, curvature increases after birth, when the hands are first used to grasp branches and the mothers' fur. In *Hylobates* and *Pongo*, which remain primarily arboreal throughout ontogeny, curvature changes

insignificantly from infancy to adulthood. In contrast, *Gorilla*, *Pan*, and the macaques from Cayo Santiago practice less arboreality as they grow to adulthood. Included angle decreases significantly during postnatal growth in these taxa (but not in humans). These results suggest that curvature is partly a remodeling response to functional behavior during growth, or that curvature is a strongly controlled adaptive trait, tightly linked to behaviors practiced at different times during growth. Either alternative suggests that curved phalanges of fossil taxa, such as pedal phalanges of *Australopithecus afarensis*, reflect their use in an arboreal setting.

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**“Whose woods are these?”: Ethno-primatology and conservation in Sulawesi, Indonesia.**

E.P. Riley. University of Georgia.

In the changing contemporary world, human and nonhuman primates are forced to live in ever-increasing proximity, and thus, are more likely to experience conflict as each attempts to exploit common features of the environment. Human-nonhuman primate conflict, such as overlapping resource use (e.g., crop raiding), often occurs in protected areas where villagers must comply with restricted use/access policies, often perpetuating negative attitudes towards the protected area (and the wildlife it hosts) and potentially encouraging illegal land conversion and poaching. It is therefore critical that research, which occurs in the context of these protected areas, address both sides of the conflict. Ethnoprimatology is a new area of interest within anthropology that explicitly addresses the ecological and sociocultural interconnections between human and nonhuman primates as well as the implications these interconnections have for conservation. In this paper I will present some of the preliminary results of my dissertation research project which, using an integrated research design drawing from methods in both primatology and cultural anthropology, seeks to elucidate the interface of macaque ecology, human ecology, and conservation in Lore Lindu National Park, Central Sulawesi Indonesia.

**Imaging the neural correlates of mate competition in dominant male rhesus monkeys.**

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Male sexual jealousy may have evolved by natural selection due to its utility in establishing paternity certainty by way of securing exclusive sexual access to female mates. In this study, we attempted to induce in dominant male rhesus monkeys a psychological state that may be homologous to sexual jealousy in human males, and we used Positron Emission Tomography (PET) to image the neural correlates of this state.

Nine groups of monkeys were formed, each with two adult males and one adult female. In eight groups, one male emerged as clearly dominant and established exclusive sexual access to the female. Dominant males were placed alone in a cage, injected with 10 mCi <sup>18</sup>F-FDG intramuscularly, and then exposed to each of two conditions: 1) a challenge condition in which the subordinate male and female were together in a nearby pair cage and free to mate, 2) a control condition with the female alone in the pair cage. After 45 minutes exposure to each condition, both males were sedated with ketamine (5 mg/kg), blood samples were collected, and a PET scan was acquired from the dominant male. The challenge condition provoked both aggressive responding and increases in plasma testosterone in dominant males. Comparison of images from the two conditions revealed significant alterations in regional cerebral glucose metabolism (rCMR<sub>glu</sub>) in response to the challenge condition. Voxels were also identified where alterations in rCMR<sub>glu</sub> were significantly correlated with the changes in plasma testosterone concentrations. Supported by NIH MH12736-01 and the Emory Center for PET.

**Cementum annulations and age estimation in an early Holocene population.**

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Recent work has provided increasing certainty that cementum annulation counts are correlated with known age of extraction or death ( $r = 0.98$ ) with a margin of error of  $\pm 2.5$  years. The aim of this Master's degree research was to explore the possibility of using cementum annulations in an ancient archaeological population from Damdama, a site in Northern India (8000 BP). Cross-sections were prepared using a protocol designed specifically for fossilized remains and the teeth were examined for the following age related changes: attrition, secondary den-

tine, length and area of root translucency, root resorption, and count of annulations in acellular cementum. Age estimates from several histological methods were compared with macroscopic estimates based on dental attrition, pelvic morphology, and other degenerative changes. The cementum annulation estimates resulted in a high correlation with the mean macroscopic estimates for young adults between the ages of 16-29 ( $r = 0.69$ ,  $p = 0.05$ ) however a significant, systematic, centrist tendency was noted in the results. The cementum annulations tended to overestimate age at death in younger individuals and underestimate age in younger individuals. A similar tendency was noted in studies using this method on samples of known age at death, studies that also obtained high correlation coefficients and small margins of error. While work remains to be done on understanding the biological basis of these annular structures and thereby hopefully explaining their accumulation, this study provides some hope for including fragmentary adult individuals in demographic and biocultural research.

**Scaling effects on mental foramen position in *Gorilla gorilla*.**

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Building on recent literature concerning mental foramen position within the genus *Homo*, our research expands the focus to include other hominoid genera. Specifically, we explore the position of the mental foramen with respect to mandibular size in the three subspecies of *Gorilla gorilla*. Due to the large degree of sexual dimorphism exhibited by gorillas, we investigate males and females separately. Our data consist of 3D landmarks that are converted to linear distances. We compare the AP distance between the mental foramen and infradentale to dental arcade length, our surrogate size measure, for 17 *Gorilla gorilla beringei*, 52 *Gorilla gorilla gorilla* and 32 *Gorilla gorilla graueri*. The three subspecies of *G. gorilla* demonstrate a positive and consistent relationship between mental foramen position and dental arcade length, although it is weaker for *G. g. gorilla*. Moreover, males and females of each subspecies scale in the same positive direction and with similar slopes. The positive scaling relationship between mental foramen position and mandibular size suggests that nerve and vascular supply to the anterior portion of the man-

dible may be related to structural requirements and loading regimes within all hominoid genera. Deviations from this pattern may indicate unique ontogenetic and/or dietary adaptations.

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**A multivariate apportionment of global diversity in contemporary humans based on craniometric traits.**

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The apportionment of diversity within and between human populations based on classical genetic markers and molecular polymorphism has shown that the majority of diversity is found between individuals within local populations. Previous assessments of quantitative genetic variation based on Howell's (1973) craniometric data set result in estimates of within and between population diversity that are similar to genetic data, suggesting a limited role for selection in producing human cranial diversity. However, these analyses were conducted on a pooled set of measurements and therefore included information about size, shape, and random error. Additionally, all variables were treated as a single large metavariable without assessing intercorrelations between variables. To address these issues, we convert the original measurements in Howells' data set into Mosimann shape variables and size (geometric mean of the original measurements) and extract principal components that serve as new independent variables. Few reliable principal components could be extracted. The first two principal components principally discriminate between populations. Subsequent components discriminate poorly between populations. Estimates of Fst based on the first two principal components are larger than previous estimates based on phenotypic variance pooled across all variables, suggesting that at least some differences in contemporary human cranial shape may be the product of interregionally differing selection. The limited number of reliably extractable principal components has implications for assessing the biological affinities of ancient samples.

**Geomorphometric study of artificially modified crania from coastal Ecuador.**

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Human groups worldwide have practiced artificial cranial modifications. Various types of cranial vault reshaping have been identified by gross morphology and numerous classification systems have been proposed based on the type of binding apparatus utilized. Because of the increased range of morphological variation produced by intentional reshaping, many of these skeletal series cannot be included in population analyses. In this study, we present an analysis of craniofacial shape variation within and among modified (N=5) and unmodified (N=25) crania from a single skeletal series from Ayalán, coastal Ecuador.

Procrustes superimposition and thin-plate spline (tps) analysis were applied to investigate morphological variation between modified and unmodified crania allowing us to detect subtle biological variation with respect to the precise position of specific landmarks. A *Microscribe 3-DX* digitizer was used to collect Cartesian coordinates for 37 homologous craniofacial landmarks. The Procrustes superimposition and tps analysis were performed using *Morpheus et al.*, written by Dennis E. Slice and available for downloading from the SUNY-Stony Brook Morphometrics homepage. Sample covariance structure was compared and a non-parametric MANOVA was performed on the scaled, translated, and rotated coordinates to test for mean shape differences. Significant biological shape differences and patterns of variation are presented using 2- and 3D graphical representations. New insight into the local shape change present between modified and unmodified crania would aid in further understanding developmental and functional forces of craniofacial growth and the possibility for "correcting" reshaped crania that could facilitate the use of previously unavailable skeletal series due to their reshaped nature.

**Temporal relationship of EMG and muscle force in the anterior temporalis muscle and its utility for finite element modeling.**

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The temporal relationship of EMG and muscle force in the anterior temporalis

muscle was investigated to determine how EMG data could be used to load a finite-element model of a macaque skull. In two experiments, EMG was measured using bipolar electrodes placed bilaterally in the anterior temporalis; force was estimated unilaterally using rosette strain gauges on the anterior temporal line. Relative timing of EMG and force were gathered at 31 points in the power stroke, 15 before and after peak EMG and strain. Analysis of variance revealed that relative timing of force and EMG throughout the power stroke was significantly affected by inter-experiment variation and food type. Controlling for these factors, chewing side showed significant effects throughout the power stroke. Average (n=125) values by which EMG precedes bone strain at different times during power strokes of ipsilateral almond chewing are: 25% of peak during loading, 30ms; 50%, 31ms; 75%, 42ms; peak, 40ms; 75% of peak unloading, 28ms; 50%, 24ms; 25%, 22ms. Average (n=188) values for contralateral almond chewing are: 25% of peak during loading, 11ms; 50%, 13ms; 75%, 13ms; peak, 12ms; 75% of peak unloading, 6ms; 50%, 4ms; 25%, 7ms. Temporal differences associated with chew side are similar to timing differences between working and balancing superficial masseters, suggesting that the masseter may be exerting force on the temporal line via the temporalis fascia. This may compromise the utility of strain data from this region for estimating the relative timing of EMG and force in the anterior temporalis.

**Nasal and paranasal anatomy of Oligocene and Miocene catarrhines.**

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Neontological comparisons have indicated that paranasal sinus anatomy is diagnostic of several catarrhine clades such as Cercopithecoidea, Hominoidea, Homininae, and Ponginae. However, while the reduced paranasal anatomy of cercopithecoids is generally recognized as a derived condition, determining the polarity of character-state changes within non-cercopithecoid catarrhines requires knowledge of the primitive catarrhine condition. To address this problem, the paranasal sinus anatomy of several early catarrhine taxa was investigated.

Two faces of *Aegyptopithecus* were computed tomography (CT) scanned at 1 mm. collimation and reconstructed in 0.5 mm slice intervals with the CTi scanner at the Duke University Medical Center. These data were compared with palatofacial

specimens of *Proconsul*, *Limnopithecus*, *Dendropithecus*, and *Kalepithicus* in the National Museums of Kenya, Nairobi, and to specimens of living taxa in the Department of Anthropology at Yale University.

Results confirm that cercopithecoid paranasal anatomy is derived, and suggest that the sinus anatomy of stem catarrhines included a hominoid-like maxillary sinus as well as an ethmofrontal system like that of hominines. Accordingly, these two features do not constitute evidence for hominoid, hominid, or hominine status of any fossil species. Conversely, the absence of the ethmofrontal sinus system in *Sivapithecus* and *Pongo* is synapomorphic. In addition, features of the nasal cavity of *Limnopithecus* and *Kalepithicus* support previous suggestions that these taxa are stem catarrhines rather than stem hominoids.

#### **A longitudinal study of child growth, nutrition and health in five Rendille communities of northern Kenya.**

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Anthropometric, morbidity and dietary recall data were collected for on a bi-monthly basis over the period 1994-97 for samples of children in five Rendille communities of Marsabit District, northern Kenya. Four communities had recently undergone the transition from nomadism to sedentism and one still practiced nomadic pastoralism. The total sample consisted of 5,565 measurements representing 488 children. Anthropometric data were used to delineate and analyze longitudinal growth, nutrition and morbidity patterns. Analysis showed significant differences in age-specific height and weight patterns between all sedentary communities and the nomadic sample, with nomadic children heavier and taller at all ages. Analysis by Generalized Estimating Equations showed that milk intake, seasonality, breastfeeding status were significant determinants of nutritional status throughout the study period.

#### **Ontogenetic changes in limb bone structure: a longitudinal analysis of the Denver Growth Study sample.**

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Some of Frank Johnston's earliest research documented ontogenetic changes in limb bone lengths in the Indian Knoll sample, and the study of limb bone growth and development remained an important theme of his work throughout his career. In this study I report on new longitudinal data collected from limb radiographs taken of the Denver Growth Study sample in the 1940's through 1960's. The sample includes 10 males and 10 females measured from near birth through late adolescence at approximately 6 month intervals (average number of time points per individual = 34.5). Femoral and humeral bone lengths and cross-sectional diaphyseal dimensions were measured on AP radiographs using a ruler and calipers, respectively, with diaphyseal breadths used to calculate section moduli (measures of bending/torsional strength). Body weight, stature, and limb muscle breadths (also measured radiographically) were available from the study database.

Several clear trends are apparent in the study results. First, there is an "infancy peak" in growth rate in femoral strength between 1 and 2 years, combined with a sharp decrease in growth rate in humeral strength between 1.5 and 3 years, corresponding to the initiation of walking and reduced use of the upper limb for locomotor activities. The best predictor of bone strength throughout later growth and development is body weight\*bone length, except for the upper limb during adolescence, when muscle breadth is the best predictor. Results such as these demonstrate the value of ontogenetic studies, and in particular true longitudinal data, in addressing questions of skeletal adaptation.

#### **Dental disease: The root of all evil?**

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Epidemiological and clinical studies suggest that periodontal disease may be correlated with heart disease, acute myocardial infarction, arteriosclerosis, stroke, respiratory disease, and diabetes. Seldom can these conditions be diagnosed in archaeological specimens, since they rarely leave evidence on tissues that do not decay. However, if an association exists, evidence of dental disease could indicate probability of death due to systemic diseases. In order to investigate whether skeletal specimens corroborate the observed associations and to investigate, 416 specimens from the Terry Collection were scored for number of pulp exposures

due to caries and number and type of abscesses and antemortem losses. This study utilized new scoring systems for overall periodontal disease and for endocranial modeling.

Dental disease parameters did not differ significantly between cause-of-death groups when individuals were grouped into six age-at-death cohorts. Nonetheless, in the cohorts 35-49, 50-64, and 65-74 years at death, the average periodontal distress sum was higher among myocarditis fatalities than among controls. Whites exhibited significantly more periodontal disease and endocranial modeling than blacks. Endocranial modeling was found to be significantly correlated with the periodontal distress sum ( $r=0.198$ ,  $n=415$ ) and age-at-death ( $r=0.245$ ,  $n=415$ ). In particular, small pits in meningeal grooves and deepening of meningeal grooves correlated significantly with the periodontal distress sum ( $r=0.329$  and  $0.267$ , respectively,  $n=75$ ). We suggest these small pits indicate a pathological condition, since they occurred significantly more frequently in myocarditis fatalities than controls ( $p=0.029$ ). Individuals who died of myocarditis also exhibited significantly more smooth depressions with diameters  $>1$ cm ( $p=0.024$ ).

#### **A multi-site comparison of dietary preferences and seed dispersal by spider monkeys (*Ateles* spp.)**

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Investigations of coevolutionary relationships between plants and the animals that disperse their seeds suggest that disperser-plant relationships are likely shaped by diffuse, rather than species-to-species, coevolution. We investigated the potential for diffuse coevolution in a tropical seed dispersal system by comparing fruit preferences and seed dispersal by three species of spider monkeys (*Ateles* spp.) at four neotropical sites in Colombia, Ecuador, Panamá, and Suriname. At all sites, spider monkeys were highly frugivorous and preyed upon seeds of few species, relative to the number of species dispersed. Few similarities in dietary preferences among sites were evident. Of the 52 genera that comprised the top 20 most frequently consumed genera summed over all sites, only two, *Cecropia*

(Moraceae) and *Virola* (Myristicaceae), were ranked within the top 20 at every site. In contrast, 44 genera were within the top 20 most frequently consumed at only one or two sites. Patterns in fruit preference at the family level were similar. Moraceae and Myristicaceae ranked within the top ten families at every site, but most families were important only at one or two sites. Among-site variation in plant species composition and relative abundances may partly explain these patterns. These results suggest that variation in plant community structure may strongly influence dietary preferences, and hence, seed dispersal by spider monkeys. Thus, even diffuse coevolution in spider monkey-plant relationships may be limited to few taxa at the genus and family levels.

**Evaluation of the functional adaptation of femoral trabecular bone in *Galago* and *Loris* using micromechanical finite element models.**

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Recent work on the interspecific variation of trabecular bone in the proximal femur of extant strepsirrhines demonstrates important architectural differences between taxa with different locomotor behavior. It is generally assumed that these differences reflect differences in joint loading to which the bone is adapted. Recently introduced numerical techniques now enable a quantitative evaluation of this assumption. Using these new techniques, the purpose of this study is to evaluate functional adaptation of femoral trabecular bone in *Galago senegalensis* and *Loris tardigradus*, two animals with broadly differing locomotor behaviors and trabecular structures.

One femoral head from each taxon was scanned using a high-resolution X-ray computed tomography scanner with a resolution of 0.036 mm. Micro-finite element models were created by converting bone voxels to eight-noded brick elements, resulting in models with approximately 1.8 million elements. Several loading conditions, representing the takeoff phase of a leap or those during climbing, were applied to the model and the joint force magnitude and structural adaptation were evaluated for each load case by comparing trabecular bone tissue strains to physiological values.

Very similar joint forces in the range of 3.3x-8x body-weight, depending on orientation, were calculated for both taxa.

These seem reasonable for the leaping *Galago*, but too high for the quadrupedal *Loris*. This suggests that bone in the *Galago* is functionally adapted, but that in the *Loris* is over-dimensioned. A possible explanation for this is that, since mass is less important for quadrupeds than for leaping animals, the former may have a higher safety factor against fracture.

**Computer tomography and calculation of bone biomechanics in cross-sections of long bones.**

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Computer tomography offers a non-invasive possibility to examine cross-sectional geometry of long bones. We tested different methods (Nagurka and Hayes 1980, Corcacon et. al. 1995) for calculating biomechanical parameters from CT images of long bone cross section based on trigonometric and image analysis approaches using archaeological (75 adult bronze age individuals from 3 different populations from Lower Austria) and recent samples (anatomical collection from the Institute of Anatomy, University of Vienna) of long bones. Both approaches do not only lead to different problems concerning computation but also to different biological meanings of the calculated biomechanical parameters. However, image analysis of digital CT-images suggests an easier and observer independent way of calculating the desired biomechanical parameters automatically and directly from standard medical image-files (DICOM). We have developed computer software that allows optional, interactive and automated data preparation for computation, depending on the state of preservation of the bone samples and the method applied. Our software uses the CT files directly and offers immediate computation of biomechanical parameters with either approach and as a series of anatomical context. Therefore it is possible to analyse larger series of long bones in a convenient period of time. After computation the results can be easily exported to other programs for further calculations like statistical analysis and 3D visualisation. Because of the modular design of the computer program new data processing units can be added in future.

**Schultz's Rule and dental development in Malagasy lemurs: A cautionary tale.**

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Schultz's Rule states that there is a relationship between the pattern of eruption of molar vs. secondary (replacement) teeth, and the overall pace of growth and maturation. Species with "fast" life histories (rapid dental development, rapid growth, early sexual maturation, short lifespans) are said to exhibit relatively early eruption of the molars and late eruption of the secondary replacement teeth (premolars, canines, incisors), whereas species with "slow" life histories are said to exhibit relatively late eruption of the molars and early eruption of the secondary dentition. In a recent review, B.H. Smith noted that primates with toothcombs might violate this rule because toothcombs tend to erupt early, regardless of the pace of life history. We show that exceptions to Schultz's Rule among lemurs are not limited to the relative timing of eruption of the toothcomb. Rather, among lemurs: (1) some species with extremely accelerated dental development exhibit a pattern of eruption of molars and of secondary teeth in direct opposition of the expectations of Schultz's Rule; and (2) the pace of dental development is not necessarily correlated with the pace of growth or the timing of reproductive maturation. We focus particularly on the pattern and pace of dental development and eruption in *Avahi* and *Lepilemur* – two relatively small nocturnal folivores with rapid dental development. These taxa differ markedly in their eruption sequences (the premolars erupt in *Avahi* but not *Lepilemur* prior to M2 and M3). We offer an explanation for the failure of Schultz's Rule to predict these differences.

**Fauna, taphonomy and ecology of the Plio-Pleistocene Chiwondo Beds, Northern Malawi.**

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The vertebrate fauna of the Chiwondo Beds in Northern Malawi is heavily biased towards the preservation of large terrestrial mammals. A case study carried out at the Late Pliocene hominid site at Malema shows that twenty species are recognized, eighteen of which are ungulates, known from other African Pliocene localities. Their diversity resembles an African open-adapted short grass plains assemblage. The taxonomic diversity is nevertheless low, emphasizing an incomplete fossil record. Based on modern bovid abundances in African game parks, statistical tests show that the bovid fauna consists of a mixture of the Somali-Masai and the Zambezian ecozones. The occurrence of *Paranthropus boisei* makes Malema the southernmost locality in Eastern Africa yielding this early hominid taxon. Its discovery at a lake margin site corresponds to robust australopithecine bearing localities along Lake Turkana, Kenya.

The death assemblage was subject to heavy modification after deposition. This has effected the size distribution, the frequencies of skeletal elements, and thus the taxonomic composition. High-density skeletal elements such as molars and partial mandibles prevail. The analysis of the chemical composition of mammal and fish bones from Malema suggests a different site formation process than in other African localities such as Olduvai Bed I despite the proximity of a paleolake. While bovids also dominate at the *Homo rudolfensis* locality at Uraha, the faunal composition and preservation potentials at that site point to a different taphonomic history.

#### **Social organization and ecology of Mentawai leaf monkeys.**

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Mentawai leaf monkeys (*Presbytis potenziani*) are endemic to the Mentawai Islands, a small island chain about 100 kilometers off the coast of West Sumatra, Indonesia. Mentawai leaf monkeys have been the subject of few studies, and there has been relatively little documentation of the social behavior or ecology of the species. Prior to this project, Mentawai leaf monkeys had never been habituated nor been the subject of any study exceeding 200 hours of visual contact.

Previous studies suggest that Mentawai leaf monkeys are the only Old World monkeys to live exclusively in monogamous social groups throughout their range and that they do not exhibit a behavioral and ecological pattern typical of any other mo-

nogamous primate. However, it was found that Mentawai leaf monkeys are not exclusively monogamous but exhibit flexibility in their social organization. Like simakobu monkeys (*Simias concolor*) and Javan leaf monkeys (*Presbytis comata*), the only other colobines known to live in monogamous groups in parts of their range, Mentawai leaf monkeys also live in one-male and multi-male groups.

A habituated group of Mentawai leaf monkeys on North Pagai Island was monitored from June 2000 to October 2001. Three neighboring groups, one bachelor pair, and one lone male were also followed on an opportunistic basis. Systematic data were collected on their general activity, feeding and ranging behavior, social interactions within and between groups, inter-specific interactions, and vocalizations. Phenological data were collected to assess the general availability of their food resources in the study area.

#### **Potential patterns of male mate competition among wild ring-tailed lemurs, *Lemur catta*.**

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Ring-tailed lemurs do not exhibit body size dimorphism, but males do have canine dimorphism. This suggests that some form of male mate competition is occurring, but the behavioral correlates remain unknown. Male dominance relationships may be stable for long periods, but can also become rapidly unstable. The goal of this analysis was to determine how male *L. catta* compete for mates, and the effects of stable versus un-stable male hierarchies on such strategies. Behavioral data collected at the Beza Mahafaly Special Reserve from 1987-88 and 1991-2 were analyzed. In stable, but not unstable groups, top-ranking males exhibited more male-male agonism and engaged in more bouts of agonistic scent-marking. Top-ranking males also spent more time near females than did all other males. In the non-stable groups, most males developed preferred affiliative relationships with at least one female, but in stable male groups, most males did not associate more with particular females. Males in both stable and non-stable groups also had preferred affiliative relationships with certain males that may be related to patterns of male migration. The number of males in a group may be an important variable affecting male strategies. For stable and non-stable groups, males living in groups with only two males were able

to affiliate more with females than were males in larger groups. Results indicate that male ring-tailed lemurs may have a number of reproductive strategies that vary depending on the number of males in a group, as well as whether groups have stable or non-stable dominance relationships.

#### **Female attractiveness — Physical appearance as shape.**

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Facial and body attractiveness in humans are proposed to be evidence of developmental and hormonal health. Attractiveness ratings by males of female faces and their nude bodies correlate positively, which underpins the notion that face and body comprise one single ornament and refute objections that facial attractiveness in women is instead a deceptive signal such as youth. Two questions arise: (1) which physical features drive these judgements, and (2) can these features be associated with aspects of the women's actual developmental and hormonal status?

As image data we use photographs of 100 young American women in three standardized views: faces only, nude fronts (faces covered) and nude backs. Each image was rated for attractiveness by 60 males. Our morphometric data consist of 50 cranial and 50 postcranial soft tissue landmarks, digitized as 2D-coordinates. We analyze the three image sets separately, using relative warps analysis, shape regression (upon rated attractiveness) and Procrustes symmetry analysis. We then apply singular warps analysis to consider explicitly the interrelations among the three different parts of the same body.

In all three views, we find the attractiveness ratings significantly associated with both (1) specific localized shape differences in regions of known estrogen sensitivity, and (2) the amount of fluctuating asymmetry. Interestingly, the grids of the first singular warp (all three sets) seem to concur with the shape changes that predict attractiveness. These results support the notion that the psychology by which women's physical attractiveness is rated may exploit indicators of their hormonal and developmental status.

### Is vitamin A status related to outcomes in young children with sickle cell disease?

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Both low serum levels of vitamin A and poor growth have been documented in children with SS type sickle cell disease (SCD-SS), however, the association of vitamin A status and growth status or health outcome is unexplored. Based upon serum retinol, children with SCD-SS ages 2.0 to 9.9 yrs. were divided into optimal ( $\geq 30$   $\mu\text{g/dL}$ ) and suboptimal ( $< 30$   $\mu\text{g/dL}$ ) vitamin A groups. Intake of vitamin A and calories was assessed by 24 hr recall. Z-scores were computed for height, weight, and BMI using the US CDC 2000 growth charts. Health outcome was assessed by hematologic status and by the number of hospitalizations over a one-year period.

Forty-four of 66 children (39 girls) had suboptimal vitamin A status, although intake of vitamin A was adequate. Compared to those with optimal levels, children with suboptimal vitamin A had significantly lower BMI-Z ( $-0.66 \pm 1.0$  vs.  $-0.09 \pm 0.64$ ) and hemoglobin levels ( $7.9 \pm 1.1$  vs.  $8.5 \pm 1.1$  g/dL). They also had significantly more total hospitalizations ( $2.8 \pm 2.0$  vs.  $0.7 \pm 0.8$ ), including pain ( $0.9 \pm 1.2$  vs.  $0.1 \pm 0.4$ ) and fever episodes ( $1.1 \pm 1.2$  vs.  $0.2 \pm 0.4$ ). Controlling for age and gender, children with optimal levels had a significantly reduced risk for hospitalization (adjusted odds ratio (AOR)=0.09, 95% confidence intervals (CI)=0.02-0.44) compared to those with suboptimal levels.

Suboptimal vitamin A status was prevalent in young children with SCD-SS and associated with poorer growth and hematologic status and an increased risk for hospitalizations. Vitamin A requirements may be increased in SCD-SS, and improving vitamin A status may improve overall health, growth and nutritional status in these children.

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### Bone structure and mineralization in a late antique skeleton with osteomalacia.

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Osteomalacia is characterized by mineral disturbances of bone tissue caused by lack of vitamin D due to inadequate exposure of sunlight and also by malnutrition. This disease manifests itself in mechanically stressed regions in adults, substituting regularly arranged bone formation of osseous tissue by unmineralized osteoid of minor quality.

Based on a recently done study on vertebral bodies with and without disturbed mineralization from a medico-historical collection of the 19<sup>th</sup> century (housed in the Federal Museum for Pathological Anatomy, Vienna) a late female skeleton (estimated age of death 40-45 years) from a Roman cemetery (1600 BP) from Linz, Upper Austria, was investigated to obtain a differential diagnosis.

Non-invasive radiological and invasive histological techniques, which have been tested in a previous study on trabecular bone using a documented historical skeletal collection (Schamall et al. 2002) were applied to examine an archaeological specimen with severe pathological alterations. An additional aim of the present study was to proof the ability to distinguish between disturbed mineralization of bone and alterations caused by post-mortem influences.

X-ray-documentation could demonstrate a low mineral content in general and characteristic symmetrical dense zones representing the "Milkman-Syndrome" typical for osteomalacia. BSE-images confirmed this diagnosis by evidence of imperfectly mineralized bone structures, enlarged osteocyte lacunae and extended resorptive borders. The presented case is the first record of osteomalacia in an ancient population in our country. The investigations demonstrate, that the methods experienced on a medical historical collection, can be successfully applied for differential diagnostic purpose on earth-stored fragmentary preserved skeletal remains.

The basic study was financially supported by the Oesterreichische Nationalbank (Project Nr. 7109).

### Taurodontism: Methodological limitations and pulpal dynamics.

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Morphological characteristics of the molars are used to differentiate between Neandertals and modern *H. sapiens*; it is argued that taurodontism is a Neandertal autapomorphy. This trait is characterized as one emphasizing superio-inferior elongation of the pulp, the consequence of which is a shortening of the length of the

roots visualized from their point of bifurcation just below the cemento-enamel junction. Traditional methods use buccal-lingual radiographs to measure pulpal dimensions of the mesial-distal plane. Since, pulpal dimensions are measured using only a single plane, this method thereby assumes that mesial-distal dimensions correspond to buccal-lingual dimensions. The objective of this analysis is to explore the limitations of conventional methods and examine pulpal dimensions in both a mesial-distal and a buccal-lingual plane. The study sample consists of forty modern *H. sapiens* molars from a central Asian population dating to approximately 5,000 B.P. Radiographs were taken of first and second mandibular molars from a collection housed at the Archaeological Institute in Samarkand, Uzbekistan. Metric measurements of the pulpal chambers were taken using Sigma Scan Pro software.

Preliminary results indicate that the dimensions of the mesial-distal plane are not an accurate representation of the dimensions of the buccal-lingual plane. The inverse relationship between the mesial-distal and buccal-lingual dimensions of the pulp may reflect physiological constraints related to pulpal dynamics. Hence, the functional significance of taurodontism may be questioned. Consequently, it is necessary to reevaluate previous analyses and perhaps, evidence supporting taurodontism as a distinguishing characteristic of Neandertals.

### A pilot study of Y chromosome analysis on Melanesian populations.

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Recent and past anthropological literature shows Island Melanesia to be an area of extreme cultural and biological heterogeneity. DNA analysis has uncovered high levels of genetic variation both within and among islands in Melanesia. This area, however, is poorly studied with regard to Y chromosome analysis.

We conducted preliminary Y chromosome analysis on a linguistically diverse panel of unrelated males. Specifically, we chose 30 samples from the Kuot speaking population residing in New Ireland, 30 samples from the Atta speaking population residing in New Britain, 30 samples from an amalgam of Austronesian speak-

ing populations residing in New Britain, and 30 samples from an amalgam of Austronesian speaking populations residing in New Ireland. Using PCR and gel electrophoresis methodology, we typed four markers: YAP, M9, M15, and 50f2/c.

Our data show statistically significant variation among the four sampled populations at the 50f2/c locus. While the Kuot and both Austronesian sample sets were negative for the deletion, the Atta sample included 10 out of 30 50f2/c deleted individuals. This 33% occurrence of the mutation is the highest frequency documented outside of Europe to date. Many population genetic studies have examined the relationship between linguistic affiliation and the pattern and distribution of genetic variation. Our pilot data on the NRY in combination with preliminary chromosome 22 typing suggest this relationship is relevant in New Britain and New Ireland.

#### **Weight growth velocity from birth to 2 years of age in relation to lead burden.**

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To determine the impact of lead pollution on human health and variation we examined growth from birth to 24 months of age in relation to child's blood lead. The sample consists of children enrolled in the 1<sup>st</sup> phase of the APILS (Albany/Pregnancy Infancy Lead Study). Mothers in APILS were drawn primarily from urban disadvantaged neighborhoods in Albany, NY. Children were measured for size and lead level at birth, 6, 9, 12, 18, and 24 months of age. The Jeness-Bailey model was fit to all children with 6 or more weight measurements out of 7 possible from birth to 24 months (n=53). All fits were good ( $r > 0.97$ ). Controlling for birth weight, gestation length, sex, maternal smoking, race/ethnicity, parity, and the average calories consumed from 312 months, we found that an increase in lead levels from the first to the second half of infancy is significantly associated with lower weight velocity from age 6 to 12 months ( $r = -0.36$ ,  $p=0.03$ ), and from 9 to 12 months ( $r = -0.39$ ,  $p=0.02$ ). There was no effect of lead level change during infancy on weight velocity prior to 6 months of age ( $r = 0.13$ ,  $p=0.93$ ), suggesting that change in weight velocity follows the change in lead rather than the countercausal explanation that slow velocity is characteristic of children who later develop higher lead

levels. We conclude that blood lead can impair weight growth in later infancy. Supported by NIEHS - ES05280.

#### **Understanding and correcting molar robustness index error.**

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The primary limitation of the Robustness Index (MDxBL diameters) is that it provides the area of a rectangle and, thus, overestimates molar occlusal area. Some have argued that the error should be about the same on all molars. Still others have decided that the error is simply too much and that the method should be disregarded. Given the intuitive and convenient way in which the Robustness Index (RI) expresses occlusal area, it merits the effort required to understand and improve its error before it is abandoned altogether.

The current study seeks to see if the RI error differs significantly between molars of different shape. A total of 144 maxillary and mandibular molars were sorted into six shapes defined by the relative size of their hypocone/hypoconulid (i.e., no, small, and large hypocone; no, small, and large hypoconulid). The "actual" occlusal area was determined for each molar by tracing the occlusal outline on a detailed digital image using ScionImage software (a derivative of NIHImage). Care was taken to insure that all images were in the same plane and to a corresponding scale. The RI error was then calculated for each of the six molar shapes. Analysis of Variance tests between the errors of each shape suggest rejecting the hypothesis that RI errors are the same for all molars. Of the maxillary molars, those with large hypocones were statistically distinct from those with small or no hypocones. Among the mandibular molars, those with no hypoconulids were statistically distinct from those with small or large hypoconulids. Regression-based formulae were then derived from the "actual" and RI areas. These formulae may hold promise for the future use of this method.

#### **Locomotor modes of primates at moderate speeds. I. The implications of the amble and the canter for primate locomotor evolution.**

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It is widely recognized that primates walk and gallop, but rarely use trotting gaits with a whole-body aerial phase. Previous researchers have suggested that at intermediate speeds, primates "amble". During an amble, forelimb and hindlimb contacts alternate, as in the walk but the forelimbs and hindlimbs experience an aerial phase, though not simultaneously. This lack of a whole-body aerial phase ensures that the body is always supported by at least one limb during the gait cycle. We examined how common this mode of locomotion is among primates using videotapes of 14 prosimian, platyrrhine, and catarrhine species. We found over 200 steps that could be categorized as an amble. In addition, we found that most primate gallops do not involve a whole body aerial phase, and thus could be classified as a canter. Both the amble and canter allow primates to maintain a secure hold on a substrate during locomotion and potentially lower peak vertical forces compared to gaits with whole body aerial phases. This conclusion supports Schmitt's (1995) contention that primates avoid trotting because of the high stresses that have been observed for this gait in other mammals. Maintaining a secure support and lowering substrate reaction forces may be important for locomotion on arboreal supports, particularly on thin and flexible supports. The regular use of the amble and canter by primates may have evolved in early primates to meet mechanical requirements necessary for moving at intermediate speeds on thin supports.

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#### **Evolution of the prefrontal cortex: A stereological analysis of primate brain MRI scans.**

P.T. Schoenemann, L.D. Glotzer. Dept. of Anthropology, University of Pennsylvania.

While it is well established that the human brain is ~3 times larger than expected for a primate of our body size, there is dispute over the extent to which the prefrontal cortex (which mediates a number of behaviors thought to be important to human evolution) has increased disproportionately. Semendeferi et al. (2002, 1997) have argued that the frontal lobe (of which the prefrontal cortex is a major subcomponent) is *not* relatively larger in modern humans, in contrast to earlier studies dating back to Brodmann (1912).

However, Semendeferi et al. use estimates of cortical volume, whereas the

earlier studies suggesting a disproportionate increase have used measures relating to cortical surface area. The volume/surface area distinction may be crucial because it appears that cortical surface area may be more behaviorally relevant than cortical volume. We measured both cortical surface area and volume using stereological techniques on a sample of primate MRI scans (obtained from the Yerkes Regional Primate Research Center; Rilling and Insel 1999) and a sample of modern humans. Both the entire cortex and prefrontal only (operationally defined as all cortex anterior to the corpus callosum) were analyzed. To avoid missing cortical surface hidden deep within sulci, surface area were estimated using the grey-white interface. A full statistical analysis of the relative differences in proportion of prefrontal cortex across primates is presented, for both volume and surface area. Preliminary indications from a subsample of chimp and human scans suggest relative increases in the anterior portions of the prefrontal in humans.

#### **Insulin, gestational diabetes and maternal thrift.**

T.O. Scholl. University of Medicine and Dentistry of New Jersey.

Hyperinsulinemia has been proposed as an adaptation that increases the efficiency of energy storage in an environment where there is feast or famine. 'Thrifty' individuals may be predisposed to gain weight, become overweight or obese and develop type 2 diabetes or other diseases related to hyperinsulinemia and insulin resistance. However, research often does not support this hypothesis. We examined the relationship of fasting insulin at entry to care ( $15.2 \pm 5.3$  wks gestation) in more than 800 women from Camden without pre-gestational diabetes. After control for potential confounding variables (age, parity, ethnicity, BMI, smoking, week gestation at entry to care) gravidas in the highest quintile of fasting insulin had significantly increased sum of skinfolds and a more central fat distribution (trunk/extremity ratio) than the others. They had a significantly higher rate of gestational weight gain and an increased risk of excessive weight gain for BMI (Adjusted Odds Ratio (AOR) = 1.56, 95% Confidence Interval (CI) 1.05-2.33), nearly a threefold increase in the risk of gestational diabetes mellitus (AOR=2.67, 95% CI 1.19-5.99) as well as significantly increased risks of new overweight (BMI>26) and new obesity (BMI>29) in the postpartum (4-6 weeks). Thus, preg-

nant women with high levels of insulin do evidence 'thrift', enhancing their own nutritional status while simultaneously nourishing a fetus. Unlike the situation in mature individuals where hyperinsulinemia limits weight gain, high levels of insulin early in pregnancy increase maternal energy stores at the expense of subsequent overweight, obesity and diabetes.

#### **Terrestrial walking versus climbing in bonobos (*Pan paniscus*): Position of the center of mass and consequences for the locomotor behavior.**

K. Schoonaert, K. D'Août, P. Aerts. Dept. of Biology, University of Antwerp.

Two major groups of theories exist on the precursor of habitual bipedalism in hominids, both primarily based on paleontological findings. On the one hand, the "terrestrial theories" postulate that bipedalism evolved from terrestrial quadrupedalism. On the other hand, the "arboreal theories" state that bipedalism originated from climbing, the latter being an exaptation for (eventually habitual) bipedalism.

In order to help evaluate current theories, we have recently started a project on the kinesiology of arboreal locomotion versus terrestrial locomotion in bonobos (*Pan paniscus*). Like all apes, bonobos are habitually arboreal, but they are also adept terrestrial walkers, both quadrupedally and bipedally. Together with chimpanzees (*Pan troglodytes*), they are the closest known relatives to hominids, but bonobos likely resemble the common ancestor better from a morphometrical point of view.

For walking and climbing, two separate set-ups were used, both allowing for synchronous recording of kinematics (50 Hz video) and of substrate reaction forces. These were measured by force platforms for terrestrial walking, and by a 4-m long, straight pole (12 cm diameter), partially instrumented with two 3D force transducers for incline walking and climbing.

During terrestrial quadrupedalism, weight is generally well distributed between the front and hind limbs, although this is variable and typically oblique to the walking direction. When the slope increases, the load shifts towards the feet. At a slope of 30°, locomotor behavior resembles terrestrial walking, although less oblique, including knuckle-walking and bipedalism. At 60°, bipedalism occasionally occurs, but locomotion is typically quadrupedal with grasping hands.

#### **Bioarchaeology and sociobiology in the pre-Columbian Grasshopper Pueblo, Arizona.**

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The skeletons of 246 children excavated at the Grasshopper Pueblo, a Mogollon pueblo community in the mountains of east-central Arizona, were studied to calculate the causes and the frequencies of deficiency and infectious diseases in the populations of three different large room blocks. These blocks were used for approximately 60-90 years during the 14<sup>th</sup> century. As a rule, the skeletons are very well preserved. They were investigated by macroscopy and low power microscopy. Pathological changes of the skulls and long bones were documented by measurements, photographs and drawings. To diagnose and to score the lesions, a new morphologic pattern was used. For this contribution, only the vestiges of diseases in the skull were examined.

The results are striking and characterize in limits different living conditions in the three room blocks of this pre-Columbian community that elucidate some aspects of pre-Columbian social life. There is evidence of different health pattern dealing with the frequency of deficiency diseases such as scurvy and anemia but also of infectious diseases such as inflammatory processes in the middle ear region and the paranasal sinuses. The expression and the frequency of the vestiges of meningeal reactions (e.g., inflammatory-hemorrhagic meningitis, epidural hematoma, irritation of the venous sinuses of the brain) show an interesting distribution within these three groups. On the other hand, there is, of course, also conformity in many aspects. Thus, the disease profiles are, for instance, very similar and group the Grasshopper population to the well-known pattern of other the pre-Columbian populations from the Southwest.

#### **mtDNA variation in Central Siberians identifies West Eurasian and East Asian components of their gene pool.**

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Analyses of mtDNA diversity in indigenous Siberian peoples have illuminated much about their population histories. Recent work has shown considerable genetic diversity in southeastern Siberians and the genetic influence of Turkic speaking groups on them, while other studies have elucidated the genetic prehistory of northeastern Siberian groups. However, there are fewer genetic data for central Siberian populations such as the Kets, Sel'kups, and Altayans, leaving their genetic histories and relationships to other Siberian populations to be clarified. To address these issues, we reanalyzed the mtDNAs from several Central Siberian populations (Kets, Sel'kups, Altayans) that did not belong to haplogroups A-D to determine their possible affinities with East Asian and West Eurasian haplogroups. Overall, these populations lacked most West Eurasian haplogroups, including I, J, K, T, V, W, and X. However, the Altayans, Kets and Sel'kups all had haplogroup H and U mtDNAs at significant frequencies, with these haplogroups comprising 32.5%, 43.5%, and 65.0% of their mtDNAs, respectively. In fact, four different subclusters of haplogroup U were present in these populations, including U1, U2, U4 and U5, with the Kets having the greatest diversity of these haplotypes. Thus, central Siberian populations appeared to have significant frequencies of both West Eurasian and Asian mtDNAs as part of their overall genetic composition. Overall, West Eurasian haplogroups appear in a decreasing west-to-east gradient in Siberian populations, while East Asian haplogroups have the opposite distribution. The implications of this pattern of genetic diversity for reconstructing the peopling of the Siberia are explored.

**Body size, limb proportions, and positional behavior during ontogeny in captive chimpanzees (*Pan troglodytes*).**

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Associations between body size, limb proportions, and specific positional behaviors in primates have been proposed based on both interspecific and intraspecific comparisons. In general, the results from intraspecific comparisons are not consistent with those from interspecific comparisons, suggesting that relationships between these variables are not always clear-cut. This study considers how changes in body size and limb proportions

relate to changes in positional behavior during ontogeny in chimpanzees.

Positional behavior data were collected for thirty subjects between the ages of 6 months and 13 years using instantaneous focal animal sampling. Linear body segment data were collected for 73 subjects representing the same age range. All subjects were housed at the Primate Foundation of Arizona. Four limb proportion indices were calculated from the linear segment data: intermembral index, brachial index, upper limb-to-trunk index, and hindlimb-to-trunk index. Positional behavior and limb proportion data were plotted against age using locally-weighted scatterplot smoothing (LOWESS).

Results for positional behavior indicate that as body size increases during ontogeny, the frequency of climbing and suspensory posture decreases. Following an initial increase in frequency, suspensory locomotion, brachiation, and leaping decrease with increasing body size. The intermembral index changes very little during ontogeny, while the brachial index decreases during the first 48 months before leveling off during adolescence. Both the upper limb-to-trunk and the hindlimb-to-trunk indices decrease slightly during ontogeny. These results are consistent with other intraspecific studies of positional behavior in apes and with functional consequences of body size and limb proportions on behavior.

**Dental morphology of subadult teeth from Byzantine St. Stephen's Monastery, Jerusalem.**

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Approximately one-third of the 15,000 skeletal elements found in the burial crypts of the Byzantine monastery of St. Stephen's in Jerusalem represent subadults. Who were these children and why were they buried within a monastic compound? Although much appears in the literature of the time about St. Stephen's, no mention is made of the presence of children.

The current study examined five dental morphological traits of the deciduous and permanent teeth of these individuals. Frequencies of non-metric characters were compared to those found for the adult dentition to determine possible genetic relationships. The permanent dentitions were scored using the Arizona

State University Dental Anthropology System (ASU DAS). Plaques created by K. Hanihara and A. A. Dalhberg, along with the ASU DAS, were used for the deciduous remains. A total of 104 teeth were identified in the subadult collection and over 200 teeth were used from the adult collection. Chi-square comparisons were insignificant for within group tests of the subadults. The tests were also insignificant between the deciduous teeth and the adult permanent teeth, except for cusp 7 ( $p < 0.05$ ). However, this may be due to differing trait development and expression, or a variation in scoring methods.

The virtual lack of significant difference provides us with no evidence to suggest that the adults and juveniles were from two distinct biological groups. When combined with demographic and disease patterns for the community, a circumstantial case can be made for the theory that these children were from the surrounding community, buried near the bones of venerated individuals.

**Patterns of dental variation in extant hominids and species recognition in the fossil record.**

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It has been suggested that living hominids (*Gorilla*, *Homo*, *Pan*, and *Pongo*) may possess a common pattern of craniodental variation that could aid in detecting taxonomically heterogeneous fossil hominid assemblages, i.e., the presence of a pattern of variation in a fossil sample that deviates from one shared among living hominids would be considered evidence of multiple taxa. Here, dental dimensions of extant hominids are examined to determine if such a pattern exists.

Analyses are conducted on patterns of variation in size (mesiodistal and buccolingual dimensions together, mesiodistal dimensions only, buccolingual dimensions only, and tooth crown areas) and shape (tooth crown shape indices). The mandibular and maxillary dentitions are considered both separately and together. Degree of similarity for each pairwise comparison is established using parametric and nonparametric correlation methods and randomization tests are employed to determine their statistical significance. Patterns of size variation are also examined without the canines and lower P3 to evaluate how these teeth affect the analyses.

The results indicate that patterns of size variation in the dentition of extant hominids are too variable to be of use for evaluating variation in fossil assemblages. In terms of shape variation, the hominines (*Gorilla*, *Homo*, and *Pan*) share a pattern, which is most strongly expressed in the mandibular dentition. However, combined samples of different hominine species exhibit patterns of shape variation that are similar to those of single taxa, indicating that, although a stable pattern is present, it is not useful for recognizing taxonomically mixed paleontological samples.

**Twin research findings and methods and their implications for human behavioral development.**

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Twin studies are a vital tool for exploring hypotheses generated by behavioral-genetic theory. They have, however, been used less frequently from the perspectives of human ethology and evolutionary psychology. The ways in which twin research methodology can be integrated into these disciplines will be illuminated with reference to recent and ongoing studies. For example, the nature and bases of human social relationships have fascinated the scientific community for years. Using a "twins-as couples" approach, greater cooperation and affiliation have been observed within MZ than DZ twinships, underlining the contribution of the genotypes of the interactants to social outcomes and processes. This finding is exemplified in a 1999 study of the Prisoner's Dilemma in which more frequent cooperative trials occurred between MZ than DZ twin adolescents and adults. More compelling, MZ twins reared apart have indicated greater closeness and familiarity following reunion, relative to DZ twins reared apart. These various findings are consistent with Hamilton's theory of inclusive fitness. Studying twins whose cotwins are deceased offers a different approach to this same class of questions. Recent work shows more severe bereavement response among surviving MZ than DZ twins. MZ twins also show a smaller reduction in grief over time, further demonstrating the greater intensity of their reaction. Evolutionary reasoning suggests that losing a close relative represents a loss in future genetic representation.

Studies of a novel "twin-like" research design offer a more instructive alternative to the ordinary adoption method. Virtual twins (VTs) are unrelated siblings of the same age adopted into the same family at

nearly the same time. These unique sibling pairs replay essential features of twinship, enabling sensitive tests of shared environmental influence on behavioral development. This project has been ongoing at California State University, Fullerton since 1983. New analyses, based on a sample of 90 pairs, yielded an IQ intraclass correlation of .26 ( $p < .01$ ). This correlation, while statistically significant, falls considerably below correlations of .86, .60 and .50 reported for monozygotic (MZ) twins, dizygotic (DZ) twins and full siblings, respectively. The VT IQ subtest profile correlation of .08 also falls below corresponding MZ (.45) and DZ (.24) twin correlations. These results are consistent with explanatory models of intelligence that include genetic factors, demonstrating that shared environments have modest influence on intellectual development. Future plans for this ongoing study include comparing social relatedness across a broad range of genetically and environmentally informative relationships. It will, for example, be important to include VT pairs in studies of cooperation and competition for comparison with MZ and DZ twins, thus extending the body of twin-based research in this domain.

**New World Paleoindians in craniometric perspective: New looks at old faces.**

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Prehistoric and recent human craniofacial metric comparative data were used to assess the similarities and differences between selected New World Paleoindian and early Archaic crania. Affiliations of groups and individuals were examined by discriminant function analysis, canonical variates plots, and posterior probabilities and typicality probabilities. The 11,000 year old Brazilian Dos Coqueiros individual, Nevada's Spirit Cave and Wizard's Beach individuals at slightly under 9,500 years, the Buhl, Idaho woman at approximately 10,700 years and the Kennewick individual at 9,400 years were each examined using these methodologies.

Preliminary results of this study have suggested morphological similarities between the Dos Coqueiros burial and the recent Ainu of Japan and Polynesia. Affiliations for Spirit Cave lean toward Archaic American Indians in the Mississippi drainages, upstate New York, but as well the western Mongolian Bronze Age. Buhl

and Wizard's Beach also tie to Mississippi Valley and Glacial Kame Archaic period peoples, as well as recent Ossossone and Juntunen site collections from Ontario and northern Michigan. The Kennewick individual ties to Polynesian and the Ainu of Japan. These peoples' biological affinities run to the Northern Plains as well as into the Old World with the prehistoric Jomon, the ancestors of the Ainu of Japan, Tierra del Fuego, and the Patagonians, the inhabitants of the southernmost edge of the South America, also link to the prehistoric Jomon. These suggest that the early inhabitants of the New World were not related to the Chinese core of mainland Asia, but rather the Late Pleistocene descendants of Northeast Asia.

**Occlusal molar borings in Native American dentitions.**

J.C. Seidel. Central Connecticut State University.

During the archival documentation of the dentitions of an 18<sup>th</sup> and 19<sup>th</sup> century skeletal collection from the Middle Columbia River, alterations are identified on occlusal tooth surfaces of four individuals. Under direct light examination, the circular depressions of the dentin in molar teeth demonstrate striated walls. The size, striations and conically shaped pits are consistent with dental modifications in the literature identified as therapeutic drillings (Schwartz et.al.1995, White et.al. 1997). The six borings, in two males and two females, are all located on the occlusal surfaces of maxillary first molars. This location has not been previously documented in the North American skeletal literature. One maxillary left molar of an adult male has two borings and neither communicates with the pulp chamber. Three of the six however, do open into the dental pulp. On all of the teeth with borings, there is severe attrition including secondary dentin formation, alveolar lucencies at the root apices and cortical fenestrations. A boring technique, using a hafted chert point drill was replicated on a recently extracted human molar with exposed dentin. The SEM comparisons between the test and sample are favorable. The dental endodontic literature indicates that severe attrition may result in dental necrosis (Trowbridge 2002). Pulpal death, periapical lesions and cortical fenestrations are therapeutically treated by establishing a path of fluid drainage and pressure release (Tarabinejad and Walton 1994). The presence of dental borings in the sample indicates that Native American healers of the re-

gion used this therapy with success and frequency.

#### **Modules and locomotion in the evolution of the anthropoid hand.**

M. Selby, P. Reno, R. Meindl, M. Serrat, C.O. Lovejoy. Dept. of Anthropology, Kent State University.

During terrestrial mammalian locomotion most propulsion is generated by the hindlimb, often resulting in metatarsal elongation in mammals employing metatarsal fulcrimation or other forms of digitigrady. Force plate analysis demonstrates that in some primates a significant portion of propulsion is forelimb generated. Metacarpals may therefore undergo elongation in terrestrial forms to increase their contribution to the power arm. We measured lengths in the third metacarpals (MC), intermediate (IP) and proximal phalanges (PP) of several anthropoid primates. When each element (IP, PP, MC) is considered as a proportion of the total, terrestrial monkeys demonstrate relatively elongated metacarpals. However, arboreal anthropoids display overall elongation of the entire metacarpus, and thereby have longer metacarpals than terrestrial forms relative to body size. They also maintain more consistent proportions between metacarpals and phalanges. It has been shown that the posterior manual digits (metacarpals plus phalanges) behave as a single module in hominoids and arboreal monkeys (via modification of *Hox* expression or target genes). However, as expected, our data also show that the metacarpals can evolve as a separate module from the phalanges. Pearson correlation shows that IP3 and PP3 are more highly correlated ( $r=0.970$ ) than are PP3 and MC3, or IP3 and MC3 ( $r=0.723$ , and  $0.685$ , respectively, all  $p<0.01$ ). These data show that additional "submodules" downstream of (but entirely within) *Hox* domains also contribute to autopod evolution. Therefore, patterns of mammalian morphological change may help specify such subdomains in a manner than can further guide identification of additional modules with more restricted perimeters.

#### **Developmental field fluctuation II: A potential basis for skeletal morphological variation.**

M.A. Serrat, P.L. Reno, B.A. Rosenman, C.O. Lovejoy. Dept. of Anthropology and School of Biomedical Sciences, Kent State University.

We previously proposed a "fluctuating field" hypothesis to explain population

differences in skeletal trait expression (Lovejoy et al., 2002 *AJPA* suppl. 34: 104). We found significant ontogenetic differences in surface reticulation of the gluteal insertion of the femur in two modern human populations: Libben and Hamann-Todd. We attributed these differences to slight fluctuations in developmental pattern formation, rather than to the classic inference that morphology reflects a history of strain transduction. This hypothesis was challenged by the suggestion that differences in activity level could have also produced these results. To address this criticism, we obtained additional data to examine the potential veracity of the strain history hypothesis. If robusticity in the gluteal region is a response to activity level, then we should find commensurate and parallel changes in other portions of the skeleton. We chose the deltoid insertion on the humerus for further examination.

We seriated the deltoid tuberosity in 50 individuals using methods from our previous analysis. We found no difference between Libben and Todd individuals in the morphology of the deltoid, even though they differed substantially in their gluteal regions. Furthermore, we found only a weak correlation between femoral and humeral seriations, which directly contradicts the predictions of the "activity level" premise. We therefore maintain our original hypothesis that morphological variation is more likely the result of minor fluctuations in such factors as cis-regulation of gene expression, rather than direct responses to local strain as has long been advocated.

#### **Survival and reproduction in chacma baboons.**

R.M. Seyfarth, T. Bergman, D.L. Cheney, J. Beehner. Depts. of Biology and Psychology, University of Pennsylvania.

We review ten years' data on survival and reproduction in a troop of baboons living in the Moremi Game Reserve, Botswana. The population experiences high rates of predation by leopards and lions, as well as high rates of infanticide by immigrant males who have recently acquired alpha status. We use data on age at first birth, inter-birth intervals, and infant survival to test hypotheses about the effects of dominance rank, matriline size, the presence of female kin, and infanticide on lifetime reproductive success.

#### **Late Pleistocene postcranial skeletal remains from Tam Hang (Laos).**

L.L. Shackelford. Dept. of Anthropology, Washington University.

Tam Hang is a cave site located in the Southern Annamite mountain chain in northern Laos along the Laos-Vietnam border. The site has been C-14 dated to  $15,740 \pm 80$  years BP. Based on cranial remains and exploratory analysis of the postcrania, this sample represents a population of five males and five females of young adult and adult age. Six of these individuals (two males, four females) preserve nearly complete postcranial skeletons.

The population of Tam Hang is small in stature, currently estimated from long bone lengths as ranging from approximately 138 cm (4'6") to 162 cm (5'4"). There are no congenital dysplasias and no trauma or pathology of any kind in the postcrania. These individuals have relatively gracile upper limbs, but robust lower limbs. The femora have strong antero-posterior reinforcement that approaches a pilaster in several individuals. Three complete pelves are preserved that demonstrate broad bi-iliac breadths. This Late Pleistocene southeast Asian site is unique with respect to its time and place, as it expands the geographic range from which Late Upper Paleolithic fossils are currently known.

#### **Locomotor development and the uniqueness of primate quadrupedalism.**

L.J. Shapiro, D.A. Raichlen. Dept. of Anthropology, University of Texas, Austin.

Primate quadrupedalism is unique among mammals. Primates prefer diagonal sequence walking, employ relatively large limb angular excursions, highly protracted forelimbs and humeri at touchdown, relatively long strides and low stride frequencies. Although kinematic aspects of primate quadrupedalism have been well delineated, it remains less clear how aspects of body size and shape might have led to this unique form of locomotion. Because of their developmental changes in size and shape, infants provide an excellent "natural experiment" with which to test the influence of body structure on the kinematics of quadrupedalism. Although infants differ from adults in footfall sequence, it is unclear if they differ from adults in other aspects of their locomotion.

In this study, we present longitudinal data on two infant baboons between the ages of one and seven months. Data on limb shape and quadrupedal kinematics were collected biweekly, and compared to

data known for adult primates. Infant baboons exhibit appreciable frequencies of lateral sequence walking in combination with diagonal sequence gaits and walking trots. Unlike adults, infants lack humeral protraction at touchdown, appear to have relatively small forelimb excursion angles for their body size, relatively shorter strides and higher stride frequencies at certain dimensionless speeds. Infants clearly do not walk like adult primates even when using diagonal sequence gait, nor do they walk like nonprimate mammals when using lateral sequence gait. The unique kinematics utilized by infants are likely associated with their distinctiveness in body shape from adult primates and other mammals.

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**Schmorl's nodes at Orendorf: A test of clinical etiologies and paleopathological assumptions.**

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Schmorl's nodes are depressions within the vertebra, typically in the middle or posterior portion of the centrum, that reflect herniation of the intervertebral disk through a weakened cartilaginous endplate. While there is little dispute concerning the morphological identification of the nodes, the underlying etiology of the lesions has provoked great debate in both the clinical and paleopathological literature. While some paleopathologists purport to identify specific activity- or trauma-related causes of formation, much of the clinical literature cites multiple non-specific etiologies. Further, paleopathologists often link differences in sex incidence to gender-based division of labor though the frequency of Schmorl's nodes is fairly high in both sexes.

The relatively large (N=326) skeletal sample from Orendorf, a Mississippian (~AD1150) cemetery site in the central Illinois valley, is used to test hypotheses concerning the etiology of Schmorl's nodes as well as their value as indicators of activity-related stress. To do this, we examine the earliest age at which Schmorl's nodes occur in the sample as well as the correlation between node formation and vertebral and extra-vertebral pathology and arthritis. While correlations may be high, they do not reflect causation and it is our conclusion that the paleopathologist will rarely be able to determine a specific etiology for cases at the individual or population levels. Based on our work at Orendorf, we encourage paleopathologists to accept Schmorl's nodes as non-specific

indicators of stress rather than as direct measures of trauma or workload.

**Co-evolution of communication and the brain in primates: New evidence from the brainstem and motor cortex.**

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The face is a focal point for primate communication. The production of communicative signals relies on the coordinated action of orofacial muscles. A recent focus has been on the co-evolution of neural specializations for orofacial motor control and human speech. To date, however, little is known about the comparative neurobiology of orofacial movement in primates. The current study reports results from a stereologic and morphometric analyses of brainstem orofacial motor nuclei (i.e., facial and hypoglossal) and face area of primary motor cortex in representatives of all primate superfamilies. Results show that several structural features of primate orofacial motor nuclei, including nucleus volume, neuron number, neuron packing density, and subnucleus differentiation are highly correlated with medulla volume. No anatomical differences were found that support the hypothesis that the hypoglossal nucleus of humans is specialized for speech production. Compared to Old World monkeys, the face area of motor cortex in great apes and humans is characterized by increased thickness of superficial cortical layers, decreased neuron packing density, increased proportions of neurofilament protein-containing neurons signifying more elaborate dendritic arborization, and greater numbers of particular inhibitory interneuron subtypes. The results of this study help to elucidate the anatomical substrate of the evolution of gestural communication in primates and place the neural mechanisms of human speech in a phylogenetic context. *Supported by the Leakey Foundation, the Wenner-Gren Foundation, NSF BCS0121286, NIH AG14308, and NSF DBI9602234 (to NY-CEP).*

**Quantitative genetics of modern human craniofacial variation: Implications for the interpretation of the hominin fossil record.**

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The geometry of the craniofacial complex plays a central role in functional and phylogenetic interpretations of the hominin fossil record. Implicit in such considerations, however, is the assumption that the genetic contribution to morphological variation is high and equivalent across traits. We discuss here the phyletic valence of craniofacial traits in the context of the genetic architecture of modern human craniofacial variation. We have shown elsewhere (Duren et al., this volume) that 12 of 13 craniometrics are significantly heritable in participants of the Fels Longitudinal Study. Several traits examined in that study are of particular relevance for the assessment of early hominin evolution. For example, angular measures of basicranial flexion (basion-sella-nasion) and facial hafting (sella-nasion-subspinale) were shown to have high heritabilities ( $h^2$ ) of 0.54 and 0.58, respectively. Other measures, including linear metrics of the clivus (basion-sella) and cranial thickness, had somewhat lower heritabilities of 0.35 and 0.26, respectively.

The response (R) of a trait to selection (S) is given by the equation  $R=h^2S$ . Therefore, under the same selective pressures, a more highly heritable trait will exhibit (within certain boundaries) a more rapid change per unit time than a trait with a low heritability. Thus, given what is currently known of the genetic foundations of craniofacial variation in modern humans, it may be possible to understand better the rapid acquisition of highly heritable traits such as a flexed cranial base in both *Homo* and *A. boisei* or retention of traits with low heritability such as cranial thickening in *H. erectus*.

**Traumatic injuries in the Archaic Period: An example from Mulberry Creek, Alabama.**

B.M. Shields. Dept. of Anthropology, University of Alabama.

Mulberry Creek, an Archaic Period shell mound, was excavated under the auspices of the Works Progress Administration and Tennessee Valley Authority during their

survey of the Pickwick Basin of northern Alabama in 1936-1937. 134 human skeletons were excavated from the site, as were many other skeletal series along the banks of the Tennessee River. In recent years, these collections have received increased attention in constructing evolutionary models of prehistoric warfare and raiding in this region of the Southeast. The thus far observed patterns of skeletal injuries for Mississippian groups, in tandem with ethnohistorical accounts, may indicate that warfare and raiding were a primary concern to agriculturalists in this area. This paper seeks to provide additional information on Archaic hunter-foragers in the Southeast and addresses methodological problems in how these injuries are used to construct models of interpersonal violence. Despite a human skull bowl and individuals with embedded projectile points, the overall injury pattern at Mulberry Creek emphasizes injuries that are more conducive to an accidental etiology for the site.

#### **Skin pigmentation, biogeographical ancestry and admixture mapping.**

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Ancestry Informative Markers (AIMs) are genetic loci showing alleles with large frequency differences between populations. AIMs can be used to estimate Biogeographical Ancestry at the level of the population, subgroup (e.g. cases and controls), and individual. Ancestry estimates at both the subgroup and individual level can be directly instructive regarding the genetics of the phenotypes that are different qualitatively or in frequency between populations. We present details on a panel of 34 AIMs and demonstrate how such studies can proceed, using skin pigmentation as a model phenotype. We have genotyped these markers in two population samples with primarily African ancestry, African Americans from Washington D.C. and an African Caribbean sample from Britain, and in a sample of European Americans from Pennsylvania. In the two African population samples we observed very strong correlations between estimates of individual ancestry and skin pigmentation as measured by reflectometry ( $R^2 = 0.21$ ,  $p < 0.0001$  for the African-American sample and  $R^2 = 0.16$ ,  $p < 0.0001$  for the British African-Caribbean sample). These correlations confirm the validity of the ancestry estimates and also indicate the high level of population structure related to admixture, which

characterizes these populations and is detectable using other tests to identify genetic structure. We have also applied two methods of Admixture Mapping to test for the effects of three candidate genes. We show that TYR and OCA2 have measurable effects on skin pigmentation differences between the West African and West European parental populations. The implications and applications of ancestry estimates in biomedical research are discussed.

#### **Primate social systems and predation risk: Factors influencing prey selection by crowned eagles in Taï National Park, Côte d'Ivoire.**

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Despite the numerous theories about the costs and benefits of group living in terms of predation avoidance, there remains little documented evidence of how social system and group size actually affect predation risk. Taï National Park is an ideal site to test theories relating social systems and predation risk in primates because the twelve primate species present demonstrate a range of group size, body size, and habitat use characteristics. If sociality is an effective adaptation against predation risk, we would expect social species to suffer lower predation rates than solitary species, and species in larger groups to suffer lower predation rates than those in small groups. Here we present prey remain data for twelve African crowned eagle (*Stephanoaetus coronatus*) nests in the Taï National Park and relate various ecological aspects of the primate species to their relative occurrence in the eagle diet. To measure prey preference, we compared, for each species, the relative proportion of the eagles' diet to their overall proportion of the primate community. Our results indicate that when all species are considered neither group-size nor body-size alone correlate with prey preference. This is because the only terrestrial species, the sooty mangabey, is preferred despite occurring in large groups and having a relatively large body size. When only arboreal primates are considered both group size and, to a lesser extent, body size are negatively correlated with prey preference. These characteristics are explained in terms of eagle "sit-and-wait" hunting behaviour.

#### **Geographical distribution of hot flash frequencies: Considering climatic influences.**

L.L. Sievert, E.K. Flanagan. Dept. of Anthropology, University of Massachusetts at Amherst.

Previous studies have shown that menopausal hot flashes are more frequent in warm ambient temperatures. Laboratory studies suggest that hot flashes are triggered by small elevations in core body temperature acting within a reduced thermoneutral zone -- the temperature range in which a woman neither shivers nor sweats. While the biological basis of hot flashes is becoming increasingly clear, variation in hot flash frequencies across cultures remains largely unexplained. The study presented here focuses on the influence of climate. It was hypothesized that, as a result of physiological acclimatization, women in different populations develop climate-specific thermoneutral zones. Consequently, correlations were predicted between hot flash frequencies and latitude, mean annual temperature, minimum annual temperature, or maximum annual temperature. Studies of hot flash frequencies were drawn from literature reviews and from additional data base searches. Latitude and temperatures corresponding to the sites of hot flash studies were collected from published sources. Due to methodological inconsistency among hot flash studies, hot flash frequencies were examined among women who reported hot flash experience within the past month ( $n=27$  studies) and among women who reported whether or not they had ever experienced a hot flash ( $n=38$  studies). Although hot flash frequencies were positively correlated with latitude and negatively correlated with temperatures, the correlations were not statistically significant. This presentation details the findings and examines why climate may not play a role in determining hot flash frequencies. In particular, the confounding variables of BMI and occupation are discussed.

#### **New discoveries on the middle ear anatomy of the Paromomyidae (Mammalia, Primates) from ultra high resolution X-ray computed tomography.**

M.T. Silcox. Dept. of Anthropology, University of Winnipeg.

The study of the middle ear anatomy in plesiadapiforms has been central to debates about the pattern of relationships within Archonta. Analysis of a skull of

*Ignacius graybullianus* (USNM 421608) using ultra high resolution X-ray computed tomography yields new information about the prepared right ear and allows study of the unprepared left ear. These data confirm previous assertions that the auditory bulla is formed by the entotympanic, not the petrosal, basioccipital, or basisphenoid. Contrary to most previous reconstructions of the middle ear anatomy in plesiadapiforms, this specimen exhibits a bony tube for the promontorial artery and/or internal carotid nerves. The identification of this structure is confirmed by the presence of a lumen and its origination at the posterior carotid foramen. Remnants of this tube are present bilaterally in USNM 421608, running along the lateral extreme of the promontorium. The presence of bony tubes for branches of the internal carotid artery and internal carotid nerves is a feature of scandentians and euprimates, missing in dermopterans and chiropterans. The unusual lateral route taken by the internal carotid nerves is a primitive euprimate feature, missing in scandentians, dermopterans, and chiropterans. As such, this evidence supports a close euprimate-paromomyid relationship, and the inclusion of paromomyids in the order Primates. This finding is in line with recent studies of the dentition and postcranium. The history of revisions to our understanding of paromomyid middle ear anatomy suggests caution in interpreting this complex region in damaged fossils, and in overemphasizing the phylogenetic importance of such interpretations.

#### **Reconstructing individual life histories using the chemistry of the skeleton.**

A. Sillen. Dept. of Archaeology, University of Cape Town.

Environmental variables during growth affect not only skeletal morphology, but also isotopic chemistry. In turn, analysis of the isotopic variation within skeletons makes it possible to reconstruct aspects of life-histories of historic and prehistoric individuals (as opposed to populations). One important isotopic tracer is the strontium isotope ratio  $^{87}\text{Sr}/^{86}\text{Sr}$ . Since this ratio is not measurably fractionated by organisms, it represents in various skeletal tissues the  $^{87}\text{Sr}/^{86}\text{Sr}$  available to an individual at the time of calcification. Because there is considerable natural variation in  $^{87}\text{Sr}/^{86}\text{Sr}$ , the index has been useful in source-tracing various biological substances, including, wood and wine. Skeletal applications include tracing the

rearing streams of juvenile salmon, migratory birds, and elephant ivory.

In order to reconstruct the movement of human individuals across landscapes or continents, various strategies have been proposed to compare juvenile calcification and adult calcification (or adult calcification reflecting various different times of life) from individual human skeletons. These strategies include (i) comparison of whole cortical bone to dental enamel; (ii) comparison of bone of various different densities—reflecting bone of different age—from the same individual; and (iii) micro-dissection of individual osteons of varying maturity.

The approach will be illustrated using hominid skeletons from the South African Pleistocene site of Swartkrans. Comparison of dental enamel to bone suggests that one adult male robust Australopithecine individual, SK 876, had migrated to the site from another region. Such results make it possible to reconstruct previously invisible aspects of early hominid behavior.

#### **APOE distribution in world populations with new data from the Indian sub-continent and the British populations.**

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Human apolipoprotein E (apo E) is a plasma glycoprotein that plays a major role in lipoprotein metabolism. Three common variants (\*E2, \*E3, & \*E4) of APOE show interesting population genetic variation. Epidemiological studies have found that the \*E4 allele is associated with longevity, increased plasma cholesterol levels and increased prevalence for cardiovascular and Alzheimer diseases. In this study (n=2100), we have analysed the distribution of apolipoprotein E (apo E) polymorphism among 15 endogamous groups of India and 5 regionally divided populations of the UK. Also, we examine the level and extent of genetic variation at this locus in world populations and its utility as a population genetic marker using Principal Component Analyses and spatial autocorrelation analysis. There are marked differences in phenotype and allele frequency between the populations of England and India. Indian populations showed extensive genetic diversity at caste, non-tribal and tribal levels. The interesting feature of this analysis is low incidence or absence of \*E4 allele in many caste and tribal

populations, even though cardiovascular diseases are relatively common. The UK populations showed higher allele frequency of \*E4 allele that is compatible with observed North-South cline. Overall, the observed variation at this locus in Indian and UK populations is comparable to many Caucasian populations. A comprehensive statistical analysis of world populations showed that APOE is a useful genetic marker for population and anthropological studies. The data presented also suggests that autochthon groups (like tribes) in India may throw better insight on the role of apolipoproteins in disease.

#### **Functional shape variation in the cercopithecine masticatory complex.**

M. Singleton. Dept. of Anatomy, CCOM, Midwestern University.

Recent investigations of craniofacial scaling in papionin primates document shared patterns of ontogenetic allometry resulting in homoplastic similarities between small- and large-bodied taxa, respectively. Such patterns are often associated with functional allometry, and mechanical demands on the masticatory complex make biomechanical scaling a likely contributor to facial homoplasy in papionins. Therefore, this study examines scaling in the cercopithecine masticatory complex using geometric and traditional analytic methods. The sample encompasses all cercopithecine genera and selected colobine outgroups. Three-dimensional coordinates for 45 craniometric landmarks were recorded; centroid size was computed; and a subset of landmarks was selected to capture specific functional aspects of the masticatory system. Landmarks were aligned using generalized Procrustes analysis. Aligned coordinates were subjected to principal components analysis, and principal axes of shape variation were explored statistically and graphically.

As expected, the first principal component of shape variation shows strong positive allometry across all cercopithecines; it is likewise strongly correlated with masseter lever arm length. The second principal component is strongly correlated with cranial size in cercopithecines but only weakly so in African papionins, implying geometric similarities among African papionins (excluding *Theropithecus*) largely independent of size. Papionins are distinguished from comparably sized cercopithecines by relatively low zygomatic roots and posteriorly positioned molar bite points. Among African papionins, *Cercocebus* and *Lophocebus* are distin-

guished by posteriorly positioned molar bite points relative to masseter lever arm length. Phylogenetic, functional, and ecological implications of these results are discussed.

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#### **Kinematics and EMG activation of head-neck muscles during locomotion in *Erythrocebus patas*.**

J.S Sipla, C.F. Ross, S.G. Larson. Dept. of Anatomical Sciences, Stony Brook University.

In quadrupedal primates, dorsal extensor muscles of the neck are presumably needed to hold up the head and counteract gravitational torques at the atlanto-occipital and cervico-thoracic joint interfaces. During locomotion, additional demands are placed on these muscles to reduce or eliminate head oscillations due to body motion in order to maintain a reasonably stable field of vision. To evaluate the muscular mechanisms for head stabilization during locomotion, recruitment patterns for trapezius, sternocleidomastoid, semispinalis capitis, splenius capitis, rhomboid capitis, and spinalis, and kinematic data on head and neck posture were collected for two individuals of *Erythrocebus patas*. The EMG data and kinematic measurements were taken to assess patterns of intracycle variability in head attitude and muscle use during a variety of locomotor tasks.

The data reveal a stereotyped pattern of head-neck movements in the sagittal plane during locomotion. Orbital inclination, measured as the angle relative to the gravity vector of the line joining supra-orbitale and infra-orbitale, was not observed to change significantly during the locomotor cycle, despite large oscillatory movements of the body in the sagittal plane (mean orbital inclination = 6.98°, s = 3.44°). Judging from qualitative observations of neck kinematics during walking and galloping behaviors, we find that the dorsal neck muscles act in synergy to extend the head during forelimb support phases. This suggests that quadrupedal primates stabilize the head in pitch axes during locomotion, possibly to reduce the computational load of the vestibular apparatus in the neural control of head, neck, and eye movements.

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#### **Limitations in the use of predominant collagen fiber orientation for**

#### **inferring loading history in cortical bone.**

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Predominant collagen fiber orientation (CFO) is considered to be highly reliable for inferring loading history in bones where obtaining strain data is difficult or impossible. For example, predominant CFO has been used to indirectly establish putative differences in habitual strain mode (e.g., tension, compression) distribution across the femoral necks of chimpanzees and humans (chimps: habitual bending; humans: net compression) (Kalmey and Lovejoy, 2002 Bone). However, few studies have examined the reliability of using this characteristic in this context. The ulnae of rhesus macaques (n=4) and tarsometatarsi (TMT) of chickens (n=7) were obtained from mature animals. The medial ulna and cranial TMT cortices sustain net compression; the lateral ulna and caudal TMT cortices sustain net tension during functional ambulation. Using circularly polarized light, we quantified predominant CFO in the cranial, caudal, medial, and lateral cortices. 'Control' bones included horse radii and deer calcanei (habitual bending), and sheep tibiae (torsional loading). Expected results include CFO that is significantly more longitudinal in "tension" regions *vs.* oblique-to-transverse CFO in "compression" regions, and no significant regional differences in torsional loading. The results were unexpected: 1) TMTs: the cranial ("compression") cortex had more longitudinal CFO than the opposing "tension" cortex, 2) ulnae: the medial *vs.* lateral ("compression" *vs.* "tension") differences were insignificant. In two ulnae, there was evidence of newly deposited bone, suggesting that cortical maturity lags behind growth plate fusion. But this explanation is not parsimonious for the TMTs. These data suggest that significant limitations may exist when using predominant CFO for inferring strain history.

#### **ESR Dating at Mezmaiskaya Cave, Russia.**

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liams College, <sup>2</sup>RFK Science Research Institute, Flushing, NY, <sup>3</sup>Institute of Prehistory, St. Petersburg, Russia.

Mezmaiskaya Cave has yielded more than 10,000 artefacts, thousands of very well preserved faunal remains, and hominid remains, found in eight Middle Paleolithic (Mousterian) and three Upper Paleolithic levels comprising silty sands with *éboulis*. A post-cranial Neanderthal infant skeleton was preserved in anatomical juxtaposition lying on a large limestone block, overlain by the earliest Mousterian layer, Layer 3. No burial pit was observed. Twenty-four skull fragments showing *post-mortem* deformation from a 12 year-old infant occurred in a pit originating in the Mousterian Layer 2 and penetrating into underlying layers. The Middle Paleolithic industries have high sidescraper, but variable bifacial tool, percentages. Some bone tools were found in Layer 3. Excepting *Ursus spelaeus*, some bird, rodent, and carnivore remains, the majority of the bovids, cervids, caprids, and other ungulates represent human kills hunted by selecting prime adults. Bone from Layer 2A was dated by AMS <sup>14</sup>C at 35.8-36.3 ± 0.5 kyr BP. Twelve ungulate teeth from Layers 2 to 3 have been dated by standard and isochron ESR. Low U concentrations in both the enamel and dentine ensure that ESR ages do not depend significantly on the U uptake model, but do depend strongly on the sedimentary dose rates and water concentrations. Sedimentary dose rates range from 500 to 800 ± 100 mGy/yr, depending mainly on the *éboulis* concentrations in each layer. Assuming a sedimentary water concentration equals 20 wt% (the modern concentration), preliminary ESR ages for the layers range from 38.2 to 42.0 ± 0.5 ka for the Mousterian layers.

#### **Age-related changes to the intervertebral discs of the human sacrum.**

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While investigations into the phylogeny, ontogeny, and comparative external morphology of the modern human sacrum exist, similar studies of the *internal* morphology of the modern human sacrum are few. This project investigates age-related changes to the intervertebral discs sealed within the modern human sacrum. Specifically, it tests the hypothesis that, if sacral intervertebral discs are not functional, the results of disuse, such as poor nutrition, will result in resorptive remod-

eling leading to an age-related decrease in disc size.

Quantitative analyses of sacral intervertebral disc size were performed on a sample of sagittally-sectioned sacra ( $n = 63$ ) that was divided into two age classes:  $<80$  years and  $= 80$  years. Each sectioned intervertebral disc (referred to as disc classes D1, D2, D3 and D4 moving cranio-caudally) was digitally photographed and disc size was measured as cross-sectional area using a digital image analysis program.

Results demonstrate a significant decrease in the mean cross-sectional area of D2 individually and D2, D3, and D4 collectively between the two age classes ( $p < 0.05$ ), but no similar change in the size of D1. The results of this preliminary study support the hypothesis that there is both age-related resorption of inferior sacral intervertebral discs, as well as the biomechanical maintenance of the superior disc. The implications of these results for understanding the phylogeny and intraspecific variation in the hominoid sacrum will be discussed.

#### **The pattern of robusticity among early Bronze Age groups of Central Europe: Sex differences.**

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It has been argued that the males from Early Bronze Age groups in Central Europe are generally more robust than the females. This interpretation is difficult to evaluate, since no clear definition of robusticity is present in the studies. To assess sexual pattern of robusticity, a sample of femora of 58 individuals from three Early Bronze Age groups of Lower Austria (Únetice, Unterwölbling and Wieselburg) have been selected. Nine biomechanical parameters (TA, CA, MA, %CA,  $I_x$ ,  $I_y$ ,  $I_{max}$ ,  $I_{min}$ , J) have been computed by semiautomatic approach using CT data and newly developed software. Comparing 80% and 50% cross-sections of the femoral diaphysis, a complex pattern of robusticity among males and females of Early Bronze Age groups has been found. Part of described "robusticity" in the raw data is primary related to body size, when the larger body size of males is interpreted to be more robust. This is indicated by significantly large values of areas (TA, CA and MA), second and polar moment of areas (I and J) for male individuals but no

significant differences in percentage of cortical area to total area (%CA) between both sexes. However, the opposite pattern appears when size adjusted data are employed. In size adjusted data, no significant differences in cross-sectional areas (TA, CA and MA) have been found between males and females. Surprisingly given previous statements, females exhibit significantly larger values in relative bending and torsional strength (I and J). Therefore, if robusticity is not confused with body size differences, but defined as strengthening of bone tissues to higher mechanical loading, females in Early Bronze Age groups of Central Europe exhibit significantly greater robusticity in femoral diaphysis than males.

#### **Medical survey of the local human population to determine possible health risks to the mountain gorillas (*Gorilla gorilla beringei*) of Bwindi Impenetrable Forest National Park, Uganda.**

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Recently, there has been increasing contact between mountain gorillas (*Gorilla gorilla beringei*) and the human population surrounding Bwindi Impenetrable Forest National Park (BIFNP) in Uganda. Due to the close taxonomic relationship between humans and gorillas, the potential for disease transmission between the species exists. Preventing the introduction or spread of transmissible diseases to the gorillas is essential for protecting this endangered species. We interviewed 301 villagers living in close proximity to BIFNP with a medical questionnaire in July, 2000. We collected information on demographics, vaccination and health history, and human/gorilla interaction. Our objectives were to estimate the prevalence of several diseases in the human population, and to evaluate the risk for anthroponotic transmission (from humans to gorillas). We found a high prevalence of disease symptoms such as coughing (72.1%) and fever (56.1%) compatible with acute infectious diseases; over half of the respondents

(59.1%) had a specific disease diagnosis within the six months preceding the study. Using a Chi Square test, we compared villagers who had visual contact with gorillas in the six months preceding the study (53.5%) to villagers who had no visual contact (46.5%). Men were 2.3 times more likely to have visual contact with gorillas than women. In addition, individuals aged 41-59, those living in Buhoma or Bujengwe, or with the occupation of subsistence farmer or trader were more likely to have had visual contact with gorillas compared with other demographic groups. In general, the frequency of disease history and symptoms was similar for people with and without contact. The high prevalence of acute infectious diseases in the population surrounding BIFNP and the high rate of contact with gorillas creates the potential for anthroponotic disease transmission. Interventions and educational efforts should be directed at increasing the understanding of inter-species disease transmission, and promoting behaviors designed to minimize risk such as burial of wastes. Improvements in public health infrastructure would benefit the villagers as well as the mountain gorillas.

#### **The analysis of shape sequences.**

D.E. Slice. Dept. of Biomedical Engineering, Wake Forest University School of Medicine, and Institute for Anthropology, University of Vienna.

Some sets of morphometric data are best analyzed as sequences of related shapes. Examples include data for geometric motion analysis as described by Slice (1999) and the analysis of serially homologous structures such as vertebrae. Most current geometric morphometric methods, however, treat all configurations of landmarks as independent shapes. In this presentation, I will provide general extensions of familiar geometric morphometric methods that allow for the comparison of sequences of shapes as trajectories on the Procrustes hemisphere (Slice, 2000, 2001). The extensions are applied to closed (periodic) sequences arising from the analysis of jumping and open trajectories derived from modern human (thoracic) vertebral series. Elliptic Fourier Analysis (Kuhl and Giardina, 1982) provides a convenient parameterization for the former while various regression and interpolation procedures are available for the latter data types.

In addition, these new methods can be made to retain select within-sequence variability while allowing overall between-sequence comparisons. This can be

achieved by once-and-for-all superimposition of shapes within each sequence followed by the registration of entire sequences for subsequent analyses. Many possible options are available for both of these registration procedures. Again, examples from jumping and thoracic vertebrae are used to illustrate the principals involved.

**Using LINE1 insertions to distinguish between closely related hominoid species.**

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The first step of any molecular study should be to confirm the species of interest, ruling out contamination and/or DNA collection or extraction error. Despite a recent wealth of genetic and sequence data on humans and great apes, few molecular techniques are available for easily and efficiently distinguishing between hominoid species. We have developed a single-PCR assay for identifying hominoid species using lineage-specific LINE-1 (Long Interspersed Element) insertions. LINE-1 (L1) elements belong to a family of retrotransposons that have influenced the evolution of eukaryotic species for over 600 million years. L1s that inserted into the genome of a species after its divergence from its Last Common Ancestor are unique to that species. Thus, the presence of a species-specific L1 insertion in a DNA sample positively identifies the species origin of the sample. There are 500,000 L1s in the human genome but virtually nothing is known about the L1s in other primates. We developed a technique to construct "LOAF" libraries that contain recent L1 insertions from primate genomes. From LOAF libraries, we identified insertions that are unique to each of the great ape species. For each species-specific insertion, we developed a PCR assay capable of detecting both the presence ("occupied allele") and the absence ("empty allele") of the L1 insertion. These assays are capable of rapidly and unambiguously identifying the species of origin of a DNA sample. We are currently extending this approach to develop assays for distinguishing between Old and New World monkeys, and prosimians.

**Patterns of mitochondrial variation in Melanesia and implications for the settling of the Pacific:**

L.L. Smith, D.A. Merriwether. Dept. of Anthropology, University of Michigan.

The Bismarck Archipelago has been identified by archaeologists as the homeland of the Lapita people, the first settlers of remote Oceania, yet little genetic research has been undertaken in these islands to test hypotheses of migration to Polynesia. We have analyzed a total of 152 samples from Austronesian and non-Austronesian speaking populations of New Britain sequenced for over 1000 base pairs of HVS 1 and 2, and we are currently sequencing additional samples from New Ireland, as well as from Papua New Guinea, Ontong Java, and Bougainville. Of the 15 haplogroups found in Melanesia by the Merriwether lab and from the literature, 11 have been recognized in the Bismarcks. Preliminary results indicate potential gene flow between Austronesian and non-Austronesian speakers in New Britain, but this finding is not yet quantified. However, a transition at position 16468 of the Anderson, *et al.* sequence was identified which is common in New Britain populations and observed in remote Oceania but is absent from all but one New Guinea sample and not found in any sequences from Southeast Asia. This could provide a novel way to assess how much indigenous Melanesians in the Bismarcks or elsewhere contributed to the Lapita gene pool.

**Old versus new: Interpretation of flint toolmarks observed on skeletal material from West Tump Long Barrow, Gloucestershire, England.**

M.J. Smith. Institute of Archaeology and Antiquity, University of Birmingham.

West Tump is a Neolithic chambered tomb of Cotswold Severn type excavated in 1880. The mound was found to contain a mixed skeletal assemblage, the majority of which was disarticulated. Between 2000 and 2001, this material was re-examined, having otherwise received no further attention since, with a portion of this project focusing on the taphonomic evidence the collection exhibited. Amongst the factors selected for investigation were deliberate toolmarks. In total 3 specimens were identified as exhibiting toolmarks, analysis of which showed all the observed marks to be consistent with the use of flint tools. However those on two of the specimens were found to be both post-mortem and recent. The multiple cutmarks observed on the remaining specimen, a right clavicle, were identified as having been inflicted during the peri-

mortem period and consistent with decapitation.

British Neolithic mortuary practice has been discussed repeatedly in recent years, particularly regarding the kind of disarticulation seen at West Tump and its purported relationship to practices such as collective ancestor veneration. Until very recently however, few such assemblages have been re-examined and much of the data in use has derived from sources of considerable age and questionable reliability. The selective removal of specific skeletal elements (particularly skulls) frequently described, has often been assumed to have taken place after the soft tissues had decayed. This example suggests that this may not always have been the case and its potential significance is discussed in addition to a possible interpretation of the toolmarks seen on the remaining specimens.

**The relationship of skeletal and dental ages, with implications for the adolescent growth of KNM-WT 15000.**

S. Smith. Dept. of Sociology and Anthropology, University of Texas at Arlington.

In a forensic or paleoanthropological context, an examination of skeletal centers and dental calcification allows age estimation. The skeletal and dental systems, however, do not display perfect concordance. For a fossil hominid, what degree of discordance indicates a non-human-like maturational pattern?

In this study, mean differences between skeletal and dental ages (SA-DA) for a longitudinal sample of Montreal children aged 10-15 years (29 to 36 girls, 34 to 40 boys) are relatively small, with the greatest difference being 0.52 years for girls at age 15. Individual differences, in contrast, may be considerable; 25% of 12 year old girls and 12.5% of 14 year old boys display SA-DA differences of  $> \pm 2$  years, with a range of 5.8 years and 4.6 years, respectively. Furthermore, for individual girls and boys, skeletal age may exceed dental age at one chronological age and lag behind at another. A SA-DA discrepancy of up to about 3 years should not be used to infer non-human-like developmental timing.

Some Montreal children can match KNM-WT 15000 for dental age as assessed by the Demirjian system. Nonetheless, full consideration of modern human clinical data and previous research on primate growth and fossil hominid development suggests that KNM-WT 15000's growth was probably unusual by modern human standards. While KNM-WT 15000 likely would have had a growth

spurt in both weight and leg length, the timing of dental developmental events, particularly canine development, may have shifted relative to skeletal development in the course of human evolution.

### **An apparent case of treponematosi s in a human skeletal sample from the Great Salt Lake, Utah.**

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In the fall of 2001, a small sample of prehistoric human skeletal remains was recovered from Willard Bay as part of ongoing salvage efforts on the Great Salt Lake, Utah. The sample included the remains of nine adults and two children. Analysis of these remains revealed two individuals, both older (40+) adult males, with fairly extensive periosteal lesions. In the first case, pronounced appositional bone was apparent on both tibiae and one fibula; less pronounced periosteal lesions were also present on nine other bones, including six long bones. In the second case, fully remodeled periosteal new bone was limited to the tibiae. Both the nature and distribution of the lesions, as well as the age of affected individuals, suggests treponematosi s as a possible cause of the lesions in at least one and possibly both cases. These findings contrast sharply with those reported in a previous study of skeletons from the Great Salt Lake, where no tibial lesions were observed in a sample of 20 individuals with at least one tibia available for observation. One notable distinction between these two Great Salt Lake samples is chronological: the larger sample is composed exclusively of Fremont individuals (pre-A.D. 1000), whereas the Willard Bay sample clearly includes at least some skeletons from the Late Prehistoric period (post-A.D. 1000). The purpose of this paper is to present osteological evidence for a disease previously unreported in the Great Basin, and to examine possible explanations for why treponematosi s might have been present in the Willard Bay population.

### **Molar crown formation in Miocene hominoids: a preliminary synthesis.**

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pology and Anatomical Sciences, Stony Brook University, <sup>5</sup>Dept. of Oral Biology, Dental School, University of Newcastle upon Tyne, <sup>6</sup>Dept. of Anthropology, Northern Illinois University.

Several recent studies have reported on dental development in Miocene hominoids based on analyses of incremental features recorded in dental hard tissues. In this report, we present a preliminary synthesis of recent and on-going work, including results on crown formation times, daily secretion rates, and the periodicities of long-period features of the enamel (Retzius lines). These data are examined with reference to relative enamel thickness and estimated body mass in 15 Miocene and four extant ape species. Correlations between ranked pairs of variables are tested for significance.

Spearman's coefficient of rank correlation shows that, within hominoids, first molar crown formation time is positively correlated with both body mass and periodicity, and periodicity is also positively correlated with body mass ( $p < 0.05$ ). No association was found between relative enamel thickness and either body mass, periodicity, or crown formation time. Several Miocene hominoids show a similar pattern of cuspal enamel secretion rates, with higher initial rates than in extant apes and humans. Although rates may be fairly similar, the duration of cuspal enamel secretion is highly variable, leading to large differences in cuspal enamel thickness and crown formation times. Intrageneric variation, most notably within *Proconsul*, and sampling biases preclude identification of clear regional or temporal associations. Studies in progress on large samples of extant apes, as well as on root development and age at M1 emergence in extant and fossil hominoids, will provide additional insight into patterns of variation within and between groups.

### **Sexual dimorphism in the vomeronasal organ of *Otolemur*.**

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Recent studies have linked sexual dimorphism of the vomeronasal organ (VNO) to differing reproductive behaviors. Primates have not been examined for sex differences in the vomeronasal organ (VNO). In the present study, sectioned

VNOs of 7 *Otolemur crassicaudatus* (4 females, 3 males) and 9 *O. garnettii* (4 females, 5 males) were used to investigate VNO parameters in species with pronounced sex differences in reproductive behavior. The rostrocaudal length of the right VNO sensory epithelium (VSE) and palate were measured. Cross-sectional area of the VSE and density of receptor cells (per sq. mm) were quantified at the 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentile of VNO length. Results were compared using a 2-way (species by sex) ANOVA (significance at  $p < 0.05$ ). No significant differences were found between the species for any measure. The VSE was not significantly different between sexes in absolute or proportionate length. ANOVA results revealed significant main effects for sex in VSE area (males > females) and receptor density (females > males). *Post hoc* comparisons within species revealed that males had larger VSE area in each species, whereas the receptor density was only significantly different in *O. crassicaudatus*. Although *Otolemur* spp. have been reported to have sexually dimorphic body weight, both species showed dimorphism in the VSE but not palatal length. Differences in VSE area are consistent with predictions based on behavioral sex differences (e.g., parental investment, home range) in *Otolemur*. Conflicting results regarding VSE area versus receptor density may reflect differing cellular organization and require immunohistochemical study.

### **Implications of sex differences for aging of the vertebral column.**

J.J. Snodgrass. Northwestern University.

Degenerative changes in the human skeleton have been recognized as useful for estimating the age at death of an individual. In the vertebral column, the development of osteophytes has been shown to be an indicator of age, although substantial variation has been documented. The system used for estimating age from osteophyte development is based exclusively on males and it is unknown whether patterns of osteophyte development are comparable between the sexes. Other anatomical regions, such as the pubic symphysis, have been shown to exhibit substantial sex differences in age-related changes. This study examines sex differences in osteophyte development and attempts to clarify the mechanisms associated with the production of osteophytes, thus refining methods used for estimating age at death from the vertebral column.

A random sample of 400 adults (200 males and 200 females) was examined from the Terry Collection, housed at the National Museum of Natural History (Smithsonian Institution) in Washington, D.C. All individuals used in the study had information available on age, sex, ancestry, and decade of birth. For each skeleton, the thoracic and lumbar regions were scored for osteophyte development according to a five-stage system established by Stewart. While males and females show similar patterns of age-related changes in osteophyte development in the thoracic and lumbar regions, females show significantly greater variability in osteophyte stage for a given age. This suggests that larger confidence intervals in age ranges should be used when assessing age from the vertebral column in females.

Supported by the Forensic Sciences Foundation.

**Assessment of traumatic injuries in an early industrial population: occupational stress and interpersonal violence among the Albany County Almshouse inmates, Albany, New York (1826-1926).**

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Osteological analyses of almshouse cemeteries provide a critical view of health and behavior among the underprivileged social classes during the nineteenth and early twentieth centuries. The assessment of fractures and other traumatic events in the Albany County Almshouse skeletal collection serves as an indicator of the working and social environment for urban laborers during this time.

Fifty-six individuals possess traumatic injuries, comprising 8.6% of all observable skeletons (n=650). Fifteen affected individuals are female, with one-third of their injuries affecting the upper limb. The majority of injuries among males are on the long bones of the lower limb (17), followed by fractures of the craniofacial region (11), ribs (4), and metacarpals (4). The remaining cases are minor fractures of the hand and foot phalanges, and vertebral spinous processes.

The cause of these injuries may be inferred from anatomical location and fracture type, though historic documents on the Almshouse residents provide additional information on the health and activity patterns of these individuals. The upper limb fractures among females are likely due to falls, while the high proportion of lower limb fractures among males is suggestive of falls and industrial acci-

dents. Additionally, the high number of craniofacial and metacarpal (boxer's) fractures among males is indicative of interpersonal violence. Though most injuries were healed at the time of death, nearly half of all affected individuals (46%) possessed debilitating injuries, including poorly set fractures of the long bones, and four cases of amputation. These cases of severe trauma and inadequate medical care are probably a contributing factor for the subsequent admission of these individuals to the Almshouse.

**Can differential mortality be inferred from post-cranial variability? A test from Medieval Scandinavia.**

C.S. Sparks. Dept. of Anthropology and Population Research Institute, Pennsylvania State University.

Differential mortality between males and females has been studied by numerous researchers in the past. Often explanations of differential mortality in paleodemographic samples have focused on approaches dealing with differences in overall "health" in the sample. The data used to describe the differences in "health" between males and females usually come from dental and skeletal lesions. Recent theoretical work has suggested that this notion may not be well founded. This paper focuses on a new data source, postcranial metric data, applied to the study of differential mortality and selectivity in Medieval Scandinavia.

The data for the study consist of postcranial measurements on 581 adult individuals from sites in Denmark and Sweden, ranging in date from 1100 to 1500AD. In order to estimate effects of postcranial variability on selective mortality, a series of parametric hazards models were fit to the data using the metric variables as covariates. Likewise considered are models testing effects of individual variability within the samples. These models address the notion of selection acting on individuals, thus making more variable individuals exposed to a higher risk of death.

Results indicate a higher early adulthood hazard for females compared to males. Several of the models indicate that for females, being extremely variable tends to increase the probability of death earlier in life. No effects are seen in males. The majority of covariate effects are reversed between the sexes indicating slight selection acting on larger adult females, and smaller adult males, thus increasing their probability of death in early adulthood.

**Muscle function and temporomandibular joint loading in humans.**

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The forces experienced in the temporomandibular joint (TMJ) have a crucial influence on the function and evolution of the primate masticatory system. During normal mastication the mandibular condyle is typically pressed against the articular eminence. However, it is unknown if the condyle may also be pulled away from the eminence during portions of the chewing cycle, or whether such distractive forces are avoided. The current study explores this issue.

Temporomandibular joint loads are determined by chewing muscle forces and the configuration of the masticatory system. To estimate these forces we collected surface electromyographic (EMG) data simultaneously from the working and balancing side superficial masseter and anterior temporalis muscles in human subjects eating various foods. Standardized root-mean square EMG values and data on masticatory system configuration were used to estimate TMJ forces at 2ms intervals for each chewing sequence. This running calculation allowed muscle and joint forces to be explored throughout each chewing cycle.

Average and peak loads at the TMJ were estimated to slightly greater in the balancing side joint. However, these loads change substantially during each chew. Distractive forces occur intermittently and at low magnitude in the working side TMJ, typically at the beginning or end of a chewing cycle when muscle forces are low. These results support the proposal that the primate TMJ is not regularly or forcefully distracted. Muscle activity and masticatory system configuration appear to be structured to produce predominantly compressive forces at the TMJ. Evolutionary changes in masticatory form should maintain this basic structure.

**A stable isotope and elemental study of South-African Plio-Pleistocene hominins.**

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A spate of new data on early hominin nutritional ecology has become available in the past few years. Stable isotope data suggest that Plio-Pleistocene hominins consumed large quantities of C<sub>4</sub> foods (grasses, sedges, animals eating these foods), sometimes representing more than 50% of their diets. Several possible C<sub>4</sub> foods have received attention of late, yet the degree to which these foods could have contributed to the hominid C<sub>4</sub> signature remains uncertain. To address this problem, we undertook a modern stable isotope and elemental study of potential hominin foods in Kruger National Park, South Africa. We also include new stable isotope and elemental data from an expanded dataset of hominin and non-hominin fossils from the sites of Swartkrans and Sterkfontein.

Termites are an important potential food resource for early hominins, most recently highlighted by use-wear analysis of bone tools from Swartkrans. Most termite taxa examined in this study were about 50% C<sub>4</sub>, while several of the hominins were greater than 50% C<sub>4</sub>. This suggests that termites alone do not account for the high-C<sub>4</sub> signature of early hominins. Several researchers have also noted the potential importance of sedge USOs as hominin foods. However, our data show that fewer sedges are C<sub>4</sub> than had previously been thought. All told, these data suggest that Plio-Pleistocene hominins were most likely generalist feeders, exploiting a variety of C<sub>3</sub> and C<sub>4</sub> food resources, including both plant and animal materials.

#### **Correlation of prognathism in fossil hominin skulls.**

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Modern human skulls show reduced prognathism of the mandibular symphysis, the subnasal area, and the face in general. This could suggest that these forms of prognathism are correlated. Indeed, the more vertically-oriented symphysis of the *Australopithecus bahrelghazali* mandible KT12/H1 has been said to indicate a more orthognathic face (Brunet et al. *C.R. Acad.Sc. IIA* 322, 907-913, 1996). The contemporary *Kenyanthropus platyops* cranium KNM-WT 40000 does show such facial morphology, and this could be seen as evidence linking the two fossils. To assess the possible basis of this association we studied the

correlation between forms of prognathism.

Angles were taken from lateral photographs of skulls with landmarks indicated. The sample includes modern humans and great apes, as well as a range of other primates, the hominin skulls AL444-2 and KNM-WT 15000, and individual hominin crania and mandibles.

Results show highly significant intraspecific correlations between the degree of facial, subnasal and mandibular prognathism in modern humans, but not in extant great apes. Interspecifically, only facial and subnasal prognathism were found to be well-correlated, and hominin crania follow the regression trend. KNM-WT 15000 also follows all intraspecific modern human trends. In contrast, AL444-2 has a much more vertically-oriented mandibular symphysis than predicted by its facial or subnasal angles on the basis of modern human regressions. Thus, there is no comparative basis for correlating the degree of prognathism shown by the mandible and the cranium outside the genus *Homo*, and such an association cannot be used to link KNM-WT 40000 and KT12/H1.

#### **Regional variation in late 19<sup>th</sup> and early 20<sup>th</sup> century anatomical collections.**

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Recent forensic crania exhibit considerable variation when compared to anatomical collections such as the Terry and Hamann-Todd Collections, in large part due to secular change (Jantz and Meadows Jantz 2000). It has been suggested that these two collections may not nationally represent Blacks and Whites of this time period (Jantz and Moore-Jansen 1988). While secular change may explain a large portion of the variation that exists between the anatomical collections and modern forensic collections, analysis of regional variation between anatomical collections is important. Terry and Hamann-Todd Collections, representing the St. Louis and Cleveland areas respectively, allow for the assessment of cranial variation between two well-documented samples from different geographic areas, roughly during the same time period.

Cranio-metric data from the Terry and Hamann-Todd Collections are subjected to a series of multivariate statistical analyses to assess any regional variation between Black males, Black females, White males and White females from each collection. Mahalanobis distance was

obtained for all groups. The D<sup>2</sup> values indicate that the distance between Terry and Hamann-Todd Black females is not significant. However, distances are significant between Black males, White males and White females from the two collections. Additionally, F<sub>t</sub> values indicate that regional variation is present between White males and White females.

#### **Electric fences between farmers and monkeys? Reconfiguring rural land use for wildlife conservation in Japan.**

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Electric fences are sprouting around fields and orchards throughout Japan. The fences are a recent expression of the age-old conflict between farmers and Japanese monkeys (*Macaca fuscata*) lured by the farm crops. The fences are just one of many modern high-tech fixes Japanese farmers have tried in searching for a decisive solution to a problem widely viewed by them to be difficult and intractable. The technological fixes proposed range from electric fences to radio-telemetry based early warning, birth control hormone implants, hard-to-climb flexible fencing, and mini-rocket launchers for elderly farmer ladies. Many rural communities, however, resort to cages and firearms.

Technology is being mobilized in an attempt to demarcate the boundaries of rural land use, and separate exclusively human from semi-human rural areas where human land use alone cannot exclude wildlife. However, the effectiveness of technology depends more on social factors than mechanical specifications. Rural communities are often unable or unwilling to organize technology to defend fields from monkeys. The human rural population is aging, many are only part-time farmers or foresters, and the more remote rural areas are becoming depopulated. The quirks of government funding leave critical needs unsupported, such as some maintenance costs. Rural communities need to mobilize themselves as well as governments and NGOs if field defense technology is to be deployed effectively in farming communities.

#### **Do wild chimpanzees and mountain gorillas compete for food ?**

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The behavioral ecology of great apes in sympatry may reveal aspects of the evolutionary forces shaping their social systems, as well as important information about the ecology of extinct sympatric hominoids. The Bwindi Impenetrable Great Ape Project is an ongoing six year study of chimpanzees (*Pan troglodytes schweinfurthii*) and mountain gorillas (*Gorilla gorilla beringei*) in Bwindi Impenetrable National Park, Uganda. We found that the two species had similar diets. Bwindi gorilla diet was overall more folivorous than chimpanzee diet, but was markedly more frugivorous from that of gorillas in the nearby Virunga Volcanoes. During four months of the year Bwindi gorilla diet included more food species than that of the chimpanzees did. Three factors in particular - seasonal consumption of fibrous foods by gorillas, interspecific differences in preferred fruit species, and meat consumption by chimpanzees - contributed to dietary divergence between the two species. Gorillas ate *Myrianthus holstii* at much higher rates than Bwindi chimpanzees did, while chimpanzees included more figs in their annual diet than gorillas did.

We observed two encounters between Bwindi chimpanzees and gorillas. In April 2002, the two species had an aggressive encounter over access to a *Chrysophyllum* sp. Tree bearing ripe fruit; the chimpanzees controlled access to the fruit and displayed when the gorillas attempted to enter the tree crown. In a second encounter in 2001, the two species shared the crown of a large *Ficus* sp. Without aggression or interaction. We conclude that contest competition for food exists between chimpanzees and gorillas, although whether such occasional contests of ecologically important to either species is unknown.

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#### **Stimulation of the monkey HPA axis by SERMS: Elevated cortisol levels after SERM treatment.**

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Data from the Women's Health Initiative suggest that traditional hormone

replacement therapy may increase incidence of cardiovascular events, thrombosis, and breast cancer. This outcome has increased interest in alternative interventions, including selective estrogen response modulators (SERMs) in postmenopausal women. Primarily estrogen analogues with antiestrogenic effects, SERMs have prophylactic effects on bone, breast and uterus. However, SERMs and estrogens may both stimulate the hypothalamic-pituitary-adrenocortical (HPA) axis, and thus may share some pathogenic effects. For example, chronic elevation of the HPA axis is associated with impairment of immune and cognitive function, and suppressed reproduction. We here report the effects of a SERM (levormeloxifene) and 17 $\beta$ -estradiol on serum cortisol levels in ovariectomized cynomolgus monkeys (*Macaca fascicularis*). Monkeys were divided into five conditions: 1) 0.5 mg/kg levormeloxifene (L1, n=24); 2) 1 mg/kg levormeloxifene (L2, n=24); 3) 5 mg/kg levormeloxifene (L3, n=22); 4) 0.016 mg/kg 17 $\beta$ -estradiol (EST, n=26); and 5) placebo (OVX, n=24). Cortisol concentrations were measured 3, 6, 9, 12, 15 and 17 months following initiation of treatment. Repeated measures analysis revealed a significant interaction of time and treatment on concentrations ( $p < 0.001$ ). Subsequent analyses demonstrated that levormeloxifene-treated animals had significantly higher cortisol concentrations than either placebo- or estradiol-treated animals ( $p < 0.001$ ) at all time points. EST also significantly increased cortisol concentrations ( $p < 0.002$ ), but this effect was neither as strong nor as prolonged as that of levormeloxifene. These data demonstrate that SERMs may markedly elevate cortisol concentrations in female monkeys, providing the basis for pathologies on processes influenced by hyperactivity of the HPA axis.

#### **The ecological environment and stature among Native Americans in the Western Hemisphere.**

R.H. Steckel, K.D. Williams. Ohio State University,

For over a century physical anthropologists have studied stature for insights into health and nutrition during the growing years. Much research has been done by human biologists on living populations, however this paper contributes by using the Western Hemisphere database to investigate nutritional status among nearly 2,000 Native American adult individuals who lived in a variety of ecological environments over four time periods:

early pre-Columbian (>1500 yBP); late pre-Columbian (450-1500 yBP); intermediate (250-450 yBP); and late post-Columbian (250-50 yBP). Our variable of study is femur length, which is highly correlated with stature but also more sensitive to environmental conditions than stature because leg length tends to increase as a proportion of height as environmental conditions improve.

Several interesting patterns emerge: (1) both men and women were distinctly shorter in urban or village as opposed to mobile societies; (2) Low as opposed to high elevations were advantageous for growth; (3) Stature was greater in post-Columbian versus pre-Columbian time periods; (4) Men but not women were systematically shorter if they consumed domesticates as opposed to a diet lacking domesticates

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#### **Climate, racial category and body proportions in the U.S.**

T. Steegmann, Jr. Dept. of Anthropology, University at Buffalo,

In 1955, Newman and Munro reported correlations between American physical characteristics and climate. For example, the body weight/surface area ratio correlation to January temperature was -.587. Since their sample of U.S. Army males descended from relatively recent migrants to North America, these physical clines implicitly derived from differential lifetime growth rather than natural selection. Consequently, both causation and adaptive function of Bergmann's and Allen's Rules was called into question.

Analysis of a sample of men and women from the 1988 U.S. Army anthropometric survey<sup>1</sup> updates and clarifies results of the 1955 study. One approach used state means of anthropometric and climate variables, as did Newman and Munro. As an example, correlation between relative sitting height and mean annual temperature was -.520 in both male and female samples. However, further analysis of black and white sub-samples, and of percentages of blacks or whites per state, suggest that the "physical-climatic" correlations are not environmental. Rather, they are due to proportions of racial categories per state. Whites have relatively longer trunks and shorter legs than blacks. Consequently, high percentages of whites in climatically colder states produces greater mean relative sitting heights in colder areas. By implication, environmental effects on growth have

little role in producing Bergmann's and Allen's Rules.

<sup>1</sup>Data graciously provided by Dr. Claire C. Gordon, U.S. Army Natick Research Development and Engineering Center, Natick, MA.

**Population level DNA sequence diversity at the alpha-2 globin locus in orangutans.**

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Hemoglobin is a crucial molecule for life because it transports oxygen through the blood. Its two protein components are alpha- and beta-globin. In humans, several genetic mutations at the loci encoding alpha- and beta-globin have shown evidence of natural selection in response to malaria. Orangutans have long been observed to have several different hemoglobin variants segregating in both Bornean and Sumatran populations. In this study, a population of Bornean orangutans was screened for DNA sequence diversity at 1.4 kilobases of the alpha-2 globin locus. These data were tested against different expectations based on selective versus neutral DNA sequence diversity. Some minor deviations from neutrality were observed. Interestingly, one highly derived allele is segregating in the population at a frequency of nearly 10%. Comparative structural protein analyses suggest that this allele may be a thalassemia-type allele. One implication of these findings is that malaria may have long been a selective force on hominoids and hence may have similarly acted on early hominids.

**Colobine molecular phylogeny.**

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There are essentially no published studies on the molecular phylogeny of the genera in the subfamily Colobinae. Outstanding issues in colobine phylogeny include: (1) What is the phylogenetic position of *Nasalis*? Is it basal to all other colobines, or a member of an Asian colobine clade? (2) Do the members of the former *Presbytis* (*Trachypithecus*, *Semnopithecus*, and *Presbytis*) form a monophyletic clade? (3) What are the interrelationships of *Presbytis* (*sensu lato*), *Nasalis*, and *Rhinopithecus-Pygathrix*?

New sequence data collected by our research groups includes that from mitochondrial genomes, intron 1 of the IRBP gene, an intergenic region on the X chromosome (Xq13.3), the lactalbumin gene, and the Y chromosome loci TSPY and SRY. Our studies include representatives of *Colobus*, *Ptilocolobus*, *Nasalis*, *Trachypithecus*, *Semnopithecus*, *Presbytis*, and *Pygathrix*.

Analyses show that: (1) Groves' hypothesis of a basal divergence between *Nasalis* and other colobine genera does not hold. There is a clear separation of the colobines into monophyletic African and Asian lineages. (2) It is currently not clear if *Presbytis* (*sensu lato*) is a monophyletic group. (3) The interrelationships of the Asian genera from the above loci are somewhat incongruent. This suggests that the initial divergence of the Asian lineages was quite rapid, and therefore may be difficult to resolve with statistical certainty. Furthermore, our analyses suggest that this Asian divergence occurred about 9 Ma and that the African and Asian colobine lineages diverged approximately 10 Ma, about the same time as the cercopithecine-papionin divergence.

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**How energetically efficient were early hominids? The effect of their relatively short hindlimbs.**

K. Steudel-Numbers, M.C. Tilkins. Dept. of Zoology, University of Wisconsin, Madison.

The effect of the relatively short hindlimbs characteristic of AL 288-1 have been widely discussed. Previous studies of the effect of hindlimb length on the energetic cost of locomotion have reported no relationship, however, limb length could have accounted for as much as 19% of the variation in cost and gone undetected (Steudel & Beattie, 1995; Steudel, 1994, 1996). Kramer (1999) and Kramer & Eck (2000) have recently modeled the effect of the shorter hindlimbs of early hominids, concluding that the shorter limbs may actually have been energetically advantageous.

In the present study fifteen human subjects, of varying limb lengths, walked on a treadmill at 2.8 and 3.0 mph, while their expired gases were collected and analyzed. The subjects walked for 12 minutes at each speed and their rates of oxygen consumption (VO<sub>2</sub>) over the last four minutes were averaged to estimate VO<sub>2</sub>. We also measured each subject's height, weight and hindlimb length. Lean

body mass and %fat were determined using dual-energy x-ray absorptiometry.

ANCOVA with total VO<sub>2</sub> at either speed as the dependent variable and total lean mass, %fat and hindlimb length as covariates resulted in all three covariates having a significant positive effect on VO<sub>2</sub> at  $p < 0.01$ . Thus subjects with relatively longer legs had lower locomotor costs. Thus the short hindlimbs of AL 288-1 would have resulted in her locomotion being more costly than that of a similar sized biped of modern human limb proportions.

**How does branch stability affect prosimian arboreal quadrupedalism?**

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Current views on primate origins suggest that the initial divergence of primates was related to adaptations for foraging and feeding on small terminal branches. One of the challenges of such a habitat is that the supports are frequently compliant and unstable. Thus an arboreal quadruped must contend with the fact that the supports on which it rests, feeds and travels may move beneath its feet. While researchers have commented on effects of branch stability upon energy costs, foraging strategies, and resting postures, fewer studies have attempted to identify the kinematic mechanisms primates use to maintain balance while walking on unstable supports (Stevens et al. 1999).

This study examined the effects of branch stability in a sample of cheirogaleids, lemurids, and lorises. All are arboreal quadrupeds, but differ in body size and shape. Limb posture was recorded during locomotion on fixed and compliant supports, and joint angles and gait patterns were examined.

The five species examined in this study all adopted a suite of accommodations to unstable supports. These included bringing the center of mass closer to the branch and using larger forelimb and hindlimb excursions. This was accomplished by more protracted forelimbs at touchdown and more retracted hindlimbs at lift-off. In addition, hindlimbs maintained relatively longer contact times on unstable branches. Taken together, these consistent patterns suggest that animals of diverse body shapes may use markedly similar strategies to cope with branch instability.

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### **Introduction: Challenges in behavioral genetics.**

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One of the rapidly expanding scientific frontiers concerns the relationship between genetics and human behavior. There are many new methods for identifying the genetic bases of phenotypically and etiologically complex diseases, and success partly reflects our greater appreciation of neurodevelopmental and biochemical pathways that influence these phenotypes. To date, however, fields related to neuroscience have had relatively little success at identifying any specific "disease-causing" genes for mental or cognitive disorders. The objective here is to briefly review the status of the current genetic or gene-search strategies used for the study of complex human behaviors and how problems with phenotypic definitions complicated gene-search goals. We will argue that "more tactics are better than fewer" and that interdisciplinary collaboration is the key to future progress.

We suggest the use of endophenotypes, ideally physiological traits with a closer association to gene action, as a promising research strategy. A powerful aid to these efforts could be the Rasch analysis, until now, used rarely in genetics. Rasch models are latent trait models that can assist in identifying the existence of a latent trait within the "chaos" of empirical observations. The Rasch model allows one to select only those observations consistent with a specific physiological or behavioral trait using fit statistics. Unlike other stochastic measurement models used in the social sciences (e.g., item response theory models), Rasch models do not automatically produce good fit of the data to the model making them ideal for constructing measures with internal consistency related to a biological trait.

### **Climatological differences in areas inhabited by African ape taxa and Plio-Pleistocene hominoid/hominid fossil ecology and systematics.**

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The tropical Distribution and elevation ranges of African ape taxa in light of climatological differences in their respective geographic ranges serves to help clarify Plio-Pleistocene hominoid/hominid fossil ecology, distribution, and systematics.

Gorilla habitats range in elevations from sea level to 4000m with rainfall usually greater than 1800mm/year and dry seasons of 34 months. Eastern gorillas (*G. berengei*) can withstand relatively low temperatures with occasional snowfall and very few fruiting trees. Common chimpanzees have a much lower elevation range and do not withstand yearly average temperatures as low as those of gorillas, but appear to have a higher tolerance for longer dry seasons and lower rainfalls than gorillas. *Pan troglodytes*, *P.t. verus*, and *P.t. schweinfurthii* withstand rainfalls as low as 1370mm/year, 1600mm/year, and 988mm/year respectively with dry seasons up to 5 months. This tolerance allows for a much wider latitudinal distribution and a greater eastern and western extension into drier areas east of the western rift and west of African equatorial forests than seen from gorillas and pygmy chimpanzees (*P. paniscus*). Consequently, fruit availability appears to limit common chimpanzee distribution, while yearly precipitation affects gorilla and pygmy chimp distribution.

Higher rainfall in Plio-Pleistocene times would have allowed gorilla and chimpanzee ancestors to extend into South and East Africa respectively. There is no a priori reason, therefore, to expect all Plio-Pleistocene fossil hominoid/hominid sites in Africa to yield solely human ancestors. Fluctuation of fruit availability in South African sub-tropics could not, however, have supported a chimpanzee-like ape with year round fruit dependence.

### **Childhood stress and determinants of adult sexual size dimorphism in late prehistoric skeletal assemblages from Guam, Mariana Islands.**

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Skeletal assemblages from Latte Phase (AD 1000-1521) villages on Guam were analyzed in the course of cultural resources management projects. Observing that some females with linear enamel hypoplasias (LEH) had markedly small teeth, we hypothesized that some of the

sexual dimorphism in this population resulted from childhood stress and impaired development.

We address this by comparing mean bucco-lingual (BL) dimensions of permanent teeth (within sex groups) of individuals with no LEH to those of individuals with one or more LEH in a permanent maxillary central incisor or mandibular canine. Females with 1+ LEH in either tooth had slightly smaller BL dimensions than females with no LEH, and mean BL dimensions are progressively smaller in groups of females with progressively more defects. Females with LEH have shorter mean estimated stature than those without. In contrast, among males some individuals with LEH have the largest teeth. The differing patterns are due at least in part to the higher average number of defects in females than in males. Among those with hypoplasias, females have significantly more defects per individual than males. This suggests that girls were subject to more repeated stress, with cumulatively greater impairment of development.

Reduced crown size in females who experienced LEH-causing stress events in childhood (14% and 25% of females have LEH in incisors and canines, respectively), increased the magnitude of sexual size dimorphism in this population. This study expands our understanding of the range of proximate, biocultural factors underlying the dynamics of dimorphism in specific populations.

### **Analysis of complete mtDNA sequences in *Pan*.**

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The analysis of Mitochondrial DNA (MtDNA) sequences has been important for the understanding of primate evolutionary history. In the last ten years, numerous complete mtDNA genomes have become available, including those from *P. t. verus*, *P. paniscus*, and other Hominoids. Here, we report the sequence of the mitochondrial genome of three chimpanzees: one *Pan troglodytes troglodytes*, one *P. t. schweinfurthii*, and one individual with a hypervariable region sequence consistent with those of the proposed fourth subspecies, *P. t. vellerosus*. These data were compared with previously published mtDNA genome sequences to provide finer resolution of the timing of the divergence between the subspecies of chimpanzee and between chimpanzees and bonobos. These results

were then compared to those generated from Y chromosome and autosomal DNA data. Because the phylogenetic relationships between members of the *Hominoidae* are not in question, the ability of different mitochondrial genes to find the true phylogenetic relationship between taxa is also examined.

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#### **Finite element analysis applied to masticatory biomechanics.**

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Attempts to test hypotheses pertaining to facial biomechanics are confounded by the fact that the geometry of the facial skeleton is extremely complex. One means of testing such hypotheses is to employ finite element analysis (FEA). FEA is a widely used engineering technique designed to examine how objects of complex geometry resist loads. Finite element models of primate skulls are used to demonstrate the utility of FEA for testing functional hypotheses related to mastication, and the challenges involved with creating realistic models.

Several variables must be considered when modeling the biomechanics of primate chewing: 1) the geometry of the skull must be captured with reasonable accuracy, 2) the relative magnitudes and orientations of the forces generated by the muscles of mastication must be specified, 3) the material properties of cranial bones and sutures must be measured, 4) the model must be constrained in such a way that the applied forces simulate a realistic chew, 5) there must be an understanding of the time lag between when a muscle is active and when its activity produces measurable strain in a bone, 6) the bite point must be known or approximated, and 7) the relationship between two-dimensional experimental strains and three-dimensional modeled strains must be understood. These variables can be modeled using a combination of electromyographic, strain gage, ultrasonic, physiological, imaging, morphometric and mathematical analyses. Our methods for applying these analyses are described.

#### **MorFIDs: Morphometric Forensic Identification of Sub-adults**

U. Strand Vidarsdottir. Dept. of Anthropology, University of Durham.

The identification of ancestry in human skeletal remains is an important factor in narrowing down the potential identity of individuals in a forensic context, and for repatriation. Hitherto, this type of identification has been based on quantitative or qualitative assessments of the morphology of the adult cranio-facial skeleton. However, due to large scale allometric changes that take place in the cranio-facial skeleton during ontogeny, it has been difficult to use techniques developed using adult remains, to identify ancestry in sub-adults. Recent work using geometric morphometric techniques (Strand Vidarsdottir et al, 2002), presented at these meetings 2000 & 2002, has shown that using this school of techniques, it is possible to identify ancestral morphologies in the cranio-facial skeleton of infants as young as 1 year of age. MorFIDs (Morphometric Forensic Identification of Sub-adults) is a computer-based resource specifically developed from this research for the application of morphometric techniques to the identification of sub-adult skeletal remains. It aims to facilitate identification of ancestry on the basis of complete and partial cranio-facial skeletons. Tests show that given large sample-data sets, in particular where ancestral populations can be narrowed down by other means, sub-adults can be identified to racial group with up to 95% certainty. This is comparable to the success rate of ancestral identification in adults using established techniques.

This research is supported by the Royal Society

Strand Vidarsdottir U, O'Higgins P, and Stringer C (2002). *Journal of Anatomy*, 201:211-229.

#### **Community ecology and nonhuman primate macroparasitology.**

M.D. Stuart. Dept. of Biology, University of North Carolina at Asheville.

Primates exist and evolve within an ecological framework established by interactions with both the abiotic and the intra- and interspecific relationships with other living organisms. Parasites (members of a different species that exist at the expense of the host species) clearly influence host ecology in a variety of ways. The parasites themselves are faced with serious ecological problems in getting their offspring from one host "island" to

another. Many parasite species have evolved elaborate life cycles to accomplish this goal. Parasites may be viewed as members of a functional ecosystem in which the monkey and the parasite are interrelated elements. Their life cycles usually interface with the primate hosts' feeding or behavioral patterns in some manner to enhance probability of transmission. An understanding of the parasites' perspective can provide clues about host ecological and behavioral responses to the environment. Feeding patterns, frequency of contact with intermediate hosts, host distribution patterns, and competitive interactions are among the many elements that may be influenced by parasites. Primatologists are in a unique position to collect and utilize parasites as "ecological indicator species" that provide insight into primate ecology.

The complexity of parasite life cycles, however, has occasionally led to overgeneralizations or acceptance of unsubstantiated conclusions. Outdated collection methodology or extrapolations from human or livestock parasitic patterns to different primate groups can confuse the issues. It is important that primatologists utilize all available resources to understand parasitological concepts and how to apply them in interpretation of field parasite data.

#### **Body size estimation using cranial predictors in large-brained hominids.**

P.R. Stubblefield. CA Pound Human Id Lab, Dept. of Anthropology, University of Florida.

Body weight is critical to understanding an organism's biology, but acquiring this statistic for fossil hominids is hampered by fragmentary preservation and by species being defined from cranial remains that frequently lack associated postcrania. Thus body size information is restricted to that which can be extracted from the skull. To address this issue, I examined cranial measurements as predictors of body weight using modern humans as the reference sample.

I proposed two hypotheses, that cranial measurements in modern humans covary with body weight, and that cranial thickness in modern humans is a function of skeletal robusticity as indicated by cortical thickness of a postcranial element. To test these hypotheses I sampled 147 adults of recorded body weight (100 from the Terry collection at the Smithsonian National Museum of Natural History and 47 from recent autopsies) for nine endocranial and seven cranial vault thickness measurements. Cortical thickness at

four points at midshaft of the clavicle was also measured. The correlation coefficient was calculated for each cranial measurement versus body weight and the vault thickness measurements versus the clavicle cortical measurements.

In contrast to published literature, cranial measurements were not well correlated with body weight and either had low correlation coefficients ( $< 0.6$ ) or lacked significant correlation. There was also no pattern of correlation between vault thickness and clavicular cortical bone thickness. The lack of engagement between body size and many cranial measurements in modern humans warrants caution in applying cranial predictors to other hominid species subject to cranial expansion.

#### **Female mate preference in chimpanzees of the Taï Forest, Côte d'Ivoire**

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According to the assumptions of sexual selection theory, females should exhibit mate selectivity for mates. Yet, chimpanzee females are known to mate promiscuously. Although there is substantial rationale for a promiscuous mating strategy, the question arises as to whether females are really so indiscriminate as to risk leaving paternity to chance. Females should carefully select high quality sires to enhance the survival of their offspring and maximize their reproductive success. The aim of this study is to examine if female chimpanzees exhibit mate preferences for particular males, and if so, to determine how and when these preferences are expressed. Over 2600 hours of focal observation were collected on 14 estrous females from two communities. Non-periovoluntary and peri-ovulatory phases were sampled. Female mate preferences were measured by quantifying female proceptive and refusal behaviors toward males, independent of whether a copulation occurred or not. Results suggest that all females express both measures of preference, and interfemale variation in the expression of these measures did not covary with age or rank of the female or male. Females generally preferred the same males. Male dominance rank was not a clear predictor of female mate preference. Females may prefer up-and-coming dominant males. However, females showed increased mate preference for the dominant male during the periovoluntary period. Females were more

selective during the peri-ovulatory period, (particularly against non-preferred males), and less selective outside of the peri-ovulatory period, suggesting that females may follow a mixed reproductive strategy of both promiscuity and selectivity to achieve their reproductive ends.

#### **Faunal differences in the sequence at Laetoli: Implications for taphonomy and paleoecology.**

D.F. Su, T. Harrison. Dept. of Anthropology, New York University and NYCEP.

Paleoecological investigations of the hominid-bearing upper Laetoli Beds (~3.4-3.8 Ma) at Laetoli, Tanzania, have previously been based on analyses of the composite fauna from different localities that span the entire stratigraphic sequence. This study re-examines the paleoecology at Laetoli using finer-grained stratigraphic control (the sequence is divided into four main temporal zones) and faunas from 26 individual collecting localities. Preliminary analyses focus on the artiodactyls, the best represented group of mammals at Laetoli.

Paleoecological reconstruction based on the overall composition of the artiodactyl community indicates a mosaic habitat of savanna, bushland, and woodland. Comparisons of faunal lists for each locality and time zone show that the general paleocommunity structure is relatively uniform regardless of space and time. The seven most common taxa, comprising over 90% of the artiodactyls, are found at all localities that have relatively large samples. Rarer taxa are absent from certain localities, but simulations indicate that their frequency of occurrence is directly related to the size of the sample available and the rarity of the taxon. In other words, differences in the faunas between localities are primarily a consequence of sampling. However, the proportion of each taxon does vary significantly between different localities and time zones, implying that there are subtle paleoecological differences that are not revealed through comparisons of faunal lists. We infer from these data that the paleoecology at Laetoli remained generally unchanged throughout the sequence, but that differences in the frequency of artiodactyl taxa reflect subtle shifts in the proportions of savanna and woodlands.

#### **Acquirement of social ranks of females in one group of Taiwanese macaques (*Macaca cyclopis*) at Fushan Experimental Forest, Taiwan.**

H-H. Su. Dept. of Anthropology, Rutgers, the State University of New Jersey.

Maternal rank inheritance and youngest ascendancy have been argued to apply to dominance acquirement in female macaques. Youngest ascendancy is observed in some Japanese macaque groups and in one rhesus monkey group. However, it has not been observed in Barbary macaques. My studies of one group of Taiwanese macaques at Fushan show that females acquire social ranks below and adjacent to their mothers. Younger sisters in two of three sister pairs studied are dominant to their older sisters.

I conducted the field observations on the macaque group from July of 1998 through July of 2000 as well as in October of 2001 and July of 2002. Social ranks of females in the study group are determined by direction of aggression and displacement displayed during their dyadic agonistic interactions. During the study five daughters turned sexually mature and acquired social ranks just below their mothers, and no outrankings have been observed.

Three pairs of sisters in the group were studied from 7/16/02 through 7/26/02 to determine their dominance relationships. During a total of 79.5-hr observation of the entire group, 37, 31 and 38 focal samples of 10 minutes were collected from the three sister pairs. Data on aggression and submission that occurred in each pair were collected to calculate the dominance index. Based on the index, two of three younger sisters are dominant to their older sisters. Effects of the presence or absence of their mothers in the group on social ranks of the younger sisters are presented here.

#### **Route choice in spider monkeys: A spatially explicit model using GIS.**

S.A. Suarez. Interdepartmental Doctoral Program in Physical Anthropology, Stony Brook University.

Researchers have observed that primates frequently re-use particular travel routes, sometimes referring to these as "arboreal highways" (Sigg & Stolba, 1983; MacKinnon, 1974; Milton, 2000). These highways are not always the shortest connection between two locations. Euclidean distance will not accurately reflect energy expenditure during travel where terrain is not flat. GIS analysis, however, permits both the evaluation of cost in three dimensions, and the assignment of cost to environmental characteristics. This project incorporates both GIS analysis and the ranging behavior of wild

spider monkeys to investigate the question: Which environmental features influence route choice in spider monkeys? Four hypotheses for predicting travel routes are used to generate least-cost shortest-distance paths from a starting point to a primary feeding patch. In the models, routes preferentially: H1) pass in close proximity to known feeding trees; H2) are at the highest altitude; H3) avoid steep slopes; or H4) avoid secondary forests.

ArcMap 8.1 and ERDAS Imagine 8.5 are used to evaluate travel costs and generate model routes. Daily travel routes used to test models come from 1273 hours of observation of white-bellied spider monkeys (*Ateles belzebuth belzebuth*), collected between March 1999 and May 2000 at the Proyecto Primates Research Site in the Yasuni National Forest, Eastern Ecuador [75°28'E, 0°42'S]. Preliminary results indicate that for Yasuni spider monkeys, indirect routes are often less energetically costly than direct routes, and that model routes reflecting the need to travel at highest local altitudes show the smallest maximum deviations from actual routes (100 meters).

**A re-evaluation of human and macaque "imitation:" Human children and rhesus macaques do not qualitatively differ in a copying task.**

F. Subiaul, J. Cantlon, H. Lurie, R. Holoway, H. Terrace. Columbia University.

Meltzoff and his colleagues have presented evidence, which strongly suggests that humans are endowed with an innate ability to copy the actions of others. However, this has not been the case for primates in general. An extensive review of the non-human primate literature suggests that non-human primates learn from models via simple perceptual mechanisms like stimulus and/or local enhancement (Tomasello and Call, 1997). But human children succeed in similar tasks because they seem to have an understanding of the intention and goals of the model (Nagell, Oguin, & Tomasello, 1993). However, Subiaul et al (2002) using a new imitation paradigm previously demonstrated that when motor confounds are eliminated from the task, adult rhesus macaques can successfully learn a 3 and 4-item list of pictures from an experienced model. Here we present new evidence, comparing the performance of rhesus macaques with that of human children (ages 3.5 to 5.3). Despite the superior memory and attentional abilities of humans, as well as, the unique ability to linguistically encode information, their

performance did not qualitatively differ from that of monkeys. These results further confirm our previous conclusions that (1) different neural and cognitive structures may underlie the copying of cognitive information and the copying of motor actions, (2) once motor and tool confounds are adequately controlled, non-human and human performance on a copying task do not qualitatively differ, and (3) the ability to copy abstract information may be a shared-derived catarhine trait.

**Human genetic polymorphisms of hepatic enzymes: Physiological evidence of human dietary patterns and exposure to psychoactive substances in prehistory.**

R.J. Sullivan. Global Health Studies Program, The University of Iowa.

The physiological processes employed by the body to neutralize and dispose of ingested toxins reveals much about the foods and substances consumed by our distant ancestors. One such mechanism is the hepatic cytochrome P-450 enzyme system (CYP). The CYP enzymes groups CYP 1, CYP2A-E, and CYP 3 have evolved with specificity for the detoxification of phytochemicals, or plant toxins, many of which are still recognizable today as commonly used drugs.

A meta-analysis of the biomedical literature shows considerable ethnic variation in the expression of the hepatic enzymes CYP1A2 (interacts with caffeine), CYP2A6 (nicotine), CYP2C9 (cannabinoids), and CYP2D6 (amphetamines and opiates), and associated population level differences in the ability to metabolize specific substances. For example, a polymorphic multiple expression of the gene coding for the CYP2D6 enzyme is present in ~12%, 21% and 29% of people originating from Turkey, Saudi Arabia and Ethiopia, respectively. The CYP2D6 polymorphism occurs at rates far higher than can be accounted for by random evolutionary processes, and must reflect selection pressures resulting from dietary exposure to phytochemicals in the past. Although each polymorphic human CYP enzyme metabolizes several different phytochemicals, it is notable that CYP2D6 is a form with specificity for plant toxins targeting the central nervous system.

Whether or not past human exposure to psychoactive phytochemicals was intentional or incidental, hepatic enzyme polymorphisms indicate that human populations have been variably exposed to psychoactive substances over an evolu-

tionary timescale. This finding has significant implications for current proximate theories of human drug use and addiction.

**Female reproductive strategies in hamadryas baboons: Paternity certainty, infanticide avoidance, and copulation calls.**

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In addition to ensuring her own survival, ensuring the survival of her offspring is the primary determinant of a female's reproductive success. Infanticide and aggression towards infants are risks for female primates and have consequently been suggested to play a primary role in shaping female primate sociality. One way that females may guard against such threats is by increasing paternity uncertainty through promiscuity and the incitement of male contest and sperm competition. Most baboon societies are characterized by some degree of infanticide risk and, correspondingly, both female promiscuity and male competition. Female copulation calling in particular has been suggested as a mechanism whereby females may incite male competition at both the pre- and post-copulatory levels, thereby increasing paternity uncertainty and lowering their risk of infanticide. Another, alternate route to ensure protection against infanticide is association, and exclusive copulation, with a single protective male. Here we present evidence suggesting that the latter strategy – one of paternity concentration rather than paternity confusion – is used by female hamadryas baboons. Paternity certainty is probably quite high among hamadryas leader males, and protective behavior towards infants has probably been selected for during the evolution of hamadryas social organization. Female hamadryas are consequently less promiscuous, do not frequently initiate copulation, and rarely engage in behaviors that would incite male-male competition, such as copulation calling. When hamadryas females do give copulation calls, the calls are shorter and quieter compared to those of more promiscuous baboon subspecies that rely more on paternity confusion as a reproductive strategy.

### Population growth and decline in a multiagent model of the Prehistoric Anasazi of Long House Valley, Arizona.

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Long House Valley in the Black Mesa area of northeastern Arizona was inhabited by the Kayenta Anasazi from about 1800 BC to about AD 1300. These people were the prehistoric ancestors of the modern Pueblo cultures of the Colorado Plateau. Paleoenvironmental research based on alluvial geomorphology, palynology and dendrochronology permits accurate quantitative reconstruction of annual fluctuations in potential agricultural production (kg. of maize per hectare). The archaeological record of Anasazi farming groups from AD 200-1300 provides information on a millennium of sociocultural stasis, variability, change and adaptation. We report on a multiagent computational model of this society that closely reproduces the main features of its actual history, including population growth, changing spatial settlement patterns, and eventual population collapse. The agents in the model are monoagriculturists, who decide both where to situate their fields as well as the location of their settlements. Nutritional needs constrain fertility. Agent heterogeneity, difficult to model mathematically, is demonstrated to be crucial to the high fidelity of the model.

### Three-dimensional analysis of the knee: Testing old assumptions with new techniques.

W.D. Sweitzer. Dept. of Anthropology, Arizona State University.

Several features of the hominin knee joint have been considered diagnostic of habitual bipedality. Most anthropological approaches to the study of this region have relied on two-dimensional analyses. Although often informative, these studies neglect a large proportion of the available data, a major concern when three-dimensional (3D) shape is the object of study. This inadequate capture of 3D shape information leaves ample room for conflicting interpretations.

This study applies current 3D techniques to the analysis of the distal femur in modern humans, fossil hominins, and other non-human primates. Specifically, the shape of the patellar groove is assessed with traditional 2D and novel 3D measures. The new approaches largely

confirm results obtained by more traditional methods, namely that a deep patellar groove with a prominent lateral lip is typical of bipeds. But the results obtained here raise questions about traditional functional interpretations and expose important methodological issues that need to be addressed.

Many of these methodological issues are common to 2D and 3D analyses (e.g., how to standardize the orientation of bones), but seem particularly pressing in the 3D context. Others are exclusive to 3D techniques (e.g., interpreting the biological meaning of curvature values). Because the final interpretation of any result is dependent on the robustness of the methods used and because 3D techniques are relatively new to physical anthropology, a significant portion of this paper is devoted to a discussion of methodology.

### Big males are responsible for our recognition that females have big pelves.

R.G. Tague. Dept. of Geography and Anthropology, Louisiana State University.

Most primate species are sexually dimorphic in size; males are larger than females. Females, however, are larger than males for some pelvic dimensions. Females have big pelves because they give birth to big babies. However, not all pelvic dimorphisms are obstetrically relevant. Schultz (1949, *Am. J. Phys. Anthropol.* 7:401-424) reported that females have relatively wider pelvic inlets than males in gorillas and orang-utans, though females give birth to small babies. He concluded that some pelvic dimorphisms, with females larger than males, are a developmental adjunct to general secondary sexual differentiation, with males larger than females. Conversely, species with little secondary sexual differentiation have little pelvic dimorphism. This study evaluates Schultz's conclusions. The hypothesis is that species will have high variability [average median variation (AMV)] in the index of pelvic dimorphism [ $\ln(\text{female mean}/\text{male mean})$ ] if males are significantly larger than females in nonpelvic size. Conversely, species monomorphic in nonpelvic size will have low variability in the index of pelvic dimorphism.

Twelve anthropoid species were studied. Twelve pelvic and two femoral measurements were taken. The results support Schultz. Species dimorphic in femoral size have significantly higher AMVs of pelvic dimorphism than those monomorphic in femoral size (Kruskal-Wallis test). The proposed etiology is that female pel-

vic size is the default for the species. Male pelvic size results from modulation in growth of the default type by testicular androgens. Interspecific differences in AMVs of pelvic dimorphism are due to corresponding differences in responsiveness of the pelvis to androgens.

### New aotine fossil from the middle Miocene of La Venta, Colombia.

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Since the 1940s many platyrrhine fossils have been recovered from the middle Miocene sediments of La Venta, the Tatacoa desert, Southern Colombia: such as *Stirtonia tatacoensis* and *S. victoriae*, *Neosaimiri fieldsi* (including "*Laventiana*"), *Cebupithecia sarmiento*, *Micodon kiotensis*, *Mahanamico hershkovitzi*, *Aotus dindensis*, *Lagonimico conclutatus*, *Patasola magdalena*, *Nuciraptor rubicae*, and *Miocalicebus villaviejai*. Most of these fossil taxa have been associated with the living platyrrhine groups. Especially *Aotus dindensis* has been regarded the middle Miocene species of extant platyrrhine genus, *Aotus* (owl monkey), because of its morphological resemblance to extant forms in lower dentition and mandibular corpus (Setoguchi & Rosenberger, 1987).

In 1998 a new fossil specimen of aotine platyrrhine was discovered from the La Venta fauna. It was collected from the lowermost part of the "Upper Red Bed", which is about 100 m higher than the type horizon of *Aotus dindensis*. The specimen consists of isolated right C<sub>1</sub>, P<sub>4</sub>, M<sup>2-3</sup>, left P<sub>1</sub>, C<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub>, fragmentary symphysis preserving right I<sub>2</sub>, right mandibular fragment preserving M<sub>1</sub>, isolated left P<sub>4</sub>, and left mandibular fragment preserving M<sub>1-3</sub>. All these specimens most probably belong to the same individual, because they were collected from a very small spot and appear almost the same in dental size without overlap of tooth class. The lower dentition of this new material is nearly identical to that of *A. dindensis* except in its much larger size, so it could be referred to a new fossil species of Aotinae.

### Functional morphology of the *Nacholapithecus* forelimb long bones.

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Postcranial bones of *Nacholapithecus kerioi* from the middle Miocene of Kenya had been known largely from a single skeleton of adult male (KNM-BG 35250). Regrettably, many elements of KNM-BG 35250 are suffered from plastic deformation and surface erosion. A number of additional specimens were excavated *in situ* in the 1999 field season at the same site as KNM-BG 35250 (BG-K) had been recovered. These specimens provide more accurate information about *N. kerioi* postcranial morphology. We report morphologies of the humerus, ulna, and radius.

The distal humerus, as was reported for KNM-BG 35250, exhibits some similarity with *Kenyapithecus wickeri* (KNM-FT 2751), such as an articular expansion on the lateral wall of the olecranon fossa. However, *N. kerioi* differs in a larger, globular, and distally expanded capitulum, a deep gutter of *zona conoidea* and a proximodistally taller anterior trochlear surface. The humeral shaft is moderately retroflexed and has a large flat deltoid plane. The strongly developed lateral supracondylar ridge of the humerus and the deeply excavated insertion of *M. brachialis* suggest developed ability of climbing. The radial head is rounded. The radial notch of the ulna faces laterally. Together with the distal humeral morphology, these elbow features indicate that pronation-supination of the forearm throughout the range of elbow extension and flexion was predominated.

Current evidences generally confirm the "forelimb-dominated arboreal positional behavior" of *N. kerioi* as has been suggested previously.

#### **Dietary strategies and digestive efficiency of the southern muriqui (*Brachyteles arachnoides*).**

M. Talebi. Dept. of Biological Anthropology, University of Cambridge.

Studies have show that wild primates have marked preferences in their food choice. However, there is a lack of information on the nature of their choices; whether they occur based upon nutritional, physical, or, chemical factors and whether digestive efficiency is related to these choices. *Brachyteles arachnoides*, (Southern Muriquis), despite being considered one of the most folivorous species of Neotropical primates, have notable adaptations of the digestive tract (e.g. dentition traits and large cecus for fermentative digestion) compatible with both folivory and frugivory. Although muriquis rely preferentially on fruits when they are available, they are able to sup-

port a diet almost entirely of leaves during fruit scarcity.

This study tests the hypothesis that food is selected on physico-chemical contents that reflect the digestive flexibility of the species. Food selection data are presented on the nutritional content (crude fibre, protein and carbohydrates), texture (toughness) and colour (reflectance) basis. It was found that food selection could not be predicted just by nutritional factors as first expected. However, toughness was found to be an additional factor of importance for food selection. These results support the hypothesis that digestive efficiency modulates food choice and suggest that food toughness must also be considered as a good predictor of food choice in wild primates.

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#### **Bones and burials: Issues and strategies for teaching about issues related to human skeletal remains.**

N.E. Tatarek. Ohio University.

Physical anthropology is most often associated with the controversial topics of evolution and race, both as a practicing discipline and with regard to questions of a pedagogical nature. Potentially equally charged are issues surrounding teaching with and about human skeletal remains. First and foremost of these issues are the emotional aspects encompassing human cultural viewpoints on death, dying and human remains. Students may bring a broad spectrum of these cultural values with them to the classroom, from the emotion of a recently deceased loved one to group level cultural issues such as NAGPRA to feelings of a national tragedy such as September 11 or civil rights violations. Additionally, in the United States, cultural attitudes shaped by widened media attention on crime, criminals, and in particular, crime investigators, also shape student viewpoints on human remains. This 'glamorization' of death, and human remains can impede student learning through perpetuating an unrealistic mythology about the science of studying human remains. This presentation aims to discuss these issues and offer for discussion some strategies for treating these issues in physical anthropology

courses at both the introductory and advanced levels.

#### **Patterns of mandibular variation in *Pan* and *Gorilla*.**

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*Pan* and *Gorilla* taxonomy are currently in a state of flux, with the number of existing species and subspecies of common chimpanzee and gorilla having been recently challenged. While *Pan* and *Gorilla* systematics have been evaluated on the basis of craniometric data, only a handful of studies have evaluated craniometric variation within *P. troglodytes*, and none have evaluated in detail mandibular variation in either *P. troglodytes* or *Gorilla gorilla*. Using canonical variates analysis, we assess the patterning and degree of mandibular distinction within *Pan* and *Gorilla* using raw and allometrically size-adjusted data. Morphological differentiation in *Pan* and *Gorilla* varies, both with respect to cranial and dental morphology, and in terms of the application and manner of size adjustment. Mandibular differentiation supports the conventional separation of bonobos from chimpanzees regardless of size adjustment. *P.t. verus* is the most distinctive among common chimpanzees but still shows a considerable degree of overlap with *P. troglodytes*, and size adjustment alters the relative positioning of *verus* to the other two chimpanzee subspecies. We find no differentiation of the Nigerian gorillas, and degree of differentiation and relative alignment of taxa in *Gorilla* alters depending on the manner of size correction and whether cranial or mandibular characters are used. Results are discussed in terms of the recent suggestion that *P.t. verus* may represent a separate species of *Pan*, the recent recognition of Nigerian gorillas as a separate subspecies of western lowland gorilla (*G.g. diehli*), and the concomitant separation of western and eastern gorillas into two separate species.

#### **Mechanical properties of molar enamel in *Homo sapiens* and *Alouatta palliata*.**

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Dental enamel has traditionally been viewed as a rather homogeneous material. However, enamel is still a complex composite, made up of crystals and prisms spun together in a complicated fashion. As a result, one might expect summary-type measurements of properties such as hardness to be of limited value in functional interpretations. The purpose of this study was to use nanoindentation-testing to compare the properties of molar enamel in two species of modern primates: *Homo sapiens* and *Alouatta palliata*.

Three isolated upper molars from each taxon were embedded in epoxy and then sectioned across the mesial cusps using a diamond saw. The exposed surfaces were finely polished, and microscopic indentations were made in the enamel ("Nanoindenter," MTS Systems Corp.) at regular intervals between the occlusal surface and the dentin-enamel junction.

Results indicate that (1) the enamel of the monkey teeth is generally softer and more elastic than that of the human teeth, and (2) the enamel of the monkey teeth exhibits a more limited range of hardness and stiffness values than does that of the human teeth. Since the enamel on the monkey molars is significantly thinner than that on the human molars, and since the monkeys have a more abrasive diet than we do, these results raise interesting questions about the evolution of dental function in these primates. Supported by NSF grant #9601766.

**Hereditary multiple cartilaginous exostoses in a young adult male from early medieval coastal Germany.**

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During excavations in the early medieval terp settlement of Niens (Germany), which is located near the ancient coastal line of the North Sea, the skeleton of a 20-24 year-old male has been discovered in the barn of a longhouse. During the anthropological and paleopathological investigation macroscopic, radiological and light microscopic techniques were used. There are more than 100 exostoses of various size located all over the postcranium but mainly on the long bones. Furthermore, some ribs showed exostoses on their internal surfaces. The bones of the forearms are characteristically bent and the distal part of both femurs are enlarged. Several joints suffered from premature degenerative changes and both femur heads show large lesions caused by osteochondrosis dissecans.

The most likely diagnosis for these exostoses are hereditary multiple cartilaginous exostoses. This is a genetically heterogeneous autosomal dominant disorder. Males are more affected than females (2-3:1). Its prevalence today is at least one in 50,000 (Schmale et al. 1994). Therefore, hereditary exostoses are a rare find in prehistoric and historic populations. Only a few cases have been published up to now (e.g., Gladkowska-Rzeczycska & Urbanowicz 1970). The young man from Niens was disabled in many ways. People, possibly his relatives have had to care for him for many years. This case is an impressive example for sympathy and social care in the very rough environment of the coastal area of the North Sea during the early Middle Ages.

**With whom, when, & why: Primate polyspecific associations at Ngogo, Kibale National Park, Uganda.**

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Colobus monkeys often associate with cercopithecines at various African sites. Such polyspecific associations presumably have an anti-predation function. For example, observations from Tai National Park, Ivory Coast, indicate that red colobus monkeys (*Procolobus badius*) seek the company of diana monkeys (*Cercopithecus diana*) when threatened by predators.

The chimpanzee community at Ngogo, Kibale Forest National Park, Uganda, is the largest known in the wild, with about 150 members. Its members prey heavily on red colobus monkeys: chimpanzee hunting success rate is extremely high, and they kill many individuals per successful hunt. Red colobus at Ngogo spend much time in association with redtail monkeys (*Cercopithecus ascanius*). However, despite the high chimpanzee hunting pressure on red colobus monkeys and much lower hunting pressure on redtail monkeys, these associations seem to be initiated, maintained, and terminated by redtail monkeys.

I report on playback experiments simulating the presence of chimpanzees that show that red colobus monkeys do not approach groups of other monkeys in the vicinity in response to the threat of chimpanzee predation. This contradicts findings from Tai and suggests that red colobus at Ngogo do not benefit from associations with redtail monkeys by improved protection against predation. Instead, predation pressure on redtail monkeys by avian predators may lead to

polyspecific associations between these taxa.

**Anthropology during National Socialism times: Projects done in the Anthropologische Abteilung, Natural History Museum Vienna, 1938-1945.**

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This interdisciplinary research project deals with the tradition of how physical anthropology was done in Austria from 1938 to 1945 and the links of the Anthropologische Abteilung of the Natural History Museum (NHM) in Vienna with other, similarly directed institutions as it became increasingly involved in "racial studies". These studies were carried out on human beings: prisoners of war (1940-1943), 440 male eastern Jews of Polish origin who were detained immediately after the outbreak of the war for three weeks in the Vienna Stadium and then deported to the Buchenwald concentration camp, and the material collected in racial surveys — some of which is still preserved in the museum (data sheets, photographs, hair samples, plaster cast masks, "race expertises"). These racial surveys have never been addressed in relevant literature. Included in this project are our evaluations of the more than 100 "race expertises" carried out by anthropologists at the NHM.

We first investigated these activities initiated by members of the NHM staff in order to assess the extent to which anthropology could be exploited by anthropologists under National Socialism who could take advantage of the new political situation for pursuing their research interests and the war for acquiring "new material". Then we traced the life histories of the Polish Jews detained in the Vienna Stadium in the context of National Socialist deportation policy. Third, we deal with the question of racist theory constructs and its approach to the measurement of the human body.

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**Fueling infant growth: A longitudinal study of body composition and length.**

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While there is significant debate concerning the health consequences of infant growth rates, with the assumption that body composition and physiology interact in a programmatic manner, longitudinal investigations of infant body composition are rare and correlations between weight, body fat distribution, and linear growth are not well understood. Given recent histological findings that the stem cell for both bone and fat is the same (Pittenger et al., 1999), and directed towards its final morphology by specific differentiation and proliferation factors (Ahdjoudj et al., 2001), the temporal relationship between linear growth and fat acquisition is a central theoretical issue in the study of normal infant growth processes. This study addresses the timing of growth in weight, body composition, and linear growth with a focus on how the body uses energy, reflected in adipose tissue stores, as a resource for growth.

In this analysis, thirty-four infants were followed weekly during the first year of life. Anthropometric measurements include total body length, weight, circumferential measurements of the upper arm, thigh, chest, and abdomen and skinfold thickness of the limbs and torso. Growth velocities were calculated for all parameters. Multivariate and logistic regression were used to analyze the relationships between the timing of growth in total body length and growth in body weight and specific skinfold measures.

Body weight and the sum of all measured skinfolds increase significantly in the interval preceding significant incremental growth in total body length. The relative importance of weight versus specific skinfold sites differs by sex. The effects of feeding mode, illness and activity patterns on these relationships were also explored.

**Identity and living conditions of the 'Red Queen': A bioarchaeological study of the sarcophagus tomb of Temple XIII at Palenque, Mexico.**

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The present study aims at contributing to the detection of the personal identity of the "Red Queen", the dynastic occupant whose remains were recovered in the sarcophagus tomb of Temple XIII at Palenque, Mexico. The investigation focuses on a gross facial morphological re-

construction, in profile following Rhine, Preg, Krogman and Iscan, which is then compared to sculptural representations and epigraphic record of identified female dignitaries from the site. Support in the detection of the woman's identity comes from macroscopic skeletal morphology and results obtained from histological sections that focus on the woman's age and her advanced osteopenia. Results are discussed in terms of the associated archaeological information and the importance of this personage in Palenque's society

**Evidence of founder effects in North Atlantic island populations.**

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This study documents the genetic impact of historical population movements occurring at the periphery of northwestern Eurasia. Genetic data from three different compartments of the human genome were collected to test for reductions in genetic diversity associated with putative founder effects associated with the settlement of Iceland and Shetland. Theory predicts that a population that has recently undergone a reduction in effective population size will exhibit transient excess heterozygosity when compared to the observed number of alleles. Given that Iceland and Shetland were very recently colonized by Vikings, these historical founder effects should be detectable. A set of 60 Y-chromosomal biallelic polymorphisms, 11 Y-chromosomal microsatellites, 12 autosomal microsatellites from the Combined DNA Index System (CODIS) database were typed, and the mitochondrial control region was sequenced in individuals from island populations and likely source populations from northern Europe. Complete Y-chromosomal and mitochondrial data provide evidence for founder effect. When Norway is considered the parent population for Iceland, there was 15.1% loss of SNP-corrected Y-chromosomal STR diversity, and no loss of rate-corrected mitochondrial diversity, while for Shetland, there was 8.6% loss of Y-STR diversity and 30% loss of mitochondrial diversity. When Ireland is considered the parent population for Iceland, there was 1.5% loss of Y-STR diversity, and 6% loss of mitochondrial diversity. Statistical analyses of the unlinked autosomal CODIS markers will permit assessment of

transient excess heterozygosity due to bottlenecks and comparisons of the relative effect of demography on diploid versus haploid compartments of the genome during colonization of the North Atlantic.

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**Evidence of treponematosis from a historic paupers' cemetery in Dallas, Texas.**

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Prior to the development of effective antibiotic treatment, venereal syphilis plagued the United States, particularly urban centers. Of fourteen human skeletons (nine adults, five subadults), excavated from a historic (1878-ca. 1911) white paupers' cemetery, in Dallas, Texas, three (one adult male, two adult females) exhibit skeletal indications of treponematosis. The time period and geographic location further suggest that venereal syphilis is the most probable form of the disorder. All three skeletons are of fair preservation, and all three demonstrate bilateral expression of proliferative periosteal lesions on the tibiae. Two of these individuals also exhibit similar lesions on additional lower limb elements. One possesses a stellate lesion on the frontal as well as two healed depressions, one each, on the frontal and left parietal.

These data, combined with evidence of congenital syphilis from a larger, contemporaneous burial sample in Dallas, indicate that syphilis was a problem for at least some populations in the city near the turn of the twentieth century and corroborate historical assertions of the widespread nature of the disease. Furthermore, the proportion of individuals (33 percent of recovered adults) from the paupers' cemetery with skeletal evidence of syphilis is high. The small sample size is a contributor to this statistic; however, several cultural factors must also be considered because these findings raise many issues about the social treatment of those with the disease, as well as the overall plight of the poor in Dallas and likely elsewhere during this time period.

**The genetic history of linguistically diverse Tanzanian populations: A multilocus analysis.**

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Eastern Africa represents one of the most culturally and linguistically diverse regions in the world and is the likely origin of the migration of modern humans out of Africa within the past 100,000Kyr. Over 100 languages are spoken in Tanzania, representing the four major language families present in Africa: Afro-Asiatic, Nilo-Saharan, Niger-Congo, and Khoisan. Migration events into and out of Tanzania have likely played an important role in shaping the history of eastern Africa and other African regions (e.g., the ancestors of Khoisan-speaking Hazda and Sandawe populations in Tanzania may have migrated into Southern Africa). However, the genetic history of these peoples remains largely unknown.

Here, we present a large sample of mtDNA, Y-chromosome, and autosomal genetic data obtained from a linguistically and culturally diverse panel of >600 Tanzanians. These include Nilotic-speaking Maasai and Datog, Cushitic-speaking Mbugu, Gorowaa, Burunge, and Iraqw, Bantu-speaking Pare, Gogo, Turu, Rangi, Mbugwe, and Sukuma, and Khoisan-speaking Sandawe and Hadza. These genetic data were compared to a worldwide sample available in public genetic databases. Several phylogenetic and population genetic methods were applied to these data to: 1) characterize genetic variation between these linguistically-diverse groups; 2) to reconstruct past relationships of these East African populations to one another and to other African populations; and 3) to reconstruct modern human origins. These analyses suggest that the peoples of eastern Africa have played a pivotal role in the origin of modern humans and in shaping the modern history of Africans. Funded by NSF grant No. 9905396 to ST.

#### **Are virtual bones as good as the real thing? A test of measurement error.**

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Three-dimensional (3D) digital data acquired with laser digitizers present an exciting new medium for osteological analysis. 3D digital analyses can include highly specific observations that are difficult to obtain from actual bones, such as surface area and curvature, in addition to traditional linear measurements. A fundamental assumption of 3D analysis is that measurements taken from a virtual bone are equivalent to those taken from its real counterpart. In this study, we test this assumption and evaluate observer error for virtual bone measurements.

Each author separately measured the bicondylar length and the anterior-posterior midshaft diameter of 20 human femora. The femora were then scanned by each author separately at Arizona State University's Partnership for Research in Stereo Modeling (PRISM) laboratory with a Cyberware Model 3030 laser scanner that captures high resolution surface data. These data were then modeled as a triangle mesh, creating a digital 3D replica of the original. Each author observed the same two measurements on the virtual femora. Finally, to evaluate interobserver error, one author (DT) re-measured the virtual femora using the other author's (WS) virtual bone models.

Preliminary results suggest that measurements taken from the virtual bone are comparable to those taken by hand from the actual bone, and interobserver error of virtual bone measurements is minimal. Though the scanning process proved to be somewhat subjective, measurements taken from different models of the same bone were comparable. These results suggest that 3D data acquisition and analysis can be used with confidence in future research designs.

#### **Functional capabilities of modern and fossil hominid hands: a 3D comparative analysis of the trapezium.**

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Three-dimensional trapezium models from *Homo sapiens*, *Gorilla gorilla*, *Pan troglodytes*, *Australopithecus afarensis* (A.L.333-80), and *Homo habilis* (O.H.7) are acquired through laser digitizing. Least-square planes are generated for each articular surface and the angles between the planes are compared. Each extant species displays an overall pattern that distinguishes it from the others. The observed angles in *G. gorilla* and *P. troglodytes* are more similar to one other than either are to *H. sapiens*. Our results, obtained from using new 3D modeling and analytical tools, raise interesting questions about the functional capabilities of the fossil hands of *A. afarensis* and *H. habilis*. Multivariate statistical analyses indicate that A.L.333-80 is morphologically more similar to that of modern humans whereas the O.H.7 trapezium is more similar to that of the gorilla. Significant differences between A.L.333-80 and the extant species occur, but some similarities to humans suggest the ability to

form two distinctively human grips. The presence of some key morphological differences from humans highlighted and quantified by our research indicates marked differences in the functional capabilities of the O.H.7 trapezium, particularly in those that facilitate modern human tool manufacture and tool use. If the O.H.7 trapezium represents part of the hand responsible for manufacturing and using the stone tools found at Olduvai, our results suggest that the hand manipulated the stones in a way for which we have no modern analog.

#### **Intra-site variation at the middle valley site of Estuquiña in southern Peru: Isotopic evidence.**

P.D. Tomczak. Vanderbilt University.

Isotopic analysis is used to assess diet and intra-site variation within the site of Estuquiña, located within the Osmore valley of Southern Peru. Estuquiña cultural presence has been archaeologically identified throughout the valley during the Late Intermediate Period (A.D. 1000-1476). The culture type site, Estuquiña, is located in the upper middle valley (~1500 m ASL) and contains three defined cemeteries and a distinct domestic area. A minimum of 411 individuals was excavated from the various areas. In general, Estuquiña sites are located in geographically inaccessible locations and are often fortified, suggesting the importance of defense.

Mortuary analysis at Estuquiña indicates that numerous grave goods were evenly distributed throughout the site. However, grave goods were relatively simple in design and often consisted of utilitarian items. Using patterns of differentiation in mortuary attributes, it has been argued that Estuquiña social structure was relatively homogeneous, thus indicating little status distinction.

In this study, a total of 30 adults were examined for carbon and nitrogen collagen ratios and carbon carbonate ratios. Seven to eight adults were randomly chosen from each cemetery and the domestic area. There were no significant differences between males and females with respect to isotopic values ( $P > 0.05$ ). Overall, carbon and nitrogen isotope analysis indicates a predominantly terrestrial diet among inhabitants at Estuquiña. While nitrogen values remain consistent among samples, carbon values vary greatly, suggesting heterogeneity in diet. This paper further explores possible reasons for the inconsistency between dietary and mortuary data with respect to within site variation.

**Variation in the diet of *Cercopithecus ascanius* monkeys in Kibale National Park, Uganda: Influence of habitat, sex, and age.**

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In primates, fruit abundance, distribution, and availability in habitats directly affect feeding behavior and diet. My analysis considers the influence of logging, age, and sex on dietary behavior of *Cercopithecus ascanius schmidti*. I test the hypotheses that habitat differences due to logging influence the diet of *Cercopithecus ascanius*; and, there will be differences in diet among age and sex classes of *C. ascanius*. Fieldwork was carried out in Kanyawara, Kibale National Park, Uganda between June and August 2001. Kibale National Park is comprised of forestry compartments ranging from unlogged, lightly logged, moderately logged, heavily logged, to heavily logged and poisoned (Skorupa, 1988; Struhsaker, 1997). This study occurs in K14, a 405 ha compartment selectively logged between May and December 1969, and K30, a 282 ha compartment comprised of undisturbed mature forest (Skorupa, 1988; Struhsaker, 1997). I observed habituated *C. ascanius* groups: Group I ranges in K30 (unlogged) and Group II ranges in K14 (lightly logged). I used 30-minute continuous focal animal sampling methods (Altmann, 1974). Behavioral data were gathered for traveling, resting, grooming, and aggression. Dietary data were collected for frugivory, insectivory, and folivory. I observed 114 h of behavior, totaling 1816 behavioral bouts. All behaviors except insectivory were widely variable between unlogged and logged forests. Diet varied considerably among habitat, sex, and age over a small spatial and temporal scale within one species. These findings emphasize flexibility within *Cercopithecus ascanius* dietary behavior and highlight difficulties in making species-level generalizations and comparisons in studies of primate foraging and feeding.

**Dental variability in Peruvian tamarins (*Saguinus mystax*).**

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Detailed analysis of dental variation in a single, wild population of platyrrhine (or any) primates is extremely rare (see Sauther et al., 2001). This study seeks to investigate dental variability within a single, wild population of moustached

tamarins (*Saguinus mystax*), thus providing information regarding dental variability in primates with characteristically "simple" teeth.

Using molds taken from 76 *Saguinus mystax* individuals that were wild-tranquilized as part of a 1990 field study in Padre Isla, Peru, casts of the upper and lower right dentitions were made. These dental specimens were scored for 135 metric and non-metric traits, and subjected to statistical analyses of variance.

Analyses demonstrate that there is no significant dimorphism between the sexes in most dental traits, although the greatest differences between the sexes lie in dimensions of the cheek teeth and resulting length of the cheek tooth row. Pooled coefficient of variation for each metric character demonstrates that the greatest amount of metric variation is found in aspects of the anterior dentition, with the distal premolars and first molars being least variable. While generally described as simple, tritubercular teeth, significant variation exists in degree of hypocone and pericone development, development and orientation of crests, cingular development, and the presence of styles and styliar cuspules.

**A bioarchaeological analysis of crania from Pachacamac, Peru.**

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The coastal Peruvian site of Pachacamac functioned as the paramount Andean pilgrimage and religious center for nearly a millennium. In 1910 Aleš Hrdlicka collected over 2,200 crania from Pachacamac, which are now curated at the *National Museum of Natural History*. A randomly selected sample of 1,069 crania from this sacred location (572 females, 446 males, 51 indeterminate) was analyzed for cranial vault modification, trauma, and nonspecific stress indicators.

Archaeologists have customarily portrayed Pachacamac as the home of a religious elite and a destination for pilgrims from throughout the Andes. Based on this it was hypothesized that Pachacamac crania should display low amounts of stress and a variety of modification styles commensurate with the variation in this sign of cultural affiliation in the surrounding Andean area. In contrast to this prediction, examination of the Pachacamac collection revealed a remarkably homogenous population. Nearly half the sample (n=500) displayed cranial vault modification. All of these were of the tabular form. Healed traumatic injuries

were present in 11% (n=124) of the crania while 22% exhibited cribra orbitalia and/or porotic hyperostosis (n=229 and n=239). The homogeneity in vault modification practices suggests that the site served as a burial ground for one cultural group that did not include pilgrims from distant areas. An alternative explanation may be that the burial population at Pachacamac is not representative of a religious elite or of the different people who came to the site for religious purposes, but instead depicts a group who helped to maintain the functioning of the city.

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**Sex chromosome phylogenetics indicate a single transition to terrestriality in the tribe Cercopithecini.**

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This is one of the first molecular studies to support strongly the notion that the transition from an arboreal to a terrestrial habitus is a rare occurrence in the evolutionary history of primates. We surveyed 19 guenons (tribe Cercopithecini) and four outgroup taxa for two Y-chromosomal genes, TSPY (~ 2,250 bp) and SRY (~ 800 bp), and one X-chromosomal intergenic region (~ 1,600 bp). Parsimony and maximum likelihood analyses of the sex chromosomal datasets consistently cluster the three terrestrial taxa, *Cercopithecus aethiops*, *Cercopithecus lhoesti*, and *Erythrocebus patas*, into a group that is reciprocally monophyletic with a clade of arboreal *Cercopithecus* spp. Given that the common ancestor of the two clades was most likely an arboreal taxon, this phylogenetic pattern suggests the transition to terrestriality occurred only once among the extant guenons. This pattern also indicates that the genus *Cercopithecus* is paraphyletic, as presently defined, and calls for taxonomic revision so that the nomen describes a strictly monophyletic group. We discuss four acceptable taxonomic schemes and suggest that the most appropriate is to reassign *C. aethiops*, *C. lhoesti*, and *E. patas* to the resurrected genus *Chlorocebus*. Finally, while the phylogeny and

taxonomy of the terrestrial guenons were the focal points of this study, the X-chromosome sequences presented here represent the first molecular dataset to place unambiguously *Allenopithecus nigroviridis* as the basal lineage of the tribe Cercopitheciini. (Supported by NSF Grant SBR-97-07883 to DJM, and NIH Grant R01-GM60760 to TRD).

**Phenotypic and genetic associations between age at menarche and parameters of the pubertal growth spurt.**

B. Towne, S.A. Czerwinski, E.W. Demerath, A.F. Roche, R.M. Siervogel. Wright State University School of Medicine.

Age at menarche is correlated with other measures of growth and development, but little is known of the nature of their shared genetic underpinnings. For this study of the genetic architecture of age at menarche and parameters of the pubertal growth spurt we analyzed data from 241 females in 94 families participating in the Fels Longitudinal Study. Age at menarche data were collected prospectively, and parameters of the pubertal growth spurt were obtained by fitting individual growth curves to serial stature data (AUXAL; Bock et al., 1994). These data were analyzed using a maximum likelihood method for pedigree data (SOLAR; Almasy and Blangero 1998). The heritabilities of the study traits were: age at menarche (A@M) = 0.42, age at minimum height velocity before puberty (AMHV) = 0.58, height at AMHV (HT@AMHV) = 0.80, growth velocity at AMHV (GV@AMHV) = 0.74, age at peak height velocity during puberty (APHV) = 0.62, height at APHV (HT@APHV) = 0.86, and growth velocity at APHV (GV@APHV) = 0.75. The phenotypic (Pearson) correlations between A@M and, respectively, AMHV, HT@AMHV, GV@AMHV, APHV, HT@APHV, and GV@APHV were: 0.76, 0.36, -0.51, 0.82, 0.32, and -0.52; while the additive genetic correlations were: 0.70, 0.31, -0.55, 0.83, 0.23, and -0.63. These results show that each of the study traits is highly heritable, and that a significant proportion of the observed covariation between the timing of the onset of the menses and most parameters of the pubertal growth spurt can be attributed to the pleiotropic effects of genes on these traits.

**Musculoskeletal Stress Markers (MSM) and weaving activities at a prehistoric coastal site in Peru.**

J.M. Toyne. Tulane University.

Weaving has been an important occupation in the lives of Andean peoples for thousands of years. Identifying the physical markings of weaving and spinning on the skeletal remains of prehistoric individuals serves to aid in reconstructions of daily activities. The Inka period sample from Túcume, Peru provided an opportunity to test this using the observation of Musculoskeletal Stress Markers (MSM). Due to the location of the burial context in a ceremonial structure and the associated weaving implements, it was proposed that these female individuals represented members of a specialized group of weavers called *Aqlla*.

The goal of the project was to examine MSM patterns at an individual level. The expectation was that the females would demonstrate similar patterns of MSM ranking if they were participating in the same lifestyle. Since weaving is a repetitive manual activity, it was expected that it would demonstrate a clear MSM pattern.

MSM were observed and scored for 41 bilateral expressions of the upper extremity for 22 individuals in the sample. The rank ordering of the MSM scores for each individual were then compared. The results indicate that the MSM patterns for the female individuals were not similar, suggesting that they may not all have been participating in the same lifestyle. Additionally, the MSM on the hands and forearms do not exhibit any significantly patterned expression. This may indicate that they were not weaving on a fulltime basis or, alternatively, that while weaving may be a habitual activity, it does not significantly alter the skeleton.

**The timing of linear enamel hypoplasia in the bonobo, *Pan paniscus*.**

S.A. Tsukamoto and M.F. Skinner. Dept. of Archaeology, Simon Fraser University.

Enamel hypoplasia (EH) is a sensitive but non-specific marker of physiological or metabolic stress. There are numerous studies involving the prevalence of EH in human and non-human primates, however, the timing of these defects has only recently been examined. Although previous studies do show prevalence approaching 100% little is known about the timing of EH for bonobos.

The timing and periodicity of repetitive linear enamel hypoplasia (rLEH) in the bonobo are determined through relative caliper measures of LEH location standardized against crown heights (n=490 teeth, 68 individuals) and perikymata counts (n=23 teeth, 17 individuals). Where possible, timings are ascertained

from imbricational enamel formation estimates for the bonobo generated from SEM montages showing perikymata ranging from the occlusal to the cervical margins. These estimates are 3 and 5 years for the incisors (n=3) and canines (n=1), respectively. The bonobo specimens are from the Musee Royal de l'Afrique Centrale collection (Tervuren, Belgium).

From caliper measures for the incisors and canines respectively, the onset of LEH ranges from 1.5-3 years, the stress is recorded for another 13 years, and the interval between rLEH is around 6-8 months although imbricational chronologies yield an interval closer to 6 months. The 6-month periodicity is also observed with perikymata counts on incisors and canines. The duration of the hypoplastic event, including period of enamel recovery, ranges from 6-8 weeks based on the number of perikymata counted within an hypoplastic groove. This 6month periodicity of rLEH in the bonobo is believed to be influenced by moisture cycles.

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**Surnames analyses of two ancient Italian populations in the XIX century: Alia (Sicily) and Civitella del Tronto (Abruzzo).**

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Surnames are markers of human population structure. In patrilineal communities, they can be considered as an allelomorph of a gene situated on chromosome Y, transmitted along the male line and are a function of the reproductive and migratory behaviour of the population. The main purpose of the research is to observe changes of surnames in two ancient populations, similar for size and history, but different for isolation degree and behaviour during stressful events: Alia (Sicily) and Civitella del Tronto (Abruzzo). We used, for each group, surnames taken from birth, marriage and death registers.

We found that marriage registers contain more surnames (S) than total events (N): S/N is 0.53-0.7 in Civitella and 0.37-0.52 in Alia. Births series are the most numerous (Civitella: 0.22-0.28, Alia: 0.124-0.153). Death registers show intermediate values of S/N. In Alia the temporal trend of the number of husband surnames decreases with time, while in

Civitella it remains unchanged. Furthermore, in Alia, when birth rate increases the surname frequency remains unchanged. Surname turnover is analysed through “new surnames” (less in Alia), “stable surnames” (80% in Alia, variable in Civitella) and “disappeared surnames” (15-25% in Civitella, 10-20% in Alia) in each series. Through Multidimensional Scaling, we reconstructed the temporal distribution of the surnames. Civitella shows variations in each period. In contrast, the similarity between periods is evident in Alia: this is characteristic of an isolated population with low level of immigration and high level of consanguinity. In conclusion: Alia, for position and population behaviour, has the characteristics of isolation, while Civitella has a faster biological variation.

#### **Bioarchaeological analysis of Wari trophy heads from Conchopata, Peru.**

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Trophy heads from the prehistoric Andes have been documented osteologically and iconographically, but rarely are both encountered in direct association. Recent excavations at the Wari site of Conchopata (AD 600 – 1000) in the central Peruvian Andes have uncovered *in situ* trophy heads associated with oversized ceramic urns depicting trophy heads in various forms. These are the first scientifically excavated Wari trophy heads to undergo bioarchaeological analysis.

The skeletal remains include at least 31 trophy heads (24 adults and 7 children) and 84 hand phalanges, all of which were intentionally burned and smashed on the floor of two ritual structures. All sexed adults are male, and the non-child trophy heads range in age from 16-50 years, while child trophy heads are all 3-6 years of age. The inclusion of seven child trophy heads is relatively rare, as is the adult age distribution showing that half of the 24 adults are over 35 years. Other observations include: 1) perimortem cut marks; 2) intentionally drilled holes on the crania and mandibulae; and 3) patina on the edges of occipital bones. The significance of these observations with regard to the unique phases of cranial modification is presented, and the combined osteological and archaeological data are then discussed to examine the social life of trophy heads within Wari society. Finally, comparisons are made between the Wari modified skulls and those from Nasca and Moche revealing some common characteristics, but ultimately showing

distinct differences in preparation, reuse, and overall style.

#### **Nutritional assessment based on $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ analyses of weanling, subadult and adult remains from Sudanese Nubia.**

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The utility of stable isotope analysis in the reconstruction of subsistence and migration activities of skeletal populations is well documented in anthropological literature. This method of analysis is especially useful in analyzing cross-sectional dietary patterns in populations with wide demographic representation. This study seeks to reconstruct the dietary patterns from an early Christian population from the island of Kulubnarti, located on the western bank of the Nile in Sudanese Nubia, using a large sample of ribs (N= 215). The sample was excavated from the cemetery of a medieval hamlet, dated roughly to AD 550-750. Archaeological evidence points to subsistence-level agriculture supported by intensive irrigation, and sedentary, nucleated settlement patterns.

The high percentage of individuals aged 0-5 in this sample suggests disproportionate stress on the very young, and significant vulnerability to morbidity and mortality among infants and children. The purpose of this study is to examine the contributory role that nutritional stress may have played in these high rates of infant mortality. The excellent preservation in this sample allowed for the analysis of multiple age groups, including adult (N=55), subadult (N=56), weanling (N=99) and fetal (N=5) remains. As a result, it was possible to trace patterns of diet across several age categories. Bone collagen was analyzed isotopically for carbon and nitrogen, which reflect stages of the weaning process and patterns of diet. The ultimate goal is to integrate these results with other lines of evidence, including Linear Enamel Hypoplasia data, in order to reconstruct more accurately patterns of diet and pathology at the Kulubnarti site.

#### **Baboon endogenous virus (BaEV) variation in natural anubis, hamadryas, and hybrid baboon populations.**

M. Uddin. New York University and NY-CEP.

Endogenous retroviruses (ERs) are vertically transmitted viral genetic elements that are ubiquitous among vertebrates. Hundreds to thousands of copies are known to persist in all anthropoid genomes examined to date; however, attempts to quantify particular ERs within and/or between lineages have tested few individuals. This study reports the first attempt to quantify a specific ER, baboon endogenous virus (BaEV), within and between natural baboon (*Papio hamadryas ssp.*) populations using quantitative real-time PCR methods. Results show that considerable BaEV copy number heterogeneity exists among individuals, both within and between populations. Analyses of inheritance patterns indicate that BaEV conforms to a pattern of maternal inheritance previously observed for ERs in other organisms. Insertion site data confirm a proviral integration shared among the four baboon forms tested, indicating a long term, vertically transmitted presence in the *Papio* genome. Most importantly, the increasing numbers of average BaEV copies maintained by non-hamadryas, hamadryas and gelada baboons, respectively, appear to be a function of the progressively greater degrees of inbreeding observed in each of these primate taxa. This finding represents the first example in primates (and, more generally, in mammals and vertebrates) relating ER dynamics to social structure.

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#### **A comparison of morphological traits in deciduous and permanent dentitions.**

J.M. Ullinger. Arizona State University.

Morphological traits in the deciduous dentition have been understudied compared to their permanent counterparts. Reasons the primary teeth are not as intensely studied include: 1) there is no scoring standard, 2) they are often found in lower frequencies than permanent teeth, and are more subject to wear, and 3) the relationship of development of traits between the deciduous and permanent dentitions is still unknown. This study examines the third problem by comparing frequencies of traits found in both types of teeth within and between two groups. The first sample is from a collection of Pima casts collected by the Dahlbergs approximately 50 years ago. The second is an archaeological Nubian sample dating primarily to the Meroitic period (ca. 400BC-350AD). Twelve com-

parable crown traits were examined on fifty individuals with deciduous teeth and fifty individuals with permanent teeth from each group. The primary teeth were scored using a combination of visual and written descriptions based on A.A. Dahlberg and K. Hanihara, in conjunction with the Arizona State University Dental Anthropology System (ASU DAS). The permanent teeth were scored according to the ASU DAS. The results of the study indicate that most traits have comparable frequencies but certain traits, including cusp 7, have significant differences. These differences may be a result of the scoring method used, or perhaps a difference in development. With a refinement in scoring procedures and a standard method, the deciduous dentition of subadults can be used in dental morphology research to increase our knowledge of the people we are studying.

#### **A 3D approach to the functional morphology of worn primate teeth.**

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Most studies of primate dental functional morphology focus on lengths of shearing crests on unworn molars or 2D planimetric area of individual cusps. These approaches are limited because molars wear, and because occlusal surfaces are three-dimensional. This presentation describes a new, 3D approach to studying occlusal morphology of worn teeth. This approach was developed to address two questions. First, are there functional aspects of morphology that do not change with wear? Second, can worn teeth be included in functional analyses?

3D points are collected at 0.025mm intervals along a molar occlusal surface using a laser scanner. GIS software is used to model teeth, and then slope and angularity are measured for individual cusps. These variables are analyzed using ANOVAs, with taxon, cusp, and wear stage as factors. Cusp wear is scored using Scott's (1979) method. Significant differences among taxa suggest functional differences in morphology. Differences among wear stages indicate changing occlusal morphology with wear. Interactions among factors would indicate differences among species in how morphology changes with wear.

Preliminary results from 104 wild-shot chimpanzee and gorilla lower M2s demonstrate that some aspects of morphology (e.g., slope) change with wear whereas others (e.g., surface angularity) appear

not to. Further, differences between species suggest that worn teeth can be used to compare dental morphology among taxa. Finally, a lack of interactions among variables suggests that differences between these species are maintained throughout the wear sequence.

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#### **Amish cemeteries have a patrilineal genetic spatial pattern: Implications for ancient DNA analyses.**

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The authors have developed models of the spatial pattern of genetic markers that can distinguish between cemeteries used by patrilineal/patrilocal and matrilineal/matrilocal societies. The purpose of this research ultimately is to compare patterns of ancient DNA from archaeological cemeteries to provide kinship information about past cultures. Last year, we presented a poster showing that our models could distinguish between simulated patrilineal and matrilineal endogamous cemeteries. This past summer, we mapped and recorded Amish cemeteries from central Pennsylvania. For this poster, we analyze four cemeteries (size ranging from about 50 to almost 1000 graves) with almost complete genealogical data. We have used the genealogical records to assign unique Y chromosome and mitochondrial markers to all individuals descended from the same male or female founders. Analysis of the genetic spatial patterns in these cemeteries clearly matches the patrilineal models, as would be expected from Amish social structure.

This project has been supported by SUNY Potsdam (Research and Sponsored Program, LTEC, School of Arts and Sciences, and the Provost's Office) and UUP; with assistance from the Mifflin County Historical Society.

#### **Matrilineage and allelic sorting within an expanding population.**

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Genetic analyses, demographic data, and climatic indices were used to examine kin and group structure of wedge-capped capuchin monkeys, *Cebus olivaceus*, in the Venezuelan llanos. One large and one small group were followed for 23 and 7 years, respectively. Variables included rates of birth, death, male and female individual transfer, and group fission and fusion. Capuchins in both groups and across the region were genotyped at autosomal microsatellite loci, and sequenced at a 485-base pair segment of the mitochondrial control region.

The large group's birth rate and matrilineal infant death rate were influenced by annual fluctuation in rainfall levels, which in turn were signalled in part by ENSO cycles. Some low-ranking matrilinees went extinct and others fissioned from the group. Of eight initial matrilinees in 1977, only the three highest-ranking persisted in 1999. Unique alleles in the group were lost with each matriline. Thus, matrilineage loss and allelic erosion were nonrandom with respect to female rank.

Multiple group fissions followed El Niño events. In 1999, members of two matrilinees from the large group fused with the small group, introducing new microsatellite alleles. The new females also assumed higher ranks than natal females. Based on the empirical evidence above, matrilineage sorting in the small group likely will remove natal members and unique alleles, and replace them with those of the new females. Across the region, depauperate mitochondrial variability and deficient heterozygosity in autosomal genotypes revealed a recent population expansion.

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#### **High HIV prevalence and incidence among young African American men who have sex with men in 6 US cities: What factors are contributing?**

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Background: Having found high HIV prevalence and incidence among young men who have sex with men (MSM) in 6 US cities, particularly among African Americans (AA), we investigate factors contributing to the higher HIV rates among AAMSM compared with non-AAMSM.

Methods: The 1998-2000 Young Men's Survey (YMS) was a cross-sectional,

venue-based, multi-stage, sample survey of 23- to 29-year-old MSM sampled at public venues in Baltimore, Dallas, Los Angeles, Miami, New York City, and Seattle. At sampled venues, men were interviewed and HIV counseled and tested.

Results: Among 2557 MSM, HIV prevalence was 13%: among AA, 32%; Hispanics, 14%; and whites, 7%. HIV incidence was 4%: among AA, 15%; Hispanics, 4%; and whites, 3%. In their lifetime and past six month sex behaviors, AAMSM reported fewer male sex partners, a lower prevalence of unprotected anal sex with men, more female sex partners, and a higher prevalence of unprotected sex with women, compared with Hispanics and whites. AAMSM reported lower lifetime prevalence of injecting drug use, alcohol use, and many individual illicit drugs used. AAMSM were no more likely to report ever being forced to have sex, but more likely to report bisexual identity, or ever having an STD, or being incarcerated.

Conclusions: Our data generally do not explain the higher HIV rates among AAMSM. Our findings do suggest reaching AAMSM in jail or with STD control; the bisexual behavior findings suggest appropriate prevention for women as well as AAMSM.

#### **Variation in early and recent Australian populations: Implications for the settlement of Australia.**

A.P. Van Arsdale. Dept. of Anthropology, University of Michigan.

Several authors (Thorne and Wilson 1977) have suggested that Pleistocene/Holocene Australians show greater variation than more recent Australian populations, and have used this evidence to support the claim that the earliest settlers of Australia come from multiple source populations. To assess the variation between these two samples, I employ two different statistical techniques. The first examines the variance of each sample using a random sampling technique with replacement. The second test used to examine variation is a weighted scores test developed by Fligner and Killeen (1976) and rated by Donnelly and Kramer (1999) as the most reliable test for examining relative variation when sample sizes are small. Of the 41 cranial measurements examined, few show any significant departure from recent Australian populations in either analytical approach (4 and 3 respectively). This suggests that multiple source populations are not necessary to explain the variation in the Australian fossil record.

Donnelly, S.M., Kramer, A., *Am. J. Phys. Anthropol.* (108:507-529, 1999); Fligner, M.A., Killeen, T.J., *J. Am. Stat. Assn.* (71:210-213, 1976); Thorne A. G., Wilson S.R., *J. Hum. Evol.* (6:394-402, 1977).

#### **Orangutan cultures and the comparative study of culture.**

C.P. van Schaik. Dept. of Biological Anthropology and Anatomy, Duke University.

For comparative purposes, culture can be defined as socially transmitted behavioral innovations. Orangutan tool use has earlier been shown to exhibit critical features of culture: all-or-nothing distribution across sites, stability, and loss across a dispersal barrier. Using the Whiten et al. (1999, *Nature* 399: 682) heuristic criteria for recognizing culture from geographic distributions of behavioral variants, the orangutan research community has so far recognized 24 putative cultural elements. Hence, orangutans have similar cultural variation to that found in chimpanzees, implying that the capacity for great-ape cultures, including material culture, is at least 14 My old. In addition, we could use these data to test for the existence of properties of cultural systems, as in humans, and these tests were successful. However, because culture, as defined above, may be more common among animals, we need to distinguish between different kinds of culture, and develop a comparative study of culture that identifies the major evolutionary differences and their underlying mechanistic bases.

#### **Prediction of the development of jaws in patients with complete unilateral cleft of the lip and palate.**

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The study illustrates the cooperation between anthropologists and orthodontists in which physical anthropology methods were used in the postoperative control of the reconstruction of congenital malformations. The main objective was to find a predictive multivariate model of jaws development in patients with the most frequent cleft malformation, i.e. complete unilateral cleft lip and palate (UCLP). The predictive model is urgently needed from the clinical perspective be-

cause it will facilitate early detection of adversely developing patients to whom intensive care and adequate orthodontic treatment could be devoted in time.

The study is based on the long-term cephalometric follow-up of lateral X-ray films of 48 boys during puberty with UCLP. Using multivariate methods we investigated the relationship of 75 craniofacial characteristics of size, shape and position during the period from 10 to 15 years of age. Though the prediction of the development of the jaws in patients with clefts is very complicated we found a reliable predictive system. Sagittal intermaxillary relations can be predicted most accurately in the investigated group using the angular dimension Ss-N-Sm (A-N-B angle). We suggest the use of trinomial equations in clinical practise because the coefficient of determination varies round 0.80 and the position of the variables can be explained with sufficient accuracy (in orthodontics the determination coefficient 0.64 is considered as a value of predictive significance). The proposed predictive technique was successfully tested in a group of 20 patients with the same diagnosis and therapy.

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#### **Social and economic structures and health status of the early medieval population from Greater Moravia.**

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The Greater Moravian Empire (9<sup>th</sup> – 10<sup>th</sup> century AD) was the first early state formation of the Slavonic populations in Central Europe. Skeletal material from this period is very interesting because it dates from a stressful period of rapid cultural and social change. The focus of this research is the comparative assessment of the health status of three cemeteries of different socio-economic status in the area surrounding the Mikulčice castle. We have compared about 850 skeletons from (1) the castle cemetery and (2) non-castle cemeteries in Mikulčice and (3) a cemetery from the poor village of Josefov located eight kilometres from Mikulčice. The following characteristics were examined: linear enamel defects, dental caries, cribra orbitalia, Harris lines, trauma, degenerative joint disease and occupation stress markers, sexual dimorphism and demographic estimators. Cribra orbitalia

appears more frequently in the Josefov cemetery. Hypoplastic defects of enamel determined on the permanent dentition of children appear with high frequency (over 80 %). As the incidence of these defects is found mostly in individuals between the ages of 2 to 4 years, it is interpreted to be a consequence of weaning stress. Inhabitants at the extramural settlement exhibit poorer dental health than people buried inside the castle. Demographic estimators showed also clear the differences between the cemeteries in the Mikulcice settlement and inside the castle. The results show that there were significant differences between the health status of early Slavonic populations from South Moravia.

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### **The bipedal locomotion of *Hylobates lar*: Preliminary results.**

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It is widely known and well documented that gibbons are excellent brachiators. They move very rapidly through the canopy using ricochet arm-swinging. Their specialized limb proportions, with long, powerful arms (and long legs) and their small body size make them well adapted for this purpose. However, these adaptations also force them to walk bipedally on branches and on the ground. Wild gibbons have been observed to walk 10-12% of the time bipedally, and are as such the most bipedal nonhuman primates. The particular combination of having the morphology of a specialized brachiator while also being a nearly obligate biped, invoked our interest in hylobatid bipedalism, with the aim of getting to a better understanding of the form-function relationship of bipedalism in Hominoidea.

We collected dynamic plantar pressure distributions and 3D ground reaction forces of four white-handed gibbons (*Hylobates lar*) with simultaneous videotaping, to make a qualitative assessment of hylobatid bipedalism. We noted a rather plantar positioning of the foot with a widely abducted hallux. The footfall pattern is variable and usually without an initial heelstrike. Hylobatid bipedalism is a relatively fast and 'bouncing'-like progression mode with flexed hip and knees. Additionally, we investigate the functional relationship between the locomotor behavior and the lower limb morphology. This can lead to a more accurate interpretation of prehomimid fossils and give us a

better idea of the locomotor repertoire of our early ancestors.

This study is supported by a grant from the FWO Flanders and by the Centre for Research and Conservation (RZSA, Belgium).

### **Characterization of variation at a Major Histocompatibility Complex locus in two wild gorilla populations.**

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Characterization of the genetic variation present in wild animal populations has been mainly limited to loci presumably unaffected by selection, such as mitochondrial DNA and nuclear microsatellites. While informative, such neutral loci do not exhibit variation associated with a phenotypic effect. The genes of the major histocompatibility complex (MHC) loci play a role in immune response and appear to experience strong diversifying selection. Standard methods for characterization of individual variation at MHC loci are not applicable to the degraded, low concentration DNA obtained from noninvasive samples. We have used direct amplification of exon 2 of the MHC Class II DRB loci with subsequent cloning and sequencing to type gorillas from two wild populations, including mountain gorillas (*Gorilla beringei*) of the Bwindi Impenetrable National Park, Uganda and western gorillas (*Gorilla gorilla*) of the Mondika Research Center, Central African Republic/Republic of Congo. As expected, sequences from multiple DRB loci are detected in individuals. Microsatellite genotype data identifies relatives, and along with phylogenetic analysis of the sequences allows characterization of haplotypes. Preliminary results indicate that both gorilla populations, despite very different ecological conditions and demographic histories, are highly diverse. As in chimpanzees and in contrast to humans, high variability is seen at DRB3 and DRB5 as compared to DRB1. More generally, we have demonstrated that it is feasible to characterize variation at MHC loci in individuals from wild animal populations, information that could be used to test hypotheses concerning, for example, the role of MHC variability in mate choice and reproductive success.

### **Genetics of sexual development.**

E. Vilain. Dept. of Human Genetics, University of California at Los Angeles School of Medicine.

Sex determination orients development toward sexually dimorphic individuals, male or female. In mammals, male sex determination is triggered by a primary signal, encoded by the testis-determining factor SRY, localized on the Y chromosome. Subsequently, a complex network of genes, most of them still unknown, leads to male sexual differentiation, including development of genitalia and sexual behavior. Disorders of the sex determination pathway result in malformations of the genitalia, varying from sexual ambiguity to complete sex reversal (XY female, XX male). Until recently, only transcription factors such as SRY, SOX9, DAX1, WT1, and SF1 were known to be involved in this process, as they were responsible, when mutated, for abnormal gonadal development and sexual ambiguity. We and others showed that Wnt-4 was a new sex-determining signaling molecule responsible for masculinization of XX mouse pups when deleted, and for XY sex reversal when duplicated in humans. A transgenic mouse overexpressing Wnt-4 has been designed and its phenotype is a model for alteration of sexual development. We have shown that Wnt-4 upregulates Dax1 consistent with clinical data showing that a duplication of Wnt-4 results in XY sex reversal as does a duplication of DAX-1. Altogether, these observations suggest that mammalian sex determination is sensitive to dosage at multiple steps in its pathway. Further dissection of the molecular pathway of mammalian sex determination will be crucial in understanding the development of the gonads, and the pathophysiology of human disorders of sex determination.

### **An optimized panel of microsatellites for fecal DNA studies of wild baboons: Preliminary analyses of genetic variation among Gombe baboons.**

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The use of feces as source material for genetic analyses of wild primate populations continues to increase. However, past research has been hampered by the necessity of using markers with variable amplification success, unknown linkage

relationship, or too few easily distinguishable alleles. Additionally, low quantities and poor quality of DNA from feces contribute to higher genotyping error. We address these problems first by developing an extraction protocol to increase total DNA yield and quality. We describe a modified Qiagen tissue protocol that yields total DNA with mean yield 165.4 ng/ul (range 21-620 ng/ul). Initial results show 83.5% success in amplifying fecal samples from wild Gombe Stream baboons. To develop a panel of microsatellites ideal for analysis using fecal DNA, we chose from among 334 human microsatellites used in the baboon linkage map, using four criteria: 1) consistent, simultaneous amplification of both alleles in heterozygotes; 2) minimum of 4 alleles; 3) tetranucleotide repeats; 4) mapped to separate baboon chromosomes, or at least 50 cM apart on the same chromosome. We genotyped 13 such markers in an initial sample of 30 olive baboons (*Papio hamadryas anubis*) from Gombe Stream National Park, Tanzania. Markers are characterized by mean expected heterozygosity of 0.727 (range 0.620-0.834), mean number of alleles 5.8 (range 4-10), and frequency of allelic dropout across all markers of 0.017 (per marker range 0.000-0.077). We compared allele frequencies between Gombe and 51 SFBR olive baboons originally from southern Kenya. We found significant differences at five of 12 loci (Kolmogorov-Smirnov Z-test,  $p < 0.001-0.027$ ).

**Functional interpretations of jaw shapes: Beware of morphometricians bearing geometric means.**

C.J. Vinyard. Duke University Medical Center.

Shape ratios (created by dividing a variable of interest by a size estimate) are extremely valuable in functional analyses of primate skeletons. It has become commonplace in biological anthropology to estimate size as a geometric mean (GM) of all measurements in shape analyses. One issue with this approach is that we have not rigorously examined how shape ratios change when different measurements are used to calculate a GM. I examined this question in the context of comparing functional aspects of jaw shapes in tree-gouging primates (*Phaner furcifer*, *Eutotius elegantulus* and *Callithrix jacchus*) to closely-related, non-gouging species. I created five shape ratios for each jaw dimension using five GMs constructed with different measurements. I then made pairwise comparisons of shape ratios between gouging and non-gouging

taxa. The criterion for similarity between shape ratios made with different GMs was whether these pairwise tests gave similar results.

*C. jacchus* consistently showed similar differences in jaw shapes relative to non-gouging tamarins across different GMs. However, changing the GM altered the functional interpretation of jaw shape in other gougers. *E. elegantulus* had either significantly longer or significantly shorter jaws than non-gouging galagos depending on the GM used to create a shape ratio. The variation introduced by changing the GM suggests we should carefully consider the denominator of shape ratios before making functional interpretations of shapes. Shape ratios holding constant other aspects of a functional complex offer an alternative for examining the functional consequences of changes in form.

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**Comparisons of variance-covariance (VCV) structure of the humero-ulnar joint in humans, apes and monkeys.**

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Morphological differences in the humero-ulnar (HU) joint among major primate groups are thought to correlate with differences in locomotor and/or positional behaviors. For example, differences in the hominoid and monkey HU joint suggest hominoids have increased stability and weight-bearing ability over multiple directions. It is unclear whether or how variance-covariance (VCV) structure has diverged with these changes in trait means. Divergence in trait means need not coincide with changes in VCV structure (Steppan 1997).

We examined HU joint VCV structure among *Homo* (n=101), *Pan troglodytes* (n=124), *Gorilla* (n=139), *Pongo* (n=49), *Hylobates lar* (n=103), *Macaca fascicularis* (n=58) and *Cebus apella* (n=85). We measured eight HU joint dimensions thought to reflect weight bearing, stability and movement. For each species, we mean-centered measurements to remove sexual dimorphism. PCA indicates differences in HU joint form among these species. We compared HU joint VCV structure among species using randomization tests and Common Principal Components (CPC) analysis (Phillips & Arnold 1999; but see Houle et al. 2002).

Large-bodied hominoids, *Homo*, *Pan*, *Gorilla* and *Pongo*, tend to have relatively similar VCV structures. *Macaca* and *Cebus* have equal VCV structures. These hominoids and monkeys generally share little of their VCV structure in common. *Hylobates* VCV structure is most similar to *Pongo* and *Macaca*. These results suggest that evolutionary changes in the humero-ulnar joints of large-bodied hominoids and/or monkeys altered VCV structure between these two groups. Alternatively within hominoids, neither locomotor behavior, positional behavior nor phylogenetic factors appear to have caused major VCV restructuring.

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**Patterns of variation of the internal architecture of the primate proximal femur.**

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The analysis of bone internal architecture for the comparative assessment of the locomotion-related strains and stresses represents a research approach of great potential value in (palaeo)biology, at the intersection of biomechanics and physical anthropology. While most investigation on primates (including our own one on extant and fossil taxa) concentrated till now on the relationship between trabecular structures and locomotor modes, the potential influence of additional factors – such as body mass, age, sex, bone shape – has not yet been adequately taken into account.

By using an original radiographic record representing over 120 specimens from 27 extant primate taxa (including *Homo*), we investigated macroscopic trabecular patterning at the proximal femur by means of advanced digital image processing techniques, and also detailed and compared textural anisotropy through the calculation of the Line Fraction Deviation index.

In the hominoid subsample (n=30), a previously unreported significant correlation (Spearman's Rho up to 0.73) has been found between femoral head size (used as a proxy for body mass) and degree of textural anisotropy. Conversely, while a well-known influence of age on the trabecular structure has been confirmed, no sex-related differences have been detected in our human reference sample (n = 30).

When taking differences in body mass into account by using the residuals of multivariate regressions, we could not detect any differences between positional behaviours, supporting similar claims by Fajardo and Müller (2002).

**To breed or not to breed: Flexible responsiveness of the human female reproductive system to environmental signals.**

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The human female reproductive system (HFRS) is often conceptualized as little more than an energy conversion machine: more calories, more babies-less calories, less babies. Like any mammal, it is certain that energy availability is a critical environmental constraint under which the HFRS must operate. However, current evidence and arguments from life history theory, developmental biology, and studies of human adaptation do not support a simple relationship between energy availability and reproductive functioning. For example, in U.S. women ovarian functioning is easily perturbed by relatively light energy stress, yet women in less developed countries have high fertility levels in the face of heavy workloads and chronic nutritional stress. The Flexible Response Model (Vitzthum 1990, 1992 1997, 2000) resolves this apparent paradox and makes several testable predictions regarding the functioning of the HFRS under conditions of chronic and acute low energy availability.

Project REPA (Reproduction and Ecology in Provincia Aroma), a longitudinal study among Bolivian Aymara women (n=373), was undertaken to test hypotheses regarding the HFRS. Data for women followed from before conceiving through fetal loss or birth include reproductive steroids, anthropometrics, dietary intake, energy expenditure, and breastfeeding patterns. Tests of alternative models predicting the reactions of the HFRS to environmental signals support the hypotheses of the Flexible Response Model.

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**The effect of ecology on aggressive interactions in White-faced capuchin**

**monkeys, *Cebus capucinus*, in a Costa Rican dry forest.**

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Aggressive interactions in the context of feeding are more common when resources are sparse and/or more patchily distributed (Janson 1985; Barton & Whiten 1993; Sterck & Steenbeek 1997; van Schaik & van Noordwijk 1988). Several studies have analyzed the effects of resource distribution and abundance on the frequency of dyadic interactions, but no studies to date have related the severity of aggression to food resource characteristics. I studied two levels of dyadic aggressive behavior (active and passive) as well as polyadic aggressive behavior during feeding in white-faced capuchins, *Cebus capucinus*. This study addresses whether resource quality, quantity, and distribution have an effect on the type and quantity of competitive interactions observed.

I evaluated the importance of nine ecological and behavioral variables that may influence escalations in food related aggression during a 15 month period. Focal feeding trees (n=700) were observed from the beginning to end of a feeding bout and all dyadic and polyadic aggressive interactions were recorded. These types of aggression are likely to be associated with different risks of further escalation and subsequent costs of time and possible injury. Preliminary analysis indicates that frequency of food-related aggression can be predicted by both ecological and behavioral variables, whereas the type of aggression appears to be influenced mostly by the crown volume and the number of competitors in the feeding tree. These results agree with previous studies on capuchin monkeys and further support our understanding of the role of ecology in affecting primate social structure.

**The proximal extremity of the humerus: morphology and adaptation. Application to neandertal remains.**

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The post-cranial skeleton is not similar in neandertal and modern human, especially for the proximal extremity of the humerus. However, interpretation of these differences is still subject of discussion. This work compares proximal extremity of the humerus in hominoids (in-

cluding neandertal remains) and spider monkeys. Each variable is not studied separately, but instead globally by PCA (Principal Component Analysis).

The PCA revealed six morphological groups for the proximal extremity of the humerus: 1) African great apes, 2) gibbon, 3) orang-utan, 4) spider monkey, 5) modern human and 6) neandertal. The human plot includes a large part of the spider monkeys, gibbon and orang-utan plots but not the one of African great apes and not the one of neandertal.

These differences show that within hominoids the morphology of the proximal extremity of the humerus expresses differences in locomotor behaviour. The great variability observed inside modern human is associated to the loss of the locomotor function of the upper limbs. The peculiar morphology of the proximal extremity of the neandertal humerus can be explained by two hypotheses: 1) it reflects functional differences between this human group and modern human, 2) it represents a genetic drift in an isolated population without any functional aspect. It may be more accurate to consider that these differences reveal, at the same time, a genetic drift and a peculiar functional adaptation. Whatever the answer is, the proximal extremity of the humerus is characteristic enough for distinguishing modern human remains from those of neandertals.

**Recent research on the evolution of Late Neogene African mammals, with emphasis on Pliocene Bovidae.**

E. Vrba. Dept. of Geology and Geophysics, Yale University.

I will present results on the fossil Bovidae from the Ethiopian Middle Awash strata dated between about 6 Ma and 0.5 Ma. These results will be set in the context of a broader analysis of all the larger mammals known from Africa over the past 10 Ma. The latter analysis addresses the questions: What do the patterns in the fossil record indicate about paleoenvironments? Can the patterns be used to test models of evolutionary processes, such as the allopatric speciation model? Were there intervals that departed significantly from a null hypothesis of averagely constant speciation and/or extinction rate, and if so, what were the causes and how did they relate to the paleoenvironmental dynamics? In order to test that null hypothesis, one needs to grapple with the problem of biased recovery in the fossil record. For instance, gaps in the record can distort averagely constant turnover in the real world to mimic origi-

nation and extinction pulses. I have applied a new model which measures such biased fossil recovery and compensates for it.

### Trauma patterns in Western Hemisphere skeletal collections.

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Traumatic injury data collected from the skeletal remains of 7,703 individuals as part of the History of Health and Nutrition in the Western Hemisphere Project provide a unique opportunity to examine patterns of injury among Native Americans (n= 6,068), as well as, Americans of European (n=738) and African (n=879) ancestry. Consistent with modern clinical data on injury rates, males (16.1%) have traumatic injuries significantly ( $\chi^2=41.4$ ,  $p < 0.0001$ ) more frequently than females (10.0%). There are also significant population differences in the frequency of traumatic injuries. The frequency of trauma is higher for people of European ancestry (17.2%) than for people African (9.6%) or Native American (9.1%) ancestry. These groups also show different age-specific trauma rates. The rate of accumulation of injuries with increasing age is about the same for all three groups during the first three decades of life. For people of European and African ancestry, the number of injuries continues to increase at about the same rate with increasing age at death. For Native Americans, in contrast, the rate of increase in injuries declines markedly after 30 years of age. For all groups, elderly individuals (>50 years old at death), have a lower frequency of injuries than people 40-50 years old at the time of death. These data suggest that a complicated, group-dependent, relationship exists between the risk of injury and longevity. The distribution of injuries also shows interesting group differences. Americans of European ancestry showed a significantly higher frequency of leg fractures than Native Americans. Native Americans, in contrast showed higher cranial fracture rates than people of European or African ancestry.

### Variation in remodeling about the perimeter of the midshaft human femur.

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Haversian remodeling reflects in part response to mechanical forces bone is

subjected to during life. Variation within/among bones can thus reflect life history, once variation due to other causes is understood. Previous work has demonstrated bilateral symmetry in density of haversian structures (complete and fragmentary osteons) in cats (Walker, *AJPA* Supplement 26: 224-225 (1998)), chickens, and the human forelimb (Walker and Lovejoy, *AJPA* Supplement 28: 272 (1999)). Here, we examine densities of osteons in 24 fields in the midshaft femur in three zones: periosteal, endosteal, and midcortical (n = 33; 15 male, 18 female). Cortices are symmetrical mediolaterally in density of haversian structures. However, the haversian density of the anterior cortex is significantly less than the posterior. There are differences among the three zones. Endosteally there is a greater density of haversian structures than in the middle zone, which in turn is significantly more remodeled than the periosteal zone. Densities in none of the 24 fields are correlated with age in this elderly sample (mean age, 73 for both males and females; range 51-95 years), though complete osteons in the anterior quadrant correlate significantly with area moments of inertia and endosteal area. As previously suggested (Walker et al., *Am. J. Human Biol.* 6: 659-667 (1994)), beyond 50 years factors other than age, most likely activity patterns, are responsible for the variation in the histomorphology of human cortical bone. This has implications for both forensic and health applications. This research is supported in part by the NYCC Research and Academic Affairs Departments.

### The pitheciine postcranium: Functional morphology and phylogeny of *Pithecia pithecia*, *P. monachus*, and *Chiropotes satanas*.

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Previous studies of pitheciine locomotor adaptations have focused on functional differences between *Pithecia pithecia* and *Chiropotes satanas*, with the former exhibiting leaping and clinging adaptations, and the latter more quadrupedally adapted. We here synthesize positional behavioral data of *Pithecia pithecia*, *P. monachus*, and *Chiropotes satanas* together with over 160 metric traits taken on the appendicular postcranial skeleton in order to investigate pitheciine functional anatomy and phylogeny. We pre-

sent intrageneric anatomical differences in *Pithecia*, some of which even align members of the *Pithecia monachus*-group with *Chiropotes satanas* rather than with its congener, *P. pithecia*.

*Pithecia monachus* was recently reported to be primarily quadrupedal and use horizontal supports, a pattern characteristic of *Chiropotes*. In contrast, *P. pithecia* primarily uses leaping and vertical supports. Nearly 60% of the postcranial characters measured lack interspecific differences between the three pitheciines. Interestingly, over 20% are undifferentiated between *C. satanas* and *P. monachus*. *Pithecia pithecia* emerges as unique in numerous features, some of which may be leaping and vertical clinging adaptations as suggested in previous studies. It is evident that some features shared by *P. monachus* and *C. satanas* may be consistent with their propensity for quadrupedalism, although the significance of other similarities is less clear. The similarities of *P. monachus* and *Chiropotes* suggest that quadrupedalism likely represents the ancestral pitheciine locomotor mode, which was retained both in the *Chiropotes/Cacajao* lineage and in most species of *Pithecia*. In terms of its locomotor adaptations, *P. pithecia* appears to be the most anatomically and behaviorally derived pitheciine.

### Phenotypic associations of the alcohol and aldehyde dehydrogenase genes in ethnic groups

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Epidemiological studies have shown that the prevalence of alcohol use, alcoholism, and other alcohol-related disease varies widely across different ethnic groups. To date, the genes with the strongest associations with alcohol dependence are those that encode the major enzymes involved in alcohol metabolism, alcohol dehydrogenase (ADH) and aldehyde dehydrogenase (ALDH). Two ADH genes (*ADH2* and *ADH3*) and one ALDH gene (*ALDH2*) exhibit functional polymorphisms that vary across ethnic groups, accounting for some of the differences in rates of alcoholism. Findings of various alcohol-related phenotypes will be presented from different ethnic groups who have been genotyped at the ADH and ALDH loci. For example, our research of Asian Americans reveals disparate rates of alcohol involvement in different subgroups, with Korean Americans reporting significantly greater alcohol use and more alcohol-related problems than Chinese Americans. Results indicate that genetic

variation in *ALDH2*, as well as other factors that differ in Koreans and Chinese, but do not interact with *ALDH2*, are associated with heavy alcohol use. From our study of Jewish and non-Jewish Caucasians, we have found that the *ADH2\*2* allele is prevalent among Jews, and associated with various alcohol-related behaviors including lower frequency of alcohol use. Finally, our research of Native American Mission Indians indicates that the *ADH2\*3* allele is associated with lower rates of alcohol dependence and a lower maximum number of drinks ever consumed in a 24-hour period. These phenotypic associations are important because they can lead to a better understanding of the mechanism by which these genes influence alcoholism.

#### **Primate conservation and human to nonhuman primate disease transmission.**

J. Wallis. Dept. of Psychiatry & Behavioral Sciences, University of Oklahoma Health Sciences Center.

As our closest relatives, nonhuman primates (especially apes) can be susceptible to many of the same pathogens that affect our own species. While this fact has led to strict health precautions in captive settings, it is often overlooked under natural conditions; field studies involve our living in and around primate habitat, which places us in very close proximity to our subjects. As a result, the very humans dedicated to the study and protection of primates can be at risk of negatively influencing their health and safety. In recent years, the topic of disease transmission has become an important aspect of primate conservation. Whereas we have long acknowledged the threats of deforestation and poaching, the risk of disease transmission is a topic that may be more easily addressed – because it is more directly under our control. Consequently, some researchers now impose more strict sanitation standards *in situ* and conduct health seminars for staff and local residents as an important part of their field management plan. Moreover, investigation of the prevalence and spread of disease in the wild has increased, allowing the possibility of our confirming disease origin and, more importantly, developing prevention plans. This presentation will provide summary of the disease risks and review some of the progress made in addressing this topic. Although much has been accomplished, the presentation discusses efforts to prevent disease transmission in the wild, including development of sanitation and health standards,

education programs, and crisis response plans for primate field sites.

#### **Tri-nucleotide CAG repeat number in the androgen receptor gene as a mechanism for inter-specific variation of sexual dimorphism in primates.**

D. Walrath, P. Bingham. University of Vermont.

Evolutionary models of sexual dimorphism link increased male size to male-male competition, while female size is tied to the nutritional requirements of reproduction. Molecular correlates of this model have not been explored. The androgen receptor gene, located on the X chromosome, mediates male reproductive development. Mutations of this gene interfere with virilization suggesting that this gene may be linked to the evolution of primate sexual dimorphism. A genetic mechanism for the evolution of dimorphism must account for the continuous inter-specific variation of dimorphism. Expansion of the tri-nucleotide CAG repeat in the androgen receptor gene is a possible mechanism for modulating dimorphism among primate species. The androgen receptor gene was sequenced from a convenience sample of Catarrhine primates including chimpanzee (n=6) gorilla (n=3), orangutan (n=1), gibbon (n=1), baboon (n=4), and macaque (n=3). The index of dimorphism was calculated as mean female weight divided by mean male weight for the species. Results show a negative correlation between repeat expansion and this index of dimorphism. This finding is consistent with a role for the expansion of this simple sequence repeat in the evolution of primate sexual dimorphism. Directional evolution toward an expanded CAG repeat has been proposed elsewhere. However, the causal link between the expanded tri-nucleotide repeat and several neuro-degenerative diseases indicates that excessive expansion has deleterious effects. One of the attractive features of this hypothesis is that it provides a genetic mechanism underlying variation in sexual dimorphism among species.

#### **Iron deficiency anemia in pre-contact hunter-gatherers from Bay West (8CR200) and Windover (8BR246).**

H. Walsh-Haney. Dept. of Anthropology, University of Florida.

Porotic hyperostosis and cribra orbitalia, hallmark lesions of acquired iron

deficiency anemia, often result from malnutrition and parasitism. Since clinical studies show meager diets contain satisfactory amounts of iron, parasitism is a frequent causative factor. Parasitism is of highest prevalence in the tropics, as are unsanitary conditions, associated sedentism, and diets of marine resources.

Lesions presumably begin in childhood and may persist into adulthood. A common etiology is assumed with lesions predilecting the vault, affecting the frontal first (as cribra orbitalia), then parietals, and occipital. Variation in this pattern may reflect different types of biocultural stress.

This study examines two Florida Archaic samples for evidence of porotic hyperostosis and cribra orbitalia. Previous studies show Bay West (N=42) and Windover (N=168) were healthy. Being hunter-gatherers, the affect of population density and sedentism was also negligible. Stable bone isotope analysis revealed a diet of marine resources for Bay West and riverine/terrestrial resources for Windover. I set out to determine if a diet of marine resources predilected Bay West to parasitism. I also evaluated age, lesion location, and healing to determine if a disjunction between lesion location and parasitism existed.

I found no significant difference in lesion occurrence between the samples ( $z=-1.382$ ;  $P=0.1670$ ;  $z=-0.645$ ;  $P=0.5186$ ) and lesions were equally distributed among the frontal, parietals, and occipital. Co-occurrence of cribra orbitalia and porotic hyperostosis in each sample was low. Windover exhibited a significant difference in the frequency of orbit and vault lesions between adults and subadults; adults had the highest incidence of cribra orbitalia.

#### **Was *Australopithecus anamensis* ancestral to *A. afarensis*?**

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The early mid-Pliocene hominin species *A. anamensis* is usually depicted as a direct ancestor to the geologically younger *A. afarensis*. If this portrayal is accurate, character state changes between the temporally successive site-samples from Kanapoi, Allia Bay, Laetoli and Hadar should be congruent with hypothesized

polarity transformations based on outgroup conditions. To evaluate this hypothesis, we conducted a phylogenetic analysis of the four site samples using 24 characters of the maxilla, mandible, and dentition, and incorporating chimpanzees and gorillas as outgroups.

Results indicate that each temporally successive sample shares apomorphies with later samples. Moreover, the most parsimonious reconstruction of character evolution suggests that autapomorphies are not present in any site-sample except the terminal branch of Hadar (the one possible exception is Allia Bay lower P3 length). In other words, the Kanapoi sample of *A. anamensis* is more primitive than the Allia Bay one, and Laetoli sample of *A. afarensis* teeth and jaws retain more primitive characteristics than do the Hadar fossils.

Given the small and/or anatomically limited samples from Kanapoi, and especially Allia Bay and Laetoli, the hypothesis that these samples represent autapomorphy-bearing terminal units cannot be ruled out. However, the distribution of known characters is consistent with the hypothesis that *A. anamensis* is ancestral to *A. afarensis*, and that the four site samples constitute an evolving lineage across ~1.2 myr. One locus of pronounced change is the C/P3 complex, in which Kanapoi and Hadar differ markedly, and Allia Bay and Laetoli samples document an intermediate combination of characters.

#### **A study of the heritability of craniofacial asymmetry.**

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We examined craniofacial asymmetry in a sample of 178 individuals consisting of 59 pairs of monozygotic twins, 7 pairs of dizygotic twins and 29 sibling pairs to test the hypothesis that there is a measurable heritable component to craniofacial asymmetry. If the hypothesis is correct, we would expect there to be greater correlation between monozygotic twins in asymmetry values than between dizygotic twins (or the genetically equivalent sibling pairs.) Data consisted of previously collected anterior-posterior radiographs. Ten horizontal and eight vertical bilateral variables were measured from standard

reference lines. Differences were calculated for paired measurements and tested for directionality using one-sample t-tests. All horizontal variables displayed significant left side dominance and six of the eight vertical variables showed significant directionality to the right in all subsamples. Heritability estimates were obtained from the intraclass correlation coefficients for all differences using weighted asymmetry values  $[(L-R)/.5(L+R)]$  to control for directionality and differences in measurement magnitude. Heritability values ranged from .35 to -.53 with a mean value of .04 and a standard deviation of .22. Thus, there is little evidence of a pronounced heritability of facial asymmetry, suggesting that most craniofacial asymmetry is environmental or functional in origin.

#### **Primate bone microstructural variability: Relationships to mechanical and life history adaptation.**

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To date, paleobiological reconstruction of primates has largely been founded upon study at the whole bone level. However, such inquiry often suffers from superficial analogies with living taxa, as well as from the frequent incompleteness of fossil material. In addition, whole bones alone do not provide information regarding specific aspects of life history adaptation. Particularly in light of recent methodological advances, many of these deficiencies can be effectively addressed through the inspection of bone microstructure. Yet the additional insights that this approach can provide to the study of primates have, with a few notable exceptions, been overlooked.

Here we examine variation in three bone microstructural features – primary tissue type, secondary osteonal remodeling, and collagen fiber orientation – all of which have been shown to impact upon the mechanical properties of bones and/or to reflect life history. Our sample includes histological sections from the midshaft postcranial long-bones of extant primates (strepsirrhines, platyrrhines and *Tarsius*) and a selection of non-primate mammals. All sections are examined in conventional transmitted and circularly polarized light microscopy. Taxa have been carefully selected to encompass a range of sizes, life history strategies, positional behaviors, and lineages, geared towards the

clarification of the relationships between these features on the one hand, and microstructural variables on the other. The microscopy and image analysis methods we employ have been developed to facilitate quantitative comparability between sections. Our preliminary results identify the presence of taxon specific distributions of microstructural features, laying the foundation for future interpretations of bone microstructure in fossil primates.

#### **Complementary approaches toward evaluating dental health in skeletal samples: New recommendations to existing standards.**

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Bioarchaeology has been prominent in physical anthropology since the 1930s. Improved statistical tests have resulted in an increase in the quality of studies that compare health across time and space, yet there remain areas within this research that could be strengthened. Diagnostic imaging has become standard procedure in medicine and dentistry and has been successfully applied to paleoanthropological research. However, it has not been routinely incorporated into bioarchaeological studies with major dental components.

The present study compared assessments of dental health based on standard anthropological criteria and techniques with those routinely employed in clinical dentistry. Researchers used tools typical of their respective fields and examined a sample of maxillae and mandibles from 2 Philadelphia historical contexts: the Tenth Street First African Baptist Church Cemetery (1810-1822) and the Washington Avenue Project (early nineteenth century burials). Nineteen maxillae and 33 mandibles from both skeletal samples were examined. Lesions reported included missing teeth, retained roots, periapical lesions, caries, and impacted teeth. The hypothesis that the use of dental radiographs would result in greater numbers of all lesions reported by the dentist was rejected. Results indicate that the anthropologist reported more caries but fewer lesions deep within dental structures than did the dentist. While clinicians may not always agree on the nature and extent of all oral lesions, experience identifying tooth decay and other lesions surely equips them better than anyone else to report accurately lesions of the oral cavity, supporting our contention of the need for clinical components in multidisciplinary bioarchaeological research.

**Male dominance rank and mating success in an extremely large chimpanzee community at Ngogo, Kibale National Park.**

D.P. Watts. Dept. of Anthropology, Yale University.

Chimpanzees provide a challenging case for the hypothesis that male rank and reproductive success are positively correlated. Most males establish dominance relationships and many put great effort into attaining high rank, but most mating is promiscuous and females typically mate with all males in their community. Nevertheless, data from several communities show that rank is positively correlated with copulatory success, and paternity data reveal that alpha males gain reproductive advantages, although their magnitude can depend on the number of males in the community. The chimpanzee community at Ngogo, Kibale National Park, Uganda, has about 150 members, with 22-24 adult and 14-16 adolescent males. The large number of males might lead to the expectation that high rank confers no mating advantage. However, data on 15 cycling females show a positive relationship between male rank and copulatory success. The rank-related skew is stronger during periovulatory periods than earlier in female cycles, as predicted by the hypothesis that males obtain some information about female fertility and adjust competitive effort accordingly, and is stronger for parous than for nulliparous females. Paternity data to show whether reproductive success is similarly skewed are not yet available. If it is, alpha males and others who obtain top ranks should enjoy considerable reproductive advantages. These would hold despite the fact that the large number of males means that even the alpha male accounts for a relatively small proportion of all copulations, because the number of adult females at Ngogo is correspondingly high.

**Fetal and subadult age estimation using the os temporale pars petrosa: Accuracy of quantitative and qualitative criteria.**

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The pars petrosa is unique with respect to growth and development for several reasons. Paramount among these is the fact that this bone undergoes rapid maturation and dense mineralization during the fetal/infant period. Greater preservation and completeness of the pars petrosa improve archaeological recovery and

sampling of this bone as a potential subadult age indicator of value for both paleodemographic and forensic analyses of skeletonized infant remains.

This study was initiated to establish a method of subadult age estimation using a set of metric and non-metric characteristics of the pars petrosa. Over 300 individuals ranging in age from 4.5 months *in utero* to 20+ years were examined. The sample includes male and female American Black, White, and prehistoric Late Woodland Amerindian skeletal remains. In order to quantify pars petrosa age-related growth patterns this study used age estimates based on published dental crown/root maturation standards.

Results showed that (1) the adult pars petrosa exhibits very little size difference with respect to sex and ethnicity. Thus, algorithms predicting subadult age from the pars petrosa can be applied to skeletal materials of diverse ancestry. (2) For the set of 9 linear metrics examined, Measures 1 and 2 provide high correlations with low SEE's for the fetal/infant period of life, and Measures 6-7-8 provide useful estimates of early, middle, and late childhood period (in addition to the fetal/infant period). (3) Of the 25 qualitative age criteria surveyed only a handful were useful as threshold indicators (i.e., fetal, neonate, post-neonate, etc.) for subadult age status.

**Relative cerebellar proportions in humans and non-human primates.**

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The primate cerebellum, especially its lateral lobes, has been implicated in sequencing, timing, and coordination of neural signals, whether sensory, motor, or cognitive. Our analysis of a large sample of non-human primates (n = 111), modern humans (n = 1424) and fossil hominids (n = 17) suggests that proportional differences in cerebellar, neocortical, and whole brain volume may arise from the interplay between cerebellar and neocortical functions in distinct cognitive adaptations.

Lateral cerebellar proportions in hominoids reflect an allometric "grade shift" compared to monkeys, resulting in larger cerebella relative to the rest of the brain (NetBrain). The earliest hominids have similar cerebellar proportions with respect to NetBrain; but later hominids display a fluctuating trajectory of relative cerebellar volume. Within the genus *Homo*, although *absolute* cerebellar vol-

ume increases over time, *relative* cerebellar volume decreases through the Middle and Late Pleistocene, reaching its lowest relative proportions in Neandertals and early modern humans. Thus, encephalization in *Homo erectus* and archaic *Homo sapiens* reflects expansion of both the cerebellum and the NetBrain; but NetBrain growth occurs at a faster rate than cerebellar growth during this period.

Recent modern human cerebella are relatively and absolutely larger than in any other hominid group, and are dramatically larger than the cerebella of Late Archaic and Early Modern humans. We suggest that intensification of cultural complexity in the last 20,000 years placed increasing demands on the cerebellum, particularly the lateral lobes, as the need to automate complex cognitive functions intensified.

**Skull Reference Models (SRM) and the ontogeny of *A. africanus*.**

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Skull Reference Models (SRM's), which incorporate empirical sample distributions of shape in a low-dimensional morphospace, can be created from landmark data for modern taxa, fossil taxa, or the combination. They contain information both about the morphological average (the "virtual morphotype") and about within- and between taxon covariance structures. Developmental and evolutionary constraints such as ontogenetic allometry, phylogenetic allometry, heterochrony, or sexual dimorphism can be seen in these spaces as general factors shaping these covariance structures, while such considerations as locomotion, diet, behavior, or relative brain size may be treated as correlated causes or effects of skull form. In this statistical context, SRM's derived from landmark configurations are useful for ecophenotypic analysis of skull shape variation, classification of new specimens, completion of incomplete forms, and relating variation in extinct taxa to variation in extant ones. In this paper, a preliminary application of SRM's to real fossil data, we show that the estimated ontogenetic shape trajectory for the data set combining Sts 5, Sts 71, and the Taung child lies roughly parallel to those of the other Hominoidea, particularly Pan. By exploiting this observation we can present three-dimensional visualizations of fur-

ther intermediate stages in this reconstructed ontogeny of *A. africanus* as well as the morphological average derived from these significant specimens.

**Variation in limb proportions in pre-Contact human skeletons from different altitudes in the Andes.**

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Living human populations from high altitudes in the Andes exhibit relatively short limbs for their body size compared with neighboring groups from lower elevations. Relatively short limbs reflect adaptations to cold climates characteristic of high altitude environments. This study compares relative limb lengths and proportions in pre-Contact human skeletons from different altitudes to test whether variation in limb proportions also existed in Andean prehistory.

I measured maximum lengths of the humerus, radius, femur, and tibia, and joint diameters of the humeral and femoral heads in sex-specific groups of adult human skeletons (N=346) from the central (n=80) and the south-central (n=123) Andean coasts, the Atacama Desert at 2500 meters (n=102), and the southern Peruvian highlands at 3500 meters (n=41). Using regression and principal component analyses, I compared long bone lengths to each individual's geometric mean and upper and lower limb joint diameters. I also compared relative lengths of the proximal and distal limb segments for both the upper and lower limbs.

Relative limb lengths and intra-limb proportions do not statistically differ between the coastal and mid-elevation samples, whereas these variables are significantly shorter in the highland group. Relative limb proportions progressively decrease with increasing altitude. The coastal samples have the longest limbs, the mid-elevation sample is intermediate in length, and the highland sample exhibits the shortest limbs, especially in the distal limb segments. These results suggest that pre-Contact Andean populations from high altitudes developed body shapes that enabled them to withstand severely cold temperatures.

**Relationships of Slovak Roma populations assessed from finger ridge counts.**

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ogy, Smithsonian Institution. <sup>3</sup>Dept. of Anthropology, Comenius University.

The finger ridge counts of three Slovakian Roma populations have been compared with 12 world populations in order to explore relationships amongst the populations. Numerous studies have utilized genetic, linguistic, and historic evidence to trace the origin and migration of Roma populations; however, finger ridge count data have not been used. Unlike previous studies which have documented a relationship between Roma and North Indian populations; this study finds evidence of a link between the linguistically distinct Roma populations, part of the Indo-European language family, and the Urali, a South Indian population that is part of the Dravidian language family. The comparative samples are taken from three Indian populations, as well as Middle Eastern and European populations, totaling more than 3000 individuals. The Slovakian Roma samples are from three distinct sub-ethnic groups defined by different Romany dialects and differing degrees of acculturation. Analysis is based on phenotypic and genetic distances. The data from all ten digits are analyzed in RMET in order to produce phenotypic distances. Genetic distances are estimated from the additive genetic covariance matrix obtained from a large German family sample. Eigenvectors from the genetic covariance matrix are used to get principal component scores, which are then used to calculate genetic distances from RMET. From a graph of the principal coordinates it is possible to define three groupings. European and Middle Eastern populations form one group, the North Indian samples a second group, and the Slovakian Roma and the Urali a third group.

**Genetic contributions to neurological and behavioral traits.**

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Many neurological disorders show strong evidence of familial aggregation. These grade into aspects of normal behavior. In the case of epilepsies, a number of genes have been identified in which mutations can have strong effects, including ion channels that make direct functional sense. However, most familial aggregation remains unexplained, and the majority of cases may be sporadic (not recur at all in families). Even within families the traits vary in severity, onset age, location within the brain, and other attributes. We can account in principle for these facts

by somatic mutation during embryological development, in different genes and/or different times in different individuals. There is a close parallel with cancers in this respect, except that rather than the proliferative growth of a single mutated cell as occurs in cancer, the neurological amplification of a somatic mutation may occur by the entrainment of normal neurons by mutated ones or by the early occurrence of mutation in the tree of cellular descent during brain development. If somatic mutation occurs with sufficient frequency, its effects would be expected to extend into the normal range of behavior, again consistent with the well-known gradation of behavioral and neurological traits from normal to pathological. Somatic mutation may be an important causal component of the normal range of many aspects of behavior of interest in anthropology and society.

**Faunal taphonomy and biostratigraphy at Ngandong, Java, Indonesia and its implications for the late survival of *Homo erectus*.**

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Dates taken from faunal remains at the Indonesian site of Ngandong, Central Java, have been used to bring the boundary forward for the *Homo erectus* extinction event to the late Pleistocene, between 53,000 to 27,000 BP. It is argued that as the mammalian fauna are associated with the hominins they are most likely contemporaneous. If accurate, the implications of these dates suggest that there were sympatric or parapatric hominin species in some parts of Sunda, with *Homo erectus* coexisting for at least several millennia with *Homo sapiens* (Swisher, *et al* 1996).

The purpose of this paper will be to improve our understanding of the taphonomic issues at Ngandong and establish how they may contribute to an understanding of the site's formation history. Preliminary analysis of the fossil assemblage indicates that there are considerable variations in patterns of bone modification at Ngandong, suggesting that most of the faunal remains may have quite different taphonomic histories. Recon-

structions of the palaeoenvironment at the locality based upon faunal evidence does not correlate with an age sometime within the last 100,000 years, the biostratigraphy suggesting that the age of much of the fauna is more typical of an earlier open woodland environment. This study therefore cautions against the dates obtained by Swisher *et al* in order to establish an age for *Homo erectus* at Ngandong.

Swisher, C.C., Rink, W.J., Anton, S.C., Schwarcz, H.P., Curtis, G.H., Suprijo, A., Widiasmoro. *Science* 274:1870-1873, 1996.

**Throwing behavior and the mass distribution of rock selection in tufted capuchin monkeys (*Cebus apella*).**

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Cannell (2002) argues that sexually dimorphic patterns among humans in the mass of chosen throwing stones may be used to infer body mass and patterns of sexual dimorphism in early hominids from Olduvai and Koobi Fora by examining the mass distributions of manuports at those sites. We examined this hypothesis using a comparative approach, investigating the relationships among body mass, sex, and rock weight preference in an aimed throwing task among tufted capuchin monkeys (*Cebus apella*). The subject sample consisted of four adult male and four adult female monkeys trained in an aimed throwing task in which a food reward could be obtained by throwing a rock into a bucket. We found: 1. Subjects showed a strong mean rock weight preference both within and across individuals. 2. Although actual mean weight preference did not differ by sex, females chose rocks heavier relative to their body weight than did males. 3. Subjects threw more accurately when using rocks of preferred weight than when they used rocks that were not of the preferred weight.

We conclude that tufted capuchins are highly selective when choosing throwing stones, and that this confers an advantage for throwing accuracy. Our results indicate that the sexually dimorphic pattern in rock weight preference observed among humans does not generalize to *Cebus apella*.

Cannell, A. (2002) Throwing behavior and the mass distribution of geological hand samples, hand grenades and Olduvai manuports. *J. Arch. Science.* 29:335-339.

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**Community ecology of the middle Miocene primates of La Venta, Colombia: The relationship between divergence time and ecological diversity.**

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It has been suggested that the degree of ecological diversity that characterizes a primate community correlates positively with both its phylogenetic diversity and the time since the members of that community diverged. Therefore, it is questionable whether or not a community with a relatively recent divergence time but high phylogenetic diversity would be as ecologically variable as a community with similar phylogenetic diversity but a more distant divergence time. To address this question, the ecological diversity of a middle Miocene platyrrhine primate community with phylogenetic diversity comparable to modern New World primate communities but a relatively short time since divergence is compared with that of 11 modern neotropical primate communities.

Shearing quotients and molar lengths (which together are reliable indicators of diet) for both fossil and extant species are plotted against each other to describe the dietary ecospace each community occupies. Community diversity is calculated using three measures: the area of the minimum convex polygon encompassing all community members, the average distance from the centroid of the polygon to each community member, and the average distance between community members on the bivariate plot. The number of species in the community and the sum of the phylogenetic branch lengths separating community members best predict diversity among modern communities. Although the diversity of the La Ventan community does not differ significantly from modern communities, it is less diverse than would be expected based on the regression between phylogenetic and ecological diversity of modern communities.

**The effects of fetal load on bipedal kinematics and the evolution of lumbopelvic sexual dimorphism.**

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Human pregnancy generates compressive loads during bipedal locomotion that challenge routine alignment of the vertebral column and pelvis. The gravid modern human female represents a testable analogy for postural and locomotor challenges experienced by early female bipeds.

Kinematic positional data collected with a 3D measurement system were used to calculate angles of lordosis and pelvic tilt during natural stance and normal walking under no-load and fetal load simulated conditions. Compared with the no-load condition, lumbar lordosis during simulated advanced pregnancy significantly increases by 15% and 17% in stance and gait, respectively. Kinematic adjustments in lumbar lordosis result in a more acute lordotic angle dorsally reorienting the upper body. During standing posture the normal anterior tilt of the human pelvis increases significantly. While no significant difference in pelvic orientation occurs during the upward rotation of heel strike, during toe-off when the pelvis rotates downward, obstetric load exerts a small but significant biomechanical effect on the angle of sagittal pelvic tilt, suggesting pregnant women opt for more stable pelvic rotation.

Sex specific lumbopelvic loading generated by fetal load in modern bipeds indicates that female lumbopelvic morphology is not singly driven by childbirth events but is more complexly impacted by a suite of reproductive demands. Adaptations of this nature may have had a more basal influence on the hominid lineage than previously inferred. Specifically, aspects of female lumbopelvic morphology may have arisen in association with fetal load prior to the hominid encephalization events that introduced selection for a larger maternal birth canal.

**Immigration and ethnicity in two Teotihuacan neighbourhoods: The isotopic evidence.**

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Stable carbon-isotope ratios in bone collagen and oxygen-isotope ratios in bone and enamel phosphate were used to reconstruct the degree of immigration that took place in two Teotihuacan neighbourhoods: Tlajinga 33, an apartment compound of craft producers in which there is little archaeological evidence of foreign origin, and Tlailotlacan, a neighbourhood

where abundant archaeological evidence suggests that it was settled by Zapotecs from the Oaxaca. About 1/3 of the inhabitants of Tlajinga 33 had grown up elsewhere, but dwelt in Teotihuacan for many years before death. The data suggest achieved status, along with political and/or ethnic assimilation, and support Storey's (1992) hypothesis that because of high morbidity, immigration would have been necessary to maintain population viability. In comparison, Tlailotlacan contained a higher proportion of immigrants (50%) and maintained a distinct ethnic character throughout its occupation. The discovery of immigrants in all time phases suggests that a continuous influx of immigrants may have helped in the maintenance of its ethnicity. These data provide evidence that the social and economic complexities associated with immigration in the earliest urban society in the New World, have analogues with our modern cities.

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**A preliminary survey and GIS analysis of ring-tailed lemur habitat use in and around Beza-Mahafaly Reserve, Madagascar.**

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Today's assemblage of lemurs in Madagascar represents only a fraction of their past successful adaptive radiation on the island. Much controversy surrounds the demise of the species that have disappeared from Madagascar's landscape (Burney, 1997). There is a repeating theme, however, of human involvement. Deforestation and habitat fragmentation continue to jeopardize the future of lemurs in Madagascar.

This study demonstrates the usefulness of GIS technology in addressing questions of habitat change by examining ring-tailed lemur habitats both within and outside of Beza-Mahafaly Reserve in Southwestern Madagascar and analyzing the results with a GIS. We located several sub-populations of lemurs within a variety of fragmented and disturbed habitats and conducted ecological measurements to compare these areas to one another. Using a GIS, we were able to generate a map of the area surrounding the reserve and analyze some of the population dynamics that are occurring among these various habitats. Results indicate that more productive habitat, i.e. gallery

forest, contains more ring-tailed lemur groups and that ring-tailed lemur groups that have overlapping home ranges are also in areas of more productive habitat.

Not only does this research have implications for the conservation of these lemurs, but it also provides a more complete understanding of how these animals are coping, responding and adapting to human imposed changes on their environment. GIS has become an important tool in helping to analyze the habitats of endangered species (Akcakaya, 1994). Applying this science aids researchers in visualizing and evaluating spatial dynamics in groups of fauna.

**Conservation biology of Kloss's gibbons (*Hylobates klossii*).**

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The Kloss's gibbon (*Hylobates klossii*), endemic to the Mentawai Islands of Indonesia, is endangered due to commercial logging, hunting, and capture for the pet trade. No population surveys have been published since 1980, and population numbers have likely declined. While subspecies have been named for the other three endemic Mentawai primates indicating vicariance between the northernmost island of Siberut and the three smaller islands, no divisions have been designated for the Kloss's gibbon despite a shared biogeographic history. Here we present the results of a preliminary study that aims to determine the density of the remaining Kloss's gibbon population and to assess the number of conservation units within the species.

Population surveys were conducted with a method using the female's loud call at two sites in Siberut, suggesting minimum densities between 1.27 and 2.86 groups per square kilometer. For comparison, a more traditional line transect survey was conducted in north Siberut. No gibbons were sighted on the transects, supporting conclusions by other researchers that this method is inappropriate for hylobatids.

Fecal samples for genetic analyses were collected non-invasively from 19 unhabituated groups at five sites on three islands. The hypervariable region I of the mitochondrial Dloop was amplified and sequenced. These data are analyzed to test the hypothesis that there are multiple conservation units in this species. Such multiple lineages would indicate the need for additional reserve planning be-

yond Siberut National Park, the only protected area in the Mentawai Islands.

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**Endocrine components of life history trade-offs in vervet monkeys (*Cercopithecus aethiops*).**

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Life history theory is founded on the assumption that reproductive strategies are constrained by trade-offs among growth, survival, and reproduction. In spite of decades of research, the functional interactions among life history components are still poorly understood in many species, including primates. Endocrine investigations provide new approaches for understanding the mechanisms underlying negative associations between life history traits.

This study examined hypothesized trade-offs between growth and breeding onset in wild vervet monkeys from Kenya, East Africa. Individuals were drawn from four distinct populations from widely separated sites differing in altitude, temperature, and rainfall. A panel of biological samples (blood, hair, tooth casts, and morphological measurements) was collected from 59 adult males, 83 adult females and 225 juveniles. Ages were estimated from tooth eruption and wear. Serum concentrations of gonadal and adrenal steroids were analyzed by radioimmunoassay in order to assess sexual maturation and breeding onset. Serum IGF-I was used as an index of activity of the growth hormone axis. Age-specific morphometric measures were fit using loess regression. Bootstrap techniques were used to estimate pseudo growth velocity curves. Cross-sectional profiles of morphometric and endocrine data were compared to assess the timing of growth spurts and growth cessation in relation to sexual maturation.

Results showed that the four populations differed in both growth rate and duration. Estradiol and IGF-I profiles mirrored population differences. Ovarian but not testicular maturation was delayed in populations with more prolonged growth. These data demonstrate important sex differences in trade-off mechanisms.

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**An examination of the increased annual range of a Tana River crested mangabey (*Cercocebus galeritus*) group.**

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A group of Tana River crested mangabeys (*Cercocebus galeritus*) has greatly expanded its annual range over three decades: from 17.3 hectares in 1974 (Homewood 1976) and 19 hectares in 1988-89 (Kinnaird 1990) to 46.75 hectares in 2000-01. Utilizing 5-minute mapping samples (n=817), phenological samples (n=600), vegetation data, and statistical and descriptive comparisons with previous data, I tested five hypotheses concerning this range increase. The hypotheses of the departure of neighboring mangabey groups and a decrease in food tree density are not supported. There is only conditional support, because of limited comparison, for the hypothesis of a decrease in food per tree. Of five species compared between Homewood's and this study, two species had significantly lower mean fruit scores (Wilcoxon 1-tailed;  $p=.009$  and  $.03$ ). Statistical comparisons could not be made with Kinnaird's study, although she found an increase in mean fruit scores of these species between Homewood's study and hers. There is conditional support for the hypothesis of a reduction in non-forested corridors; I will also discuss data that do not support it. The hypothesis with the strongest support is of an increase in group size. Group size initially decreased from 36 to 18, but is now 50 individuals. This hypothesis is also supported by significant increases in average daily distance (Wilcoxon;  $p=.003$ ) and average half-hour distance ( $p=.002$ ) since Kinnaird's study. Descriptive comparisons with Homewood's data also show increases in average daily range and distance. The results increase our understanding, and can be applied to management, of this critically endangered primate.

**Variation in the vitamin D receptor and NRAMP1 loci in Aché and Avá of Paraguay: Implications for host susceptibility to tuberculosis.**

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Tuberculosis is a significant health problem for the majority of the world's populations, and prevalence among Native American groups since European contact has been especially high. Grow-

ing evidence indicates that host genetics play an important role in determining susceptibility and resistance to tuberculosis. Research on genetic loci in various populations worldwide indicates that susceptibility is likely polygenic and population-specific. This project examines the role of host genetics in tuberculosis susceptibility in two indigenous populations from Paraguay, Aché and Avá. Using molecular biological techniques, polymorphisms at two loci associated with tuberculosis in some African and Asian populations as well as one Canadian aboriginal population are examined for potential association with tuberculosis in Aché and Avá. These loci are the vitamin D receptor (VDR) and natural resistance-associated macrophage protein (NRAMP1). To date, we have examined 225 Aché and 60 Avá for a *FokI* restriction polymorphism in exon 2 of the VDR, which has alleles F and f (absence and presence of the site, respectively). The ff genotype has been associated with increased susceptibility to tuberculosis in some studies, and this association will be examined in the Aché and Avá. The genotype distributions are as follows, for Aché and Avá, respectively: FF = 72% and 80%; Ff = 27.6% and 15%; ff = 0.4% and 5%. Of 54 Aché examined for the 1729 + 55 del 4 polymorphism located in the 3'UTR of the NRAMP, 5 (9.3%) are homozygous for the deletion, while the remaining 49 individuals are homozygous without the deletion.

**The molecular evolution of primate energetics from the perspective of cytochrome c.**

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Primates have varied energetic requirements, and therefore the evolution of genes associated with energetics and metabolism is of primary importance to biological anthropologists. Cytochrome *c* (*cyc*) is an essential protein required for aerobic metabolism in the mitochondria of eukaryotes, where it carries electrons from complex III to IV of the mitochondrial electron transport chain (ETC). Fixed mutations in the amino acid sequences of *cyc* have caused changes in the efficiency of electron transport, and thus in the production of aerobic energy in

primate cells. Here we report cytochrome *c* nucleotide sequences in all major extant clades of the order Primates. We have also identified for the first time in primates a tissue-specific *cyc* gene duplicate previously thought to exist only in rodents. Cytochrome *c* shows an elevated nonsynonymous nucleotide substitution rate in the stem lineages of anthropoid and catarrhine primates coincident with the emergence of the relatively large neocortex. Additionally, the loss of the testis-specific isoform of cytochrome *c* in primates is similar to the other instance of ETC gene loss, that of cytochrome *c* oxidase subunit VIII heart isoform. All of these data in combination with evolutionary, functional, and protein structure information provide compelling evidence that the ETC functions differently in catarrhine primates when compared to other organisms. Supported by NSF SBR-9910679 and BCS-0118696.

**Facial-masticatory ontogeny in *Australopithecus* and *Pan*.**

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Although *Australopithecus africanus* and *A. robustus* adults exhibit a number of facial-masticatory adaptations in common, the ontogenetic origin of these features remains poorly understood. To explore ontogenetic changes in facial-masticatory shape in *Australopithecus*, relatively large ontogenetic series of *A. africanus* (n = 29) and *A. robustus* (n = 14) are compared to each other, and to a parallel set of closely related species, *Pan troglodytes* (n = 156) and *P. paniscus* (n = 151). Although the number of *Australopithecus* nonadults is limited compared to those available for *Pan*, it is not negligible (*A. africanus* = 7; *A. robustus* = 6; cf. *P. troglodytes* = 110; *P. paniscus* = 103). Indices of shape (linear distances divided by overall size) were subjected to principal components analysis. Separate analyses were performed for australopithecines only (to compare mandibular developmental stages) and for the faces of all four taxa.

For both analyses, a strong taxonomic signal is represented on the first principal component axis. The second principal component axis for both analyses captures ontogenetic changes. In *Australopithecus*, the mandibular corpus is relatively thickest during the juvenile and subadult stages when the molars are forming but have not yet erupted. The degree of facial shape change for *A. africanus* is roughly comparable to that exhibited by the two species of *Pan*. *A. ro-*

*bustus* appears to undergo less facial shape change than does *A. africanus* or *Pan*. *A. robustus* has a broad and short palate as do young *A. africanus* and young chimpanzees.

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#### **Dental decoration during the Postclassic at Lamanai, Belize: Sex and status differences.**

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Dental decoration in eighty-two elite individuals dating to the Postclassic period at Lamanai, Belize was described and investigated to determine whether status and sex differences existed. Dental decoration was present in 41% of the burial sample from Lamanai. Dental pathology and stable isotopic data from White (1986) provided evidence for diet within the sample. Diet, grave location and architecture were used to indicate social status. Dietary data did not differ between individuals with decoration versus those without. Dental decoration was totally absent in individuals buried in residential structures presumed to be of lower elite status. However, dental decoration was present in approximately 30% of the individuals buried in structures that housed the burials of nobles and high-elite individuals. Architectural and burial location data indicate that dental decoration may have been differentially distributed within elites. Dental decoration was more frequent in females than males and the most popular types of dental decoration, in both males and females, were Romero's type C4 and B4. When the region of Belize was compared with the Petén region of Guatemala, differences in the types of decoration were apparent. This lends support to the idea that dental decoration may be a means of identification with a particular area, lineage or ruler.

#### **Health and lifestyle inequalities among early and late pre-Columbian and intermediate period Native Americans in the Western Hemisphere.**

K.D. Williams, R.H. Steckel. Ohio State University,

Much research has been done using conventional socioeconomic measures such as income, wealth, or wages to explore inequality between the classes, but

a growing body of research addresses inequalities in health. This paper contributes by using the Western Hemisphere database to investigate the frequency of skeletal lesions and other health and lifestyle indicators among nearly 1,700 Native American individuals who lived in ranked versus undifferentiated societies in early pre-Columbian (>1500 yBP), late pre-Columbian (450-1500 yBP), and intermediate (250-450 yBP) periods. The health indicators considered are cribra orbitalia, porotic hyperostosis, skeletal infection, and linear enamel hypoplasias. Degenerative joint disease and trauma provide insight to inequalities in lifestyle due to status.

Several prominent health patterns emerge: (1) early pre-Columbian males living in a ranked society had a higher observed frequency of periosteal reaction of the tibia than females living in the same society and (2) health differences between males and females living in undifferentiated societies increased considerably during the intermediate period, compared to males and females living in ranked societies at the same time. Patterns of lifestyle differences include: (1) the frequency of degenerative joint disease declined with increases in social status and (2) trauma was more characteristic of men than women and wounds to the skull were significantly more frequent among men in middle strata compared to men of the lowest or highest strata. These patterns illustrate differential changes in health and lifestyle among male and female Native Americans related to status and changing environmental and social adaptations in the Western Hemisphere.

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#### **Symphyseal fusion in anthropoids and ungulates: A case of functional convergence?**

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Although symphyseal fusion has evolved independently in several mammalian lineages, its functional significance has been studied most extensively in primates. *In vivo* research in anthropoids and strepsirrhines suggests that symphyseal fusion is linked to wishboning of the symphysis due mainly to the delayed and pronounced recruitment of the balancing-side deep masseter (BSDM) (Hylander et al., 2000, 2002). Whereas the

BSDM peaks after the working-side superficial masseter (WSSM) in anthropoids, the BSDM peaks prior to the WSSM in those strepsirrhines with highly mobile symphyses. Moreover, compared to these strepsirrhines, anthropoids recruit greater amounts of relative force from the BSDM.

In this study, we test whether symphyseal fusion in ungulates is associated with the timing and magnitude of BSDM activity. We analyzed electromyographic data from the left and right superficial and deep masseters in alpacas and horses, both of which have fused symphyses, and goats, which have an unfused symphysis. In alpacas and horses the BSDM peaks well after the WSSM, as in anthropoids. In goats the BSDM peaks prior to the working-side superficial masseter, as in strepsirrhines with highly mobile symphyses. However, whereas horses recruit nearly equal amounts of working- and balancing-side relative force from the deep masseter, alpacas and goats recruit two to three times more relative force from the working-side deep masseter. The firing pattern data provide preliminary support for functional convergences in the evolution of symphyseal fusion in anthropoids, alpacas and horses.

#### **Food selection by mantled howling monkeys (*Alouatta palliata*) in a shade coffee plantation: resource abundance and nutrient content.**

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Howlers demonstrate high feeding selectivity, relying on seasonally-available foods to maximize nutrient quality and minimize consumption of structural carbohydrates and toxins. Howlers also have flexible diets, which contributes to their ability to inhabit secondary and degraded habitats. To explore the effects of reduced tree density and diversity on food selection by howlers, we studied their feeding behavior in a Nicaraguan shade coffee plantation.

Between September 1999 and November 2000 we collected data on the feeding ecology of three groups of mantled howling monkeys (*Alouatta palliata*) in Finca La Luz, Mombacho Volcano. Over the course of a year, the howlers fed on at least 65 plant species. The annual diet consisted of foliage (56%), fruit (35%), flowers (8%), and other plant parts (1%). The top food species, *Ficus costaricana*,

comprised 32% of the diet. Unlike conspecifics at less disturbed sites, these howlers relied on common tree species for the majority of their diet; howlers at other sites largely ignore the same species used at La Luz as staple foods. This population may also show less selectivity in relation to forage quality. There are no significant differences between eaten and uneaten mature foliage in content of fiber (average ADF 34.5% versus 36.0%) or protein (average crude protein 19.1% versus 20.4%). However, the forage quality appears comparable to some other sites where howlers have been studied. Although the shade coffee plantation presents howlers with fewer feeding options, the overall quality of the potential food resources may be relatively high in comparison to some primary habitats.

**Connecting anthropology to the real world: Strategies for maximizing student understanding of human variation and minimizing racism in international experiential learning courses.**

L.A. Winkler. University of Pittsburgh.

The rigid racial typology that has emerged as a result of cultural constructs of race fails to portray accurately the phenotypic and genetic variation of modern humans. Biological anthropology has a crucial role to play in promoting a more scientifically valid concept of human variation. However, despite the polytypic nature of Western nations such as the United States, many students are limited in their ability to discern the phenotypic variation in other humans by the cultural constructs of race with which they have been reared. Experiential international learning courses offer an innovative way to overcome the limitations of cultural preconception of racial identity and provide a broader and more accurate appreciation of human variation. The presentation will discuss strategies for maximizing student understanding of the polygenic and phenotypic nature of human variation in study-abroad courses. These strategies can easily be incorporated into a variety of different types of courses in order to broaden experiential learning. Examples will be provided from study-abroad courses in Nicaragua and Tanzania, two nations with polytypic and multi-ethnic populations.

**Malarial selection and the Dogon: Patterns of DNA sequence variation at the  $\beta$ -globin locus.**

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To better understand the role of malaria in influencing patterns of variation at loci that confer resistance to malaria, we sequenced 11-kb at three unlinked loci in 45 individuals from the Dogon, a population who reside in an endemic malarial environment and ~200 non-African individuals from 4 populations. The first locus,  $\beta$ -globin, contains two alleles that are known to confer resistance to malaria, HbC and HbS. The other two loci, Dmd44 and APXL, are not subject to malarial selection and likely reflect demographic processes.

The HbC allele was found at 10.4% in only the Dogon; the HbS allele was absent in all populations. The frequency spectrum at  $\beta$ -globin in the Dogon exhibited an excess of rare polymorphisms (Tajima's D = -1.15, P>0.10) but did not in the global sample (TD = +0.137, P>0.10) or in any other population sample (-0.047 < TD < +0.836). Tajima's D values at Dmd44 and APXL in the Dogon were less negative than at  $\beta$ -globin (TD<sub>APXL</sub> = -0.46; TD<sub>Dmd44</sub> = 0.87) as well as in all non-African populations (-0.24 < TD<sub>APXL</sub> < +0.76; -0.33 < TD<sub>Dmd44</sub> < +1.73).

The skew in the frequency spectrum at  $\beta$ -globin in the Dogon and the absence of this pattern at Dmd44 and APXL do not support a model of population growth in the Dogon since demographic processes are expected to affect all loci similarly. To further explore the effects of malarial selection at  $\beta$ -globin, a closer examination of sequence variation on the HbC and non-HbC chromosomes is in progress.

**A comparison of substrate use among infant and adult red-shanked douc langurs, Delacour's langurs, and Hatinh langurs at the Cuc Phuong Endangered Primate Rescue Center, Vietnam**

C. Workman, H.H. Covert. University of Colorado, Boulder.

Studies of primate locomotion since the mid-1960s have focused almost entirely on adults, yet Hurov (1991) notes that there is a need to study animals in their infancy to obtain a clearer picture of their mature locomotion, as growth provides important morphological and behavioral changes that bear directly on substrate use and preference. More than 100 hours

of positional behavior data were collected on the red-shanked douc langur (*Pygathrix nemaeus*), Delacour's langur (*Trachypithecus delacouri*), and the Hatinh langur (*Trachypithecus laotum hatinhensis*) during January, February, and March of 2002 at the Endangered Primate Rescue Center (EPRC) of Cuc Phuong National Park, Ninh Binh Province, Vietnam. Approximately equal amounts of instantaneous bout data were collected on young (less than 18 months in age) and adult animals for each of these three species.

The red-shanked douc, Delacour's, and Hatinh infants use a wider range of substrates than the adults of the same species, incorporating parts of the enclosures and other animals into their substrate repertoires. Most taxon and age groups use small substrates in overwhelmingly higher proportions than the second or third most frequently used substrates, and all travel most frequently on small supports. Infants use a wider variety of supports for locomotion than the adults, yet infants use small substrates most frequently for play behavior, followed by vertical supports and the ground. We conclude that substrate preference at the EPRC has implications for the future design of enclosures for these highly endangered animals.

**Ecological influences on chimpanzee hunting.**

R. Wrangham. Harvard University.

The hypothesis that chimpanzee meat-eating is a luxury, made possible by high energy abundance in the plant diet, has been supported to date by comparisons of hunting seasons within sites, particularly at Ngogo (Kibale National Park, Uganda). Here I explore why chimpanzees hunt rarely in Kanyawara (Kibale). Differences are particularly striking between Kanyawara and Ngogo, two communities separated by only 10 km and occupying forests of similar structure, with prey density somewhat higher in Kanyawara. Kanyawara data come from 13 years of daily observation, including detailed study of monkey-chimpanzee encounter rates over 29 months. Ngogo data come from studies by J. Mitani and D. Watts. Daily rates of encounter between chimpanzee parties and groups of red colobus were similar in the two communities (0.42 – 0.50 encounters per day). However, Kanyawara chimpanzees were less likely to hunt (15% of encounters, compared to 37% at Ngogo), they were less successful (47% of hunts led to a kill, compared to 84% at Ngogo), and they killed fewer prey per hunt (2.1,

compared to 4.2 at Ngogo). The low rate of predation at Kanyawara is attributed not only to the fewer number of males in the community at Ngogo, as proposed by Mitani and Watts (2002), but also to lower fruit availability in Kanyawara, as well as relatively intense aggressive responses by red colobus monkeys. This study suggests that greater plant food availability promotes hunting in comparisons both within and between populations.

### **The critical function of the "robust" jaws of tufted capuchins.**

B.W. Wright. Dept. Anthropology, University of Illinois.

From November 1999 through August 2000, I collected data on the toughness of plant foods processed by *Cebus olivaceus* and *Cebus apella* within and adjacent to the Iwokrama Reserve, Guyana, S.A. Prior studies of capuchin jaw morphology also were reviewed and augmented with additional measurements of canine robusticity and gross dental wear.

*Cebus apella* is noted to exhibit more robust mandibles than other capuchins. They also exhibited more robust canines and greater premolar wear. These traits have been regarded as critical for the exploitation of mechanically challenging resources such as palm fruits. The toughness of foods processed by tufted and weeper capuchins was compared in order to identify the critical function of *C. apella*'s robust jaws and to assess their degree of dependence on palms in Guyana.

It was found that the toughness of all masticated, breached, and discarded/swallowed fruit tissues was statistically similar between the capuchins. *C. olivaceus* also was the only species seen to utilize palm fruits. However, *C. apella* breached (9952.8 Jm<sup>-2</sup>) and masticated (6267.5 Jm<sup>-2</sup>) the toughest fruit tissues and was the only species seen to breach tough non-fruit tissues. Although palm fruits make up a large part of the diet of tufted capuchins at other sites in South America, they are typically opened manually. These findings suggest that the robust jaws of *C. apella* represent a general adaptation for breaching tough encased foods, which may include tough pods, palm pith, and bark.

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### **Differences in patterns of locomotor behavior and habitat use in adult and juvenile *Cebus apella* and *Cebus olivaceus*.**

K.A. Wright. Dept. Cell & Molecular Biology, Northwestern University Medical School.

From December 1999 through November 2000, I collected data on the locomotor behavior and habitat use of *Cebus apella* and *Cebus olivaceus* in and around the Iwokrama Reserve in central Guyana. Here, I present data comparing adult and juvenile patterns of locomotor behavior and habitat use for these two species of capuchin monkey.

Randomization tests (Manly, 1991) indicate that the overall pattern of locomotor behavior in *C. olivaceus* adults and juveniles is comparable. However, for *C. apella*, adults walk more than juveniles ( $p < .01$ ), while juveniles bound ( $p = .05$ ), leap ( $p = .05$ ) and climb ( $p = .02$ ) more than adults. A comparison of the juveniles of these two species shows a significantly higher frequency of climbing for *C. apella* ( $p = .04$ ).

Analyses of substrate preference and canopy use indicate that for both *C. olivaceus* and *C. apella*, adults and juveniles use small, obliquely orientated substrates most frequently. Adults of both species utilize the lower and middle forest canopy, while juveniles prefer the lower and understory canopy.

The results of this study indicate that *C. apella* and *C. olivaceus* exhibit similar patterns of locomotor behavior as juveniles, but diverge as adults (Wright, 2002). This divergence appears to be a result of changes in the pattern of *C. apella*'s locomotor behavior through ontogeny. Habitat use patterns are similar between the two species, with corresponding changes throughout ontogeny. These changes are discussed in light of the different foraging strategies exhibited by the two species.

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### **Dynamics of foot use during bipedal and quadrupedal walking in *Pan troglodytes*.**

R.E. Wunderlich. Dept. of Biology, James Madison University.

Considerable debate persists over the habitual positional repertoire of early hominids and their precursors. Interpretation of fossil hominid morphology and the mechanisms by which hominid bipedal specializations evolved requires experimental study of locomotor function in extant hominoids. Despite substantial fossil evidence of early hominid foot morphology and footprints, little research has

examined the function of the foot in hominoids walking bipedally.

Dynamic plantar pressure distribution was collected on two male chimpanzees walking quadrupedally and bipedally. Peak pressure, maximum force, contact time and impulse were evaluated for 13 regions of the foot (5 toes, 5 metatarsals, 2 midfoot, heel). Simultaneous lateral view videos were digitized using Peak Motus software to assess hindlimb postures and subject velocity.

During bipedal walking (BW), peak pressure and maximum vertical force was relatively higher on the heel, medial midfoot, and medial metatarsals and relatively lower on the lateral metatarsals and toes than during quadrupedal walking (QW). Contact time in the heel and midfoot regions was substantially longer during BW than QW. Hallux abduction and load is variable during chimpanzee bipedalism, and its position and load is a determinant of lateral foot load.

The mechanism of weight transfer through the foot during bipedalism in chimpanzees is substantially different than during terrestrial quadrupedalism and may resemble chimpanzee arboreal quadrupedalism more closely than terrestrial quadrupedalism. These results support a previously described "biomechanical link" between climbing and bipedalism.

### **Testing models of human facial biomechanics with *in vivo* strain data on retracted versus protracted faces.**

F.W. Yates, D.E. Lieberman. Dept. of Anthropology, Harvard University.

The human face differs from most other primates in that it lacks a rostrum and is oriented primarily in the coronal plane. These differences may influence biomechanical resistance to torsional, shearing, and bending forces generated during mastication that are known to affect the growth of the maxillary and mandibular arches. We tested the effects of facial retraction on facial strain patterns using *in vivo* strain data collected from rock hyraxes (*Procapra capensis*) and pigs (*Sus scrofa*). The postcanine tooth row in hyraxes is retracted beneath the orbits, as in humans, but lies anterior to the orbit under a rostrum in pigs. Average shear strains recorded for hard foods on the anterior dorsal rostrum (lateral to the midline) were 65  $\mu\epsilon$  in the pigs, and 25  $\mu\epsilon$  in the hyraxes. Average shear strains on the dorsal interorbital surface (lateral to the midline) were 125  $\mu\epsilon$  in the pigs, and 320  $\mu\epsilon$  in the hyraxes. Although some bending occurred, torsion about an A-P

axis was the major mode of deformation during mastication in both species. The lower rostral strains and higher caudal strains in the hyrax relative to the pig support the notion that facial retraction decreases resistance to masticatory forces in the superior portion of the face, but this effect is only moderate in this experiment. In both species, applied stresses are effectively generated in the rostrum and/or lower face, suggesting that a similar pattern may be inferred for the human face.

**Skeletal indicators of diet at Piedras Negras, Guatemala: An isotopic and osteological analysis.**

C.J. Yoder, M.S. Parks, A.K. Scherer, L.E. Wright. Dept. of Anthropology, Texas A&M University.

An ongoing difficulty in the study of ancient diet is the problem of multiple etiologies for many osteological indicators of diet. In our earlier bioarchaeological research at Piedras Negras, Guatemala, we attributed high levels of porotic hyperostosis and dental caries to a maize-rich diet. In order to test this hypothesis, we extracted stable isotope signatures from bone collagen samples from 45 skeletons and carbonate from dental enamel from 11 skeletons. Collagen samples were extracted using HCl at Texas A&M University and mass spectrometry was carried out by Coastal Sciences Lab in Austin Texas. Analyses of enamel carbonate were performed at the Geology Department at Texas A&M University.

We examined the association between both isotopic and skeletal indicators of diet at the individual-level within the Piedras Negras sample and between populations within the Maya lowlands. Although it is clear from population-level comparisons that the isotopic and skeletal indicators of diet co-vary, our preliminary results at the individual-level are less clear (t-test: caries  $t = .059$   $n = 16$ , porotic hyperostosis  $t = .802$   $n = 11$ ). These results illustrate the importance of population-wide analyses of paleodiet and the necessity for using multiple indicators of diet in bioarchaeological studies. Permission for bone and tooth samples was granted by IDEAH, Guatemala. Isotope analyses were funded by Brigham Young University, Pennsylvania State University, and Texas A&M University.

**A reassessment of variability in the hominoid postcranium: Issues of homology and homoplasy.**

N. Young. Harvard University.

In an analysis of hominoid postcranial variation, Larson (1998) found that many purportedly unique features of the hominoid postcranium were actually much more variable than previously reported and in some cases overlapped with both suspensory (*Ateles*) and non-suspensory primates. Based on these findings Larson concluded that convergence in the living ape postcranium was a plausible and even likely scenario given the Miocene hominoid fossil record. However, Larson did not distinguish whether non-hominoid overlap with ape similarities occurred in one ape taxon or in many, or whether great apes were more similar to each other than to lesser apes. To address this issue, Larson's postcranial data was re-analyzed using three techniques: cladistic analysis, principle components analysis, and cluster analysis. Results reveal that the postcranial characters have a strong functional signal but still discriminate hominoids and *Ateles* from all other taxa, great apes from lesser apes, cercopithecines from colobines, and cercopithecoids from platyrrhines. The majority of hominoid overlap with other primates occurs between *Ateles* and *Hylobates*, and these similarities are primarily in humeral head characters. Characters in which non-suspensory taxa overlap with ape taxa primarily distinguish *Ateles* and *Hylobates* from other primates including great apes. The great apes form a distinct cluster within the suspensory primates. These results suggest that the postcranium of *Ateles* is primarily convergent with *Hylobates*, perhaps because of a shared brachiating adaptation, and that the great apes form a relatively distinct postcranial clade. Characters which discriminate *Pongo* from the African apes are primarily located in the scapula.

**Measurement of mucosa in the human small intestine.**

M. Young Owl, R. Leal, L.L. Mai. Depts. of Biological Sciences and Anthropology, California State University, Long Beach.

The human small intestine (SI) visually reveals a carpet of mucosa in the anterior region that tapers as the length of the SI is traversed. This is known, but we could find no sources indicating this tissue has ever been measured. SI mucosa contains tissue involved with absorption of nutrients. We combined the method developed by Derting and Bogue (1993), who reported that the highest concentration of SI mucosa in voles was located in the posterior region of the SI, with Young Owl's (1994) method for estimating gut surface area. We obtained 10 human SIs

from the University of California, Irvine Medical School. We divided the SI into 3 equal segments, which were weighed wet, mucosa scraped off, and then both mucosa and the remaining intestinal segment dried at 60°C for 24h. Data was analyzed by ANOVA. Results indicate human mucosa is concentrated in the anterior third of the SI. This is what was expected and would be indicative of an organism that consumes easily digested morsels. Additionally, two callitrichids had the same pattern, while two wallaby SIs revealed a consistent distribution along the entire SI. This, and information from vole mucosa distribution, suggests the human pattern is not a general mammalian pattern. Further research is underway to investigate whether human mucosal distribution is a general primate pattern or if it varies within the order. Supported by the McNair's Scholars program.

**A new brain volume for the Sts 60 specimen of *Australopithecus africanus* from Sterkfontein, S. Africa.**

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Since the claim by Falk *et al.* (2000) that some of the australopithecine brain endocast volumes were inflated, we have undertaken a full restudy of australopithecine endocasts to ascertain their most probable volumes. Here, we report that one of the natural endocasts, Sts 60, appears to have a volume of roughly 400 ml rather than the earlier estimates of 428 ml by Holloway (1970, 1973) or 435 ml by Tobias (1971).

Sts 60, an undistorted natural endocast, has an almost complete morphology on the left side, except for portions of the occipital pole, posterior cerebellar lobe, temporal pole, frontal beak, and distal brain stem with the foramen magnum. The right side retains most of the frontal lobe and a portion of the medial part of the parietal lobe. Holloway's original reconstruction was done by completing the missing portions with plasticine on the left side, and measuring the volume of the hemi-endocast by water displacement technique. In this study, a full endocast reconstruction of Sts 60 was performed. It provided a lower estimate at roughly 400 ml, a reduction of 7% in volume from the original determination. We are uncertain what has caused this discrepancy, although we suspect that midline placement was the most likely culprit.

We do not believe that other australopithecine volumes are inflated, such as Sts 71 and SK 1585, as reported earlier. We suggest that these differing volumes justify continuing efforts by independent researchers to find the most accurate assessment of these hominids' cranial capacities.

### **Social variation and sexual dimorphism in Egypt.**

S.R. Zakrzewski. Dept. of Archaeology, University of Southampton, UK.

The development of social stratification and the formation of the Egyptian state occurred concurrently with the intensification of agriculture. A series of time successive populations were studied to assess the variation in skeletal sexual dimorphism over this period, and to investigate the pattern of linkage between social ranking and skeletal morphology.

The data consist of 55 cranio-facial and 25 postcranial variables from 560 Egyptian individuals, from seven periods, ranging in date from 5000 to 350 BC. All postcranial and most cranio-facial measurements exhibited statistically significant differences between males and females. 23 craniometric and 2 postcranial variables exhibited statistically significant interaction between sex and time period, indicating that the relationship between the sexes varied through time. ANOVA results suggest that males exhibit greater craniometric heterogeneity than females. GLM statistical analyses revealed that many variables exhibited significant differences between the time period groups, and that most of these differences remained statistically significant after correction for sexual dimorphism.

The female sample exhibited more correlations between cranial variables and postcranial measurements than the male sample, and many of these correlations showed much higher degrees of statistical significance. Many of the female correlations were significant at  $p < 0.01$ , whereas this was true of none of the male correlations. This suggests that the female sample remained relatively stable through time. A model linking sex-specific migration, social hierarchization and the changing role of women in Egyptian society has been developed to explain the pattern of sexual dimorphism exhibited by the samples studied.

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### **Native American Y chromosomes and the peopling of the Americas.**

S.L. Zegura<sup>1</sup>, M. F. Hammer<sup>1</sup>, T.M. Karafet<sup>2</sup>. University of Arizona, <sup>1</sup>Institute of Cytology and Genetics, Novosibirsk, Russia.

A total of 64 binary polymorphisms and 10 STRs were genotyped on a sample of 2,344 Y-chromosomes from 51 populations representing the Americas, Asia, and Europe. The Native American sample included 588 individuals from 18 populations (186 Na Dene speakers, 342 Amerind speakers, and 60 Eskimo/Aleut speakers). Three major haplogroups denoted as Q, C, and R (according to the recently published Y Chromosome Consortium recommendations for a standardized binary haplotype nomenclature) accounted for almost 96% of the Native American sample. Possible admixture, especially for the R haplogroup, led to the deletion of 102 Native Americans from some of the statistical analyses. Mantel tests showed that paternal genetics and geography were much more highly correlated than were Y-chromosome markers and language family, unlike the results for Siberia which showed the opposite pattern of statistically significant associations. AMOVA results were similar in that the among-groups distance measure was not statistically significant for Native American language family comparisons, *contra* expectations based on the Greenberg, Turner, and Zegura three-wave model for the early peopling of the Americas.

Two major founding Y chromosome lineages, C and Q, were both traced to an ancestral homeland in the vicinity of the Altai and Sayan Mountains of Central Asia. Different phylogeographic and microsatellite diversity patterns for these two lineages led to the conclusion that these two lineages may represent two separate migrations from Asia to the Americas, rather than a single migration of a polymorphic founding population.

This study was supported by NSF grant OPP-9806759 to MFH.

### **Patterns and pitfalls in the assessment of bone health in children.**

B.S. Zemel<sup>1</sup>, V.A. Stallings<sup>1</sup>, M.B. Leonard<sup>2</sup>. <sup>1</sup>Division of GI and Nutrition, and <sup>2</sup>Nephrology, The Children's Hospital of Philadelphia, Dept. of Pediatrics, University of Pennsylvania School of Medicine.

Recent advances in bone densitometry provide safe, rapid methods for the assessment of bone health in children. Pe-

ripheral quantitative computed tomography (pQCT) can be used to assess cortical and trabecular bone in distal segments, such as the tibia. These measures are key to understanding developmental patterns of bone mineral accrual and related factors.

244 (122 female) healthy children, 6 to 21 years enrolled. 32% were African-American ethnicity. Tibia length (TL) was measured anthropometrically. pQCT measurements (Stratec XCT2000), were obtained at the 4% (trabecular), 20% (cortical) and 66% (muscle) sites. The strain-strength index (SSI) was derived from the 20% site. Cross-sectional muscle area was derived from the 66% site (MA66%). Results were evaluated in relation to age, gender, TL, ethnicity, and MA66%, by regression analysis.

Variability in epiphyseal size resulted in glancing the distal border of the metaphysis in 30% of cases. There were no age or size trends in trabecular density; however, there was a significant interaction between gender and ethnicity ( $p = 0.005$ ). Cortical density was significantly associated with age, TL, gender, ethnicity and ethnicity ( $r^2 = 0.63$ ). Cortical thickness was associated with age, gender, MA66% and TL ( $r^2 = 0.53$ ). SSI was associated with gender, ethnicity, MA66%, and TL ( $r^2 = 0.86$ ).

This measurement protocol had limitations due to variability in epiphyseal size and shape. The effect of age, gender, ethnicity, bone size and muscularity are important considerations in the interpretation of bone health in children. The effects of modifiable factors such as diet and physical activity, and health outcomes, such as fractures, will be explored.

### **Skeletal variation in adult chimpanzees of the Tai Forest, Cote d'Ivoire, compared to other *Pan troglodytes* A preliminary report.**

A.L. Zihlman<sup>1</sup>, C. Boesch<sup>2</sup>. <sup>1</sup>University of California, Santa Cruz, <sup>2</sup>Max Planck Institute for Evolutionary Anthropology.

Chimpanzees of the Tai Forest, Cote d'Ivoire (*Pan troglodytes verus*) comprise one of three recognized subspecies of *Pan troglodytes*. Skeletons of the study animals are retrieved whenever possible. A sample of 21 adult skeletal remains forms the basis of this study.

In the combined sex sample, average limb lengths are similar to those published for a *P. troglodytes* sample and a subsample of *P. t. verus* ( $n = 6$ ) (in Morbeck & Zihlman 1989 *Primates* 30:369). For example, the humeral length of Tai chimpanzees is 296 mm, compared to other *P.*

*troglydites* at 292 mm; and *P.t. verus* at 288 mm; femoral lengths are 292; 290; and 287, respectively for these three samples. In cranial capacity, the Tai chimpanzees (n=17) average 367 cc, (range 310 to 415 cc) compared to 390 average reported by other studies. Relative to Gombe chimpanzees (n=10), a population of *P.t. schweinfurthii*, Tai chimpanzees have larger average skeletal dimensions and a smaller average cranial capacity.

In the separate analysis of the sexes, male dimensions are on average larger than those of the females. Dimensions overlap extensively, although the smallest measurements are those of females. These preliminary results place the dimensions of limb and pelvic bones close to other *Pan troglodytes* samples except for Gombe chimpanzees. In cranial capacity the average for Tai individuals are smaller than for other *P. troglodytes*, but the range in size is similar. This study was supported by a grant from the LSB Leakey Foundation.

#### **Morphological variation in the metatarsus of modern and ancient Holo-cene people from South Africa.**

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The study of the human metatarsals reveals frequent morphological variations from the typical descriptions. Pathologies of these bones in contemporary humans are common, and it has been suggested that some of these may be associated with these variants. It is not clear, to what extent footwear and other environmental factors such as modern substrates have influenced bone morphology, function and subsequent pathology.

A suite of linear measurements, observed epigenetic traits and pathologic changes were collected from the metatarsal elements of two modern human subgroups (Zulu and Sotho) and a group of pre-pastoral *Holocene* individuals from the Southern Cape, dated 9750 - 2000 B.P. The contemporary groups are associated with modern lifestyles, and the pre-pastoral individuals with habitually unshod forager societies. Multivariate analysis of the linear data revealed very subtle morphological discrimination within and between the groups. An integrated principle components analysis clusters the Zulu and Sotho groups on the one hand, and the pre-pastoral group on the other, with considerable overlap between the groups. The first principle component shows a discrimination pri-

marily in size, with the second revealing no significant variation in shape between the groups. The observed traits show considerable variation within groups, with almost identical frequencies between the groups. All groups have an appreciable number of identifiable pathological changes, with the Sotho group having the most and the pre-pastoral group the least. In all groups, the hallux metatarsal displays by far the greatest frequency in osseous modification. We conclude that regardless of temporal context, no clear correlation between morphological variation and pathologic changes could be found.

#### **Aspects of virtual reconstruction in physical anthropology.**

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Computer-based tools and techniques permit the execution of data acquisition and measuring tasks at a higher degree of complexity than physical tools. Likewise, they open up new ways of data exploration, analysis and visualization. However, the data structures acquired, generated, manipulated and analyzed with computer tools are virtual three- or multidimensional entities, which have a complex relation with the real objects they represent. This relation is not an immediate one, but implies various aspects of virtual reconstruction. First, 3D data acquisition with devices such as computer tomographs or laser scanners implies the reconstruction of object images using multi-stage image processing methods. Second, the reconstruction of virtual 3D object representations from 2D image data typically is an "ill-posed" problem, which requires specific knowledge about the physical properties of both the data acquisition tools and the specimens under investigation. Third, fossils as well as extant museum specimens are often incomplete, requiring pre-defined criteria for the reconstruction and correction of the effects of diagenetic events, and computer graphics tools for the reconstructive assembly and completion of fragmentary specimens in virtual reality. Fourth, organisms are spatiotemporal processes rather than static entities, such that a major goal of the analysis of anthropological data is the reconstruction and visualization of patterns of temporal and spatial change, both on ontogenetic and evolutionary time scales. We discuss theoretical and practical problems related to these aspects of virtual reconstruction,

and illustrate them with examples from computer-assisted paleoanthropology.

#### **Bending strength of primate metacarpals measured using computed tomography.**

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Cross-sectional area and shape of long bone diaphyses are useful parameters in assessing limb usage in locomotion. Central to this issue is our ability to distinguish characters of the hand that reflect knuckle walking as opposed to digitigrady. Experimental studies have shown that changes in loading of an adult long bone affect the amount and distribution of cortical bone in the diaphysis. These kinds of shape complexities and their influence on overall bone strength are best addressed with the use of computed tomography. In order to determine if cortical distribution and overall bending strength differs between knuckle walkers and non-knuckle walkers, the metacarpals are used in this analysis of bending and torsional rigidity.

A sample of third metacarpals from five extant primate taxa (*Gorilla*, *Pan*, *Pongo*, *Hylobates*, and *Papio*) were scanned at midshaft using computed tomography. The percent cortical area, relative maximum bending strength ( $I_{max}/I_{min}$ ), directional bending strength in ML and AP directions ( $I_x/I_y$ ), and polar second moment of area ( $J=I_x+I_y$ ) were calculated. Preliminary analyses indicate that gorillas and baboons have greater cortical area and higher  $J$  values than would be expected given metacarpal length. *Pan* and *Pongo* are not significantly different from each other in  $J/TL$ , however orangs (and gibbons) fall below the regression line, indicating less bending rigidity relative to length. For  $I_x/I_y$ , *Papio* is significantly different with cortical bone distribution in a predominantly mediolateral as opposed to anteroposterior direction. The heavily buttressed metacarpals of *G.g. beringei* differ from all other taxa in  $I_{max}/I_{min}$  and  $I_x/I_y$ .

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