

# **Program of the Seventieth Annual Meeting of the American Association of Physical Anthropologists**

To be held at  
**The Westin Crown Center Hotel**  
Kansas City, Missouri  
March 28 to March 31, 2001

## **AAPA Scientific Program Committee**

Phillip Walker, Chair and Program Editor

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## **Local Arrangements Committee**

David Frayer

Sandra Gray

with help from

Michael Crawford

Jim Mielke

and many student volunteers

## Message from the Program Committee Chair

The 2001 AAPA meeting, our seventieth annual gathering, will be held at the Westin Crown Center Hotel in Kansas City, Missouri. There will be more than 540 podium and poster contributions, distributed among 33 sessions. We will have nine invited symposia including a memorial session in honor of Sherwood Washburn. The symposia cover a broad range of topics such as “Molecules and Morphology,” the proliferation of new hominid taxa, the population history of south Asia and Oceania, Great Plains skeletal biology, growth and development in the genus *Homo*, adaptations to coastal environments, age-related bone loss, and “populational thinking.”

It is gratifying to see a continuation of the trend toward our meetings becoming truly international in scope. This year, over twenty percent of the authors of presentations live outside of the United States. In addition to a large contingent of attendees from Canada and the United Kingdom, there are also substantial numbers of participants from Austria, Australia, France, Germany, Indonesia, Italy, Japan, Portugal, South Africa, and Spain.

This year we are beginning to computerize the process through which you will submit abstracts and register for future meetings. This will have a number of benefits, not the least of which is relieving you of the annual ritual of figuring out how to make your printer place your abstract within the boundaries of the infamous “blue line” of our traditional abstract submission form. Among the first tangible benefits of our entry into the digital age are the improved typography and indexing that you will note in this volume. Another is the searchable on-line database of the abstracts in this volume that is available at the AAPA web site: [www.physanth.org](http://www.physanth.org). By enter-

ing 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.

Our creative local arrangements committee has scheduled several exciting special events including a piano concert featuring physical anthropologists Per Enflo and Sang-Hee Lee, and a townhall-style debate and dinner featuring Ian Tattersall and Milford Wolpoff that will be held at one of Kansas City’s many fine restaurants.

As in the past, several scientific societies are meeting immediately before or in conjunction with the AAPA. These groups include the Human Biology Association, the Paleopathology Association, the Paleoanthropology Society, the Primate Biology and Behavior Interest Group, the American Dermatoglyphics Association, the American Association of Anthropological Genetics, and the Dental Anthropology Association. The AAPA looks forward to collaborating with these organizations at this and future meetings.

The following pages provide a summary table of conference events; a map of the Ballroom, Lobby, and Executive Office levels of the Westin Crown Center Hotel showing the locations of meeting rooms; a day-by-day conference schedule, including meetings of affiliated societies, editorial boards, workshops, and various business meetings; a detailed listing of AAPA podium and poster session; the abstracts of presentations; and indexes of authors showing the session numbers of their presentations and the page numbers where their abstracts can be found.

AAPA activities commence with a reception on Wednesday evening, March 28. Poster and podium sessions begin Thursday morning and continue through Saturday evening. Plan on attending the annual plenary session and the meeting luncheon on Thursday and Friday, respectively. For the plenary session, we will have talks by Meave Leakey (Kenya National Museums) and Bill Kimbel (IHO, Arizona State) that will provide an overview of recent developments in early Australopithecine research. Leslie Aiello will present the annual AAPA luncheon talk on “The Life and Times of Ice Age Humans.” Also keep in mind the business meeting for Friday evening, and the award reception on Saturday afternoon.

The AAPA Program, Local Arrangements, and Executive committees cordially invite you to our seventieth annual meeting. We look forward to seeing you in Kansas City.

***Phillip L. Walker***

*AAPA Vice President and  
Program Committee Chair*

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## The Conference at a Glance

	Tue Morning	Tue Afternoon	Tue Evening	Wed Morning	Wed Afternoon	Wed Evening	Thur Morning
<b>Boardroom</b>							
<b>Brookside</b>				Press & Interviews	Press & Interviews		Press & Interviews
<b>Century A</b>	HBA & PPA Poster Sessions	HBA & PPA Poster Sessions		HBA & PPA Poster Sessions	HBA & PPA Poster Sessions		Poster Sessions 1 & 2: Skeletal Biology I/ Dental Anth. Primates I, Behavior & Ecology
<b>Century B</b>							
<b>Century C</b>						AAPA Reception & Cash Bar, 8-11pm	
<b>Century Foyer</b>					Registration, 4-7pm		Registration, 8 am-4pm
<b>Club Lounge</b>							
<b>Garden Terrace</b>			HBA Reception, 8-10pm		HBA Awards Luncheon, 12:15-2pm		
<b>Liberty</b>	PS Podium Sessions	PS Podium Sessions		PS Podium Sessions	PS Podium Sessions		
<b>Pershing Place East</b>		PPA Podium Sessions		PPA Podium Sessions	PPA Podium Sessions	Panel: Student Career Entry Concerns, 6:30-7:45pm	Session 5: Human Biology I, 8 am-12 noon
<b>Pershing Place West</b>							Session 4: Washburn Memorial Symp., 8:30am-12 noon
<b>Pershing Place North</b>							Session 3: Paleoanth. I, Early Hominids, 8 am-noon
<b>Pershing Place South</b>							
<b>Shawnee</b>	HBA Plenary Session 2, 8am-12 noon	HBA Plenary Session 2, 1:30-4:15pm; HBA Lecture, 4:15-5pm	HBA Business Meeting, 5-6pm	HBA Workshop: HLA & Anth., 8am-12noon	HBA Podium Sessions, 2-6pm		Session 6: Paleoanth. II, Primate Evolution 8-11:45am
<b>Mission</b>							
<b>Signboard 1</b>					AJPA Edit. Board Lunch, 12 noon-2pm		
<b>Union Hill</b>	Slide Preview	Slide Preview		Slide Preview	Slide Preview		Slide Preview
<b>Washington Park 1</b>	PPA Podium Sessions		PPA Cocktails & Dinner, 6-10pm				
<b>Washington Park 2</b>	PPA Podium Session						
<b>Westport</b>				AJHB Meeting 7-8:15am, AAPA Exec. Com., 8:15am-noon	AAPA Exec. Com., noon-5pm		

**Sunday:** Human Biology Association Executive Committee Meeting, 6-10pm, Signboard 1

**Monday:** Human Biology Association Podium Sessions, *Mission*; Slide Preview, *Union Hill*; Registration, *Roanoke Convention Office*

**Wednesday:** Human Biology and Paleopathology Registration, *Roanoke Convention Office*; Human Biology Board Meeting, *Roanoke Room*, 6-8pm

**Saturday:** Dinner with Ian & Milford—a Town Hall Style Debate (by reservation only), Lidia's of Kansas City, 101 W. 22nd Street, 7:30-10:30pm

*For a schedule of all conference events, see page 7.  
For a detailed listing of individual AAPA poster and podium presentations, see page 10.*

Thur Afternoon	Thu Evening	Fri Morning	Fri Afternoon	Fri Evening	Sat Morning	Sat Afternoon
					Slide Preview	Slide Preview
Press & Interviews		Press & Interviews	Press & Interviews		Press & Interviews	Press & Interviews
Session 7: Paleoanth. III, Primate Evolution, Posters		Poster Sessions 12 & 13: Paleoanth. II, Primates III, Biological Variation	Sessions 18 & 19: Genetics II, Human Biology II		Session 24: New Approaches to Plains Skeletal Biology, Poster Symp.	Session 29: Paleoanth. VI, Hominid Evolution, Posters
			Luncheon Speaker: The Life & Times of Ice Age Humans, Leslie Aiello 12 noon-2pm	Business Meeting, 8-11pm	Session 28: Patterns of Growth & Development in the Genus <i>Homo</i> , Symp., 8am-12 noon	Session 33: Paleoanth. VII, Primate Evolution, 1-5pm
Registration, 8 am-4pm		Registration., 8 am-4 pm	Registration, 8 am-4 pm		Registration, 8 am-12 noon	
		Slide Preview	Slide Preview			
Session 10: Genetics I, 1-5 pm; Primate Biology Interest Group, 5-6pm		Session 17: Skeletal Biology II/ Dental Anth. II., 8am-12 noon	Session 23: Primates IV, Behavioral Ecology, 2-5:30 pm	AAAG Business Meeting, 7-8 pm	Session 27: Primates V, Social & Reproductive Behavior, 8:15 am-12 noon	Session 32: Paleoanth. III, 1-4:15 pm
Session 9: Paleoanth. I, 1-4:30pm		Session 16: Molecules & Morphology, Symp., 8:45-11:15 am	Session 22: Age-Related Bone Loss, Symp., 2-5:45 pm			
Session 8: Read Our Lips, No New Taxa, Symp., 1-5:30pm	Plenary Session, Early Australopithecines, 6-7:15pm	Session 15: Paleoanth. IV, Pleistocene, 8am-12 noon	Session 21: Paleoanth. V, 2-6pm	Piano Concert, 6-7pm	Session 25: Genetics III, Population Biology, 8am-12 noon	Session 30: Populational History of S. Asia & Oceania, Symp., 1-5:15pm
					Session 26: Populational Thinking, Symp., 8-11:30am	Session 31: Primates VI, Biological Variation, 1-5 pm; AAPA Awards Reception, 5:30 -7pm
Session 11: Primates II, Method & Theory, 1-4:30pm	DAA Business Meeting, 5-6pm	Session 14: Ethical Issues in Biological Anth. Symp., 8am-12 noon	Session 20: Adjustments to Coastal Environ. Symp., 2:15-6 pm; ADA Bus. Meeting, 5-7pm			
Slide Preview						
	Wiley/Liss Reception, 8:30-11pm					

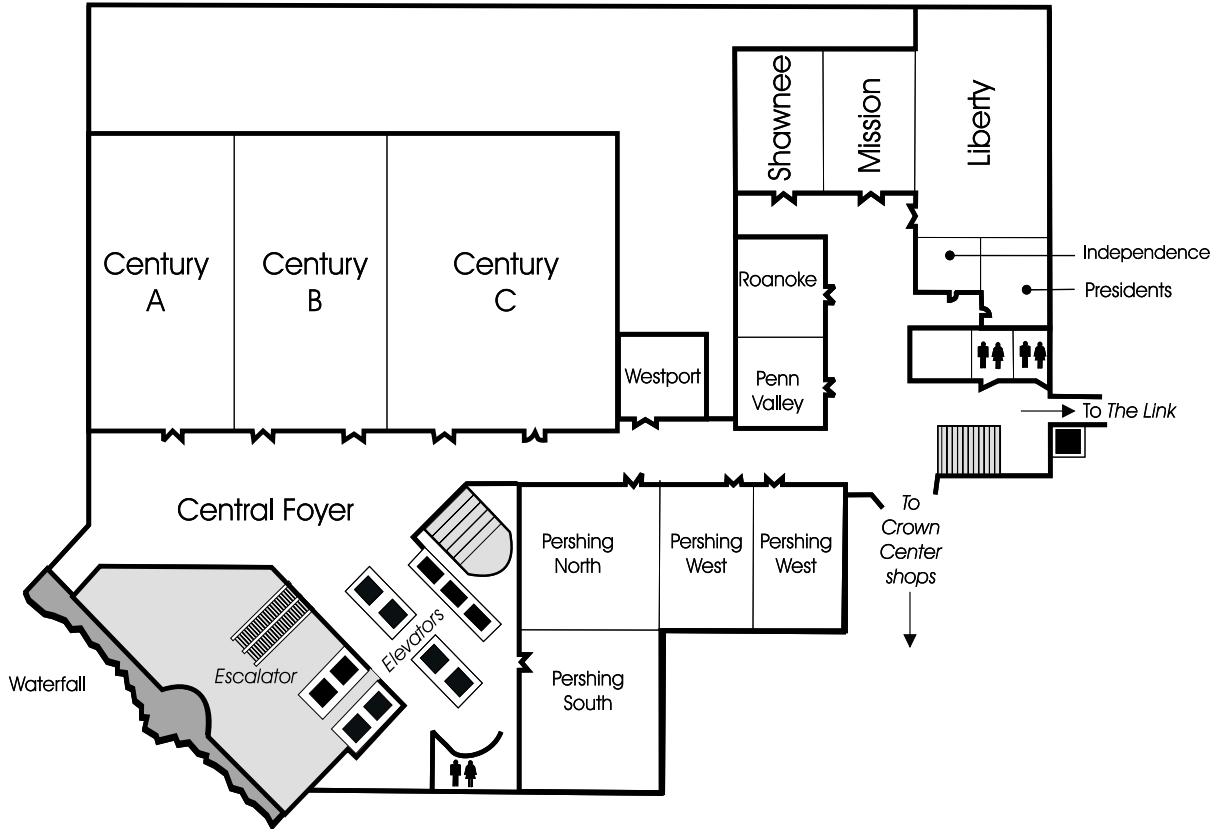
**Key to acronyms:**

**AAAG** American Association of Anthropological Genetics  
**AAPA** American Association of Physical Anthropologists  
**ADA** American Dermatoglyphics Association  
**AJHB** American Journal of Human Biology

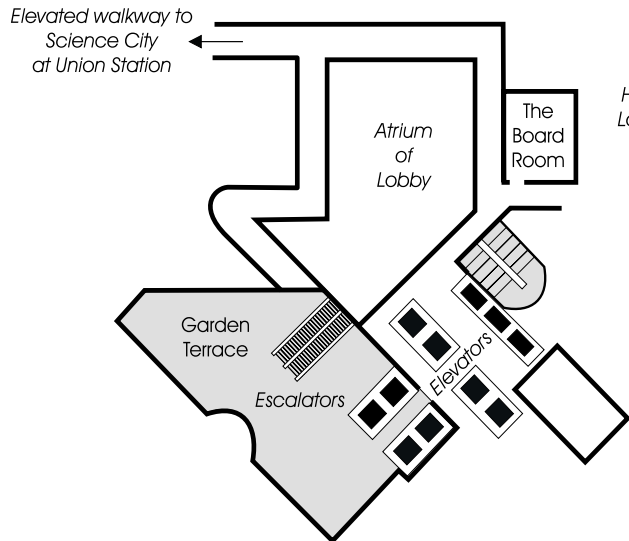
**AJPA** American Journal of Physical Anthropology  
**DAA** Dental Anthropology Association  
**HBA** Human Biology Association  
**PPA** Paleopathology Association  
**PS** Paleoanthropology Society

# Westin Crown Center Hotel Meeting Rooms

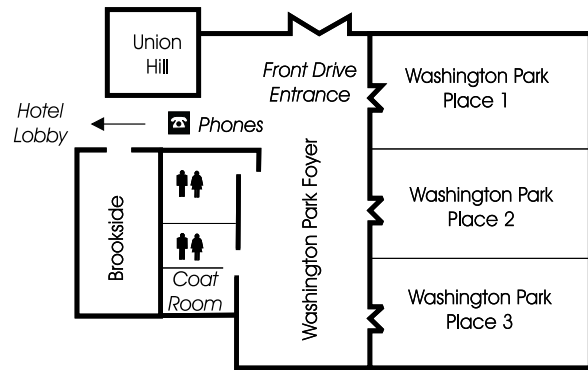
Ballroom Level



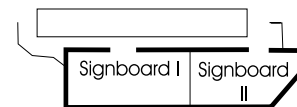
Executive Office Level



Lobby Level



Signboard-Lobby Level



## Conference Schedule

*For a schedule of individual AAPA poster and podium presentations, see page 10.*

### Sunday, March 25, 2001

#### Human Biology Association

6:00 pm–10:00 pm Executive Committee Meeting. *Signboard 1*

### Monday, March 26, 2001

#### Human Biology Association

7:30 am–5:30 pm Registration. *Roanoke Convention Office*

8:00 am–5:00 pm Plenary Session 1. *Mission*

8:00 pm–10:00 pm Human Biology in the Coming Millennium. *Mission*

#### Paleopathology Association

5:00 pm–7:00 pm Registration. *Roanoke Convention Office*

### Tuesday, March 27, 2001

#### Human Biology Association

7:30 am–5:30 pm Registration. *Roanoke Convention Office*

6:00 am–6:00 pm Slide Preview. *Union Hill*

8:00 am–4:15 pm Plenary Session 2. *Shawnee Mission*

8:00 am–5:00 pm Poster Sessions. *Century A*

4:15 pm–5:00 pm Raymond Pearl Memorial Lecture: Genetic Reconstruction of History and Ancient Demography, Henry Harpending. *Shawnee Mission*

5:00 pm–6:00 pm Business Meeting. *Shawnee Mission*

8:00 pm–10:00 pm Reception. *Garden Terrace*

#### Paleopathology Association

6:00 am–6:00 pm Slide Preview. *Union Hill*

8:00 am–5:00 pm Registration. *Roanoke Convention Office*

8:00 am–12:00 pm Podium Sessions. *Washington Park 1*

8:00 am–12:00 pm Podium Sessions. *Washington Park 2*

8:00 am–5:00 pm Poster Sessions. *Century A*

1:00 pm–6:00 pm Podium Sessions. *Pershing East and West*

6:00 pm–10:00 pm Cocktails and Dinner. *Washington Park 1*

#### Paleoanthropology Society

8:00 am–6:00 pm Podium Sessions. *Liberty*

### Wednesday, March 28, 2001

#### American Association of Physical Anthropologists

4:00 pm–7:00 pm Registration. *Century Foyer*

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

12:00 noon–2:00 pm AJPA Editorial Board Luncheon. *Signboard 1*

6:30 pm–7:45 pm Panel Discussion: Student Concerns Regarding Career Entry. *Pershing Place East*

8:00 pm–11 pm Reception and Cash Bar. *Century C*

**Human Biology Association**

6:00 am–6:00 pm	Slide Preview. <i>Union Hill</i>
8:00 am–5:00 pm	Press and Interview Room. <i>Brookside</i>
7:00 pm–8:15 am	American Journal of Human Biology Meeting and Breakfast. <i>Westport</i>
7:30 am–2:00 pm	Registration. <i>Roanoke Convention Office</i>
8:00 am–5:00 pm	Poster Sessions. <i>Century A</i>
8:00 am–12:00 noon	Workshop: HLA and Anthropology. <i>Shawnee Mission</i>
12:15 pm–2:00 pm	Awards Luncheon. <i>Garden Terrace</i>
2:00 pm–6:00 pm	Podium Sessions. <i>Shawnee Mission</i>

**Paleopathology Association**

6:00 am–6:00 pm	Slide Preview. <i>Union Hill</i>
8:00 am–5:00 pm	Press and Interview Room. <i>Brookside</i>
8:00 am–12:00 noon	Registration. <i>Roanoke Convention Office</i>
8:00 am–6:00 pm	Poster Sessions. <i>Century A</i>
8:00 am–6:00 pm	Podium Sessions. <i>Pershing Place East and West</i>

**American Association of Anthropological Genetics**

6:00 pm–8:00 pm	Human Biology Editorial Board Meeting and Dinner. <i>Roanoke Room</i>
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**Paleoanthropology Society**

8:00 am–6:00 pm	Podium Sessions. <i>Liberty</i>
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**Thursday, March 29, 2001****American Association of Physical Anthropologists**

8:00 am–4:00 pm	Registration. <i>Century Foyer</i>
6:00 am–6:00 pm	Slide Preview. <i>Union Hill</i>
8:00 am–5:00 pm	Press and Interview Room. <i>Brookside</i>
8:00 am–12:30 pm	Session 1: Skeletal Biology I/ Dental Anthropology I. Posters. <i>Century A</i>
8:00 am–12:30 pm	Session 2: Primates I, Behavior and Ecology. Posters. <i>Century A</i>
8:00 am–12:00 noon	Session 3: Paleoanthropology I, Early Hominids. Contributed Papers. <i>Pershing Place North and South</i>
8:30 am–12:00 noon	Session 4: Washburn Memorial Symposium. <i>Pershing Place West</i>
8:00 am–12:00 noon	Session 5: Human Biology I. Contributed Papers. <i>Pershing Place East</i>
8:00 am–11:45 am	Session 6: Paleoanthropology II, Primate Evolution. Contributed Papers. <i>Shawnee Mission</i>
1:00 pm–5:30 pm	Session 7: Paleoanthropology III, Primate Evolution. Posters. <i>Century A</i>
1:00 pm–5:30 pm	Session 8: “Read Our Lips, No New Taxa.” Symposium. <i>Pershing Place North and South</i>
1:00 pm–4:30 pm	Session 9: Paleopathology I. Contributed Papers. <i>Pershing Place West</i>
1:00 pm–5:00 pm	Session 10: Genetics I. Contributed Papers. <i>Pershing Place East</i>
1:00 pm–4:15 pm	Session 11: Primates II, Method and Theory. Contributed Papers. <i>Shawnee Mission</i>
5:00 pm–6:00 pm	Primate Biology Interest Group. <i>Pershing Place East</i>
6:00 pm–7:15 pm	Plenary Session: Early Australopithecines. <i>Pershing Place North and South</i>
8:30 pm–11:00 pm	Wiley/Liss Reception. <i>Washington Park Place</i>

**Dental Anthropology Association**

5:00 pm–6:00 pm	Business Meeting. <i>Shawnee</i>
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**Friday, March 30, 2001****American Association of Physical Anthropologists**

8:00 am–4:00 pm	Registration. <i>Century Foyer</i>
6:00 am–6:00 pm	Slide Preview. <i>Club Lounge</i>



8:00 am–5:00 pm	Press and Interview Room. <i>Brookside</i>
8:00 am–12:30 pm	Session 12: Paleopathology II. Posters. <i>Century A</i>
8:00 am–12:30 pm	Session 13: Primates III, Biological Variation. Posters. <i>Century A</i>
8:00 am–12:00 noon	Session 14: Ethical Issues in Biological Anthropology. Symposium. <i>Shawnee</i>
8:00 am–12:00 noon	Session 15: Paleoanthropology IV, Pleistocene. Contributed Papers. <i>Pershing Place North and South</i>
8:45 am–11:15 am	Session 16: Molecules and Morphology, Comparisons of Recent Living Human Populations. Symposium. <i>Pershing Place West</i>
8:00 am–12:00 noon	Session 17: Skeletal Biology II/ Dental Anthropology II. Contributed Papers. <i>Pershing Place East</i>
12:00 noon–2:00 pm	Luncheon Speaker: The Life and Times of Ice Age Humans, Leslie Aiello. <i>Century B</i>
2:00 pm–5:30 pm	Session 18: Genetics II. Posters. <i>Century A</i>
2:00 pm–5:30 pm	Session 19: Human Biology II. Posters. <i>Century A</i>
2:15 pm–6:00 pm	Session 20: Adjustments to Coastal Environments. Symposium. <i>Shawnee</i>
2:00 pm–6:00 pm	Session 21: Paleoanthropology V. Contributed Papers. <i>Pershing North and South</i>
2:00 pm–5:45 pm	Session 22: Age-Related Bone Loss, An Anthropological Perspective. Symposium. <i>Pershing Place West</i>
2:00 pm–5:30 pm	Session 23: Primates IV, Behavioral Ecology. Contributed Papers. <i>Pershing Place East</i>
6:00 pm–7:00 pm	Piano Concert featuring Per Enflo and Sang-Hee Lee. <i>Pershing North and South</i>
8:00 pm–11:00 pm	Business Meeting. <i>Century B</i>

#### American Association of Anthropological Genetics

7:00 pm–8:00 pm	Business Meeting. <i>Pershing Place East</i>
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#### American Dermatoglyphics Association

6:00 pm–7:00 pm	Business Meeting. <i>Shawnee</i>
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### Saturday, March 31, 2001

#### American Association of Physical Anthropologists

8:00 am–12:00 noon	Registration. <i>Century Foyer</i>
6:00 am–6:00 pm	Slide Preview. <i>Board Room</i>
8:00 am–5:00 pm	Press and Interview Room. <i>Brookside</i>
8:00 am–12:30 pm	Session 24: New Approaches to Skeletal Biology, Examples from the American Great Plains. Poster Symposium. <i>Century A</i>
8:00 am–12:00 noon	Session 25: Genetics III, Population Biology. Contributed Papers. <i>Pershing Place North</i>
8:00 am–11:30 am	Session 26: “Populational Thinking, Dead or Alive?” Symposium. <i>Pershing Place South</i>
8:15 am–12:00 noon	Session 27: Primates V, Social and Reproductive Behavior. Contributed Papers. <i>Pershing Place East and West</i>
8:00 am–12:00 noon	Session 28: Patterns of Growth and Development in the Genus <i>Homo</i> . Symposium. <i>Century B</i>
1:00 pm–5:30 pm	Session 29: Paleoanthropology VI, Hominid Evolution. Posters. <i>Century A</i>
1:00 pm–5:15 pm	Session 30: Understanding the Populational History of South Asia and Oceania, “How informative are genetic studies on the contemporary indigenous populations?” Symposium. <i>Pershing Place North</i>
1:00 pm–5:00 pm	Session 31: Primates VI, Biological Variation. Contributed Papers. <i>Pershing Place South</i>
1:00 pm–4:15 pm	Session 32: Paleopathology III. Contributed Papers. <i>Pershing Place East and West</i>
1:00 pm–5:00 pm	Session 33: Paleoanthropology VII, Primate Evolution. Contributed Papers. <i>Century B</i>
5:30 pm–7:00 pm	Awards Reception. <i>Pershing Place South</i>
7:30 pm–10:30 pm	Dinner with Ian and Milford: a Town Hall Style Debate (by reservation only). <i>Lidia’s Kansas City, 101 W. 22nd St.</i>

# AAPA Poster and Podium Presentation Schedule

*For a schedule of all conference events, see page 7*

*\* indicates a student prize contestant.*

## Thursday, March 29, 2001, morning

### Session 1: Skeletal Biology I/ Dental Anthropology I. Posters. *Century A*

Chair: David Weaver, Wake Forest University, Winston-Salem, NC.

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

1. Variation in the lumbar neural canal. N.E. TATAREK.
2. Age-related changes in lumbar vertebral dimensions. A. GALLOWAY, J.J. SNODGRASS.
3. Age-related changes on the auricular surface of the ilium: A revised recording system. J.L. BUCKBERRY.\*
4. Is eight enough? A comparison of eight aging methods on a juvenile skeletal sample from the Dakhleh Oasis, Egypt. T.L. DUPRAS, M.W. TOCHERI, J.E. MOLTO.
5. An observer error test of the transition analysis aging technique. C.J. YODER, J.L. BOLDSSEN.
6. Sex dimorphism and bilateral asymmetry: Modeling developmental instability and functional adaptation. R.A. LAZENBY.
7. Testing the validity of metacarpals for sex determination of human skeletal remains. V.P. ZANELLA, T.M. BROWN, A.M. BURROWS.
8. A test of the applicability of modern, US obstetric standards to skeletal populations. A.L. THOMPSON.
9. Studies of bone organization in three dimensions. N.C. TAPPEN.
10. The role of osteocyte lacunae populations in interpreting loading history of bone. K.J. HUNT, J.G. SKEDROS.
11. The influence of exercise on muscle insertion scars in sheep. A.C. ZUMWALT, C.B. RUFF, D.E. LIEBERMAN.
12. A survey of remodeling in the vertebrate skeleton, part III. Variation in percentage haversian bone. R.A. WALKER, N. MITLYANSKY, C.O. LOVEJOY.
13. Postcranial robusticity and rugosity patterning in modern humans. C.E. IMBER, L.C. AIELLO.
14. Guidelines for the use of a 'standard' for measuring bone density with DEXA and optical densitometry. M. BRICKLEY, N. CRABTREE.
15. Two distinct patterns of cutmarks as evidence for human sacrifice and ancestor worship in Tiwanaku, Bolivia. D.E. BLOM.
16. Head shaping and dental decoration: Two biocultural attributes of cultural integration and social distinction among the ancient Maya. V.G. TIESLER BLOS, R.L. BENÍTEZ FRAUSTO.
17. Prehistoric treatment of the dead: Bone handling in the southeastern United States. K.P. JACOBI, M.C. HILL.
18. Signatures of stable strontium isotopes in human hard tissues: Applications to forensic identification? H. SCHUTKOWSKI, B. HANSEN, M. WORMUTH, B. HERRMANN.
19. Changes in dietary behaviour over the life span and its impact on a French late Medieval population health (Saint-Laurent de Grenoble, France) E. HERRSCHER, H. BOCHERENS, F. VALENTIN, R. COLARDELLE.
20. Diet and mobility in medieval Greece based on bone stable isotope ratios. S.J. GARVIE-LOK.\*
21. Standardize decomposition rates of human surfaces remains in the West Texas environment. G.D. CAVNESS, R.R. PAINE.
22. An assessment of method in the study of developmental integration using the adult human cranial base. J.H. HUNT, L.R. GODFREY.
23. Frontal sinus size: Sex, population and metopism affinities. D.R. HUNT, K. EVEREST.
24. Patterns of age-related craniofacial change: Implications for choosing adult human comparison samples in craniofacial studies. A.M. LUBENSKY.
25. Midsagittal facial tissue thicknesses of Montreal children and adolescents. S.L. SMITH, P.H. BUSCHANG.
26. Mid-sagittal cranial variation in geographically distant modern human populations. D.E. SLICE, E.G. HILL, D.S. WEAVER, H. SEIDLER.
27. Modern statistical computing in R and WinBUGS for physical anthropology. L.W. KONIGSBERG, N.P. HERRMANN.

28. Fluctuating asymmetry and aggression in an American Indian population. H.T. FOSTER.\*  
 29. Kennewick Man's behavior: a CT-scan analysis. E. WEISS.\*

## Session 2: Primates I, Behavior and Ecology. Posters. *Century A*

Chair: K. Anne Nekaris, Southern Illinois University, Carbondale.

- |                     |   |
|---------------------|---|
| 8:00 am–8:30 am     | Poster set-up.  |
| 8:30 am–10:00 am    | Authors of even-numbered posters present for questions. |
| 10:30 am–12:00 am   | Authors of odd-numbered posters present for questions.  |
| 12:00 noon–12:30 pm | Poster take-down.                                       |
30. Differences in habitat type of *Otolemur crassicaudatus* and *Galago moholi* in the Makapan Valley, South Africa. P.J. CONSTANTINO.\*
31. Hand and body position during locomotor behavior in the aye-aye. E. KRAKAUER, P. LEMELIN, D. SCHMITT.
32. Analysis of a 13-year demographic study on ringtailed lemurs at the Beza-Mahafaly Reserve, Madagascar. L. GOULD, R.W. SUSSMAN.
33. Hand use preference and other lateralized behaviors in *Lemur catta*. H.G. HARRIS.\*
34. Genetic and demographic structure in a population of white sifaka (*Propithecus verreauxi verreauxi*). R.R. LAWLER, A.F. RICHARD, M.A. RILEY.
35. Foraging, feeding and defecation site selection as a parasite avoidance strategy of *Alouatta palliata* in a dry tropical forest. R.E. HENRY, L. WINKLER.
36. Daytime resting-site selection in mantled howling monkeys (*Alouatta palliata*): Relative influences of feeding and comfort. E.N. VIDEAN.
37. Fruit tissue toughness as a determinant of masticatory robusticity and food utilization: A study of primates in central Guyana. B.W. WRIGHT.\*
38. A comparison of the locomotor behavior and habitat use of *Cebus olivaceus* and *Cebus apella* in Guyana. K.A. WRIGHT.\*
39. Changes in social networks over the lifespan in male and female rhesus macaques. J. CORR.
40. Assessing the trade of primates in Indonesia and the collection of non-invasively obtained cytogenetic evidence. N.M. MALONE, A.R. PURNAMA, M. WEDANA, A. FUENTES.
41. Male sexual strategies in a semi-free ranging group of long-tailed macaques (*Macaca fascicularis*). A.R. WELCH, J.E. LOUDON, A. FUENTES.
42. An ongoing study of the female copulation call in long-tailed macaques (*Macaca fascicularis*). J.B. FRAVER, G. EMEL, A. FUENTES, K.G. SUARYANA, I.D.K. HARYA PUTRA.
43. Visual monitoring by *Macaca fascicularis* at Padangtegal, Bali, Indonesia. G.L. EMEL, A. FUENTES, K.G. SUARYANA.
44. Sex differences in habitat use of western red colobus (*Colobus badius badius*) in the Ivory Coast's Tai National Park. M.Y. FIELD, W.S. MCGRAW.
45. Dispersal and philopatry in Hamadryas baboons: A re-evaluation based on behavioral and genetic evidence. L. SWEDELL, T. WOOLEY-BARKER.
46. Mechanisms of species coexistence in a community of catarrhines: Resource switching and dietary flexibility. J.E. LAMBERT.
47. Limb preference in *Pan paniscus*. R.M. HARRISON, P. NYSTROM.
48. Adolescent male chimpanzee grooming behavior at Ngogo, Kibale National Park, Uganda. H.M. SHERROW.\*
49. Terrestrial nesting by chimpanzees in Bwindi Impenetrable National Park, Uganda. J.E. MAUGHAN, C.B. STANFORD.
50. The ontogeny of positional behavior in captive chimpanzees: A mixed cross-sectional/longitudinal study. M.L. SCHWANDT.\*
51. An examination of the relationship between post-conflict interaction method and theory. C.S. SANZ, J.A. WEGHORST, R.W. SUSSMAN.
52. Cranial morphology predicts relatively low forces and relatively large gapes during gouging in primate gummivores. C.E. WALL, C.J. VINYARD, S.H. WILLIAMS, W.L. HYLANDER.
53. Behavior of a black and white colobus group during intergroup encounters. T.R. HARRIS.
54. Presence of mother and juvenile dispersal in free-ranging howling monkeys (*Alouatta palliata*) in the tropical dry forest of Costa Rica. M.R. CLARKE, K.E. GLANDER.

## Session 3: Paleoanthropology I, Early Hominids. Contributed Papers. *Pershing Place North and South*

Chair: Mark F. Teaford, Johns Hopkins University, Baltimore, MD.

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| 8:00 am | Multivariate assessment of body shape in A.L. 288-1 ("Lucy"). T.W. HOLLIDAY, R.G. FRANCISCUS. |
| 8:15 am | Knuckle-walking and the midcarpal joint. B.G. RICHMOND, D.S. STRAIT.                          |

- 8:30 am The effect of restricted arm swing on human walking. D.A. RAICHLEN.
- 8:45 am Mechanobiology in the evolution and development of the human bicondylar angle. S.J. SHEFELBINE, C. TARDIEU, D.R. CARTER.
- 9:00 am The sacrum of A.L. 288-1 and its relevance to the question of locomotion in *Australopithecus afarensis*. B.A. ROSENMAN, C.O. LOVEJOY.
- 9:15 am Bipedal walking with elastic loading and its possible role in evolution. Y. LI, W. WANG, R. CROMPTON, M. GUNTHER, R. SAVAGE, R. PAYNE.
- 9:30 am Surface area proportions, articular surface curvature, and the locomotor repertoire of AL 288-1. A.D. SYLVESTER.\*
- 9:45 am Intermission
- 10:00 am Human hands are adapted for bipedalism, not tool use. D. WEBB, S. FABINY.
- 10:15 am Evidence of ancient viruses and their role in hominid evolution. L.M. VAN BLERKOM.
- 10:30 am Omo-323-1976-896: A robust australopithecine from Member G of the Shungura Formation, Ethiopia. D. GERAADS, Z. ALEMSEGED.
- 10:45 am Current research on Oldowan hominid activities at Kanjera South, Kenya. T. PLUMMER, J. FERRARO, P. DITCHFIELD, L. BISHOP.
- 11:00 am New hominin discoveries from the Nachukui Formation, west of Lake Turkana. M.G. LEAKEY, F. SPOOR, L.N. LEAKEY, F.H. BROWN.
- 11:15 am Was the Laetoli G-3 hominid a juvenile? K.A. MANLEY-BUSER, D. WEBB, M. ALLEN.
- 11:30 am Seeking the blueprint to the upper respiratory tract in fossil hominids: New insights from molecular approaches to branchial arch development. A.L. BALBONI, A.D. BERGEMANN, S. MARQUEZ, J. REIDENBERG, J.T. LAITMAN.
- 11:45 am New discovery of *Australopithecus* in the Somali region of Ethiopia. G.W. WEBER, H. SEIDLER, R. MACCHIARELLI, L. BONDIOLI, P. FAUPL, W. RICHTER, O. KULLMERS, O. SANDROCK, D. FALK.

#### Session 4: Washburn Memorial Symposium. *Pershing Place West.*

Organizers and Chairs: Alan Almquist, California State University, Hayward; Jane Lancaster, University of New Mexico; Russell Tuttle, University of Chicago.

Sherwood L. Washburn was the premier American physical anthropologist of the 20th Century. During his long career, he conducted embryological and ablation experiments on nerves, bones, and muscles in nonhuman animals to inform the development of cranial features. He authored papers that stressed novel approaches to the study of anatomy, functional perspectives and properly controlled comparisons. His interest in nonhuman primates ultimately focused on behavior, and he conducted benchmark fieldwork on baboons. Washburn inspired, mentored and provoked numerous students to become professional evolutionary anthropologists, and he firmly situating primatology in the human sciences. He served as President of the AAPA (1951-52). Professor Washburn was a dedicated, visionary, socially conscious intellectual leader and synthesizer *sui generis*. We revisit his interests in functional morphology, molecular genetics, paleoanthropology and behavior.

#### Part 1. Anatomy, molecular genetics and the fossil record.

Chair: Russell Tuttle University of Chicago.

- 8:30 am Knuckle-walking with Sherry. R.H. TUTTLE.
- 8:45 am Brachiation is a dead issue. M.E. MORBECK.
- 9:00 am Studying the brain with Washburn: Some reminiscence. R.L. HOLLOWAY.
- 9:15 am Molecular clocks. V.M. SARICH.
- 9:30 am Giving Sherry a hand: Tools and the evolution of the human hand. M.W. MARZKE.
- 9:45 am Discussant: N. TAPPEN.
- 10:00 am Intermission

#### Part 2. Evolution of Behavior

Chair: Jane Lancaster University of New Mexico.

- 10:15 am Male provisioning and the sexual division of labor. J.B. LANCASTER.
- 10:30 am Balancing tools and language on the head. K.R. GIBSON.
- 10:45 am The once and future baboon: A source of analogies for earliest hominid adaptations. G.E. KING.
- 11:00 am Variability and adaptability in macaque social structure. P.E. SIMONDS.
- 11:15 am Modeling future prospects for primates. Conservation? Captive breeding? Extinction? C.A. BRAMBLETT.
- 11:30 am Sherwood Washburn: The whole earth pedagogue. A.L. ZIHLMAN.
- 11:45 am Discussion

**Session 5: Human Biology I. Contributed Papers. *Pershing Place East***

Chair: Gillian Bentley, University of Cambridge, UK.

- 8:00 am Variation in field metabolic rates among primates and other mammals: Implications for human evolutionary biology. J.J. SNODGRASS, W.R. LEONARD, M.V. SORENSEN, M.L. ROBERTSON.
- 8:15 am Building a head and body from parental directives: Sexual dimorphism under fetal constraint. M. LAMPL, C. KUZAWA, P. JEANTY.
- 8:30 am Fetal programming of lipid metabolism: Long-term implications of fetal growth in Filipino adolescents. C.W. KUZAWA, L.S. ADAIR.
- 8:45 am Energetics and postpartum fecundity: Changes in C-peptide levels in breastfeeding Toba women. C.R. VALEGGIA, P.T. ELLISON.
- 9:00 am Strikingly high acute-phase protein values in stunted Nepali children reporting low morbidity. C. PANTERBRICK, P.G. LUNN.
- 9:15 am Parasite load, growth, fluctuating asymmetry, and stress hormone profiles among children in a rural Caribbean village. C.C. WORTHEN, M.V. FLINN, D.V. LEONE, R.J. QUINLAN, B.G. ENGLAND.
- 9:30 am Bedsharing/breast feeding mothers and infants: Adaptation or pathology? J.J. MCKENNA, M. ANDOLINA, P. O'DONNELL, J. ANDRY.
- 9:45 am Intermission
- 10:00 am Declining growth status of indigenous Siberian children in Post-Soviet Russia. W.R. LEONARD, J. SPENCER.
- 10:15 am Musculoskeletal pain in women of menopausal age. S.K. GOODE-NULL, L. LEIDY SIEVERT.
- 10:30 am Evolution and body shape: Somatic adaptation in the Australian Central Desert. M. LAVELLE.
- 10:45 am Exhaled nitric oxide concentration of Andean and Tibetan high-altitude natives. C.M. BEALL, K.P. STROBL, S.C. ERZURUM, D. LASKOWSKI.
- 11:00 am Type 2 diabetes and Native American admixture in the San Luis Valley Mexican-American population. C. BONILLA, E.J. PARRA, D. SOSNOSKI, F. GULDEN, J. YE, K. HIESTER, J. NORRIS, J. MARSHALL, R. HAMMAN, R.E. FERRELL, M.D. SHRIVER.
- 11:15 am Length of time in U.S., acculturation status, and overweight and obesity among Latinos in two urban settings. D.A. HIMMELGREEN, R. PEREZ-ESCAMILLA, Y. PENG, D. MARTINEZ, A. WRIGHT.
- 11:30 am Demographic adaptation and blood pressure regulation in urban Caribbean-Americans. R.A. HALBERSTEIN.
- 11:45 am Whom do you trust? Coordination among cooperative big game hunters in Indonesia. M.S. ALVARD.

**Session 6: Paleoanthropology II, Primate Evolution. Contributed Papers. *Shawnee Mission***

Chair: John Kappelman, University of Texas, Austin.

- 8:00 am Dental variation in Bridger B *Omomys* from the Bridger Basin, WY, and the taxonomic integrity of *Omomys carteri*. F.P. CUOZZO.
- 8:15 am Molar flare in Miocene hominoids-function or phylogeny? M. SINGLETON.
- 8:30 am Great ape semicircular canal size: Shared adaptation or phylogeny? The evidence from *Theropithecus oswaldi*. F. SPOOR, M.G. LEAKEY.
- 8:45 am Dental development in *Graecopithecus freybergi* (*Ouranopithecus macedoniensis*). T.M. SMITH, L.B. MARTIN, L. DE BONIS, G.D. KOUFOS.
- 9:00 am Functional adaptations and phylogenetic affinities of the distal radius of *Kenyapithecus africanus* from Maboko Island, Kenya. T.C. CRAWFORD, M.L. MCCROSSIN.
- 9:15 am The femora of *Dryopithecus laietanus*. L.M. MACLATCHY, M. KOHLER, S. MOYA-SOLA.
- 9:30 am A re-investigation into the number of cercopithecoid taxa at the middle Miocene site of Maboko, Kenya. K.T. BLUE, M.L. MCCROSSIN.
- 9:45 am New fossil Cercopithecidae from the Early Pliocene site of Aramis in the Middle Awash Valley, Ethiopia. S.R. FROST.\*
- 10:00 am Intermission
- 10:15 am Size distributions of living and fossil primate faunas. C.P. HEESY, R.J. FAJARDO, J.G. FLEAGLE.
- 10:30 am Phylogenetic utility of higher primate postcranial morphology. M. COLLARD, S. GIBBS, B. WOOD.
- 10:45 am Haplorhine evolution in the mid-Eocene of Asia. D.L. GEBO, M. DAGOSTO, C. BEARD, T. QI.
- 11:00 am Primate origins: Role of evolutionary change in limb pattern formation. M.W. HAMRICK.
- 11:15 am Paul Methuen's sleeping treasure: Subfossil lemurs in the zoological collections of the University Museum, Oxford. L.R. GODFREY, M. ATKINSON, G.M. SEMPREBON.
- 11:30 am Phylogenetic and adaptive information in the pattern of ontogeny of a fossil primate (*Archaeolemur* sp., cf. *edwardsi*). S.J. KING, L.R. GODFREY, E.L. SIMONS.

**Thursday, March 29, 2001, afternoon****Session 7: Paleoanthropology III, Primate Evolution. Posters. *Century A***

Chair: Brian G. Richmond, University of Illinois, Urbana.

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

1. Natural selection and fine neurological tuning. C.E. MACLEOD, A. SCHLEICHER, K. ZILLES.
2. Somatomedin secretion and patterns of growth in *Papio* and *Cercocebus*. R.M. BERNSTEIN.\*
3. Relative placement of the mandibular fossa. R.J. SHERWOOD, R.B. ROWLEY, S.C. WARD.
4. Lessons from the study of microwear variation within and between populations of middle Miocene primate species at Maboko Island. A.K. PALMER, B.R. BENEFIT, M.L. MCCROSSIN.
5. Dental microwear in two species of fossil papions: *Parapapio ado* from East Africa and *Parapapio jonesi* from South Africa. C.K. WATT, B.R. BENEFIT.
6. Dental microwear in *Mesopithecus pentelici* from the late Miocene of Pikermi, Greece. J.J. REITZ, B.R. BENEFIT.
7. The utility of dental data in reconstructing omomyoid phylogeny: An analysis using outgroup swapping. M.A. TORNOW.
8. Microwear of the mandibular third premolars of Japanese monkeys (*Macaca fuscata*). T. HOJO.
9. Dental microstructure and life history in subfossil lemurs. K.E. SAMONDS, G.T. SCHWARTZ, W.L. JUNGERS, L.R. GODFREY.
10. Morphological affinities of extant and fossil hominoids based on the supraorbital region. K.P. McNULTY.\*
11. Middle ear morphology in primates and its relationship to hearing. M.N. COLEMAN.\*
12. Craniodental comparisons of *Mabokopithecus* with *Oreopithecus* support an African origin of Oreopithecidae. B.R. BENEFIT, M.L. MCCROSSIN.
13. Functional analysis of the hip and thigh of *Paracolobus* and other large-bodied fossil cercopithecids. N. TING, C.V. WARD.
14. An analysis of the prosimian knee. J.L. WHITE.
15. New Omomyid (Tarsiiformes) primate from the middle Eocene (late Gardnerbuttean), southwestern Wyoming: Implications for the evolution of Utahiina. K.M. MULDOON, G.F. GUNNELL.
16. Functional morphology and scaling of *Nacholapithecus* pedal phalanges. M. NAKATSUKASA, Y. KUNIMATSU, Y. NAKANO, H. ISHIDA.
17. Postural adaptations and sexual dimorphism in the primate pelvis. K. WHITCOME.\*
18. The postcranial evidence for primate superordinal relationships. M. KRIZ, M.W. HAMRICK.
19. New perspectives on *Dryopithecus*, *Ouranopithecus*, and *Oreopithecus*: A critical reassessment of the Out of Africa and Back Again model of ape and human origins. M.L. MCCROSSIN.

**Session 8: “Read Our Lips, No New Taxa.” Symposium. *Pershing Place North and South***

Organizer and Chair: Milford H. Wolpoff, University of Michigan.

Especially over the last decade there have been a plethora of human species published, if not treated as known facts, in books, scientific journals, sessions at the AAPA meetings, and in the public press. Even discounting the habilines, some recognize as many as 7 species in Pleistocene *Homo*, a recent paper even proposes 2 species among the Skhul hominids. One might gather that professional opinion among biological anthropologists has been swayed and that the majority of paleoanthropologists and other biological anthropologists embrace the idea of multiple human taxa. But this is not so, many in the profession believe this taxonomizing has gone much too far. A number of paleoanthropologists and other biological anthropologists have a quite different perspective on the taxonomy of human evolution, and while they don't all agree on the number of taxa, it is broadly perceived that the data support the notion of few and not many. This is their turn to speak.

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| 1:00 pm | How did we get here? M.H. WOLPOFF.   |
| 1:15 pm | What are species anyway? M. CHANG, J. MONGE, A. MANN.  |
| 1:30 pm | Nonhuman primates as models of variation in human evolution. D.A. COPE, J.M. PLAVCAN, M.G. LACY.   |
| 1:45 pm | Early <i>Homo</i> and the problem of fossil species recognition. J.M.A. MILLER, G.H. ALBRECHT, B.R. GELVIN.  |
| 2:00 pm | Variability of brain size and body size during the last two million years of the evolution of <i>Homo</i> does not reflect postulated taxonomic diversity. M. HENNEBERG, C. DE MIGUEL. |
| 2:15 pm | The Levantine hominids as a fuzzy taxon. C.M. WILLERMET.   |
| 2:30 pm | The species problem in the Levantine Mousterian. B. ARENSBURG, A.E. MANN, A-M. TILLIER.  |
| 2:45 pm | The issue of multiple human species in the mid-to-late Pleistocene: A view from below the neck. K.R. ROSENBERG.  |

- 3:00 pm Intermission
- 3:15 pm One or many species?: A method for comparing Middle Pleistocene and modern human morphological variation. K.L. HUNLEY, G.S. CABANA.
- 3:30 pm Your species or mine? Blurred species definitions and the Neandertal debate. J.C.M. AHERN.
- 3:45 pm Regional affinities of Neandertal DNA. J.H. RELETFORD.
- 4:00 pm DNA evidence for our place in a phylogenetic taxonomy of primates. M. GOODMAN.
- 4:15 pm Pleistocene *Homo* and the genetics of speciation. J.D. HAWKS.
- 4:30 pm Discussant: S. ANTÓN. California Academy of Sciences, San Francisco, CA.
- 4:45 pm Discussant: R. FRANCISCUS. University of Iowa, Iowa City.
- 5:00 pm Discussant: J. RADOVICIC. Croatian Natural History Museum, Zagreb
- 5:15 pm Discussant: R. CASPARI. University of Michigan, Ann Arbor

### Session 9: Paleopathology I. Contributed Papers. *Pershing Place West*

Chair: Maria O. Smith, Northern Illinois University, DeKalb, IL.

- 1:00 pm Why Cupa Ectocranialis Eburneum (CEE) and not Button exostosis (BtE) or Button Osteoma (BtO)? V. ESHED, B. LATIMER, C.M. GREENWALD, L.M. JELLEMA, B.M. ROTHSCHILD, I. HERSHKOVITZ.
- 1:15 pm Atherosclerosis, a sign that people became old-aged in the Middle ages? C. AHLSTRÖM ARCINI.
- 1:30 pm The identification of secular trends, in health in skeletal samples. D.B. SMAY, P.P. PETRONE.
- 1:45 pm A Western Hemisphere perspective on the etiology of cribra orbitalia and porotic hyperostosis. P.L. WALKER, R.H. STECKEL.
- 2:00 pm Bone infection and porotic hyperostosis in 2000 ybp Ciboneyes of Cuba. B.M. ROTHSCHILD, C. ROTHSCHILD, J.F. GARCELL DOMINGUEZ, R. TRAVIESO RUIZ.
- 2:15 pm The bioarchaeology of Sa'ad, a late Roman/Byzantine site, Jordan. K.D. WILLIAMS, H. AL-KOUFAHI.
- 2:30 pm Preliminary analysis of elite and middle class New Kingdom cemeteries at Tombos, Sudan. M.R. BUZON.\*
- 2:45 pm Preliminary report on Neolithic human remains from Nabta Playa, Egypt. J.D. IRISH, F. WENDORF, R. SCHILD.
- 3:00 pm Intermission
- 3:15 pm Health and subsistence of a Neolithic population: a case study from Alepotrypa Cave, Greece. A. PAPATHANASIOU.
- 3:30 pm Theopetra cave: A regional analysis of the paleopathological patterns of the early Holocene populations in Greek peninsula, a case study. E.J. STRAVOPODI.
- 3:45 pm Brucellosis in Early Bronze Age Jordan and Bahrain: An analysis of possible cases of Brucella Spondylitits. J.S. RASHIDI, D.J. ORTNER, B. FROHLICH, B. JONSDOTTIR.
- 4:00 pm Degenerative joint diseases in the early Neolithic population from Aiterhofen, Bavaria (Germany). W.R. TEEGEN, M. SCHULTZ.
- 4:15 pm Osteoarthritis in the Middle Neolithic population from Västerbjers, Gotland, Sweden. T. AHLSTRÖM.

### Session 10: Genetics I. Contributed Papers. *Pershing Place East*

Chair: Kevin Miller, Federal Bureau of Investigation, Washington, DC.

- 1:00 pm Racial apportionment: A review. R.A. BROWN, G.J. ARMELAGOS.
- 1:15 pm Admixture mapping: The effects of continuous gene flow and assortative mating on population structure. C.L. PFAFF, E.J. PARRA, C. BONILLA, K. HIESTER, M.D. SHRIVER.
- 1:30 pm Non-homogeneous infinite sites model under demographic changes of population size: Application to mitochondrial DNA data. M. KIMMEL, A. BOBROWSKI, N. WANG, B. BUDOWLE, R. CHAKRABORTY.
- 1:45 pm Allele: phenotype associations in alcohol dependence and alcohol-related disorders. C.J. KOLMAN, R.W. ROBIN, D. GOLDMAN, J.C. LONG.
- 2:00 pm Signatures of recurrent mutations at single nucleotide polymorphism sites in the hypervariable domains of the mitochondrial control region and their implications for evolutionary studies. R. CHAKRABORTY, N. WANG, L. JIN, R. DEKA, M. KIMMEL, B. BUDOWLE.
- 2:15 pm Nucleotide diversity at autosomal, Y-chromosomal, and mitochondrial loci of African apes and humans. M.I. JENSEN-SEAMAN, T.K. ALTHEIDE, A.S. DEINARD, M.F. HAMMER, K.K. KIDD.
- 2:30 pm A global perspective on genetic variation in modern *Homo sapiens*. K.K. KIDD, A.J. PAKSTIS, J.R. KIDD.
- 2:45 pm Intermission
- 3:00 pm Preservation of skeletal remains in European Pleistocene caves: changes to the protein and mineral components of fossil bone. J. HILLER, T.J. WESS, M.J. COLLINS, A.T. CHAMBERLAIN.
- 3:15 pm Distribution of protein patterns in different groups of subadult age in prehistoric and historic populations. T.H. SCHMIDT-SCHULTZ, M. SCHULTZ.

- 3:30 pm Analysis of ancient and modern mtDNA sequences in western North America. R.S MALHI.\*
- 3:45 pm Mitochondrial DNA diversity among Native Americans from the southeastern United States. D.A. WEISS.
- 4:00 pm The genetic prehistory of California's Central Valley. J.A. ESHLEMAN.
- 4:15 pm Genetic evidence of east Asian contribution to the second wave of migration to the New World. B. SU, X. SONG, Y. KE, F. ZHANG, J.T. LELL, D.C. WALLACE, P.A. UNDERHILL, R.S. WELLS, D. LU, R. CHAKRABORTY, L. JIN.
- 4:30 pm HLA genes in Mexican Mazatecans, the peopling of the Americas and the uniqueness of Amerindians. A. ARNAIZ-VILLENNA, G. VARGAS-ALARCON, E. GÓMEZ-CASADO, M. GONZALEZ-HEVILLA, J. GUILLEN, J. MARTINEZ-LASO.
- 4:45 pm HLA genes in Arab-speaking Moroccans: close relatedness to Berbers and Iberians. J. MARTÍNEZ-LASO, E. GÓMEZ-CASADO, P. DEL MORAL, L. ALLENDE, C. SILVERA-REDONDO, J. LONGAS, M. GONZÁLEZ-HEVILLA, A. ARNAIZ-VILLENNA.

### Session 11: Primates II, Method and Theory. Contributed Papers. *Shawnee Mission*

Chair: Linda Wolfe, East Carolina University, Greenville, NC.

- 1:00 pm Costs and benefits of spatial position in primates: The feeding competition model. B.T. HIRSCH.\*
- 1:15 pm Are some species smarter than others? A meta-analysis of primate cognition studies in the 20th century. R.O. DEANER.\*
- 1:30 pm Cognitive ecology and within-patch foraging decisions in tamarins. J.C. BICCA-MARQUES, P.A. GARBER.
- 1:45 pm Effect of small home range size on use of memory. E.P. CUNNINGHAM, C.H. JANSON.
- 2:00 pm Life history and cognitive evolution show correlated evolution in mammals. C.P. VAN SCHAIK, R.O. DEANER.
- 2:15 pm Scaling and size reduction in tamarins. P.A. GARBER, S.R. LEIGH.
- 2:30 pm Factors affecting infanticide: A model. A. KOENIG, C. BORRIES.
- 2:45 pm Intermission
- 3:00 pm Heritability of responses to novel objects among pedigreed baboons. J.R. KAPLAN, L. BRENT, A.G. COMUZZIE, L. MARTIN, S.B. MANUCK, J. WORLEIN, J. ROGERS.
- 3:15 pm Why do chimpanzees hunt and share meat? J. MITANI, D. WATTS.
- 3:30 pm Methods for assessing nutrient intake in wild primates: temporal- vs. weight-based estimates. M.A. NORCONK, N.L. CONKLIN-BRITTAIN.
- 3:45 pm Assessment of reproductive strategies in wild mountain gorillas (*Gorilla gorilla beringei*) using DNA from feces. B.J. BRADLEY, M.M. ROBBINS, E.A. WILLIAMSON, C. BOESCH, L. VIGILANT.
- 4:00 pm Dynamic modeling of facial expression. K.L. SCHMIDT, J.F. COHN.

## Friday, March 30, 2001, morning

### Session 12: Paleopathology II. Posters. *Century A*

Chair: Dawnie Wolfe Steadman, SUNY Binghamton.

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

1. The effects of pathology on biological affiliation. D.M. MULHERN, S.D. OUSLEY, E.B. JONES.
2. Achondroplasia in the Middle Woodland Period, Elizabeth Site, IL. A. OSTERHOLTZ, S. BURGESS, J.E. BUIKSTRA.
3. A possible case of Down's Syndrome in a 19th century Canadian cemetery: A multidisciplinary approach. J.M. PARISH, T.E. von HUNNIUS.
4. Maxillary sinusitis as related to dental infection. E.A. DiGANGLI.\*
5. Heel spurs as markers of occupational stress in Late Woodland-Mississippian agriculturalists. J.S. BRUCKNER.
6. Comparison of spinal pathologies in northern and southern native Alaskan skeletal populations. S.S. LEGGE.
7. Patterning of joint margin lipping in relation to the location of surface osteoarthritis within appendicular joints. S.M. STAGER.\*
8. Degenerative joint disease in two pre-Columbian skeletal samples: Bay West (8CR200) and Windover (8BR246). H.A. WALSH-HANEY.\*
9. Paleopathology and biomechanical indicators of stress at the MacDuffee Site. V.L. WEDEL, L.M. RANKIN-HILL.
10. Bioarchaeology of William's Landing (1JA306) and Widow's Creek (1JA305), Jackson County, Alabama. L.R. COLONIAS.\*
11. Warfare in the Late Prehistoric Southeast: A multi-site osteological analysis from west-central Tennessee. N.J. KUEMIN



## DREWS.\*

12. An Archaic burial exhibiting a rare odontoid type III fracture of the C2. M.S. TAYLOR, R.R. PAINE.
13. Paleopathology of the prehistoric Maya from Caves Branch Rock Shelter, Belize. D.M. GLASSMAN, J.A.K. HARRIS, J.L. BONOR.
14. An analysis of the pathology of the Krapina Neandertals. J.C. GARDNER.
15. Palaeopathology at the origins of agriculture in central Syria. D.C. MERRETT, C. MEIKLEJOHN.
16. Human molar drillings in the 8th millennium B.C. Neolithics from Mehrgarh, Pakistan: First cases of dental care? A. CUCINA, R. MACCHIARELLI, L. BONDIOLI, J.F. JARRIGE, A. COPPA.
17. Gross pathology of human skeletal remains from a predynastic Egyptian cemetery. S.A. COYLE.
18. In or out of the womb? The analysis and interpretation of fifteen fetal skeletons from Roman period Egypt. M.W. TOCHERI, T.L. DUPRAS, J.E. MOLTO.
19. Models of sex-specific mortality for paleodemographic analysis. R.J. FERRELL, J.W. WOOD.
20. Paleodemography: A comparison of a Danish medieval cemetery with a modern Amish cemetery. B.M. USHER, J.D. WEETS.
21. "Let us go to the house of the Lord": Biocultural re-construction of pilgrimage. J.M. ULLINGER, S.G. SHERIDAN.
22. Cannibals in the Cooks? Dental microwear from a special-use site (MAN-84) Mangaia, Cook Islands. M.F. TEAFORD, S.C. ANTÓN.
23. Slave health and nutrition at Bremo, Fluvanna County, Virginia. S.J. MARQUSEE, R.L. HIGGINS, J.M. JONES.
24. A preliminary analysis of the birth records for slave women from the Bremo Plantations, Fluvanna County, Virginia. R.L. HIGGINS, S.J. MARQUSEE.

**Session 13: Primates III, Biological Variation. Posters. Century A**

Chair: J. Michael Plavcan, New York College of Osteopathic Medicine.

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

25. Behavioral and electrophysiological evidence for lack of ultraviolet sensitivity in strepsirrhine primates. E.C. KIRK, J.F. DEEGAN II, G.H. JACOBS.
26. Allometry of infant gorilla limb proportions. A. BELLISARI, C. GREENBERG, B. TOWNE.
27. Intrasexual competition and testis size in *Propithecus verreauxi*. D.K. BROCKMAN, A.R. RICHARD, M. SCHWARTZ.
28. Ontogenetic data suggest the presence of HOXD targets that act as growth scalars in the hominoid forearm and hand. P.L. RENO, C.O. LOVEJOY, M.A. MCCOLLUM, M.W. HAMRICK, R.S. MEINDL, M.J. COHN.
29. Relative amounts of facial expression musculature in two species of *Otolemur*: Muscles of the pinna and orbit. A.M. BURROWS, T.D. SMITH.
30. Comparative analysis of the neural spine and transverse processes in the lumbar vertebrae of the Hominoidea. N.L. BARRICKMAN.\*
31. Seasonal variation in the diet of *Hapalemur griseus griseus*. C. GRASSI.
32. Patterns of joint size dimorphism in the elbow and knee of catarrhine primates. M.R. LAGUE.
33. Ontogeny of the nasopalatine duct in prenatal mouse lemurs. K.L. SHIMP, K.P. BHATNAGAR, T.D. SMITH.
34. Is the trabecular patterning at the proximal femur body-mass dependent in primates? A test on cercopithecines. T.B. VIOLA.\*
35. Effects of branch compliance on quadrupedal walking in *Loris tardigradus*. N.J. STEVENS, A.B. DEMES, S.G. LARSON.
36. Comparison of body composition in a prime adult male lowland gorilla to a female of similar age and a male of similar body mass. R.K. McFARLAND, A.L. ZIHLMAN.
37. Stable isotope composition in *Propithecus diadema edwardsi* from Ranomafana National Park, Madagascar. E.M. MCGEE, P.C. WRIGHT.
38. Sexual size dimorphism in primates: Consideration of relative variation between sexes. A.D. GORDON.\*
39. An evaluation of tarsier phylogenetic affinities with a reappraisal of the use of nucleotide sequences in phylogeny. J.E. BARBACH.
40. Variation and scaling within a wild vervet population with comparison to closely related cercopithecine taxa. K.A. NICHOLS, H.H. COVERT, A.L. ZIHLMAN.
41. Geographic variation of skull size and shape in *Tarsius syrichta*. M. DAGOSTO.
42. The timing of hypoplastic events in gibbons. D. GUATELLI-STEINBERG, W. DIRKS.
43. Forelimb anatomy and foraging strategy in *Leontopithecus rosalia*. L.C. DAVIS, S.M. FORD.
44. The prevalence of enamel hypoplasias in the bonobo, *Pan paniscus*. S.A. TSUKAMOTO.\*

45. Growth velocity of bone variables and indices in the squirrel monkey (*Saimiri sciureus boliviensis*): A longitudinal experiment. H.M. PUCCIARELLI, M.C. MUÑE, A.B. ORDEN, E.E. OYHENART, M.E. VILLANUEVA, R.R. RODRIGUEZ, E.R. PONS.
46. An assessment of deciduous tooth mineralisation in chimpanzees (*Pan troglodytes*). K.L. KUYKENDALL, J. BOZIC.
47. Description of a feral *Alouatta palliata* population observed during three decades. J.A. RUNESTAD CONNOUR, K.E. GLANDER.
48. Dental and skeletal development in wild caught vervet monkeys (*C. aethiops*). D.R. BOLTER, A.L. ZIHLMAN.
49. Can ecology and life-history data be used to predict mortality patterns in wild primate populations? C. ROSS.
50. Reconsideration of the vomeronasal complex in Old World primates. T.D. SMITH, M.I. SIEGEL, C.J. BONAR, K.P. BHATNAGAR, K.L. SHIMP, M.P. MOONEY, A.M. BURROWS.
51. Love potions in primate brains? D.M.TOLOCZKO.
52. Anatomical subdivisions of the frontal lobe in the great apes. K. SEMENDEFERI, A.M. DESGOUTTES.
53. Gradient phenomena in primates and the intermembral index. D. SWARTZ.
54. Cerebral asymmetries on the endocasts of *Hylobates syndactylus*. J.C. REDMOND.
55. Metaphyseal angular morphology and primate locomotion. D.L. DUREN.\*
56. A quantitative morphometric comparative analysis of the primate temporal lobe. J.K. RILLING, R.A. SELIGMAN.
57. Who is crooked, and who is not: A comparative study of anatomical versus functional asymmetry in the airway. J.S. REIDENBERG, D.R. KETTEN, S. MARQUEZ, J.T. LAITMAN.
58. Heritability of CSF dopamine, serotonin and norepinephrine among baboons. J. ROGERS, A.G. COMUZZIE, L. MARTIN, J.J. MANN, S.B. MANUCK, J.R. KAPLAN.
59. Finite element analysis of a partial macaque skull. D.S. STRAIT, B.G. RICHMOND, M.A. SPENCER, B.A. WOOD.
60. Y-chromosome STR analysis in *Pan troglodytes*. J. BENN, J. SMITH, A. STONE.
61. Primate biomaterials resource. J. ALTMANN, J.C. BECK, A. DIRIENZO, K.E. GLANDER, M. GOODMAN, A. MANN, D. MELNICK, J. ROGERS, O.A. RYDER, A. STONE, T. TURNER.
62. Crushing seeds and gouging-trees: the impact on mandibular and zygomatic arch strengths. V.B. DeLEON, B. FROHLICH, E. GAROFALO, C.B. RUFF.
63. Sex typing of primate field samples by amplification of the nuclear gene amelogenin. A.L. ENSMINGER, S.M.G. HOFFMAN.
64. www. eSkeletons. org: A web site for the study of human and primate comparative anatomy. J. KAPPELMAN, M. MAGA, T. RYAN, M. ZYLSTRA, L. ALPORT, M. FESEHA.

### Session 14: Ethical Issues in Biological Anthropology. Symposium. Shawnee

Organizer and Chair: Trudy Turner, University of Wisconsin, Milwaukee.

Biological anthropologists face an array of ethical issues as they confront their involvement and obligations to their research subjects, to their discipline, to society, and to the environment. This symposium is designed to present the range of ethical controversies in biological anthropology and includes presentations from human biologists, geneticists, primatologists and paleoanthropologists.

- 8:00 am Ethical concerns in biological anthropology: Introduction to the symposium. T.R. TURNER.
- 8:15 am Primatologists: Duties, rights and obligations. L.D. WOLFE.
- 8:30 am Studies of primates in the field and in captivity: Similarities and differences in ethical concerns. L.T. NASH.
- 8:45 am Ethical issues in the molding and casting of fossil bones. J.M. MONGE, A.E. MANN.
- 9:00 am The ethics of bioarchaeology. C.S. LARSEN, P.L. WALKER.
- 9:15 am Ethical issues in human biology behavioral research and in research with children. S. STINSON.
- 9:30 am Ethics, culture and barriers to human biology research nationally and internationally. S. ZAMUDIO.
- 9:45 am Inferring African ancestry of African Americans. R.A. KITTLES.
- 10:00 am Intermission
- 10:15 am The consent process and aDNA research: Contrasting approaches in North America. D.H. O'ROURKE, M.G. HAYES, S.W. CARLYLE.
- 10:30 am Working with ancient DNA: NAGPRA, Kennewick Man and other ancient peoples. F.A. KAESTLE, D.G. SMITH.
- 10:45 am Genetics, history and public perception: The Sally Hemmings-Thomas Jefferson story. S.R. WILLIAMS.
- 11:00 am Discussants: S. ANTÓN. California Academy of Sciences, San Francisco, CA, J. FRIEDLAENDER. Temple University, Philadelphia, PA, J. LONG. National Institutes of Health, Bethesda, MD, J. ROGERS. Southwest Foundation for Biomedical Research, San Antonio, TX, M. WEISS. National Science Foundation, Washington DC.

### Session 15: Paleoanthropology IV, Pleistocene. Contributed Papers. *Pershing Place North and South*

Chair: Fred Spoor, University College London, UK.

- 8:00 am Environmental variability and the rise of the genus *Homo*. R. BOBE, A.K. BEHRENSMEYER.
- 8:15 am A new Middle Pleistocene fauna from the Busidima-Telalak region of the Afar, Ethiopia. Z. ALEMSEGED, D. GERAADS.
- 8:30 am Early Pleistocene dates and sedimentary cycles for new Bapang Formation hominins, Central Java, Indonesia. R.L. CIOCHON, R. LARICK, Y. ZAIM, SUDIJONO, M. HEIZLER.
- 8:45 am KMH2 and the comparative morphology of the hyoid bone. G.E. KENNEDY, N.A. FAUMUINA.
- 9:00 am New estimates of Neanderthal speech capabilities. F.W. YATES.\*
- 9:15 am The dentition of Saint-Césaire I, a partial skeleton from the Châtelperronian levels of La Roche à Pierrot (Charente-Maritime). B. VANDERMEERSCH, A.E. MANN.
- 9:30 am The reliability of estimates of hominin body mass derived from bi-iliac breadth and stature. O. PEARSON, W. JUNGERS, F. GRINE, K. MOWBRAY.
- 9:45 am Intermission
- 10:00 am Climate induced variation in recent human hip morphology. T.D. WEAVER.\*
- 10:15 am A simple reason why Neanderthal ancestry can be consistent with current DNA information. P. ENFLO, J. HAWKS, M.H. WOLPOFF.
- 10:30 am Neandertal, Upper Paleolithic, and recent human hands: What are the differences? W.A. NIEWOEHNER.
- 10:45 am Frontal cranial profiles of archaic and modern subadult and adult humans. K. SCHÄFER, H. SEIDLER, P. GUNZ, P. MITTERÖCKER, H. PROSSINGER, G. WEBER.
- 11:00 am Intrapopulation craniometric variation in the European Upper Paleolithic and Southeastern Florida. B.A. SCHUMANN, P.J. CONSTANTINO.
- 11:15 am Ancient population of Mongolia: Craniofacial morphological perspective. D. TUMEN.
- 11:30 am Paleoindian skeletal remains from Santana do Riacho I, Minas Gerais, Brazil: archaeological background, chronological context and comparative cranial morphology. W.A. NEVES, M. BLUM, A. PROUS, J. POWELL.
- 11:45 am Continuity and change in Late-Prehistoric Germany. A. GALLAGHER, M.M. GUNTHER, H. BRUCHHAUS.

### Session 16: Molecules and Morphology, Comparisons of Recent Living Human Populations. Symposium. *Pershing Place West*

Organizer and Chair: C. Loring Brace, University of Michigan.

Molecular genetic assessment of human populations can pin down resemblances and distinctions to specific base-pair differences in particular haplotypes. Morphometric variation is controlled by heredity to a comparable extent even if key base-pairs cannot be identified. A comparison of population samples in particular areas using both molecular genetic and morphometric approaches shows that the several techniques used produce largely comparable results. No one such approach can produce quite the same picture of links and distinctions. Evidently the use of more than a single such assessment is necessary to produce an understanding of population relationships.

- 8:45 am Morphometric and molecular perspectives on the comparison of human populations. C.L. BRACE, N. SEGUCHI, A.R. NELSON.
- 9:00 am Variation in South Indian caste populations: A comparison of genetic and morphometric data. L.B. JORDE, M.J. BAMSHADI, W.S. WATKINS, C.E. RICKER, M.E. DIXON, M.A. BATZER, B.V.R. PRASAD, B.B. RAO, J.M. NAIDU.
- 9:15 am The morphometric picture of prehistoric and recent Japan in comparison with Northeast and Southeast Asia. N. SEGUCHI, C.L. BRACE, H. OE.
- 9:30 am A history of Siberian native people from the perspectives of male lineages. T.M. KARAFET, L.P. OSIPOVA, M.A. KAZAKOVTSOVA, O.L. POSUKH, M.H. HAMMER.
- 9:45 am Craniometric relationships of Pacific, East Asian, and Southeast Asian peoples: A multivariate analysis. M. PIETRUSEWSKY.
- 10:00 am Intermission
- 10:15 am A mtDNA perspective on Austronesian and Papuan relationships in the Pacific. J.S. FRIEDLAENDER, E. KAESTLE, F. GENTZ, G. KOKI, C.S. MGONE, D.A. MERRIWETHER.
- 10:30 am A morphometric spectrum of Asian and Amerind relationships. A.R. NELSON, D. TUMEN.
- 10:45 am A mitochondrial DNA perspective on Asian and Native American population relationships. T.G. SCHURR, Y.B. STARIKOVSKAYA, R.I. SUKERNIK, D.C. WALLACE.
- 11:00 am Discussant: K.K. KIDD. Yale University, New Haven

**Session 17: Skeletal Biology II/ Dental Anthropology II. Contributed Papers. Pershing Place East**

Chair: Lyle Konigsberg, University of Tennessee, Knoxville.

- 8:00 am Thin plate splines analysis of human craniofacial sexual dimorphism. M. BASTIR, A. ROSAS.
- 8:15 am Greater sciatic notch variation between American Indians and Whites. G.J. FLORES.\*
- 8:30 am A new metric method for sex determination using the pelvis and femur. J. ALBANESE.\*
- 8:45 am A longitudinal pilot study of age estimation from dental radiographs. D.G. MCBRIDE.
- 9:00 am A population-specific model for determining enamel growth rate and defect timing in medieval Danes. M. REEVES.\*
- 9:15 am Alternative measurements for recording tooth crown size. S.W. HILLSON, C.M. FITZGERALD, H.M. FLINN.
- 9:30 am Intradental variation in stable carbon isotope ratios in human tooth enamel. J.W. WILSON, R.H. TYKOT, D.H. UBELAKER.
- 9:45 am Intermission
- 10:00 am Evaluation of mortality bias in deciduous tooth emergence, and implications for paleodemographic age estimation. N.B. NUCKLEY, D.J. HOLMAN, R.E. JONES.
- 10:15 am The middens of Aitape: The taphonomy of mortuary ritual on the Sepik Coast, Papua New Guinea. A.W. STODDER, T. RIETH, J.E. TERRELL.
- 10:30 am Assessing the effects of artificial cranial deformation using Elliptic Fourier Analysis. M. FRIESS, M. BAYLAC.
- 10:45 am The millennial trend in bone mineral density in the femoral neck of a Danish population L.W. POULSEN, D. QVESEL, K. BRIKEN, A. VESTERBY, J.L. BOLDSSEN.
- 11:00 am Wolff's Law in sheep's clothing: Limb joint response to experimentally induced mechanical loading. M.J. DEVLIN.\*
- 11:15 am Relationship between mineralization density, age and mechanical adaptation of the human mid-shaft femur. H.M. GOLDMAN.\*
- 11:30 am The shape of a long bone's shaft: Bending stress or growth plate form? J.C. OHMAN, C.O. LOVEJOY.
- 11:45 am Directional bilateral asymmetry in the sacral morphology of males from the Hamann-Todd and Terry Collections. J.H. PLOCHOCKI.

**Friday, March 30, 2001, afternoon****Session 18: Genetics II. Posters. Century A**

Chair: Theodore Schurr, Southwest Foundation for Biomedical Research, San Antonio, TX.

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

- Degradation of DNA in bone material recovered from soil in relation to soil environment and incubation time. W.M. SCHMERER.
- The Armstrong Mound: A case of difficult DNA. R.L. PARR, G. DaKUBO, S. HAMILTON, J.E. MOLTO.
- Ancestor descendant relationships in North American Arctic prehistory: Ancient DNA evidence from the Aleutian Islands and the Eastern Canadian Arctic. M.G. HAYES.\*
- Tyrosinase gene polymorphisms in global populations. S.R. INDUGULA, S. MASTANA, G. SUN, R. DEKA.
- Evolution and distribution of sequence variation in the cis-regulatory region of CC chemokine receptor 5. M. BAMSHAD, C.E. RICKER, S. MUMMIDI, E. GONZALEZ, L.B. JORDE, R. WEISS, D. DUNN, S.S. AHUJA, S.K. AHUJA.
- mtDNA hypervariable region-1 variation in Central Africa V. COIA, G. DESTRO-BISOL, G. SPEDINI, M. BELLEDI, I. BOSCHI, A. CAGLIA, F. VERGINELLI, F. CALAFELL.
- Dynamics of microsatellite genetic diversity in the Indian Subcontinent. S.S. MASTANA, G. SUN, S.S. PAPIHA, R. DEKA.
- A possible regulatory role for a cluster of Alu repeats found within the first intron of the gene encoding the human L1 cell adhesion molecule. D.B. EDELMAN, R. MEECH, F.S. JONES.
- Mapping modern mtDNA haplogroup frequencies of Native North Americans ancient Native American homelands utilizing GIS. J.A. GREENBERG, R.S. MALHI, B.A. SCHULTZ, D.A. WEISS, J.A. ESHLEMAN, B.M. KEMP.
- MtDNA variation among the Western Anasazi. S.W. CARLYLE, D.H. O'ROURKE.
- Dental variation and biological affinities among three modern ethnic groups in Malaysia. D.M. GILL.\*
- Discrete dental traits and intra and intergroup relationships between burial mounds from the Illinois Bluff/ Titterington collection, Smithsonian Institution. A.T. MAYES.\*
- Ancient Irish dental variation: Research on issues of migration and population continuity. J.D. WEETS.

14. Craniometric variation and peopling of the Americas: R matrix analysis and matrix permutation. R. GONZALEZ, S. DAHINTEN, M. LUIS, M. HERNÁNDEZ, H. PUCCIARELLI.
15. Biological effects of European contact: Craniofacial variation in the Americas. A.H. ROSS, D.H. UBELAKER, A.B. FALSETTI.
16. Calculation of isonymy from census and marriage records: A comparison from antebellum Georgia. A.F. CHRISTENSEN.
17. The Dakhleh Oasis Project: A preliminary report on mtDNA research in Dakhleh Oasis, Egypt A.M. GRAVER, R.L. PARR, S. WALTERS, R.C. PRAYMAK, J.M. MAKI, J.E. MOLTO.
18. A heritability study of the non-metric trait fronto-temporal articulation in the Dakhleh Oasis, Egypt using mitochondrial DNA analysis. R.C. PRAYMAK, A.M. GRAVER, R.L. PARR, J.E. MOLTO.
19. Environmental effects on population genetics models: A test of Australian microevolution since the Late Pleistocene. E.A. CARSON.
20. The study of populations in the past. C.D. MATHESON, J. HALL, T.H. LOY, R. VIEL.
21. Late Pleistocene North American biogeographic zones, linguistic differentiation, and the origin of Native American genetic diversity. A.G. FIX.
22. Y chromosome variation on the Isle of Man: Evidence of Celtic and Scandinavian admixture. C. TILLQUIST, E. ARNASON, H. SIGURGISLASON, M. HAMMER.

### Session 19: Human Biology II. Posters. *Century A*

Chair: Holger Schutkowski, University of Bradford, UK.

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

23. Modeling the birth weight distribution: Additive versus multiplicative processes. T.B. GAGE.
24. Linear sparing of long bone growth in the pathological fetus. M.W. WARREN, A.B. FALSETTI, T.M. COLE III.
25. Growth data collected from French-born girls of Malian descent: How do they compare to their Malian-born counterparts? L.R. PAWLOSKI.
26. Child growth among Karimojong agropastoralists of northeastern Uganda. B.L. WIEBUSCH, S.J. GRAY, H.A. AKOL.
27. Child mortality among the Karimojong agropastoralists of northeastern Uganda. M.B. SUNDAL, S.J. GRAY, H.A. AKOL.
28. Duration of breastfeeding, parasite load, growth, fluctuating asymmetry, and cortisol profiles. D.V. LEONE, R.J. QUINLAN, M.B. QUINLAN, C.C. WORTHEN, M.V. FLINN, B.G. ENGLAND.
29. Birth and growth factors influencing size and body composition in 9-year-old black and white urban South African children. N. CAMERON, J.M. PETTIFOR, S. NORRIS, T. DE WET.
30. Parent-daughter somatotype correlations and assortative mating in the Punjabis from Northwestern India. S. KAUL, N. HANDA-GUPTA, B.S. KARIR, N. GILL, P.S. GILL.
31. Influence of physical activity in the morphology of schoolchildren from the urban area of Bilbao city (Biscay, Basque Country). A.G. APRAIZ.
32. Physical growth and body proportions of Portuguese Cape Verdean children from the slums and Portuguese children living in regular dwellings: the role of SES. M.I. VARELA-SILVA.
33. Child care-taking and maternal activities in a Toba community, Formosa, Argentina. M.L. COHN, C.R. VALEGGIA, P.T. ELLISON.
34. Human cranial growth reassessed using New Geometric Morphometrics. P. MITTERÖCKER, P. GUNZ, G. TAKEHISA-SILVESTRI, H. SEIDLER.
35. Estimating sex by discriminant function analysis of long bone measurements from the Protohistoric Maya site of Tipu, Belize. G.D. WROBEL, M.E. DANFORTH, C. ARMSTRONG.
36. Variation in a pre-industrial population: occupation and stature in early twentieth century Crete. B.M. AUERBACH, M.M. LAHR.
37. Forty years gone: Pima dental eruption after Dahlberg and Menegaz-Bock. M.H. REGAN.
38. Arch growth and development in American Black children. E.F. HARRIS.
39. A comparison of human and non-human primate vocal tracts. M. CLEGG, L.C. AIELLO.
40. The effects of recumbency and sleep on the blood pressure of women employed outside the home. G.D. JAMES, D.H. BOVBJERG, G.H. MONTGOMERY.
41. Adaptive explanations of ADHD: An empirical test. A.A. BREWIS, K.L. SCHMIDT, M. MEYER.
42. The pattern of epidemics in Escazú, Costa Rica. L. MADRIGAL, B. WARE.
43. Micronutrient intake of working and non-working impoverished women in Cali, Colombia. E.A. SILVESTRE, D.L. DUFOUR, J.C. REINA, G.B. SPURR.

44. Vulnerability and stress in Mongolia: The adaptive significance of yadargaa. B.A. KOHRT, H.E. KOHRT, T. TSAGAANKHUU.
45. Involvement of HLA loci in host resistance/susceptibility to tuberculosis in the Ache, a Native American population from Paraguay. A.K. WILBUR, A.M. HURTADO, A.C. STONE.
46. Validation of waist to stature ratio and waist circumference for community based obesity screening in Mexican American women. B. CHAKRABORTY.
47. Ecology of iron deficiency and immune function in Northern Kenya. T.W. McDADE, B. SHELL-DUNCAN.
48. Patterns of alveolar crest height change in postmenopausal women treated with estrogen. C.F. HILDEBOLT, T.K. PILGRAM, N. YOKOYAMA-CROTHERS, M. DOTSON, J. MUCKERMAN, J. HAUSER, S. COHEN, E. KARDARIS, R. CIVITELLI, P. HANES, M. SHROUT.
49. Fluctuating odontometric asymmetry in the adult dentition of the Punjabi population of Chandigarh, Northwestern India. P.S. GILL, R. KAUR, S. KAUL.
50. Testosterone and cortisol response to competition within and between male coalitions. J.D. WAGNER, M.V. FLINN, S.G. GANGESTAD, A.R. THORNHILL, B.G. ENGLAND.

## Session 20: Adjustments to Coastal Environments. Symposium. *Shawnee*

Organizers and Chairs: Michael J. Dietz and Robert A. Benfer, Jr., University of Missouri.

The symposium is a forum to discuss the adjustments prehistoric peoples made to living in coastal environments. We discuss a variety of temporal settings and environments, including skeletal series from the Atlantic and Pacific coasts, and from a wide variety of latitudes. The presenters discuss the special constraints and opportunities that influenced the choices people made that affected their health and reproductive success.

- 2:15 pm Economics of cold water foraging. E.J. BASSETT.
- 2:30 pm Maritime adaptations of Southwestern Alaska: An overview. A.P. McCARTNEY.
- 2:45 pm Row, row, row your boat...activity patterns and skeletal robusticity in a series from Chirikof Island, Alaska. D.C. COOK, S.P. DOUGHERTY.
- 3:00 pm Transitions in eastern Arctic coastal diets. J.B. COLTRAIN, M.G. HAYES.
- 3:15 pm Reconstruction of late prehistoric and historic diet in Baja California Sur, Mexico: Isotopic considerations. T.M. SCHOBER.
- 3:30 pm PreColumbian diet, health, and ecological adaptation at the Tutu Site, St. Thomas, U.S. Virgin Islands. M.K. SANDFORD, J.F. FARNUM.
- 3:45 pm Biodistance and regional subsistence patterns for the Late Woodland North Carolina coast. A.M. KAKALIOURAS, D.L. HUTCHINSON, L. NORR.
- 4:00 pm Intermission
- 4:15 pm A view from the coast of ancient Maya childhood health: Marco Gonzalez and San Pedro, Belize. A.E. DOLPHIN.\*
- 4:30 pm Recent advances in the bioarchaeology of the Prehispanic Sican on the North Coast of Peru. J.F. FARNUM, I. SHIMADA, M.A. STREETER, J.W. VERANO.
- 4:45 pm Coastal adjustments to the end of the Holocene climatic optimum. R.A. BENFER Jr., E.A. PECHENKINA.
- 5:00 pm Deterioration of health and early agricultural dependence in southern coastal Peru. M.J. DIETZ, R.A. BERGFELD.
- 5:15 pm Chiribaya political economy: A bioarchaeological perspective. J.E. BUIKSTRA, P.D. TOMCZAK, M.C. LOZADA.
- 5:30 pm Archaeological evidence for early maritime adaptations in western South America, 11,000+ to 5000 14-C yrs BP. D.H. SANDWEISS.
- 5:45 pm Discussant: G. ARMELAGOS. Emory University, Atlanta.

## Session 21: Paleoanthropology V. Contributed Papers. *Pershing North and South*

Chair: Susan Antón, California Academy of Sciences, San Francisco.

- 2:00 pm A new late Miocene hominid from Turkey. A. SEVIM, D.R. BEGUN, E. GÜLEÇ, D. GERAADS, C. PEHLEVAN.
- 2:15 pm Sexually dimorphic morphology in immature chimpanzee and human mandibles: A continuum for fossil hominids. S.R. LOTH, M. HENNEBERG.
- 2:30 pm The temporal articular surface and mandibular fossa in anthropoids: Interspecific variation and relationships to diet and mastication. K.M. SANDY.\*
- 2:45 pm In vivo intraorbital bone strain from the lateral orbital wall of *Macaca* and the functioning of the craniofacial haft. C.F. ROSS.
- 3:00 pm Dental maturation assessment using computed tomography in *Pan paniscus*. Implications for early hominid studies. J.J. HUBLIN, J. BRAGA, J. TREIL.
- 3:15 pm SK 859, an infant early hominid preserving endocranial features. Evidence from osteodental maturation studied using computed tomography. J. BRAGA, F. THACKERAY, J. TREIL, P. BORIANNE.

- 3:30 pm Differentiating species, subspecies and populations of chimpanzees using dental characters: Implications for fossil species recognition. V.C. PILBROW.
- 3:45 pm Intermission
- 4:00 pm A morphogenetic model of craniofacial development: Implications for hominin systematics. B.M. MCBRATNEY, S. LOZANOFF.
- 4:15 pm The role of cross-sectional cortical morphologies in interpreting habitual bending across the anthropoid hip: A comparative analysis. J.G. SKEDROS, T.Y. KUO, R.D. BLOEBAUM, K.N. BACHUS.
- 4:30 pm The Baldwin Effect: The genetic assimilation of acquired characteristics. S. RAGIR.
- 4:45 pm Hominid phylogeny: Morphological and molecular measures of diversity. R.B. ECKHARDT.
- 5:00 pm The correlation between endocranial petalial patterns and the orbital cap. D.C. BROADFIELD, R.L. HOLLOWAY, K. MOWBRAY, M.S. YUAN, A. SILVERS, J.T. LAITMAN, S. MÁRQUEZ.
- 5:15 pm How human intelligence evolved. C.V. WARD, M.V. FLINN.
- 5:30 pm Evolution of the human brain: Size, shape, and organization. K. ALDRIDGE.\*
- 5:45 pm The evolution of the human breast. G.R. BENTLEY.

**Session 22: Age-Related Bone Loss: An Anthropological Perspective. Symposium. *Pershing Place West***

Organizers and Chairs: Sabrina Agarwal, Department of Anthropology, University of Toronto, Samuel Lunenfeld Research Institute of Mount Sinai Hospital, Toronto, Ontario, Canada and Sam Stout, University of Missouri, Columbia.

Bone loss and osteoporosis is often identified and widely discussed in the study of archaeological remains. However, its meaning and complex etiology in the past is often misinterpreted. The goal of this symposium is to better identify and understand the patterns and prevalence of bone loss among past populations and highlight future directions of study. A synthesis of our current knowledge of age-related changes in bone quantity, structure, and material will be made. Limitations in the study of bone loss in ancient remains and new state-of-the-art methods will be outlined, and an evolutionary and biocultural perspective will be emphasized.

- 2:00 pm Introductory Remarks. S. STOUT. University of Missouri, Columbia.
- 2:15 pm Bone remodeling and bone loss. M. KLEEREKOPER.
- 2:30 pm Ethnic differences in bone mass and architecture. D.A. NELSON.
- 2:45 pm Bone loss, fracture histories, and body composition characteristics of older males. W.A. STINI.
- 3:00 pm Effects of vitamin D on bone and the consequent evolution of skin color. R. VIETH.
- 3:15 pm The effects of age and trace elements on bone mineralization. M.D. GRYNPAS.
- 3:30 pm Mechanical signals for bone adaptation. D.B. BURR, A. ROBLING.
- 3:45 pm Intermission
- 4:00 pm Age-related bone loss in nonhuman primates: results and models. D.S. WEAVER, C.P. JEROME, P. PETERSON.
- 4:15 pm Differential diagnoses of intra vitam and postmortem bone loss on the micro-level. M. SCHULTZ.
- 4:30 pm The effects of pregnancy and lactation on the maternal skeleton: A historical perspective. S. AGARWAL.
- 4:45 pm Age-associated bone loss in an Imperial Roman population. H. CHO, S.D. STOUT.
- 5:00 pm Change in bone mass in subadults. M. STREETER, S.D. STOUT.
- 5:15 pm Discussants: H. FROST. Department of Orthopaedic Surgery, Southern Colorado Clinic, Pueblo, CO, D. ORTNER. Smithsonian Institution, Washington DC.

**Session 23: Primates IV: Behavioral Ecology. Contributed Papers. *Pershing Place East***

Chair: Christina J. Campbell, University of California, Los Angeles.

- 2:00 pm The bug-eyed slender loris: insect predation and its implications for primate origins. K.A.I. NEKARIS, D.T. RASMUSSEN.
- 2:15 pm Social and ecological influences on female dominance in day-active prosimian primates. D.J. OVERDORFF, E.M. ERHART.
- 2:30 pm Determinants of gregariousness in a nocturnal primate. S.L. GURSKY.
- 2:45 pm Food processing technique differences across three capuchin (*Cebus capucinus*) populations in Costa Rica. M. PANGER, S. PERRY, L. ROSE, J. GROS-LOUIS, E. VOGEL, K. MacKINNON, M. BAKER.
- 3:00 pm Ranging behavior and foraging ecology of lowland woolly monkeys (*Lagothrix lagotricha*). A. DI FIORE.
- 3:15 pm Quantifying fission-fusion behavior and social dynamics in free-ranging spider monkeys (*Ateles belzebuth belzebuth*). S.A. SUAREZ.
- 3:30 pm Intergroup differences, troop immigration, and genetic variation in mantled howling monkeys in Nicaragua. L. WINKLER, X. ZHANG, R. FERRELL.

- 3:45 pm Patterns of subgrouping and spatial affiliation in a community of mantled howling monkeys (*Alouatta palliata*). M.F. BEZANSON, P.A. GARBER, A.M. DeLUYCKER.
- 4:00 pm Intermission
- 4:15 pm The behavioral ecology and distribution of long-tailed macaques (*Macaca fascicularis*) in Bali, Indonesia. A. FUENTES, K.G. SUARYANA, I.G.A. ARTA PUTRA, I.D.K. HARYA PUTRA, A.L.T. ROMPIS.
- 4:30 pm A survey of forest primates near the Ivory Coast's Ehi Lagoon: Further evidence for the extinction of *Colobus badius waldroni*. W.S. McGRAW.
- 4:45 pm Ranging and habitat use of sympatric agile and grey-cheeked mangabeys (*Cercocebus agilis* and *Lophocebus albigena*) in the Dzanga-Ndoki National Park, Central African Republic. N.F. SHAH.
- 5:00 pm Status of the savanna chimpanzees (*Pan troglodytes verus*) at Mont Assirik in Parc National du Niokolo Koba and in adjacent areas in southeastern Sénégal. J.D. PRUETZ, W.C. MCGREW, L.F. MARCHANT, J. ARNO.
- 5:15 pm Wild chimpanzees are manually unilateralized: Replicative data from the Mahale Mountains, Tanzania. L.F. MARCHANT, W.C. MCGREW.

## Saturday, March 31, 2001, morning

### Session 24: New Approaches to Skeletal Biology, Examples from the American Great Plains. Poster Symposium. *Century A*

Organizers and Chairs: Ashley H. McKeown, Jamestown Rediscovery and Daniel J. Wescott, University of Tennessee.

Skeletal biology of the American Great Plains was originally stimulated by the need to analyze new skeletal collections excavated during reservoir construction, and was later fueled by threats of losing these valuable collections. The aim of this symposium is to re-examine some old questions and address some new ones by applying recent methodological advancements and innovative applications of traditional methods to well-known skeletal samples from the American Great Plains—many which will soon be lost forever. These presentations will describe cultural and historical relationships, adaptations, and population biology of Plains Amerindians.

- 8:00 am–8:30 am Poster set-up.
- 8:30 am–10:00 am Authors present for questions.
- 10:00 am–10:30 am Discussants: D.W. OWSLEY, Smithsonian Institution, Washington DC, R.L. JANTZ, University of Tennessee, Knoxville, *Century A*
- 12:00 noon–12:30 pm Poster take-down.

1. History of the recovery of Plains skeletal remains. W.M. BASS.
2. Reassessing human remains from the Plains: Changes in cultural affiliation and archaeological classification brought about by repatriation documentation. W.T. BILLECK, E.V. EUBANKS.
3. Assessing tribal identity in the Plains using nontraditional craniometrics (interlandmark distances). S. OUSLEY, W. BILLECK.
4. Morphological variation among Arikara crania. A.H. McKEOWN.
5. Quantifying cranial deformation in the Plains through geometric morphometry. C.S. SPARKS.
6. An innovative method for estimating fluctuating asymmetry calculated from 3D cranial and facial coordinates. E.H. KIMMERLE, R.L. JANTZ.
7. Bilateral asymmetry of epiphyseal union as an indicator of stress in the Arikara. A.M. ALBERT, D.J. WESCOTT, C.S. SPARKS.
8. Nutritional stress and femoral cortical thickness among Plains Indians. R.R. KARDASH.
9. Analysis of Arikara humeral and femoral cross-sectional morphology. D.J. WESCOTT.\*

### Session 25: Genetics III, Population Biology. Contributed Papers. *Pershing Place North*

Chair: D. Andrew Merriwether, University of Michigan, Ann Arbor.

- 8:00 am It's not all in your head: Analyses of population affinity based on postcranial discriminant functions. A. RAY, O.M. PEARSON.
- 8:15 am Mandibular morphology and its relationship to population affinity. G.E. BERG.
- 8:30 am A comparison of population distances calculated from genetic loci and dental morphological trait frequency data. W.E. POTTER, J.P. BENN.
- 8:45 am Expectations of MMD under a model of genetic drift. S.N. BYERS.
- 9:00 am Temporal variation in prehistoric Nubian skulls. T.L. ESTENSON.
- 9:15 am North Pontic populations in the Mesolithic-Neolithic: Osteological, dental, subsistence, and cultural factors. A.M. HAEUSSLER, I. POTEKHINA.
- 9:30 am Contrasting views of the race concept in the Russian and American physical anthropology. L. YABLONSKY.



- 9:45 am Intermission
- 10:00 am Identical twins from Neolithic site Llord (Castellar de la Ribera) in Catalunya, Spain. R.J. HENNEBERG, C. DEMIGUEL, J. CASTANY, J. BERNADES, L. FÀBREGAS, J. CALDERER, G. TOWNSEND, M. HENNEBERG.
- 10:15 am Neolithic diffusion in Europe: Paleodemographic data fit better the model of cultural diffusion than that of a demic expansion. J.P. BOCQUET-APPEL.
- 10:30 am Morphological dental traits to reconstruct phenetic relationships between Late Pleistocene-Ancient Holocene human groups from Eurasia and North Africa. A. COPPA, F. DI CINTIO, R. VARGIU, M. LUCCI, A. CUCINA.
- 10:45 am The origins of the prehistoric Easter Islanders (Rapanui). V.H. STEFAN.
- 11:00 am Preliminary analyses of ancient Maya kinship within the Copán Valley using dental metric traits. M.L. RHOADS.\*
- 11:15 am The sex trade: Llama caravans as a vehicle for gene flow in the South Central Andes. T.G. O'BRIEN.\*
- 11:30 am Craniometric relationships between Paleoamericans and Archaic Indians. D.L. CUNNINGHAM, R.L. JANTZ.
- 11:45 am Population relationships and patterns of social integration during the Late Precontact period in Minnesota and adjacent areas. S.M.T. MYSTER.

### Session 26: "Populational Thinking: Dead or Alive?" Symposium. *Pershing Place South*

Organizers and Chairs: Kathleen Fuller, Center for the Study of Race and Ethnicity in Medicine, University of Kansas School of Medicine Kansas City, KS and Rachel Caspari, Paleoanthropology Laboratory, Department of Anthropology, University of Michigan, Ann Arbor.

The development of the modern synthesis had profound effects on the history of anthropology primarily through the concept of "populational thinking." It has had a major impact on our understandings of human variation and evolution. However, since its inception, scholars have questioned the validity of populational thinking for paleontology, and its incorporation into studies of modern human variation is far from universal. In fact, the essentialist/ populational dichotomy may underlie most of the controversies in Biological Anthropology today. In this symposium we seek to assess the impact of populational thinking on Biological Anthropology and the status of populational approaches in the field today. Papers representative of many areas within the field will examine how differing perspectives on this core issue influence analytical techniques and results, and how these differing perspectives relate to broader social and biological issues.

- 8:30 am Introductory remarks: From the modern synthesis to Y2K: The status of populational thinking in physical anthropology. R. CASPARI. University of Michigan, Ann Arbor, K. FULLER. University of Kansas School of Medicine, Kansas City.
- 8:45 am Adaptation and population thinking. I. TATTERSALL.
- 9:00 am Species concepts, populations and evolutionary models in paleoanthropology. R. CASPARI.
- 9:15 am Populational thinking in primatology: Re-evaluating patterns of behavioral variation and implications for conservation. K.B. STRIER.
- 9:30 am How typological are population studies?: Bioarchaeology and Nubia. J.M. CALCAGNO, G.J. ARMELAGOS.
- 9:45 am How typological are population studies?: Genetics and race? G.J. ARMELAGOS, J. CALCAGNO.
- 10:00 am Intermission
- 10:15 am When forensic anthropology is disturbed by population-derived assumptions. E. CUNHA.
- 10:30 am Populational thinking in forensic anthropology. G.W. GILL.
- 10:45 am Evolutionary medicine and population-based thinking in cultural context: The best of three worlds? W.R. TREVATHAN, J.J. MCKENNA.
- 11:00 am The effect of the essentialist paradigm on health care. K. FULLER.
- 11:15 am Discussants: K. GIBSON. University of Texas, Houston, J. RELETFORD, SUNY College, Oneonta.

### Session 27: Primates V, Social and Reproductive Behavior. Contributed Papers. *Pershing Place East and West*

Chair: Andreas Koenig, SUNY, Stony Brook.

- 8:15 am Patterns of spatial proximity in red-fronted brown lemurs *Eulemur fulvus rufus* from Western Madagascar. J.S. GERSON.
- 8:30 am Natal dispersal in the monogamous owl monkey, (*Aotus azarai*) of Formosa Argentina. C. HUNTINGTON, E. FERNANDEZ-DUQUE.
- 8:45 am Patterns of agonistic behavior in Milne-Edwards' sifakas (*Propithecus diadema edwardsi*): An age-sex analysis. S.J. ARRIGO-NELSON, P.C. WRIGHT, J. ALTMAN.
- 9:00 am Copulatory behavior of free-ranging black-handed spider monkeys (*Ateles geoffroyi*). C.J. CAMPBELL.
- 9:15 am Mating season effects on male-female relationships in wild Formosan macaques (*Macaca cyclopis*). W.A. BIRKY.\*
- 9:30 am The effects of dominance rank on birth sex ratio in captive Rhesus macaques (*Macaca mulatta*). L.J. ALPORT.\*
- 9:45 am Intermission

- 10:00 am Behavioral and genetic correlates of male-infant interactions in a captive group of rhesus macaques (*Macaca mulatta*). A. CLEVELAND, P.A. GARBER.
- 10:15 am Reproductive performance in captive male rhesus macaques (*Macaca mulatta*) differing in cerebrospinal fluid 5-hydroxyindoleacetic acid concentrations. M.S. GERALD, S. HIGLEY, J.D. HIGLEY.
- 10:30 am Extra-group copulations by sub-adult gibbons: Implications for understanding gibbon social organization. T.Q. BARTLETT.
- 10:45 am Female strategies to reduce sexual coercion in the Sumatran orangutan, *Pongo pygmaeus abelii*. E.A. FOX.
- 11:00 am Male chimpanzee boundary patrolling and social bonds. D.P. WATTS, J.C. MITANI.
- 11:15 am Why do female primates engage in non-procreative mating with multiple males? J. SOLTIS.
- 11:30 am Reproductive strategies of West African chimpanzees (*P. t. verus*) of the Tai National Park: A reduced role for extra-group paternity. L. VIGILANT, C. BOESCH.
- 11:45 am Local customs in wild chimpanzees: The grooming hand-clasp in the Mahale Mountains, Tanzania. W.C. MCGREW, L.F. MARCHANT, M. NAKAMURA, T. NISHIDA.

### Session 28: Patterns of Growth and Development in the Genus *Homo*. Symposium. *Century B*

Organizers and Chairs: Jennifer L. Thompson, University of Nevada, Las Vegas. Gail Krovitz, George Washington University. Andrew Nelson, University of Western Ontario.

The rates and patterns of growth and development differ between human and non-human primates. Furthermore, it is generally accepted that the earliest hominids followed an ape-like pattern of development. Thus, the modern pattern of growth and development likely evolved within the genus *Homo*. This symposium will focus on species within the genus *Homo* in order to investigate the origins of the pattern of craniofacial and postcranial growth and development that characterizes modern humans. In doing so, it will explore the unique ontogenetic programs that characterized Lower, Middle and Upper Pleistocene populations.

- 8:00 am Introduction: The rise of auxological paleontology. B. BOGIN.
- 8:15 am Ontogeny, phylogeny, and heterochrony in human evolution. S.R. LEIGH.
- 8:30 am Growth and life history in *Homo erectus*. S.C. ANTÓN.
- 8:45 am Dental development in Lower and Middle Pleistocene hominids from Atapuerca (Spain). J.M. BERMÚDEZ DE CASTRO, A. ROSAS.
- 9:00 am Relative postcranial and cranial growth in Neandertals and modern humans. J.L. THOMPSON, A.J. NELSON.
- 9:15 am Patterns of growth in Upper Pleistocene *Homo sapiens*: Comparative analysis between La Ferrassie and Qafzeh immature os coxae. T. MAJO, A.M. TILLIER.
- 9:30 am Diaphyseal cross-sectional shape in the Amud 7 Neandertal and modern human babies and infants. H. ODWAK.
- 9:45 am Ontogenetic variation in the Dederiyeh Neandertal children: Postcranial evidence. O. KONDO, H. ISHIDA.
- 10:00 am Intermission
- 10:15 am Diagnosing heterochronic perturbations in the craniofacial evolution of *Homo* (Neandertals and modern humans) and *Pan* (*P. troglodytes* and *P. paniscus*). F.L. WILLIAMS, L.R. GODFREY, M.R. SUTHERLAND, A. CULICH.
- 10:30 am Ontogenic patterning and phylogenetic significance of mental foramen number and position in the evolution of Late Pleistocene *Homo sapiens*. H. COQUEUGNIOT, N. MINUGH-PURVIS.
- 10:45 am Morphogenetic differences in facial projection between *Homo Sapiens* and *Homo neanderthalensis*. D.E. LIEBERMAN, B.M. McBRATNEY.
- 11:00 am Shape and growth differences between Neandertals and modern humans: Grounds for a species level distinction? G.E. KROVITZ.
- 11:15 am Development of sexual dimorphism in the facial skeleton of anatomically modern *Homo sapiens*. U. STRAND VIDARSDÓTTIR, P. O'HIGGINS.
- 11:30 am Variation in deciduous tooth formation in humans. H.M. LIVERSIDGE, T. MOLLESON.
- 11:45 am Discussant: L.C. AIELLO. University College London

### Saturday, March 31, 2001, afternoon

#### Session 29: Paleoanthropology VI, Hominid Evolution. Posters. *Century A*

Chair: Mark Collard, University College London, UK.

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

1. The Taung raptor hypothesis: Caveats and new evidence. J.K. McKEE.
2. Frequency of the occipital marginal drainage pattern in African great ape endocasts. C.C. SHERWOOD, D.C. BROADFIELD, M.S. YUAN, F.X. SUBIAUL, S. MARQUEZ, R.L. HOLLOWAY.
3. The first-ever described intact cranial base of *Paranthropus robustus*. D.J. DE RUITER, L.R. BERGER.
4. Three-dimensional analysis of the lateral tibial condyle in gracile australopithecines. J.M. ORGAN, C.V. WARD.
5. Ulnar shaft curvature in early hominids. M.S. DRAPEAU.
6. The correlates of metabolic energy expenditure in humans walking: Velocity, leg length and body mass. P.A. KRAMER.
7. A preliminary study of molar microwear of early *Homo* from East and South Africa. P.S. UNGAR, M.F. TEAFORD, F.E. GRINE.
8. Identifying patterns of migration and endemism in African mammal localities. K.E. REED, C.A. LOCKWOOD.
9. Comparison between KNM-ER 1805 and other specimens of early *Homo*: a reevaluation of its taxonomic allocation? S. PRAT.\*
10. Randomization methods to analyze variation in non-metric characters, and the single-species hypothesis for *Homo erectus*. B. VILLMOARE.
11. A study on the taxonomic validity of *Homo heidelbergensis*. A. COSSETTINI.
12. Cross-sectional geometry and biomechanics of the mandibular symphysis in Middle and Late Pleistocene *Homo*. S. DOBSON, E. TRINKAUS.
13. Quantifying relationships among Pleistocene hominids. D.M. WADDLE.
14. Late Pleistocene human anterior femoral curvature. L.L. SHACKELFORD, E. TRINKAUS.
15. Analysis of Neanderthal temporal bone morphology using geometric morphometrics. K. HARVATI.
16. Morphological variability through ontogeny of the modern human chin. K. HATTMAN.
17. Cranial morphology of Dederiyeh No. 2 Neandertal child from Syria. H. ISHIDA, O. KONDO.
18. Analysis of basicranial variation in modern humans. L.D. NEVELL.
19. Man's place in cladistics: An assessment of the efficacy of the cladistic methodology in hominid systematics. M.S. HALTER.\*
20. Erfkroon: A new Florisian fossil locality in the Western Free State, South Africa. R.A. HUTCHISON.
21. Population extinction and recolonization in human demographic history. E. ELLER, J. HAWKS, J.H. RELETFORD.
22. Treil's three-dimensional cephalometry using computed tomography: Prospects in physical anthropology. J. TREIL, J. BRAGA, P. BORIANNE, J. FAURE, F. WAYSSE.
23. Coordinate-based, measurable 3-D endocasts. A.H. WEAVER A. BERGSTROM, R.L. HOLLOWAY.
24. Application of the C2000 software using computed tomography to some fossil hominids, African apes and extant humans. F. THACKERAY, J. BRAGA, J. TREIL, P. BORIANNE, J. CASTEIGT, Y. COPPENS, J.H. LABUSCAGNE, N.A. NIKSCH.
25. Computer-assisted reconstruction and morphometry of a new specimen from Qafzeh C.P.E. ZOLLIKOFER, M.S. PONCE DE LEÓN.

### **Session 30: Understanding the Populational History of South Asia and Oceania: "How informative are genetic studies on the contemporary indigenous populations?" Symposium. *Pershing Place North***

Organizer and Chair: R.J. Mitchell, La Trobe University.

The speakers will present a variety of perspectives on the settlement history of South Asia and Oceania and the affinities of the contemporary inhabitants. These two regions are examined together because it is evident that tracing movements into Oceania requires knowledge of mainland and island Southeast Asian populations. The overall theme is to assess how autosomal, mitochondrial and Y chromosome DNA polymorphisms have furthered our understanding of these issues. The goals of this symposium are to illustrate how the knowledge obtained from molecular markers has developed our understanding of the history of this significant region, and also to identify issues that still remain.

Co-sponsored by the American Association of American Anthropological Genetics and American Association of Physical Anthropologists.

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| 1:00 pm | Introduction: R.J. MITCHELL. La Trobe University, Melbourne, Australia   |
| 1:15 pm | Dental morphology of the aborigines (Orang Asli) of West Malaysia. D.R.T. RAYNER.  |
| 1:30 pm | Malarial selection on the GM Locus in Taiwan Aborigines: Effects on measuring genetic affinity to other populations. M.S. SCHANFIELD, K. OHKURA, M. LIN, R. SHYU, H. GERSHOWITZ, |
| 1:45 pm | JC virus genotypes in the Western Pacific. G.L. STONER, J.S. FRIEDLAENDER, D.V. JOBES, C.S. MGONE, R. YANAGIHARA, H.T.S. AGOSTINI.   |
| 2:00 pm | mtDNA diversity in Southeast Asian populations. D.C. WALLACE, T.G. SCHURR.   |

- 2:15 pm A genome-based investigation of consanguineous marriage in South India. A.H. BITTLES, W. WANG, S. DI GRANDI, J. KUMM, H.S. SAVITHRI, G.N. SHUBHA, N. APPAJI RAO.
- 2:30 pm Genetic diversity at the FMR1 locus in 10 ethnic groups of Indonesia. S.M.H. FARADZ, D.A. LEIGH, J. LEGGO, M.F. BUCKLEY, J.J.A. HOLDEN.
- 2:45 pm Molecular genetic diversity and its possible implications among 4 ethnic groups of Sulawesi, Indonesia. R.J. MITCHELL, N.G. WHITE, F. LAMIS, G.R. FLANNERY.
- 3:00 pm Intermission
- 3:15 pm Can nuclear genetic loci be used to discriminate between populations in Southeast Asia, Melanesia and Polynesia? J. MARTINSON.
- 3:30 pm Time scales for genetic diversity in Melanesia: A look at some evidence for estimates of 100,000 years or more. R.M. HARDING. MRC
- 3:45 pm Molecular archaeology of Pacific commensals: Animal models for human migration. E. MATISOO-SMITH.
- 4:00 pm Origins and relationships among Polynesians, Micronesians, and Melanesians. J.K. LUM.
- 4:15 pm Prehistoric migrations to the Himalayas: Insights from the Y chromosome. R. DEKA, B. SU, C. XIAO, J. XIAO, M.T. SEIELSTAD, P. UNDERHILL, R. CHAKRABORTY, L. JIN.
- 4:30 pm Mitochondrial DNA variation and human population movements in Melanesia. D.A. MERRIWETHER, J. FRIEDLAENDER.
- 4:45 pm Correlations between genetics and ethnology in the Pacific: A Y-chromosomal perspective. M.E. HURLES, J. NICHOLSON, B.C. SYKES, M.A. JOBLING.
- 5:00 pm Discussant: M.H. CRAWFORD. University of Kansas, Lawrence.

### Session 31: Primates VI, Biological Variation. Contributed Papers. *Pershing Place South*

Chair: Susan Ford, Southern Illinois University, Carbondale.

- 1:00 pm The tyranny of size. C.E. OXNARD, K.W. DE WINTER.
- 1:15 pm A biometric analysis of sexual dimorphism in wild ringtailed lemurs (*Lemur catta*). M.L. SAUTHER, J.A. STECKLER, R.W. SUSSMAN.
- 1:30 pm Variability and structural reduction: Second metapodials in lorises. R.G. TAGUE.
- 1:45 pm Anatomy and function of the hylobatid thumb and index finger region. K.L. STOUT.\*
- 2:00 pm Body proportions, climatic adaptation, and secular trends in *Macaca mulatta* skeletons from Asia and Cayo Santiago, Puerto Rico. K.J. WEINSTEIN.
- 2:15 pm Variance dimorphism in the postcrania of hominoids and several monkeys. P.S. VINYARD.\*
- 2:30 pm Locomotion, long bone structure and body mass estimation in Old World anthropoids. C.B. RUFF.
- 2:45 pm Intermission
- 3:00 pm Functional adaptation of the iliac and upper femoral cancellous network in a bipedally-trained Japanese macaque. R. MACCHIARELLI, M. NAKATSUKASA, L. ROOK, T.B. VIOLA, L. BONDIOLI.
- 3:15 pm Deep masseter recruitment patterns during chewing in callitrichids. C.J. VINYARD, S.H. WILLIAMS, C.E. WALL, K.R. JOHNSON, W.L. HYLANDER.
- 3:30 pm Biomechanical changes in the *Macaca mulatta* masticatory system during postweaning growth. B. BEHRENS.
- 3:45 pm Biomechanics of sexual dimorphism in the anthropoid masticatory system. M.A. SPENCER, R. HOGARD.
- 4:00 pm Histological analysis of dental development in Gorilla. G.T. SCHWARTZ, M.C. DEAN, D.J. REID, A.L. ZIHLMAN.
- 4:15 pm Dental evolution in the genus *Pan*. M.A. MCCOLLUM, W.C. MCGREW.
- 4:30 pm *Pan troglodytes* and *Pan paniscus* diversity: results from the Y chromosome. A.C. STONE, C.M. LEWIS, J. GRUTT, M. HAMMER.
- 4:45 pm Paternity analysis of alternative male reproductive routes in langurs (*Semnopithecus entellus*). C. BORRIES, K. LAUNHARDT.

### Session 32: Paleopathology III. Contributed Papers. *Pershing East and West*

Chair: Joel Irish, University of Alaska, Fairbanks.

- 1:00 pm Intergroup violence: a comparison between Dallas phase and Mouse Creek phase frequencies and patterns. M.O. SMITH.
- 1:15 pm Ritual or just plain warfare? Trophy heads of the Julio C. Tello collection from Nasca, Peru. C.M. KELLNER.
- 1:30 pm Anatomy of a serial killer: Differential diagnosis based on rib lesions from the Coimbra Identified Skeletal Collection. A.L. SANTOS, C.A. ROBERTS.
- 1:45 pm Skeletal biology of the Voegtly Cemetery sample, Pittsburgh, Pennsylvania. D.H. UBELAKER, E.B. JONES.

- 2:00 pm Demographic analysis of the Voegtly Cemetery sample, Pittsburgh, Pennsylvania. E.B. JONES, D.H. UBELAKER.
- 2:15 pm Assessment of mobility among the prehistoric inhabitants of the Great Salt Lake wetlands. B.E. HEMPHILL.
- 2:30 pm Mortuary patterning and skeletal health at Town Creek, a South Appalachian Mississippian community. E.M. DRISCOLL.\*
- 2:45 pm Intermission
- 3:00 pm The frequency of tuberculosis and treponematosi s in a new Middle Mississippian sample from central Illinois. A.J. HANSON, D.W. STEADMAN.
- 3:15 pm Is the fetus from Elizabeth Mound 3, Lower Illinois River Valley an achondroplastic dwarf? A.L. EAST, J.E. BUIKSTRA.
- 3:30 pm Dental evidence for a maize-supplemented diet during the Late Woodland in Indiana. C.W. SCHMIDT.
- 3:45 pm Diet, dental wear, and artificial cranial deformation: the significance of cranial shape in determination of dental wear patterns. S.J. HAUN, M. GLANTZ.
- 4:00 pm Pathogenesis of dental root caries: Biocultural approach. E. INDRIATI.

### Session 33: Paleoanthropology VII, Primate Evolution. Contributed Papers. *Century B*

Chair: Frank P. Cuzzo, Las Positas College, Livermore, CA.

- 1:00 pm Evolutionary depth of primate brain language areas: Interhemispheric symmetry of sylvian fissure, with marked hypertrophy of right middle temporal gyrus, in *Erythrocebus patas*. A.M. VALACHOVIC, N.M. KHECK, P.R. HOF, J. ERWIN, P.J. GANNON.
- 1:15 pm A comparative cross-sectional study tracking maxillary sinus (MS) growth in *Pan* and modern humans: How similar are they? S.T. SLEMMER, S. MÁRQUEZ, P.J. GANNON, D.C. BROADFIELD, J.T. LAITMAN, K. MOWBRAY.
- 1:30 pm Ancestral loss of the maxillary sinus in Old World monkeys and independent acquisition in *Macaca*. T.C. RAE, T. KOPPE.
- 1:45 pm The missing Omo L338y-6 occipital marginal drainage pattern: There it isn't, is, isn't... M.S. YUAN, R.L. HOLLOWAY, D.C. BROADFIELD, D. DeGUSTA, G. RICHARDS, K. MOWBRAY, S. MARQUEZ,
- 2:00 pm Evolution of behavioral and ecological variables in the Pitheciinae. S.E. WALKER, S.M. FORD.
- 2:15 pm The predictive value of metachromism in primate taxonomy: A critical analysis using Neotropical Cebidae. A.A. BARNETT, C. ROSS.
- 2:30 pm Phylogenetic analysis of landmark data and the evolution of ateline skull form. T.M. COLE III.
- 2:45 pm Patterns of craniofacial variation, dimorphism, and species recognition in primates. J.M. PLAVCAN.
- 3:00 pm Intermission
- 3:15 pm Hard tissue evidence for Asian colobine phylogeny. C.D. BYRON.
- 3:30 pm Testing hypothesized constraints on primate and hominin skull form. R.C. McCARTHY.
- 3:45 pm Predicting mammalian walking gaits from optimized support polygons. M. CARTMILL, P. LEMELIN, D. SCHMITT.
- 4:00 pm Convergence in gait mechanics between primates and woolly opossums: The origins of primate locomotion can be traced back to a fine-branch niche. P. LEMELIN, D. SCHMITT.
- 4:15 pm Ontogeny of gait in *Papio cynocephalus*. L.J. SHAPIRO, D.A. RAICHLEN.\*
- 4:30 pm Dimensions and moment arms of the hind- and forelimb musculature of the hominoids. R.C. PAYNE, R.H. CROMPTON.
- 4:45 pm Allometry of manual proportions. B.T. WATKINS.

# Abstracts of AAPA Poster and Podium Presentations

\* indicates a student prize contestant.

## The effects of pregnancy and lactation on the maternal skeleton: A historical perspective.

S. AGARWAL. Dept. of Anthropology, U of Toronto, Samuel Lunenfeld Research Institute of Mount Sinai Hospital, Toronto, Ontario, Canada.

The effects of parity and lactation on the maternal skeleton, and the contribution they make to bone fragility in post-reproductive years, is not well understood. Site-specific bone loss has been reported during pregnancy in some studies, while other have found no significant change in bone density at all, and parity has been reported as protective against fracture. Bone loss has been shown to occur with lactation, however, the degree and subsequent recovery of bone loss remains controversial. From an evolutionary perspective, it seems maladaptive that the female skeleton be incapable of efficient bone maintenance under the normal conditions of pregnancy and lactation. Human females share similar reproductive patterns with the genetically closest non-human primates. For example, non-industrialized female life cycles are typically characterized by late menarche, frequent pregnancies, prolonged lactation, and early menopause. Reproductive patterns have changed substantially only within the last century, causing a dramatic shift in the hormonal milieu of modern western females. The study of female skeletons in historical past populations gives us a unique opportunity to examine the skeletal effects of reproductive patterns that are more consistent with those followed throughout the majority of female evolution. A study was made of trabecular architecture and bone density in British medieval and post-Medieval female skeletons. 5mm thick coronal sections from lumbar vertebrae (n=56, divided in three age categories) were scanned in a DEXA scanner (Piximus, Lunar Corp.) for measurement of bone mineral density, and then x-rayed for image analysis of trabecular structure and connectivity. Females from both populations showed little fragility fracture, significant loss of bone density and architecture at an early age, and no significant losses between middle and old age, in contrast to modern populations. We suggest that the patterns of bone loss found in archaeological female populations may reflect the many changes that have occurred in reproductive behavior.

## Your species or mine? Blurred species definitions and the Neandertal debate.

J.C.M. AHERN. Department of Anthropology, University of Wyoming, Laramie, WY 82071-3431.

Heated debate continues to revolve around the fate of the Neandertals. Much of this debate centers on whether Neandertals were conspecific with living humans or were their own species, *Homo neanderthalensis*. Species designations are typically intended to make statements about reproductive continuity and discontinuity, thus we should expect that different species designations in regards to Neandertals reflect different interpretations of gene flow between Neandertals and the *Homo sapiens* population that succeeded them.

This study tested the hypothesis that the different species designations given to Neandertals reflect different interpretations of the degree of admixture between Neandertals and modern humans. Publications on Neandertals and the modern human origins debate spanning the last decade were reviewed in terms of views on species designations and Neandertal-modern human admixture.

In many if not most cases, different species designations did not reflect drastically different interpretations of gene flow between Neandertals and modern humans. Although scholars with widely opposite interpretations regarding admixture also have opposing species designations (e.g., CL Brace and I Tattersall), many others, with similar views on admixture, favor different species designations (e.g., G Brauer and FH Smith). Even those often viewed as opposites in the modern human origins debate, such as CB Stringer and MH Wolpoff, agree that some admixture occurred, but they differ in their Neandertal species designations. Thus, although there is considerable debate about which species name should be used for Neandertals, clearly there is very little agreement, and even less active debate, concerning what these specific designations actually mean. Although a few authors (e.g., Y Rak, I Tattersall, and MH Wolpoff) are explicit in their use of species concepts, species definitions are generally ambiguous in writings on the fate of the Neandertals.

## Osteoarthritis in the Middle Neolithic population from Västerbjers, Gotland, Sweden.

T. AHLSTRÖM. Archaeological Institute, University of Lund, Sandgatan 1, 223 50 LUND, Sweden.

Several stone age sites with associated cemeteries has been found scattered along the former shorelines on the island of Gotland, central Baltic Sea. The cemetery at Västerbjers, Gothem Parish, was excavated in the thirties. In all, 50 graves were excavated. Radiocarbon datings performed on the skeletal remains indicates a date of ca. 4000 BP, i.e. the Middle-Neolithic period. Archaeologically, the material unearthed at Västerbjers belongs to the Pitted-Ware tradition. The Pitted-Ware tradition is characterized by artefacts indicating a maritime subsistence. This is corroborated with respect to stable carbon isotopes. Further, no caries has been identified in the dentitions, suggesting a lack of carbohydrates in the diet. However, traces of domesticated animals may be occasionally identified (pig and cattle).

Osteoarthritis is a major health problem in modern societies. As advanced osteoarthritis may be identified in archaeological specimens, paleopathological findings may broaden our perspectives concerning etiology and epidemiology. This presentation will focus on the presence of osteoarthritis in the hunter-gatherer population from Västerbjers. Several specimens bear signs of the disease (eburnation). Among other things, two individuals were affected by osteoarthritis in the knee joint (one patello-femoral and one tibio-femoral).

This research has been funded by the Swedish Council for Research in the Humanities and Social Sciences.

## Atherosclerosis, a sign that people became old-aged in the Middle ages?

C. AHLSTRÖM ARCINI. National Heritage Board, Archaeological Excavations Dept., Åkergrändens 8, S-226 60 Lund, Sweden.

Today, atherosclerosis is a major cause of death in the industrialized world. The changes that are associated with atherosclerosis usually are localized to special locations in the artery. A common place for atheroma is the carotissiphon, the S-formed curve that the carotis/carotid artery makes when it has entered the base of the skull. Today we know that risk fac-

tors for developing atherosclerosis are hypertension, diabetes, high level of lipoprotein, smoking and overweight. Research also show that men are more affected than women. It is today very uncommon in individuals younger than 60 years of age.

In a skeletal material from Medieval Åhus, Scania, Sweden five cases of atherosclerosis were found. The calcification of the atheroma were encountered in the skulls when they were cleaned after the excavation. This is probably the major reason why they were encountered along with fortunate taphonomical conditions. The presentation will focus on the question whether these characters, along with other osteological findings could be used as a basis for discussion concerning old age in Medieval societies.

#### **A new metric method for sex determination using the pelvis and femur.**

J. ALBANESE. Department of Anthropology, McMaster University, Hamilton, Ontario, L8S 4L9.\*

For over a century, the pelvis in general and the pubis in particular have been recognized as being highly sexually dimorphic and the best source of information when determining the sex of an unknown individual. However, from its earliest descriptions, the measurement of the pubis length has been poorly defined. Using samples from the Terry Collection (n = 332) and the Coimbra Collection (n = 223), the purpose of this research is to (1), test the reproducibility of an alternative to the traditional measurement of the pubis, and (2) to use the best measurement of the pubis (along with other measurements of the pelvis and femur) to develop a metric method that can be used with confidence to determine the sex of individuals of various geographic origins and time periods.

In this study, it was found that, (1) the alternative pubis measurement can be collected more reliably with less mean intra-observer error (<0.6%) than the more commonly used manner of measuring the pubis (2.7%); (2) a sex determination method using the new pubis measurement, along with other measurements of the pelvis and femur, discriminates between the sexes across various independent samples with an allocation accuracy of up to 98% (depending on the model used and the manner of testing); and (3) traditional racial categorization was irrelevant to the accuracy of the method.

#### **Bilateral asymmetry of epiphyseal union as an indicator of stress in the Arikara.**

A.M. ALBERT<sup>1</sup>, D.J. WESCOTT<sup>2</sup>, C.S. SPARKS<sup>2</sup>. <sup>1</sup>Anthropology Program, UNC-Wilmington, NC 28403-3297, <sup>2</sup>Department of Anthropology, University of Tennessee, Knoxville, TN 37996.

Bilateral asymmetry of skeletal maturation has been shown to be a relatively good indicator of severe environmental stresses on a population. In this study we employ the analysis of bilateral asymmetry in epiphyseal union to examine possible fluctuations in the health and nutritional status of the Arikara. Skeletal samples ranging in time from A.D.1600 to 1832 were used to represent three archaeological periods: Extended Coalescent (EC) (A.D. 1600-1675), Postcontact Coalescent (PCC) (A.D.1675-1750) and Historic Arikara (HA) (A.D. 1780-1845). These three periods have previously been found to differ from one another with regard to health and nutrition status. In general, the EC and HA periods are characterized by a relatively poor health and nutrition status compared to the PC period. Poor climatic conditions probably played a key role during the EC, but the introduction and diffusion of infectious diseases and increased inter-tribal conflict are thought to be primarily responsible for the decline in health during the HA period.

Stages of epiphyseal union were recorded for 19, paired epiphyses on 9 different bones. Individuals used in this study range in age from approximately 12 to 30 years. A mean value of epiphyseal union was computed for the right and for the left side of each individual, and then tested for statistical significance using a paired samples t-test. A Wilcoxon Signed-ranks test was employed to assess directional asymmetry. The data were analyzed by archaeological period.

Bilateral asymmetry was not significant for any of the archaeological time periods. However, the general pattern of asymmetry is as expected. That is, the PC sample is more symmetrical than the other two groups.

#### **Evolution of the human brain: Size, shape, and organization.**

K. ALDRIDGE. Johns Hopkins University School of Medicine, Baltimore, MD 21205.\*

The human brain is many times larger than would be expected for a primate of similar body size. Still, it is not known whether the human brain differs only in size, or whether it has evolved in a mosaic pattern, altering the morphological organization of the brain. This study is designed to determine the pattern of change in the human brain over evolutionary time by examining relative proportions and positions of cortical and subcortical components in extant primate species.

The study sample consisted of whole brain magnetic resonance images (MRIs) of live, adult individuals of six hominoid species, gibbons (N=3), orangutans (N=4), gorillas (N=2), chimpanzees (N=6), bonobos (N=4), and humans (N=20). Three-dimensional landmarks defined on the surface and internal features of the brain

were located on 3-D MRI reconstructions of each individual using MEASURE software. The landmark coordinate data were scaled for differences in size and analyzed using Euclidean Distance Matrix Analysis (EDMA) to compare the brains of each non-human hominoid species to the human sample. This method allows differences in both size and structural organization to be localized to specific regions of the brain.

Results of analyses show both a pattern that is consistently different between all non-human hominoid and human brains, as well as patterns that differ between species. Further, both the consistent and the dynamic patterns include cortical and subcortical features. The pattern that remains consistent across species indicates a lateral displacement of the structures in the anterior frontal lobes in humans relative to non-human hominoids with the magnitude of difference increasing with phylogenetic distance, such that gibbons are the most different from humans, while chimpanzees and bonobos are the least different. These results suggest that although there is a pattern of morphology that uniquely defines the human brain, there are also patterns that uniquely differentiate human morphology from the morphology of each non-human hominoid, indicating differing adaptive pressures.

#### **A new Middle Pleistocene fauna from the Busidima-Telalak region of the Afar, Ethiopia.**

Z. ALEMSEGED<sup>1</sup>, D. GERAADS<sup>2</sup>. <sup>1</sup>Institute of Human Origins, Arizona State University, Box 874101, Tempe AZ 85287. <sup>2</sup>CNRS, rue de l'Amiral Mouchez, F-75014 Paris, France.

A new Middle Pleistocene site is identified in the Afar region of Ethiopia. Fossils have been collected from adjacent research areas of the Middle Awash and Gona. Nothing was known about the Busidima-Telalak area before our initial fieldwork, in November 1999, after which we realized that the potential of the area for paleontological studies was great.

At the few localities identified, we encountered a diverse mammalian fauna (31 species) with great abundance and excellent preservation. There are at least four species of Cercopithecidae. Some resemble the modern small size monkeys and baboons whereas others represent extinct species (*T. oswaldi*). The exceptionally high number of carnivores (six species) in the area is also interesting from paleoecological point of view. This is a rare case in many fossiliferous sites of the region.

Bovids are abundant (10 species), as well, with the dominant tribe being Reduncini. On the other hand, suids (represented by several species at other sites) appear to be poorly represented here. Only two species were identified in our preliminary survey. Hippopotamids are very

abundant in many other sites of the region but are also rare in our area. Rodents are, in contrast, very abundant and are encountered on the surface even without sieving.

There are three main implications of the faunal composition of the new area:

- The probability of finding hominids in the new area is high.
- Based on the fauna already collected the age of the sediments is approximately between 1 Ma and 200 Ka.
- The total faunal composition (the proportion between different taxa) is different from other sites of comparable age.
- Fossils of the new area will make it possible to test paleoenvironmental hypotheses of that time period.

#### The effects of dominance rank on birth sex ratio in captive Rhesus macaques (*Macaca mulatta*).

L.J. ALPORT. Department of Anthropology, University of Texas at Austin, Austin, Texas 78712.\*

Sex ratio variation may be one adaptive mechanism used by females to increase their lifetime reproductive success. Trivers and Willard (1973) hypothesized that females in good condition will give birth to a greater number of males. Conversely, the advantaged daughter hypothesis (Hiraiwa-Hasegawa, 1993) states that within female philopatric social organizations, high-ranking females should give birth to more daughters. Previous studies on birth sex ratio in primates have yielded conflicting results, particularly in Rhesus macaques.

The current study tests these hypotheses by controlling for the role of the male in determining sex ratio. In this study 10, one-male groups of captive Rhesus macaques were given priority of access tests. Females were then assigned ranks of high, middle, or low according to the results of these feeding trials. Birth record data were analyzed to determine the effects of these rankings on the sex of offspring born. Alpha females had significantly higher birth sex ratios than either middle-, or low-ranking females and had significantly longer interbirth intervals before the birth of a male. Females' weight was not correlated with their dominance ranking. Assuming that alpha females were in better condition than lower-ranking mothers, these data support the Trivers-Willard hypothesis.

Further analyses show that high-ranking females gave birth earlier in the birth season. Additionally, a positive correlation was found between rank and number of offspring per female. Although these trends were not statistically significant, they may be relevant to understanding the affects of dominance on lifetime reproductive success.

#### Primate biomaterials resource.

J. ALTMANN<sup>1</sup>, J.C. BECK<sup>2</sup>, A. DiRIENZO<sup>3</sup>, K.E. GLANDER<sup>4</sup>, M. GOODMAN<sup>5</sup>, A. MANN<sup>6</sup>, D. MELNICK<sup>7</sup>, J. ROGERS<sup>8</sup>, O.A. RYDER<sup>9</sup>, A. STONE<sup>10</sup>, T. TURNER<sup>11</sup>. <sup>1</sup>Princeton University, Princeton, NJ 08540 U.S.A., <sup>2</sup>Coriell Institute for Medical Research, Camden, NJ 08103 U.S.A., <sup>3</sup>University of Chicago, Chicago, IL 60637 U.S.A., <sup>4</sup>Duke University Primate Center, Durham, NC, 27708 U.S.A., <sup>5</sup>Wayne State University School of Medicine, Detroit, MI 48201 U.S.A., <sup>6</sup>University of Pennsylvania, Philadelphia, PA 19104 U.S.A., <sup>7</sup>Columbia University, New York, NY 10027 U.S.A., <sup>8</sup>Southwest Foundation for Biomedical Research, San Antonio, TX 78245 U.S.A., <sup>9</sup>Zoological Society of San Diego, San Diego, CA 92112 U.S.A., <sup>10</sup>University of New Mexico, Albuquerque, NM 87131 U.S.A., <sup>11</sup>University of Wisconsin-Milwaukee, Milwaukee, WI 53211 U.S.A.

The rapid advance in technical ability to examine genetic structures, their function, and their variation has opened a new and easily accessible window on a wide variety of questions. First applied most visibly in the sequencing of the human genome, this technology now allows powerful new insights into the origin of humans and relatedness of other species. At a workshop held at the National Science Foundation (USA) in May, 2000, a panel met to assess the need for creating a resource of biological samples, e.g., cell lines, tissues, DNA, RNA, cDNA samples, and genomic resources such as BAC or cDNA libraries, for primate conservation, evolution and population research. In anticipating future needs, the consensus was to develop a collection of primate biomaterials with several components: extensive sampling across species and intensive sampling of a few species for developmental and comparative genomic studies. For these purposes, high-quality, well characterized samples with extensive data will be assembled and provided inexpensively for non-commercial use to investigators to meet diverse scientific and conservation goals. It is anticipated that the long term impact of a comprehensive primate biomaterials resource will extend to the preservation of a valuable record of the biological and genetic diversity of endangered species. We welcome discussions from the scientific community about the establishment of this resource.

#### Whom do you trust? Coordination among cooperative big game hunters in Indonesia.

M.S. ALVARO. Texas A&M University, Department of Anthropology, College Station, TX 77843-5352.

A situation where organisms' interests overlap and they engage in joint activities

is called coordination by game theoreticians. Coordination is theoretically equivalent to mutualism as conceived by biologists. As in mutualism, it does not pay to cheat in a coordination game because there is agreement among individuals with respect to outcome preference. Coordinating is not as easy as one might imagine intuitively, however, and coordination failure is common in experimental coordination games where there is one group benefit maximizing choice among many.

Substantial coordination is involved for people subsisting on cooperatively hunted or scavenged resources where the common enemy is a prey item that a solitary individual cannot kill or defend. Behaviors must be synchronized, rules must be agreed to and transfer of information from generation to generation must be accomplished.

The people of Lamalera, Indonesia practice traditional, subsistence, cooperative marine hunting. Twelve clans maintain corporations that have whaling operations focused around whaling vessels called *tena*. Their primary prey are sperm whale and ray. Cooperation is mutualistic in the sense that *not* cooperating is costly and boats cannot go to sea with crews smaller than eight. Harvest data from 25 years indicates that cooperative whaling brings higher per capita returns for individual hunters (0.79kg/hr; N=9,192 man-hunts) than does non-cooperative hook & line fishing and net fishing (0.39kg/hr; N=505 man-trips). In spite of greater returns, coordination failures occur when a boat cannot field a crew of eight or more men. Data in 1999 indicate failure rates for individual boats ranged between 20-80% of hunting days.

Genealogical data demonstrate that kinship relations and marriage alliances provides assurance among crew members of intent-to-whale. Coordination failure is a function of the strength of kin and marriage alliance networks within boat hunting corporations.

#### Growth and life history in *Homo erectus*.

S.C. ANTÓN. California Academy of Sciences, San Francisco, CA 94118-4599.

Human growth differs from the great apes in having both an extended childhood period and a pronounced adolescent growth spurt delayed to absolutely older ages. The 'uniqueness' of our growth patterns is thought to be integral to the development of human culture, yet their origin is obscure. An extended childhood period is present in early *Homo* including *H. erectus*. But the genesis of an adolescent growth spurt is debated.

I examine the *H. erectus (sensu lato)* cranial fossil record (n = 50) to assess the extent to which evidence for or against an adolescent growth spurt can be found and



to reconstruct ontogenetic growth trajectories to test the hypothesis of paedomorphosis in *H. sapiens* relative to *H. erectus*. To recognize juveniles I use a set of multiple developmental indicators. I use linear measurements and 3d coordinates of the vault, upper face, and lower face and compare these with similar data from a worldwide sample of adult and subadult modern humans (n = 320). Limited by poor preservation, I consider the question of the adolescent growth spurt by using facial measurements to assess the degree of adult growth achieved at different developmental ages. Because of arguments over the taxonomic affinities of African and Asian fossils and because even population differences within species may influence results, I assess facial differences by geographic region in both taxa.

Within *H. erectus* only 6 substantial cranial (5 Asian, 1 Kenyan) and 9 mandibular fossils (3 Kenyan, 6 Chinese) are subadults. Ontogenetic allometric comparisons suggest that shape change is more substantial with age in *H. erectus* than *H. sapiens* and that adult humans more closely resemble juvenile *H. erectus*, thus confirming paedomorphosis in *H. sapiens*. An adolescent growth spurt is reflected in facial height increases of 15-20% in *H. sapiens*. *H. erectus* shows 10-30% increases. The timing of substantial vault and facial growth suggests that the *H. erectus* data are compatible with the presence of an adolescent growth spurt. However, the geographic and temporal diversity of the sample and its poor preservation preclude more definitive statements.

#### **Influence of physical activity in the morphology of schoolchildren from the urban area of Bilbao city (Biscay, Basque Country).**

A.G. APRAIZ. University of Kansas, Lawrence, Kansas.

Morphological studies attempt to evaluate and describe the individuals' body form. These studies are often linked to sports. The objective of this research is to show the possible influence of sport training on the morphology of a cross-sectional sample composed of 1096 (699 males and 397 females) Basque schoolchildren (with ages ranging from 5 to 19 years) participating in a sport at least three days per week. However, the schoolchildren do not participate in competitive events. The 10 most common sports were: 1) track 2) soccer 3) basketball 4) tennis 5) martial arts 6) ballet 7) muscle-building 8) skating 9) cycling 10) swimming. Sampling took place between November 1992 and May 1994. Individuals' anthropometric measurements follow the IBP procedures (Eveleth and Tanner 1991). Calculation of size and shape components has been carried out following the equations of Heath and Carter (1967), Carter (1980) and the criteria of

Carter et al. (1983). Every component has been transformed into Z-Scores in order to avoid age effect. A Multivariate Analysis of Variance (MANOVA) as well as a Univariate Analysis of Variance (ANOVA) tests by sex have been applied to identify components that contribute to possible differences that might be found. If significance is observed, Student-Newman-Keuls' test is applied to detect differences between groups. Mean morphologies are muscular-linear for boys, while girls are more muscular-fat. Males who practice muscle-building present a muscular-fat morphology that differentiates them from other categories. Females are more heterogeneous than males because the morphologies found range from linearity and muscularity to a greater presence of subcutaneous fat. Therefore, the girls who practice basketball are distinguished significantly by the presence of fat from those doing ballet or swimming. In addition, girls who practice ballet are also significantly different from those doing martial arts, the latter presenting a greater level of muscularity.

#### **The species problem in the Levantine Mousterian.**

B. ARENSBURG<sup>1</sup>, A.E. MANN<sup>2</sup>, A.M. TIILIER<sup>3</sup>. <sup>1</sup>Sackler Medical School, Tel Aviv Univ., Ramat Aviv 69108; <sup>2</sup>Anthropology, Univ. of Pennsylvania, Phila., PA 19104; UMR 5809, <sup>3</sup>Laboratoire d'Anthropologie des Populations du Passé, Univ. de Bordeaux I, 33405 Talence.

The human fossils associated with a Mousterian archaeological context in the Levant have been classified in a variety of ways. At least two, possibly three species, are said to be represented, perhaps living in this area at different times. One grouping, from Skhul and Qafzeh, is often accorded status as anatomically modern humans; another sample, from sites such as Amud, Kebara and perhaps Tabun, have usually been classified as Neandertals. A third category, containing the Zuttiyeh specimen, is viewed as an earlier species, perhaps ancestral to modern humans.

In the context of the competing theories of modern human origins, these taxonomic assessments need to be critically appraised. For example, the use of the term "Neandertal" needs to be reconsidered. Traits emphasized in the definition of European Neandertals, such as the supra-orbital fossa, or an inflated maxilla with a straight and non-angulated lateral border, are either not present on Levantine specimens or cannot be documented because of the incomplete nature of the fossils themselves (i.e. Amud 1, Kebara 2, Tabun C1). Other features, such as the morphology of the occipital-mastoid area, are present in Tabun C 1 but missing in Amud 1. The placement of the Skhul and Qafzeh sample in *Homo sapiens sapiens* also needs to be

reevaluated. The ranges of variation present in both samples requires further evaluation.

Finally, the Upper Pleistocene fossil record, with major samples from some locales, like the Levant, but with other areas, like South Asia, entirely unknown, limits reconstructions on the basis of an extremely narrow aspect of Middle Paleolithic human evolution.

In our view, these taxonomic categories create a vision of Middle Paleolithic human evolution based on populations with distinct boundaries, but one that obscures the highly complex patterns that were most likely present.

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#### **How typological are population studies?: Genetics and race?**

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Physical anthropology originated as a discipline committed to the study of human variation. The foundation of these early comparative studies was entrenched in racial typology. Shared morphological features were considered indisputable evidence of a shared racial history. Cranial and postcranial features that distinguished racial groups became, by definition, racial traits. Nearly a half century ago, S. L. Washburn heralded the "new physical anthropology," which eschewed classification and description and for a more dynamic investigation of process and hypothesis testing. The impact of population genetics on physical anthropology in the 1950s suggested that the changes in the paradigm were imminent. In 1972, Lasker disappointedly noted that the discipline had remained essentially descriptive and had not moved beyond the rhetoric of the "new physical anthropology." While strides have been made in the last three decades, typological analysis remains a consistent feature of genetic studies.

Typology is most apparent in genetic studies that attempt to establish the history of human population migration. Whether using genetic traits or mtDNA, typology is embedded in both the methodology and interpretation. Even when researchers specifically reject racial classifications, they present their analysis in terms that are typological and frequently racial. For example, while Cavalli-Sforza and colleagues' *The History and Geography of the Human Genes* rejects the racial model, their interpretation still reflects earlier racial classifications.

### HLA genes in Mexican Mazatecans, the peopling of the Americas and the uniqueness of Amerindians.

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The HLA gene profile of the Mexican Mazatecan Indians (Olmec culture) has been studied and compared with those of other First American Natives and worldwide populations (a total of 12,000 chromosomes). Genetic distances, neighbor joining and correspondence analyses have been done after HLA-DNA indirect sequencing. The main conclusions are: 1) The first genetic evidence of Olmec and Mayan relatedness is found, further supporting the notion that Olmecs may have been the precursors of Mayans. 2) Language and genetics do not completely correlate in microenvironmental studies. 3) Peopling of the Americas was probably more complex than postulated. Cultural input may have come both through Atlantic and Pacific routes; in contrast, a significant genetic input from outside is not noticed in Meso and South American Indians. 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 remain isolated in the Neighbor-Joining, correspondence and plane genetic distance analyses. A Meso-South American Indian autochthonous origin and development is discussed.

### Patterns of agonistic behavior in Milne-Edwards' sifakas (*Propithecus diadema edwardsi*): An age-sex analysis.

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Sexually immature primates that adopt "adult" behaviors at a young age have the potential to increase their lifetime reproductive success by practicing and refining these behaviors before they become necessary for survival or reproduction. A link between the patterns of agonistic behavior seen in sexually immature animals and those of same-sex adults has been reported for many species of monkey and ape. Although rarely studied, the acquisition of

gender-specific behavior patterns by immature prosimians is especially interesting, given the prevalence of female dominant species within this group. This study compares agonistic behavioral patterns in different age-sex classes of the Milne-Edwards' sifaka.

This study was conducted at Ranomafana National Park, in the southeastern rain forest of Madagascar. All occurrences data on agonistic interactions were collected during all-day follows of focal individuals in four study groups, beginning in 1986 (total = 40 group years). Agonistic behaviors analyzed include: submissive vocalizations, approach/retreat interactions, avoidance behavior, and physical aggression. For analysis, the data were partitioned into age-sex classes. Sexually mature animals were grouped as adults and sexually immature animals were grouped by age, based on the year of their birth.

Preliminary results indicate that males and females of all ages initiate agonistic interactions, both with members of their own and other age-sex classes (both older and younger). Adults are involved in the majority of the interactions and adult females initiating more and receiving less agonism than adult males. For their age, females are also more physically aggressive than males, using a wider variety of aggressive behaviors during their interactions.

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### Variation in a pre-industrial population: occupation and stature in early twentieth century Crete.

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In 1905 and 1909, the University of Cambridge expedition to the island of Crete measured anthropometric variations in crania among the population. No full analysis of the data was ever done. This study took the data from 2675 of the individuals measured by Hawes, of whom 92.4% were adult males. Measurements taken include stature and standard cranial anthropometric variables. Age, place of birth, region of residency, religion, and occupation were also recorded. For regional comparison, Crete was divided into 5 regions according to major island geography. The data was analyzed to determine if there was any regional variation among the population, and if so, what variables may contribute to such differences.

Due to the limitations, this study focused on men aged 18 years or older. Statistical analyses demonstrated no variation in the cranial sizes and shapes among inhabitants of the island. By a regional analysis, however, the male occupants of

the western area of the island (west of Hania) were significantly taller than those who lived on the rest of Crete and the island of Gavdos. Post-hoc tests showed this height difference to be related more closely to occupation differences, namely the military and police, especially when compared to farmers and unskilled workers. Greater concentrations than expected of military and police were found in the western and central eastern portions of the island. As there was little significant height difference in the central area of the island, however, this uneven distribution of law enforcers may not account entirely for the variation. To further test this issue, covariate analysis, controlling occupation by region, showed that the significant difference in height did not exist within each region, and thus over-representation of certain occupations may have explained the height difference. Still, the western area was not as imbalanced as the central, yet there was more significant difference between enforcers and farmers in the west than the central region.

The greater average height on the island among the law enforcers may reflect recruitment requirements, with minimum heights prescribed for employment. However, the differential in the western area of the island suggests shorter local inhabitants in that region. This may be the result of different nutritional standards, but cannot be tested in this analysis.

### Seeking the blueprint to the upper respiratory tract in fossil hominids: New insights from molecular approaches to branchial arch development.

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The anatomy and physiology of the human upper respiratory tract (URT) has been shown to be a key determinant of our respiratory, digestive and vocal behaviors. Given the centrality of the region for normal physiologic activity, it has received considerable attention from paleoanthropologists, particularly as it relates to the origins of speech. As bony features of a fossil's URT are often absent or fragmentary, an understanding of the molecular blueprint which determines the anatomical structure is essential. Craniofacial and URT development is highly conserved across species with homologous genes interacting in specific spatial and temporal patterns. Work by us and others has established that a specific protein, ephrin B2, a contact dependent signaling molecule, has a restricted pattern of expression in the hindbrain and branchial arches. This temporal and spatial restric-

tion is important for motor axon guidance and neural crest cell (NCC) migration, an essential step in the normal development of hard and soft tissues of the head and neck. In order to understand how the B-class ephrins work with other developmental genes to form head and neck structures, we have utilized gene transfer into live chicken embryos by electroporation. Using low fixed voltage and microinjection of exogenous DNA under the control of region specific Hox promoters, we are able to introduce changes to the normal pattern of motor axon guidance and NCC migration. Results show that alteration of the normal gene expression by this method allows for the elucidation of developmental boundaries among the branchial arches during head and neck ontogeny. These molecular approaches may shed light on the degree of genetic distinctiveness or interdependence among the structures of the head and neck and, in turn, enable us to elucidate which structures are the most reliable predictors of overall URT morphology.

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#### Evolution and distribution of sequence variation in the cis-regulatory region of CC chemokine receptor 5.

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Differences in the pathogenicity of simian (SIV) and human (HIV) immunodeficiency viruses may be caused, in part, by variation in the genes encoding host SIV/HIV entry factors. Indeed, 24-by and 32-by deletions in CC chemokine receptor 5 (CCR5) protect some non-human primates and humans against infection with SIV and HIV, respectively. However, the distribution of these polymorphisms is highly restricted. More recently, SNPs in the cis-regulatory region of CCR5 have been discovered to have a major influence on HIV-1 susceptibility and disease progression. Thus, understanding the evolution and distribution of these SNPs is important for explaining differences in SIV/HIV epidemiology among human and non-human primate populations.

We surveyed genetic variation in the ~1 kb cis-regulatory region of CCR5 in human populations ascertained by 3 different strategies: individuals shown to be homozygous for previously described polymorphisms; a panel of 130 Africans, Asians, and Europeans; a panel of 90 unidentified individuals (NIH DNA Polymorphism Discovery Resource subset 90). These data were compared to cis-regulatory sequences from >40 non-human primates.

CCR5 sequence diversity varied substantially among Africans, Asians, and Europeans. Average nucleotide diversity was higher in the worldwide sample than in the NIH panel. Extensive linkage disequilibrium was found throughout the CCR5 cis-regulatory region. The ancestral human haplotype (HHA) was defined relative to a chimpanzee outgroup that differed by 8 fixed sites. The prevalence of HHA was highest in Africans (>0.20) and peaked in the Mbuti pygmies (0.71); it was lowest in Europeans (0.09). Derived CCR5 haplotypes were organized unambiguously into a phylogenetic network. Every CCR5 haplotype with a frequency >0.1 was found in all continental populations, and no population-specific haplotypes were found. However, the prevalence of these haplotypes varied widely among different ethnic groups. These findings suggest that the biological determinants of HIV-1 susceptibility vary widely among different human populations.

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#### An evaluation of tarsier phylogenetic affinities with a reappraisal of the use of nucleotide sequences in phylogeny.

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The order Primates has traditionally been split into two gradistic sub-orders (Prosimian, Anthropoid) based on Simpson's [(1945)Bull. Am. Mus. Nat. Hist. 85, 1-350] evaluation. A subsequent realignment has been proposed which divides Primates into two cladistic sub-Orders (Strepsirhine, Haplorhine) on the premise that the tarsier, a prosimian, actually shows greater affinity to anthropoids. These different classification schemes require resolution of the question whether the suite of traits reflect an anthropoid re-invasion of the prosimian adaptive zone by the tarsier [Cartmill (1980) In Evolutionary Biology of the New World Monkeys and Continental Drift. New York. Plenum. p. 243-274]. Tarsiers lack the tapetum lucidum, the reflective membrane found in the eyes of all Strepsirhines, yet have the largest eyes relative to body size, among all primates. Such a seemingly 'regressive shift' would suggest, that the attributes attributed to nocturnal behavior are secondarily derived in tarsiers.

Recent studies have utilized protein sequences because they retain phylogenetic information. A molecular analysis of the Interstitial Retinoid Binding Protein (IRBP) can potentially aid in the resolution of this issue. The IRBP is found in nearly all vertebrates and functions in the light and dark adaptive cycles of rhodopsin, a visual pigment in the photoreceptor cells of the eye. Using the IRBP sequence

a phylogeny is generated for 15 families from 7 Mammalian orders. This sampling includes nocturnal, diurnal, cathemeral, and crepuscular species. The observed differences between the tarsiers and the other nocturnal species will be used to assess the relative sequence of divergence events. The resulting phylogeny will be compared to that expected based on behavior (i.e. nocturnal) and biology (presence/absence of tapetum). This provides a reassessment of nucleotide phylogeny. If tarsiers have indeed been secondarily adapted to nocturnal behavior, they should show affinities to both nocturnal primate and non-primate species.

#### The predictive value of metachromism in primate taxonomy: A critical analysis using Neotropical Cebidae.

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Metachromism has been a controversial taxonomic tool ever since its original proposal by Philip Hershkovitz in 1968. Though a key part of Hershkovitz's taxonomic treatments of Neotropical primates, metachromism has been criticized for its orthogenetic overtones. Consequently, it has found few adherents, even among the many whom accept Hershkovitz's taxonomic conclusions.

A recent critical test of metachromism's validity as a predictive taxonomic tool found an almost perfect match between *Saguinus* (Callitricidae) phylogenies based on metachromism and on mtDNA. To test the generality of this result, we used canonical methods for metachromic pattern analysis and PAUP, to construct a metachromism-based phylogeny for all species of Cebidae and compared this against widely accepted composite primate phylogenies.

Using these results we discuss the validity of metachromism as a predictive taxonomic tool, and compare the results found with the Cebidae and Callitricidae. We also consider the validity of extending this form of analysis to other taxa and the taxonomic and conservation consequences of this study's results for Neotropical primates.

#### Comparative analysis of the neural spine and transverse processes in the lumbar vertebrae of the Hominoidea.

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The morphology of the neural spine and transverse processes in the lumbar vertebrae of hominoids was quantitatively assessed to determine the structural components required by bipedalism. Past re-

search has suggested that the dorsal and lateral projection of the neural spines and transverse processes is not highly correlated with bipedalism, the neural spine in humans is more horizontal than that observed in apes, and the transverse process is more dorsally oriented as compared with apes, yet the intraspecific variation among hominoids in these features has not been established. In the current study, the size, projection, and orientation of these bony levers in the lumbar vertebrae is expected to show less intraspecific variation in *H. sapiens* compared to the great apes, indicating strict morphological requirements of bipedalism.

The sample includes *G. gorilla* (17), *P. troglodytes* (16), *P. pygmaeus* (18), and *H. sapiens* (20). Digital photographs were taken from the superior, lateral, and dorsal aspects of the first, penultimate, and last lumbar vertebrae of each individual. Linear distance and angular orientation were determined through image analysis using Sigma Scan Pro. Measurements of neural spines and transverse processes were used to determine the projection relative to the axis of rotation and orientation. A size index based on the linear dimensions of neural spine and transverse process was calculated, controlling for body size, for each vertebrae. For each measurement and index, coefficients of variation were computed, and means were compared using ANOVA.

The neural spine of L1 in humans is smaller, and the neural spines of all the lumbar vertebrae measured are more horizontal, while the dorsal projection is similar among apes and humans. In humans transverse processes increase in size at each successive level, while the dorsal and lateral projection and the dorsal orientation are similar to that of non-human hominoids. Humans are unique in that they display the smallest degree of intraspecific variation in all of the above features. The morphological pattern of the neural spines and transverse processes as well as the reduced intraspecific variation in humans compared with apes, indicate a specific structure for the attachment of muscles and ligaments required for bipedal locomotion.

#### **Extra-group copulations by sub-adult gibbons: Implications for understanding gibbon social organization.**

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Recent reports from long-term study sites have documented significant variation in the structure of gibbon social groups and in the ways in which gibbon social groups are formed. This, in addition to observations of extra-pair copulations, has led some authors to reevaluate the nature

of gibbon social organization at the level of the social group. The observations described here add to a growing body of literature that indicates we need also to revise the description of gibbon social organization at the level above the social group. During January 1998, I conducted over 50 hours of observation on 2 white-handed gibbons (*Hylobates lar*) social groups in Khao Yai National Park, Thailand. I had previously conducted over a thousand hours of observation on this population and many of the animals represent known individuals. During 1998 all observations were recorded *ad libitum*.

Over a period of 7 days, I observed 2 gibbon subadults from neighboring social groups engage in a minimum of 12 sexual encounters. These encounters occurred in the context of a series of border disputes involving the resident groups of the 2 subadults. The duration of the copulations increased over the observation period. In addition to the sexual encounters the 2 animals foraged together, engaged in other forms of social contact, and sang duets. Both individuals were subject to both intra- and inter-group agonism from adults.

The context of the sexual interactions reported here suggests that agonistic inter-group encounters provide opportunities for maturing sub-adults to identify potential mates.

Funding provided by Dickinson College.

#### **History of the Recovery of Plains Skeletal Remains.**

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With the construction of dams on the Missouri River by the Army Corp of Engineers following World War II numerous archaeological excavations, under the direction of William M. Bass and funded by the Smithsonian Institution River Basin Surveys and the National Science Foundation, were conducted from 1958 to 1970 to recover human skeletal remains from burial areas of some of the larger village sites. This poster will discuss the archaeological techniques, including the use of heavy power equipment, used to obtain skeletal collections from the Sully, Rygh, Moberg, and Leavenworth sites.

#### **Economics of cold water foraging.**

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In evaluating adjustments to coastal environments it is important to consider the costs and benefits of specific available resources. In regions of cold water, procuring 'wet' resources (those that necessitate exposure) entails high maintenance and

mobility costs when exposure-buffering technology is used but also diminished foraging efficiency when it is not. A review of the ethnographic and archaeological records indicate that higher-latitude coastal groups ignored 'wet' resources as long as sufficient 'dry' (i.e. seals, etc.) resources remained. This resulted in an early use of coasts but a delayed littoral adaptation.

Marine specialization and coastal mobile foraging are increasingly mutually exclusive at higher latitudes since mobile foragers will carry a pool kit with a low maximum size for portability but marine specialists require a high minimum degree of technology to buffer exposure. These constraints have implications for interpreting early coastal use and settlement and for qualifying perceptions of 'coastal adaptation'.

Resource distribution and foraging models are used to simulate population movements across virgin landscapes for marine specialists and both interior and coastal mobile foragers. Results indicate that the foragers will move more rapidly than will specialists but with much greater directionality and speed when using 'dry' coastal resources. Small, rapid pulses along coasts, rather than an interior wave of population with in filling, would result in smaller densities exhibiting greater genetic dissimilarity, continued low initial populations, and backfilling. Such trends appear to characterize early populations moving out of Africa into Australia as well as those moving out of Asia into the Americas.

#### **Thin plate splines analysis of human craniofacial sexual dimorphism.**

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Sexual dimorphism in the human craniofacial system is investigated by methods of geometric morphometrics. 2D-coordinates of 25 landmarks of 52 male and 52 female adult skulls of known sex were digitized in the lateral view. The hypothesis that the male morphology may result from a general allometric extension of the female variation pattern (i.e. hypermorphosis) is tested by generating theoretical male and female morphologies of increased centroid size. Thin plate splines analysis leads to the rejection of this hypothesis. On the contrary, we find that a local morphological component is responsible for sexual differences. The most striking contrast between male and female configurations of the same centroid size is located at the outer table of the occipital clivus, the piriform aperture and the mandibular ramus. All of these structures are related to the upper respiratory tract and the pharyngeal space, which are

found to be larger in males, both in absolute and relative terms. We conclude that increased airway dimensions in males, necessary for maintaining larger body size and muscular mass, are a major physiological factor for explaining sexual dimorphism in the craniofacial system.

#### Exhaled nitric oxide concentration of Andean and Tibetan high-altitude natives.

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Nitric oxide (NO) gas is synthesized in the lungs at a rate determined by the inducible isoform of the nitric oxide synthase gene. Acute hypoxia down-regulates the activity of that enzyme causing pulmonary vasoconstriction which is thought to be an adaptive, local homeostatic mechanism redistributing blood flow from poorly to better oxygenated areas of the lung. The response evolved at sea level where hypoxia and vasoconstriction are usually transient and localized; however, high-altitude hypoxia is chronic and diffuse. Published evidence indicates that virtually all Andean high-altitude natives have chronic pulmonary hypertension while some Tibetan high-altitude natives do not. The contrast suggests that population differences may exist in the down-regulation of NO and may be manifest as different NO concentrations in the lung. That hypothesis was tested by comparing NO in exhaled breath of healthy, non-smoking native residents, 8-79 years of age, at 3900m in Bolivia and 4200m in the Tibet Autonomous Region.

A Sievers NOA280 nitric oxide analyzer quantified NO concentration in parts per billion (ppb) of breath exhaled into a non-diffusible collecting bag after a 15-sec breath hold at maximal inspiratory capacity. The mean NO concentration of exhaled breath of 201 Bolivian Aymara was  $11.3 \pm 0.5$  (SEM) ppb as compared with a mean of  $21.7 \pm 0.8$  ppb among 178 Tibetans ( $t=11.3$ ,  $p < .05$ ), consistent with the hypothesis. However, contrary to expectations of generally lower exhaled NO at high altitude, both high-altitude samples had substantially higher means than the  $6.0 \pm 0.4$  ppb of a sea-level control sample. Thus, population differences in NO concentration are consistent with reported differences in other features of high-altitude adaptation. The contrast with low altitude suggests a more complex biology of lung NO response to hypoxia than anticipated by observation at just one altitude.

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#### Biomechanical changes in the *Macaca mulatta* masticatory system during postweaning growth.

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Using biometry and a three dimensional mechanical model, the functional effects of the changing craniofacial morphology on the masticatory system of *Macaca mulatta* are analyzed. The study is based on a cross-sectional sample from the Cayo Santiago skeletal collections (CPRC), derived from free-ranging, naturally weaned macaques. Measurements are taken on dry skulls of known-age individuals, masticatory muscle action lines are estimated using muscle scars. In this paper, focus is on postweaning growth only; individuals range in age from approximately three months (occluded third deciduous premolars) to 4.5 years of age.

For posterior most bite points, the mechanical advantage of superficial masseter and some temporal muscle subsections increases, medial pterygoid muscle decreases, and the deep masseter muscle does not change significantly. For incisor bite points, medial pterygoid and some temporal muscle subsections show a significant decrease, the masseter muscle does not exhibit significant changes.

The effect of changing craniofacial morphology is evaluated through multiple regression analyses; model selection is done by R-square and Akaike Information Criterion (AIC). General size is represented through the first principal component scores, using only non-masticatory variables. For most masticatory muscles, mechanical advantage at posterior-most bite point and lever arm are best predicted by mandibular measurements; once these are accounted for, overall size of the remainder of the skull is often not significant. Using individual variables, the best predictors are cranial base, frontal arc and mandibular measurements.

These results accord well with the concept of modularity and the relative independence of different functional components.

#### Allometry of infant gorilla limb proportions

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Longitudinal series of limb morphometrics were obtained during the first year of life from 6 nursery-reared infant gorillas (*Gorilla gorilla gorilla*) in the Columbus, Ohio, Zoo. The group included

monozygotic male twins, a male-female full-sibling pair, and two other male half-sibs who had the same sire as the twins. All infants were first-cousins. Intermembral, humero-femoral, brachial, crural, forelimb-weight, and hindlimb-weight indices (Jungers 1985) were calculated for each infant (10-26 indices per infant) to assess proportional changes during the first year and to compare infant values with documented adult values.

Throughout the first year, individual values for the intermembral, crural, and forelimb-weight indices generally remain stable. Individual brachial index values tend to increase slightly, and humero-femoral index values tend to decrease from birth to the end of the first year. Hindlimb-weight indices generally remain stable from birth to about 6 months, when the twins' values decrease and those of the full-siblings increase.

The twins' crural, humero-femoral, and hindlimb-weight indices are very similar throughout the first year, but intermembral, brachial, and forelimb-weight indices diverge after 6 months, suggesting different patterns of forelimb growth in spite of their being genetically identical.

An infant male who suffered serious intestinal illness from birth to about 5 months of age had the lowest values for intermembral, humero-femoral, and crural indices and the highest values for brachial and hindlimb-weight indices before his recovery. These findings suggest that growth of some limb elements may be delayed as a result of illness.

Infant values for the intermembral index are lower than those documented for adults (Jungers 1985), while crural and hindlimb-weight indices are higher. Infant brachial indices are somewhat higher than adults'. Infant values for the humero-femoral index and the forelimb-weight index are similar to adult values. These results indicate that infants have relatively longer legs than adults and do not manifest the extreme shortness of the adult gorilla forearm.

(Jungers WL, 1985. Body size and scaling of limb proportions in primates. In: *Size and Scaling in Primate Biology*, Jungers WL, ed. New York: Plenum, pp. 345-381.)

We thank the Administration, Nursery Staff and African Forest staff of the Columbus Zoo for their assistance.

#### Craniodental comparisons of *Mabokopithecus* with *Oreopithecus* support an African origin of *Oreopithecidae*.

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Numerous similarities are evident in the dental morphology of *Oreopithecus* from the late Miocene Grosseto lignites of

Tuscany and *Mabokopithecus* from the middle Miocene of Kenya. Two competing hypotheses have been proposed to explain these similarities: 1) convergent evolution due to processing of similar food items, and 2) descent from a common ancestor. The convergence scenario maintains that *Oreopithecus* originated as an endemic island form in the late Miocene of Eurasia, descending from a derived group of suspensory hominoids that also gave rise to *Dryopithecus*. The common ancestry model proposes that *Oreopithecidae* arose in the middle Miocene of Africa by adapting to a leafy diet and subsequently dispersing to Eurasia. In both cases substantial homoplasy is required, either of dental features between *Mabokopithecus* and *Oreopithecus* or of postcranial features between *Oreopithecus* and modern hominoids.

Barriers to resolving the relationship between *Oreopithecus* and *Mabokopithecus* are reduced through 1) the discovery of mandibles of *Mabokopithecus*, 2) recognition of *Turkanapithecus* as an oreopithecoid or "nyanzapithecoid" (based on independent observations by McCrossin and Harrison) and comparison of its cranial morphology with *Oreopithecus*, 3) comparison of cranial morphology and variation within and between samples of *Mabokopithecus* and *Oreopithecus*, 4) comparison of postcrania of the African and European apes, and 5) dental microwear analysis by Palmer and Ungar.

Similarities between *Mabokopithecus*/*Turkanapithecus* and *Oreopithecus* extend to details of the zygomatic, premaxilla and mandible, as well as to detailed aspects of the incisor, premolar and molar morphology. Although studies of occlusal microwear indicate that both *Mabokopithecus* and *Oreopithecus* consumed leaves, much of the dental morphology they share is not attributable to independent acquisition of adaptations to folivory. *Oreopithecus* and *Dryopithecus* do not uniquely share morphology. An African origin of *Oreopithecidae* and subsequent dispersal to Eurasia remains the most highly supported hypothesis.

#### Coastal adjustments to the end of the Holocene climatic optimum.

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After the shift to a cooler and dryer climate 5,000 radiocarbon years ago, inhabitants in temperate zones made adjustments in their subsistence practices that carried within factors that produced diminishing adult health along with, paradoxically, demographic expansion. In central, coastal Perú, river valley settlement after this climate shift was accompanied by continued focus on maritime resources but with increasing numbers of cultigens. Non-

specific indicators of health that had shown several thousand years of improvement before the climate change became more evident following it, even as settlements increased in size and number.

If the climatic change was the stimulus for these changes in subsistence, health, and social organization, we should find the process producing similar results elsewhere. Intensification of existing millet and other cultigens and animal husbandry followed the end of the climatic optimum in northern Neolithic China. In China we find a very similar pattern to that observed in coastal Peru with respect to anemia as indicated by linear enamel hypoplasia, and in adult stature. Masticatory stress decreases in both regions. Demographic patterns show some resemblances in density and size of houses.

The climatic oscillations that preceded the climatic shift and then became even stronger must have been precipitating factors for subsistence change, one that required greater emphasis on storable surpluses. Although adult health decreased, rapid population increase documented by settlement studies suggests that the health of children increased. It is possible that more girls were reared in both Perú and China for their greater economic value associated with agriculture, explaining the demographic expansion in the face of declining adult health. The Peruvian coastal adaptation differed from that made in the interior of China in the continuing importance of the high protein marine resources that were supplemented by calories from domesticates.

#### Y-chromosome STR analysis in *Pan troglodytes*.

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Short tandem repeat (STR) polymorphisms of the non-recombining region of the Y-chromosome can provide insight into recent evolutionary history and substructure within a species. In this analysis, five Y-chromosome STRs were examined in 101 unrelated *Pan troglodytes* including members of all three currently recognized subspecies. The STRs were initially identified in humans in previous studies.

Each locus was amplified and run on a page gel or automated sequencer to determine repeat numbers. One individual was sequenced at each locus to more closely examine repeat structure. Additionally, comparisons were made between the chimpanzee locus sequences and human locus sequences. The heterozygosity and frequencies for each of these polymorphisms were calculated and compared between subspecies as well as with *Homo sapiens*. Preliminary data at several of these loci indicated that chimpanzees exhibit some monomorphic forms of these repeats. Over-

all, however, chimpanzees exhibited a wide range of diversity within these STRs equal to or greater than humans.

#### The evolution of the human breast.

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Many explanations for the evolution of the human breast have been suggested. Most focus on the breast's role as a secondary sexual characteristic, arguing that the unique morphology of the human mammary gland evolved to attract and keep males as mates and paternal investors. This paper presents an alternative view; it contends that theories relating to human breast evolution must begin with its primary function as a mammary gland and must account for the needs of the nursing mother-infant dyad.

This paper explores the hypothesis that the human breast co-evolved with alteration of the craniofacial region, dentition and brain size in hominids. A reduction in facial prognathism posed new problems for a lactating infant. Non-human primates with prognathic facial areas can feed efficiently on a relatively flat breast without having the nasal cavities pressed against the mother's thorax. Human infants would, however, risk suffocation while feeding from a flat breast. Changes in hominid craniofacial structure would have required a corresponding change in breast morphology, allowing infants to suckle and breathe simultaneously.

This co-evolutionary theory also permits plausible estimates of the time period during which the human breast form emerged.

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#### Mandibular morphology and its relationship to population affinity.

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Determining racial affinity from human skeletal remains can be an onerous task; forensic scientists and physical anthropologists typically utilize cranial and tooth attributes to make this determination. The fragile facial bones and teeth are frequently missing or are destroyed, particularly in archaeological specimens or in a variety of high/low-speed impact collisions. Therefore, additional methods for racial determination are needed for skeletal remains. This paper examines previous methods for determining the racial affinity from the mandible and compares them to a larger data set for the three main racial groups.

Seven morphological traits (one morphometric trait) of the mandible were examined for their reliability in determining the racial affinity. Each has been described in the literature (Rhine 1990 for

all but posterior ramus edge inversion, which was defined by Angel and Kelley (1990), but several clarifications were made. The traits analyzed were: shape of chin (modified - with an additional category of "square", which is a chin that is straight across the front but does not have a distinct sulcus), lower border of the mandible, ascending ramus shape, ascending ramus profile (modified - measured rather than visual, using three categories measured from 90 degrees: straight = 0-10 degrees, medium = 11-20 degrees, slanted = > 21 degrees), gonial angle flare (modified - used the categories of inverted, straight [absent], slight, medium, and everted), mandibular torus, and posterior ramus edge inversion.

Native American Indian data published by Rhine (1990) and Angel and Kelley (1990) are used as substitutes for living mongoloid populations. It is assumed that these are interchangeable data sets but that proposition is rarely tested. Therefore, only individuals of unmixed mongoloid stock were used in this study. In addition, their mongoloid sample sizes are small; this paper seeks to enlarge the database and re-describe the mongoloid mandible.

Initial results indicate that Native American Indian populations differ from SE Asian populations in several categories. Mongoloids can often be separated out from caucasoids based on at least two traits. Finally, using a combination of traits, all three races can be generally differentiated out from each other.

#### Dental development in Lower and Middle Pleistocene hominids from Atapuerca (Spain).

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We have studied the pattern of dental development of the Lower Pleistocene (Gran Dolina site, TD6 Aurora stratum) and Middle Pleistocene (Sima de los Huesos site: SH) immature hominids from the Sierra de Atapuerca (Spain). The TD6 hominids have been assigned to a new species, *Homo antecessor*, and the SH hominids have been included in *H. heidelbergensis*. The combination of palaeomagnetic analysis and US-ESR dating gives an age range of between 780 and 857 ka for the TD6 hominids, whereas the U-series and palaeomagnetic data suggest an age between 205 to 325 for the SH hominids. Hominids 1, 2, and 3 (H1, H2, and H3) from TD6 and hominid XVIII from SH exhibit a pattern of dental development similar to that of *H. sapiens*. It is noteworthy, however, that some relative delay occurs in the lower and upper canine development in H1 from TD6 and hominid XVIII from SH, probably as a consequence of the time required for completion of development of the large crown and root of these

teeth. Furthermore, H3 from TD6 shows a relative advanced development of the upper third molars, similar to that observed in some modern populations of non-European origin. Similarly, individual XVIII from SH presents a relative advanced development of the lower second and especially third molars, which falls, however, within the normal variation of *H. sapiens*. H3 from TD6 died during phase II of tooth eruption, and his/her eruption sequence (P3, C), P4, M2 fits the general pattern observed in modern humans. In addition, the dimensions of the cranial fragment ATD6-15, probably belonging to H3, suggest a cranial capacity of greater than 1,000 cm<sup>3</sup> for this individual. The respective cranial capacities of skulls 4, 5, and 6 from SH are 1390, 1100, and 1120 cm<sup>3</sup>. Since the relative brain size and the time and pattern of dental development and eruption are two strongly related aspects defining the life history of primate species, we suggest that both *H. antecessor* and *H. heidelbergensis* shared with modern humans a prolonged pattern of maturation.

#### Somatomedin secretion and patterns of growth in *Papio* and *Cercocebus*.

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Hormones play integral roles in the timing and duration of growth. Differences in patterns of secretion of growth-regulatory hormones among primates, and the effects of such differences on the evolution of size and life histories, are poorly known. Steroids (estradiol and testosterone) and somatomedins (insulin-like growth factors I and II), while functionally pleiotropic, are crucial in the initiation and maintenance of growth.

This study examines the evolutionary dynamics of growth control in baboons and mangabeys from a hormonal perspective. Large longitudinal samples are analyzed for serum levels of IGF-I, testosterone, and estradiol, quantified using standard radioimmunoassay techniques. IGF binding protein levels are determined by a 'sandwich', or non-competitive, assay. Sex- and species-specific profiles of IGF-I secretion are presented and related to changes in body mass. Variation in timing and duration of secretory 'peaks' are compared within and between species.

Intraspecific differences exist in the timing of secretory peaks, and there are marked interspecific differences in the patterns of secretion. Baboons show a distinct pubertal peak in steroid and somatomedin secretion, but the mangabey secretory patterns appear more seasonal, peaking annually. Hormone concentrations and size covary in these species, but different patterns of covariation are apparent.

Steroids and somatomedins are associated with distinctive patterns of mass gain. Steroids and somatomedins are closely

linked in baboons, but these correlations are less obvious in mangabeys. Reproductive attributes may influence the differences between these species. These results are discussed for their possible relations to reproductive and environmental factors. Implications for the evolution of species differences in body size and life histories are considered.

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#### Patterns of subgrouping and spatial affiliation in a community of mantled howling monkeys (*Alouatta palliata*).

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Studies of social behavior in New World primates offer evidence of marked flexibility in patterns of troop fragmentation, and the size, composition, and spatial distribution of subgroups. In particular, the atelines are reported to exhibit patterns of social spacing that range from the formation of a single cohesive group to a fission-fusion system in which individuals in different subgroups remain isolated over an extended period of time. In this paper, we examine patterns of social spacing in mantled howling monkeys. Specifically, we present data on the size, composition, spread, and spatial distribution of subgroups, and identify patterns of spatial affiliation among individuals.

A community of 14 marked and 12-15 unmarked *A. palliata* were studied at the Ometepe Biological Research Station, Nicaragua. Information was collected from July 17 through August 12, 2000. A 5-minute scan sampling technique was used to record the identity and activity of each subgroup member, as well as the size, spread, and location of subgroups. During observation periods, 2-3 howler subgroups were monitored simultaneously. A total of 103.6 hours of quantitative data were recorded.

Howler subgroups ranged in size from 1-20 individuals. Mean subgroup size was 8.5 individuals, and mean subgroup spread was 23.5 m. Subgroups were defined by coordinated behavior and patterns of visual or vocal communication among its members. Moreover, there was evidence that some community members interacted infrequently, while others rested and fed together on a regular basis. For example, the orange female was observed in the same subgroup as the blue-check male 22.6% of the time, compared to 10.7% for the red male. In contrast, the pink-check female was in the same subgroup as the red male 19.6% of the time. Females were not found to be in association with other females more frequently than expected by

chance. Additional relationships between subgroup size and composition, activity of subgroup members, and spatial distribution of neighboring subgroups are discussed.

**Cognitive ecology and within-patch foraging decisions in tamarins.**

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Resources exploited by primates exhibit marked variation in spatial and temporal distribution. Therefore, the ability of an individual to use ecological information to locate and relocate productive feeding sites is likely to play an important role in foraging success. In this paper we examine the manner in which wild emperor (*Saguinus imperator imperator*) and saddleback (*S. fuscicollis weddelli*) tamarins use perceptual cues (sight and smell of food), spatial information, associative and goal sign cues, and quantity information (amount of food) in making within-patch foraging decisions.

An experimental field study was conducted on two groups of emperor tamarins and two groups of saddleback tamarins at the Parque Zoobotânico, a 100 ha protected research facility administered by the Federal University of Acre, Brazil. Our research design included the construction of four feeding stations located in the home range of the study groups. Each feeding station consisted of eight visually identical feeding platforms located in a circular arrangement. In all test settings, two platforms at each feeding station contained a food reward (banana) and the remaining six platforms contained a sham reward. Data are presented on 798 visits to these feeding stations by single-species groups (data on visits by mixed-species troops are not included) during 125 days of research.

Both emperor and saddleback tamarins successfully located food rewards when visual + olfactory + spatial information were presented together. The tamarins also were found to use spatial (place constant) or visual (sight of food) information alone in making correct foraging decisions. Only one group of emperor tamarins used olfactory (smell of food) information alone or the presence of a yellow block at reward platforms (associative cue) to locate food rewards. Emperor and saddleback tamarins exhibited similar cognitive abilities in solving experimental foraging tasks. Each species relied more on visual and spatial cues than on either olfactory, associative or goal sign cues to successfully locate reward platforms. Additional relationships between tamarin cognitive ecology and foraging behavior are discussed. Supported

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**Reassessing human remains from the Plains: changes in cultural affiliation and archaeological classification brought about by repatriation documentation.**

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Repatriation legislation requires the Smithsonian to assess the cultural affiliation of Native American human remains from the United States. A systematic review of the cultural affiliation and archaeological classifications of approximately 2000 human remains from the Plains through the examination of the human remains, associated objects, archival records and other sources of information has increased the number of remains identified to a tribal affiliation, placed most remains within a chronological framework, identified incorrect tribal affiliations, and greatly improved contextual information. Interaction between physical anthropologists and archaeologists can be critical for identifying affiliation.

**Mating season effects on male-female relationships in wild Formosan macaques (*Macaca cyclops*).**

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Male-female dynamics were studied in a multimale group of wild Formosan macaques. It was the first study of a wild group of this species which focused on social dynamics. This species is female-bonded and has a distinct mating season which lasts about four months. Understanding the patterning of male-female relationships throughout the reproductive cycle provides a foundation for looking at questions of mate choice and mate competition in this species.

Grooming, proximity, and aggression patterns between males and females were compared inside and outside of the mating season. Throughout the year, females groomed most with offspring and other females. Males and females groomed together most during the mating season. Much of this grooming was initiated by females. Outside of the mating season male-female grooming rates dropped and males were socially peripheral. Proximity measures also showed an increase in proximity between males and females during the mating season. In the mating context proximity was maintained mainly, but not exclusively by males. Aggression levels generally increased during the mating sea-

son and included a sharp rise in male aggression toward females.

This pattern indicated that increased levels of affiliative and aggressive interaction occurred during the mating season. This is consistent with other macaque studies. Increased female grooming of preferred males during the mating season may indicate female mate choice while male patterns of aggression and maintenance of proximity may indicate attempts to monopolize females while they are in estrus.

**A genome-based investigation of consanguineous marriage in South India**

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Little detailed information is available on the consequences of consanguinity at the genome level. To assess the effects of long-term consanguineous marriage, a DNA-based study was organized in a Hindu Brahmin community for whom comprehensive pedigrees had previously been compiled.

Sixty-seven dinucleotide markers on chromosomes 13, 15, 16, 17 and 18 were analyzed for 128 individuals aged 2 to 92 years. Mean levels of homozygosity ranged from 260 (ch 13) to 390 (ch 18). A fast Forward/Reverse Baum algorithm was used to calculate identity by descent (IBD) probabilities across the genome, based on a comparison of IBD patterns from 5 pairs of sibs born to consanguineous parents ( $F = 0.0156$  or  $0.0625$ ) and 5 pairs of sibs with unrelated parents. The number of changes in IBD state across the genome was significantly higher in the consanguineous offspring ( $\sim 3/1000cM$  vs  $1/1000cM$ ). In addition, statistically significant correlations in IBD patterns were found across chromosomes 13 and 15, with some regions largely identical in IBD state.

The study confirms that long- and short-term outcomes of consanguinity can be precisely monitored using an appropriately large array of genomic markers.

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**Two distinct patterns of cutmarks as evidence for human sacrifice and ancestor worship in Tiwanaku, Bolivia**

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Previous studies of human remains from the ancient Andean site of Tiwanaku (A.D. 500-1150) have reported no incidence of cutmarks on human bone found in the



ceremonial center of the site. Therefore, archaeologists interpreting the cases of dismembered bodies found in the Akapana pyramid argued that Tiwanaku was "capturing" ancestral mummy bundles of conquered groups.

Recent analyses of these remains, as well as those from the nearby residential compounds to the east (Akapana East) reveal contradictory information. Cutmarks are indeed present on the remains from Akapana and Akapana East. Further, the cutmarks on the bones from each of these areas varies considerably. Those from the Akapana are more characteristic of violent peri-mortem dismemberment and exposure of the bodies for some time before burial. In contrast those from a unique structure in the residential compound exhibit evidence of defleshing.

Photographs document the different cutmark types and alternative hypotheses to explain these features are presented. Based on comparative data from other New World sites and contextual information, I argue that these cutmarks are indicative of two processes: ancestor worship and human sacrifice. This is the first clear-cut evidence for the practice of human sacrifice in Tiwanaku.

#### **A re-investigation into the number of cercopithecoid taxa at the middle Miocene site of Maboko, Kenya.**

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*Victoriapithecus* from Maboko Island, Kenya represents the best documented early Old World monkey in the fossil record. It also provides some of the earliest evidence of postcranial morphology within the cercopithecoid lineage. The *Victoriapithecus* fossils were recovered from Middle Miocene strata at Maboko that date to roughly 15 Ma.

The question of number of cercopithecoid taxa present at Maboko has been an issue since von Koenigswald's 1969 publication. In 1987, extensive analysis of the *Victoriapithecus* dentognathic material by Benefit appeared to confirm the existence of a single species characterized by high variation within certain teeth. A 1989 analysis by Harrison of the limited postcranial sample also supported a single species with intraspecifically variable traits.

As the result of excavations between 1987-97, the postcranial sample has increased dramatically and *Victoriapithecus* now figures as one of the best-represented fossil primate samples. The forelimb alone comprises 221 specimens (in comparison to Harrison's 1989 sample of 13).

The increased forelimb sample allows a re-evaluation of the number of taxa and

their variability. Analyses of coefficient of variation (CV) for forelimb measurements and indices fall within the range of variation expected for a single species. Variability, particularly in size, is best accounted for by the possible time-averaged nature of the site (Beds 3 and 5 at Maboko could be 1 million years apart) and sexual dimorphism. Comparisons of indicators of body size reveal no consistent differences between the fossil beds, but do suggest a possible trend toward increasing size. Intraspecific variability within the species, as noted by Harrison, is discussed.

#### **Environmental variability and the rise of the genus *Homo*.**

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The emergence and diversification of the genus *Homo* has been linked to various environmental and climatic events. Foremost among these is the increase in aridity and expansion of savanna grasslands in the Late Pliocene of Africa. According to a widely cited hypothesis, the hominid genera *Homo* and *Paranthropus* diverged from a more primitive hominid species, probably a species of *Australopithecus*, between 2.5 and 3.0 Ma as a consequence of global climatic cooling and concomitant environmental change. Nevertheless, interpretations of environmental change in the African Plio-Pleistocene remain controversial, and testable hypotheses linking early hominids to particular environmental processes are compromised by the lack of controls on taphonomic and collection biases that affect most hominid localities as well as poor stratigraphic and chronological resolution. In this study we present evidence of relationships between faunal and environmental change in the context of the well-dated and abundant fossil record of the lower Omo Valley, Ethiopia, using controls for taphonomic and collection biases. Faunal evidence indicates that major environmental changes occurred in the Late Pliocene of East Africa as closed and wooded habitats gave way to more open habitats. However, the pace of change itself varied significantly during this interval. A period of relatively gradual faunal change between 2.9 and 2.5 Ma was followed by a variable pattern of accelerated change beginning 2.5- 2.4 Ma. The appearance of *Homo* and the first occurrence of stone artifacts in the Omo correlate in time with this shift in faunal variability, suggesting that ecosystem instability provided opportunities and selection pressures important to the dispersal, and possibly also the origination, of the genus *Homo*.

#### **Neolithic diffusion in Europe: Paleodemographic data fit better the model of cultural diffusion than that of a demic expansion.**

J.P. BOCQUET-APPEL. CNRS, Paris, France.

There are two competing models to explain the main mechanism of the Neolithic diffusion in Europe: i) a colonization, via a demic expansion (Ammerman and Cavalli-Sforza, 1971, 1984) or ii) a cultural diffusion of domestication and agriculture (Fix, 1996; Jackes, Lubell and Meiklejohn, 1997; Whittle, 1996). The predictable demographic patterns, formalized by the variation of the growth rate with the chronological distance from the Neolithic diffusion front, corresponding to both models are the following: From a zero growth rate, corresponding to a Mesolithic population in balance with the carrying capacity: i) for the demic expansion, there is a positive frontally acute variation (@ 1% at 250 years), which becomes a zero growth rate of an equilibrium population, at a relatively short chronological distance (@ 500 years). This pattern of variation corresponds to a frontier demography (Ammerman and Cavalli-Sforza, 1984; Bogucki, 1988); ii) for the cultural diffusion, there is a positive but slow variation, without an abrupt wave, at a relatively longer chronological distance, which becomes a zero value of an equilibrium population.

From a database (3 Mesolithic and 50 Neolithic cemeteries), representing a space-time distribution sample of a paleodemographic variable (the Juvenility Index  $JI = \text{number of skeletons: children and youth aged 5-14 years divided by adults aged 20 years and more; } 2941 \text{ skeletons}$ ), the pattern of the growth rate with chronological distance during Neolithic diffusion, is obtained in the East-West direction, under the hypothesis of an homogeneous geographical process. The data fit better the model of cultural diffusion (growth rate @ 1% at 1500 years) than that of a demic expansion.

#### **Introduction: The rise of auxological paleontology.**

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Auxological paleontology is the study of growth and development in fossil species. This symposium, "Patterns of Growth and Development in the Genus *Homo*," presents an up-to-date review of the evolution of the pattern of human growth. It is now clear that no living species of non-human primate has all of the human growth characteristics (Bogin, 1999). This means that the human pattern could only have evolved within the genus *Homo*. His-

torically, some important research developments in the study of the evolution of human growth are: 1) D'Arcy Thompson's early 20<sup>th</sup> century work on mathematical models of growth and evolution; 2) Schultz's 1920s-1960s work on the evolution of primate ontogeny; 3) Brody's 1930s discovery of the primate juvenile stage of life; 4) Mann's late 1960 use of dental development to investigate the growth of *Australopithecus*; and Bogin's 1988 proposal that the life history stages of childhood and adolescence evolved only in the genus *Homo*.

Today, the field of auxological paleontology requires technical inputs from many disciplines. Each of the presentations in this symposium highlights one or more of these areas. Some symposium participants present a few of the more recent fossil discoveries (Dederiyeh, Atapuerca, Amud 7), while other participants reanalyze some well known fossils discovered in the past 150 years (*Homo erectus*, Neandertals, early *H. sapiens*). There are also talks that focus on growth differences between living humans and non-human primates. Others focus on the biology of different maturation systems (post-cranium vs. cranium) within one species. All the participants present the latest methods for analysis and interpretation of the data. Together, these presentations tell us what we know about the evolution of growth and development in the genus *Homo*, and what we would like to know.

Bogin, B (1999) *Patterns of Human Growth*, 2<sup>nd</sup> ed. Cambridge: Cambridge University Press.

#### **Dental and skeletal development in wild caught vervet monkeys (*C. aethiops*).**

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We assessed the relationship between dental and skeletal maturation in 18 sub-adult vervet monkeys (*Cercopithecus aethiops*). The subadults are part of a skeletal collection of 57 animals of wild caught, mixed age and sex classes with recorded body weights. Subadult is defined in this study as individuals having all M1s fully erupted; adult is defined as individuals with fully erupted M3s and a completely fused proximal humerus. When M1 is fully erupted, female and male skeletal development is undifferentiated, except at the pelvis. In females pubic bones reach complete fusion between a fully erupted M1 and M2, and in males between M2 and M3. When subadult females in the sample had full adult dentition, body weight is 97% of adult females in the collection. When M3 is fully erupted in males, the upper canines are only three quarters erupted and in contrast to females, the distal femur, tibia, and fibula are completely unfused. At this

stage, males have only 80% of adult male body weight. This research provides a comparative sample for study of catarrhine growth and development and a basis for assessing skeletal and dental maturation against body weight.

#### **Type 2 diabetes and Native American admixture in the San Luis Valley Mexican-American population.**

C. BONILLA, E.J. PARRA, D. SOSNOSKI, F. GULDEN, J. YE, K. HIESTER, J. NORRIS, J. MARSHALL, R. HAMMAN, R.E. FERRELL, M.D. SHRIVER. Pennsylvania State University.

Hispanics show twice the prevalence of type 2 diabetes (NIDDM) as non-Hispanic whites. The causes of this difference in prevalence remain elusive, but undoubtedly, environmental and genetic risk factors, as well as gene-environment interactions are involved in the observed variation in diabetes risk. Previous studies have shown a remarkable correlation between NIDDM and the percentage of Native American ancestry in several North American populations. This correlation has been explained in terms of the presence of risk alleles of Native American ancestry in these populations. In this study, we have analyzed the pattern and dynamics of admixture in a sample of diabetics and controls from the Hispanic population of San Luis Valley, in Colorado. We have used a panel of diallelic genetic markers showing large frequency differences between European and Native American populations to obtain precise admixture estimates. There is no significant difference in Native American contribution between diabetics (38.5%) and controls (37.8%). We discuss this finding in the light of other available data. We also report the distribution of individual admixture proportions in this sample with respect to diabetes and other relevant phenotypes. Finally, we show the results of a study in which we have analyzed the potential association of a number of candidate gene variants and NIDDM in this Hispanic sample.

This research has been supported in part by grants to MDS from the NIH-NHGRI (HG02154) and NIH-NIDDK (DK53958).

#### **Paternity analysis of alternative male reproductive routes in langurs (*Semnopithecus entellus*).**

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In most primate species differential reproductive success of males is mainly depending on differences in access to fertile females. Differential access itself may

be the result of alternative reproductive routes available within a given population. To determine the outcome of alternative male reproductive routes, a wild population of Hanuman langurs at Ramnagar, South Nepal was investigated where groups were either one-male multi-female or multi-male multi-female. Breeding was seasonal (conceptions: July-November). Long-term observational data for several groups (membership, dispersal, dominance rank) was combined with paternity analysis from feces at five microsatellite loci. Samples for 42 out of 58 infants born during the study period (1991-96) entered the analysis. All infants born into one-male groups were sired by the only adult male indicating that males were able to reproductively monopolize a whole group of females even if breeding is seasonal. In multi-male groups the alpha male fathered significantly more infants (57%) than all other resident males. Moreover, at least 21% of the infants were sired by non-resident males. Eighty-two percent of the males who fathered more than one infant did so while they were either in a one-male group or alpha male in a multi-male group. Long-term observational data indicate these routes to be true alternatives because no male became alpha male or single male in different groups in succession. Because of the lower mean number of infants sired by alpha males (2.3 vs. 6.8) and the higher maximum (8.9 vs. 6.0), the alpha male route is considered the riskier option. Based on demographic data we suggest that the considerable variance in short-term reproductive success might not translate to the same degree into differences in long-term reproductive success.

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#### **Morphometric and molecular perspectives on the comparison of human populations.**

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Attempts to compare the similarities and differences between living human populations produce slightly different results when different techniques are used. The Y-chromosome and mtDNA haplotype pictures may differ from each other and also from the picture generated by nuclear microsatellite analysis (Merriwether et al., 1997, 1999; Lum et al., 1998; Su et al., 2000).

Since the majority of the dimensions recorded by craniofacial measurements are not directly shaped by the forces of natural selection, the populations similarities and differences revealed should produce results that can be compared with the patterns that emerge from the study of molecular genetic haplotype and

microsatellite variation. Craniofacial dimensions are biparentally inherited so the patterns of their distribution should be comparable to the patterns revealed by the analysis of nuclear DNA microsatellites.

Mahalanobis Distance figures were generated from craniofacial measurements for populations representing the major inhabited regions of the world and as much of their immediate prehistoric predecessors as possible. The neighbor joining dendrograms display their relative morphological distances. These were tested by discriminant analysis. The linkage of sub-Saharan Africa over to Australo-Melanesia and the distinction of northeast Africa makes a parallel to the nuclear DNA picture. At least as interesting is the suggestion that the mtDNA X-lineage distribution is paralleled by craniofacial ties that run from Upper Paleolithic Europe across to northeast Asia with implications for the settling of Oceania and the New World.

#### Assessment of reproductive strategies in wild mountain gorillas (*Gorilla gorilla beringei*) using DNA from feces.

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Although researchers at Karisoke Research Center, Rwanda have amassed over 30 years of behavioral, demographic and ecological data on mountain gorillas, some key issues regarding reproductive strategies cannot be resolved solely by field research. Gorillas are considered to have a one-male mating system in which the dominant silverback is assumed to sire most, if not all, of the group offspring. However, 40% of mountain gorilla groups contain more than one adult silverback and subordinate males have been observed to copulate with females. A clear understanding of gorilla reproductive success therefore requires a thorough genetic analysis of paternity.

To determine whether subordinate males or extra-group males actually sire offspring in mountain gorillas, we collected fecal samples for nuclear DNA analysis from individually identifiable, habituated gorillas comprising 3 groups at Karisoke Research Center. We analyzed samples from a total of 75 individuals, including 19 adult males and some 40 offspring. Samples of all likely sires are available for 35 offspring born between 1986 -1998. Genotyping of all group members at 10-12 polymorphic microsatellite loci reveals a sufficient amount of variance for clear paternity discrimination (total paternity exclusionary power > 0.95). The results of

this genetic study, integrated with data on male dominance rank and group composition, provide insights into mountain gorilla reproductive strategies, and how those strategies may vary for individuals living in multi-male versus single-male groups.

#### SK 859, an infant early hominid preserving endocranial features. Evidence from osteodental maturation studied using computed tomography.

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Several hominid specimens attributed to *Australopithecus afarensis*, *A. africanus*, *A. / Paranthropus robustus*, *A. / Paranthropus boisei* died near or at the eruption of the first permanent molars (M1). However, except for the Taung Child, none of them preserve endocranial features. Moreover, no sulci are visible on the occipital lobe of the Taung Child natural endocast. This is of major importance because the M1 emergence represents a major transition in life history.

In this matter, an undescribed early hominid found in Swartkrans' Member 1 in 1952 and assigned to *Australopithecus / Paranthropus robustus* is very interesting. Known as SK859, it is represented by a major portion of its occipital bone.

Examining the M1 crown and root calcification versus the anterior intra-occipital synchondrosis closure in three large skeletal reference samples (extant humans, *Pan troglodytes* and *Pan paniscus*), we calculated Bayesian posterior probabilities that SK 859 would have shown a given M1 maturation state. It was found that the M1s were very likely not erupted in this specimen (the probabilities being always higher than 95%), its age at death being less than three years whatever the extant species used as an analogue.

We believe that SK 859, with its artificial endocast, offers an important contribution to our knowledge on brain anatomy in possibly non weaned early hominids. Indeed, no other australopithecine provides a good description of the sulcal pattern in the occipital lobe.

#### Modeling future prospects for primates. Conservation? Captive breeding? Extinction?

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Exploitation of resources and expanding human populations promise to produce a loss of biodiversity that is rivaled only

by dramatic extinction events of the distant geological record. Biological anthropologists should have relevant insights into our conflicting cultural values and ecosystems. The first and most desirable option, protecting natural ecosystems, faces some dramatic failures in the next decades. What primate species are likely to survive habitat loss? Attitudes and policies promoted by scientists and the public have mixed consequences. CITES has been a powerful agreement to prevent over-exploitation through international trade, but it is effective only if there are viable breeding populations to protect. It offers little protection from local threats. Changes in research strategies and costs reduced institutional breeding of nonhuman primates in the last decade. Shifting surplus animals from labs and zoos to sanctuaries holds little promise, for the future since sanctuaries do not breed their animals. International scientific organizations have taken clear stands against private ownership and privately funded breeding of non-human primates. Though survival plans are in place for zoos and exhibitors, all of these plans can only promote a relatively few selected species. Our options are limited, and if we continue to promote values of "better dead than bred" and "the only place for a nonhuman primate is in nature", we may miss opportunities to carry more of these marvelous creatures through the perilous decades that lie ahead.

#### Adaptive explanations of ADHD: An empirical test.

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Using an evolutionary medicine approach, several explanations have been offered for the high frequency and male predominance of Attention Deficit Hyperactivity Disorder (ADHD) in contemporary settings. These propose the disorder represents otherwise normal behavioral strategies that are especially evolutionarily relevant to boys, but become maladaptive in such novel environments as the formal school classroom. Here we provide and discuss the results of some basic cross-cultural tests of this suggestion.

Measures of Colombian and U.S. children's characteristic behavior and social and academic functioning at home and in the classroom are used to develop two statistical models. These assess relationships between children's normal hyperactive and inattentive behavior and some adaptive correlates in home versus school, and how these vary by sex. The theoretical prediction that lower functioning would be associated with greater hyperactive and

inattentive behaviors at school than at home, especially for boys, was not supported. Although there is sexual variation in the average degree of the behaviors displayed, there is no sex difference in the functional consequences of the same degrees of behaviors. For both girls and boys, greater degrees of inattention are associated with declining functioning in home just as in school. Sub-clinical levels of hyperactivity in children of both sexes may be slightly more, rather than less, adaptive in school than home.

Adaptive explanations of ADHD are potentially important to Darwinian understandings of psychiatric phenomena and to broader questions of the evolution of human health and social behavior. This empirical test suggests currently published adaptive scenarios of ADHD require greater consideration and formulation as well as further empirical testing.

#### Guidelines for the use of a 'standard' for measuring bone density with DEXA and optical densitometry.

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Growing awareness of the morbidity and mortality caused by fractures associated with age-related bone loss and osteoporosis has led to an increasing number of studies of bone loss in archaeological material. There are a variety of ways through which age-related bone loss can be investigated; density, cortical thickness and micro-architectural structure of trabecular bone. One of the most widely applied approaches has been investigation of density. However, due to the lack of a 'standard' it has not been possible to make direct comparisons between the results of different investigations.

A 'standard' (calibration device) has now been produced for use with DEXA and other density techniques allowing direct comparison of results of studies in which it is used. Investigations demonstrated that only high resolution DEXA scans using research tools such as 'small animal software' (Lunar inc.) should be applied to archaeological bone. Same day scans with repositioning of samples produced precision of 1.68% C.V. (high resolution) compared to 7.8% (standard software). All samples should be scanned a minimum of 3 times, as poor condition or odd shape (e.g. osteophytes) can result in poor precision (4.7% C.V.) even with high resolution scanning. Type of analysis performed on data after scanning was also important. Only manual analysis produced reproducible results and a region of interest of 12mm X 12mm is recommended. Variation in results obtained on different days with re-

positioning (2.59% C.V.) demonstrated that scanning the 'standard' each time equipment is turned on is vital for allow calibration of results.

The study demonstrated that if basic guidelines are followed use of the 'standard' will allow direct comparison of future studies, allowing spatial and temporal differences in age-related bone loss to be determined.

#### The correlation between endocranial petalial patterns and the orbital cap.

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As the internal representation of the skull, endocasts are the primary line of direct evidence for human brain evolution. Some researchers have suggested that it is impossible to determine asymmetry in the brain from endocasts. While it is not prudent to assign cognitive ability to features of endocasts, it is possible to determine anatomic asymmetries in them. Moreover, work by LeMay (1976; 1977) among others suggests that petalial patterns may be assigned with statistical reliability to handedness. For example, right handedness is associated more often with a left occipital - right frontal petalial pattern. In addition, Broca's area is larger in the left inferior frontal lobe in right handers.

In order to elucidate the relationship between petalial patterns and the orbital or Broca's cap, we examined the asymmetry of this feature in modern human skulls which possessed a left occipital - right frontal petalial pattern (n = 15). We also included CTs of n = 30 skulls from the American Museum of Natural History. Preliminary analysis suggests that 80% of the individuals in this sample possessed an orbital cap, which is larger on the left than the right. While this information does not unequivocally place Broca's area in the left hemisphere in the individuals sampled, it does provide provocative evidence for interpreting the fossil record. If individuals with a petalial pattern consistent for right handers have Broca's area in the left hemisphere, then asymmetry in Broca's cap, which overlays correlative areas in the brain, may be suggestive of hemispheric lateralization for speech.

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#### Intrasexual competition and testis size in *Propithecus verreauxi*.

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Previous comparative studies of strepsirrhine primates suggest that sperm competition may be an important mechanism of intrasexual competition in those taxa that lack sexual dimorphism and exhibit promiscuous mating systems (Kappeler 1998). Sperm competition theory predicts that among promiscuous species, males would have relatively larger testes than those in polygynous species because females mate with multiple males in the former, resulting in the opportunity for sperm competition. Kappeler's (1998) results showed that among group-living species males had significantly larger testes than those of pair-living species, but this analysis incorporated taxa for which adequate morphological and mating behavior data were available and did not include *Propithecus*. Here we report the results of an analysis of seasonal testis size variation in monomorphic, polygamous *Propithecus verreauxi* at Beza Mahafaly Reserve, Madagascar.

Morphological data were obtained on 139 1- to 21-year old males during the breeding (n=76 males) and birth (n=63 males) seasons. Testicular volume was determined using the formula for a spherical ellipsoid,  $TV = (\pi W^2 \times L) / 6$ . After controlling for the effects of body size, results showed that, as expected, season, but not age, was the strongest predictor of testis volume, suggesting that sperm competition underpins intrasexual competition in this species during the breeding season. Within-season comparisons showed that there was marked inter-individual variation in testis volume during the birth season for reasons that are not yet clear. Studies of hormone-behavior interactions in sifaka suggest, however, that socio-demographic factors may play a role in explaining the inter-individual variation in the testis size during the birth season. Future studies will examine how these hormone-morphological-socio-demographic variables covary in sifaka, providing additional insights into the selective mechanisms influencing intrasexual competition in strepsirrhine primates.

#### Racial apportionment: A review.

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It has become increasingly popular to theorize and assert significant genetic differences between arbitrary regional, ethnic, and racial groupings of humans. Be-

ginning with Livingstone, Brace, and Newman in the early 1960s, biological anthropologists have shown that variation in human traits is *non-concordant* along racial lines, as they are products of overlapping, dynamic selective pressures.

In 1972, Lewontin analyzed blood groups, serum protein, and red blood cell enzyme variants and found that only about 6% of total genetic variance was accounted for by race, while the majority of variance is accounted for by differences *between individuals*. Using similar assays, Latter obtained similar results in 1980. In 1982, Nei and Roychoudhury analyzed 62 protein variants and 23 blood groups, finding that roughly 10% of genetic variance was accounted for by race. Analyzing protein, blood group, and HLA variants, Ryman et al. obtained similar figures in 1983. More recently, Dean et al. (1994) and Barbujani et al. (1997) have used PCR techniques to analyze RFLP and microsattelite loci, again yielding estimates of around 10% for the amount of genetic variance accounted for by race. Furthermore, recent research on regional and racial variance in mtDNA (Excoffier et al. 1992), a traditional marker for human racial groupings, shows a higher proportion of variance *within* than *across* racial categories.

These studies used a variety of assays and analytical techniques, some of which are designed to *maximize* the amount of variance accounted for by race. In light of this, the low proportion of genetic variance across racial groupings strongly suggests a re-examination of the race concept. It no longer makes sense to adhere to arbitrary racial categories, or to expect that the next genetic study will provide the key to racial classification.

#### **Heel spurs as markers of occupational stress in Late Woodland-Mississippian agriculturalists.**

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The purpose of this study is to investigate the use of heel spurs as markers of occupational stress in Late Woodland-Mississippian farmers. Both the incidence and the pattern of spurs are considered. Subtalar joint configurations that restrict motion and minimize shock absorption are hypothesized to correlate with heel spurs for aging people doing heavy labor ("occupational stress") but not for people in more relaxed work. The patterns of these spurs are hypothesized to reflect the specific occupational activities associated with manual cultivation of crops. The research sample includes tarsal bones recovered from mounds and cemeteries in Illinois. Analysis uses matched calcanei from 116 hunters and gatherers from ten Middle Woodland sites (230 BC-460 AD) and 133 agriculturalists from two Late Woodland-

Mississippian sites (800-1300 AD). Data analysis includes descriptive and chi-square statistics. The results show that foot structure did not make a difference for the hunters and gatherers but the rigid subtalar joint configurations did correlate with increased heel spurs for the agriculturalists. Spur patterns reflecting occupational stress are not statistically significant but warrant further research. This study supports the hypothesis that heel spurs can be used as markers of occupational stress and evidence showing that this approach can be utilized with osteological collections from other geographical areas is included.

#### **Age-related changes on the auricular surface of the ilium: a revised recording system.**

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An improved method for estimating age using the auricular surface of the ilium has been developed from British known-age skeletal material. The method is based on the Lovejoy et al. (1985) method and is designed to be easier to apply, thereby reducing levels of inter- and intra-observer error. The method records age-related stages for different characteristics of the auricular surface, which are then combined to provide a composite score and an estimate of age at death.

The method was tested on the Christ Church Spitalfields, London known-age skeletal collection, and was found to produce wide age ranges. The results confirm that it is inappropriate to estimate narrow age ranges from osteological material. Statistical analysis showed that the changes in the auricular surface are not significantly different for males and females. A previous test of auricular surface ageing (Murray and Murray, 1991) has shown there to be no significant difference between different races, indicating that this method may be more appropriate for use on different populations.

The new method has a slightly higher correlation with age than the Suchey-Brooks pubic symphysis stages. Considering the higher survival rates of the auricular surface compared with the pubic symphysis this method promises to be a useful tool for the osteologist.

References: Lovejoy, C. O., Meindl, R. S., Pryzbeck, T. R. and Mensforth, R. P. 1985 Chronological Metamorphosis of the Auricular Surface of the Ilium: A New Method for the Determination of Adult Age at Death. *American Journal of Physical Anthropology* 68: 15-28.

Murray, K. A. and Murray, T. 1991 A Test of the Auricular Surface Ageing Technique. *Journal of Forensic Sciences* 36:1162-1169.

#### **Chiribaya political economy: A bioarchaeological perspective.**

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Initially defined by distinctive ceramic styles, the Chiribaya culture flourished within the south-central Andes during the Late Intermediate period. Centered on the coast and extending from the Azapa to the Tambo valleys, Chiribaya peoples exploited a rich marine environment while also engaging in agriculture and camelid herding. Chiribaya grave elaboration varies markedly across space and through time, although gender-coded artifacts are pervasive. In this paper we examine variation in tomb elaboration and diet, contextualized temporally and spatially, as it informs concerning the origins of social, political, and economic complexity for Chiribaya peoples.

#### **Mechanical signals for bone adaptation.**

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Bone can respond to dynamic loads after only a few loading cycles. The magnitude of the adaptive response is sensitive to deformation (strain), but also to rate-related phenomena when bone is loaded above a threshold necessary to elicit the response. Current data suggest that bone's adaptive response can be explained as a function of strain magnitude and loading frequency, i.e. strain rate. However, our experiments show that it is the rate of displacement, not the strain itself, which is important to the expression of genes known to be involved in the osteogenic process. Strain may be only an indirect signal. The cells actually detect strain-induced fluid flow, which creates fluid shear stress on cell membranes. The rate of strain application is proportional to the velocity of fluid flow. Our experiments show that the sensitivity of bone cells to mechanical stimuli will saturate quickly (< 100 cycles @ ~1700  $\mu$ ?), and that the cells require 4-8 hours to fully recover mechanosensitivity, after which they can mount another response if stimulated. The internal architecture of the cell is partly responsible for this sensitivity. Loading causes reorganization of the cell cytoskeleton, and disassembly of actin stress fibers in the cytoskeleton is necessary to allow the cell to respond to another loading event. Therefore, the osteogenic response to mechanical loading can be enhanced if the mechanical stimulus is partitioned into several discrete loading bouts during the day, with rest periods between them, rather than if it is applied as a single larger

bout. Our view of the adaptive remodeling system now is that (1) bone responds only above a threshold of strain rate; (2) strain rate is the critical driving force, but fluid flow and consequent shear stress on cell membranes is the primary cell signaling mechanism; (3) cells saturate in a relatively brief time, so that minimal amounts of loading are required to generate a response; and (4) cell sensitivity is recovered in 4-8 hours. The importance of this for age-related bone loss is that (1) older adults may not be able to generate strain rates sufficiently large to elicit an osteogenic response and (2) cells in older adults may be less responsive to mechanical signals, and recover less quickly than those in younger adults.

### Relative amounts of facial expression musculature in two species of *Otolemur*: Muscles of the pinna and orbit.

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Muscles of facial expression are found throughout the primate order and represent one means of communication among individuals. Relative to anthropoids little is known regarding facial expression muscles in prosimians. This study seeks to better elucidate these structures in two species of *Otolemur* (*O. garnettii* *O. crassicaudatus*) and to examine any differences between species in relative quantity of facial expression musculature. While both species are nocturnal and matriarchial, *O. garnettii* has been reported to be much more territorial than *O. crassicaudatus* and to have a smaller group size. It may be expected, then, that there are differences in the relative quantity of facial expression musculature between these two species. Six muscles of facial expression controlling motion of the pinna and orbital opening were dissected on 11 cadavers (4 *O. garnettii*, 7 *O. crassicaudatus*): orbicularis oculi m., auriculooccipitalis m., orbitoauricularis m., depressor helicis m., helicis in., and superior auricularis m. A strip of each muscle was removed and embedded in paraffin, sectioned at 10-12 $\mu$ m, and stained with Gomori trichrome or hematoxylin-eosin. Muscle sections were examined under a light microscope and separate fascicles were defined. The number of fibers per fascicle was counted for each muscle in each cadaver and mean fiber numbers were compared between species. Preliminary results showed that both *O. garnettii* and *O. crassicaudatus* had more muscle fibers per fascicle in muscles primarily controlling motion of the pinna relative to muscles controlling the orbital opening. Between species, preliminary results reveal that *O. crassicaudatus* had relatively

more muscle fibers per fascicle except for the superior auricularis m., where *O. garnettii* appeared to have a greater number of fibers per fascicle. These results may be interpreted relative to the reportedly higher group size of *O. crassicaudatus*, but these results must be viewed with caution as the sample size is presently limited.

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### Preliminary analysis of elite and middle class New Kingdom cemeteries at Tombos, Sudan.

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Excavation at Tombos in northern Sudan at the third cataract of the Nile has revealed an Egyptian style pyramid and temple structure, and a cemetery with burials of middle class people dating from the mid-18th Dynasty to the end of the New Kingdom (~1400-1070 BC). At this time, Tombos was on the southern frontier of the Egyptian occupation of Upper Nubia and the site of intensive Egyptian-Nubian interaction. Although many documents date to this period, most of them are concerned with esoteric religious issues and the social elite. The Tombos burials thus provide a unique opportunity to learn about the living conditions of less affluent people living in Upper Nubia at this time.

Osteological observations were made on material collected from Tombos cemetery and pyramid during the winter of 2000. Owing to time constraints and the commingling of looted burials, osteological observations were limited to crania, os coxae, and long bones.

Six discrete burials and the disturbed remains of at least 23 additional people were associated with the pyramid structure. These remains include least 18 adults (one of which suffered from achondroplasia) and 11 subadults. The cemetery excavation produced 30 intact burials and the remains of at least 62 additional individuals. This collection contains at least 71 adults and 21 subadults. Of the intact pyramid burials, the one adult showed enamel hypoplasia, dental caries, fractures, and osteoarthritis and two of the 5 subadult burials have cribra orbitalia. Dental remains of burials from the middle-class cemetery show that 15% (5/34) have enamel hypoplasia, 28% (16/57) have at least one carious tooth, 46% (26/57) have at least one abscess, and 75% (41/55) show evidence of antemortem tooth loss. Porotic hyperostosis (including cribra orbitalia) was observed in 7% (3/44) of the individuals. Thirty-three percent (6/18) of the intact burials show osteoperiostitis of the tibia, 14% (4/28) show evidence of trauma, and 48% (13/27) have osteoarthritis. Comparisons suggest that the people buried in

the Tombos cemetery have a lower frequency of pathological conditions than other Egyptian and Nubian samples.

### Expectations of MMD under a model of genetic drift.

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A study was performed of the expectations of the Mean Measure of Divergence (MMD) under the assumptions of genetic drift. Nonmetric traits of the human skeleton were assumed to be controlled by individual alleles therefore making them subject to sampling errors from one generation to the next. The frequencies of these traits for a given skeletal series were entered into a computer program that randomly drew from an infinite number of alleles in proportion to these starting frequencies. The resultant count of traits then were used as starting frequencies of the next generation and the cycle was repeated. After a number of generations, MMDs were calculated between the starting and ending frequencies; and this simulation was repeated 1,000 times. This process was performed for a number of generations, using different starting frequencies and sample sizes, and different numbers of reproducing adults to arrive at an expected frequency distribution for this statistic. These expectations are presented and several real world examples are used to illustrate the utility of these simulations.

### Hard tissue evidence for Asian colobine phylogeny.

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The systematics of the sub-family colobinae have proven difficult to resolve. The monophyly of the African forms is generally agreed upon; however, relationships between Asian and African forms and relationships within Asian taxa have been debated. A major problem confounding resolution is the seeming homogeneity of this extremely derived Old World Monkey clade.

This study seeks to further investigate Asian colobine phylogeny by reassessing previous phylogenetic analyses that have used primarily morphological evidence. Intra- and interspecific variation were examined in a large comparative sample in order to construct a character list that includes informative hard-tissue archigenetic traits. Multiple analyses were run with PAUP 4.0 software using two outgroups: *Mesopithecus pentelicus* as one outgroup and a hypothetical outgroup of all primitive character states.

Strict consensus of this analysis

deconstructed virtually all resolution proposed in each of 38 individual trees. One clade consistently returned with each tree and thus was heavily supported following consensus computation. This monophyletic clade is comprised of the odd-nosed colobines, as suggested by molecular evidence. A suite of craniodental traits defines the structure of this clade. Included within this group are 3 features associated with odd nosed characteristics. This odd-nosed clade clustered nearest to the outgroup fossil *M. pentelicus* suggesting *M. pentelicus* lies closer, and perhaps within the clade containing extant Asian colobines, a proposition also supported by dental enamel prism patterns. This study therefore suggests congruence between morphological and molecular evidence for odd-nosed colobine monophyly.

#### How typological are population studies?: Bioarchaeology and Nubia.

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Nubia presents a classic example of the theoretical shift from essentialist to population thinking during the mid-20th century. Static and typological approaches, rooted in racial classification and historical migrationism, once characterized Nubian skeletal research. Subsequent to the "modern synthesis", evolutionary, gradual, in site change became the dominant perspective in Nubia and elsewhere.

However, can one use a "populational approach" yet still employ "typological thinking"? Similar to work presented early last century, some research today suggests that Late Paleolithic Nubians (12000-18000BP) were not ancestral to Holocene Nubians (100BC-AD350) along the Nile River. Instead, they are linked more closely with West and sub-Saharan Africans, based on statistical comparisons of discrete dental traits. Holocene Nubians result from people migrating and expanding into the region from the north.

A possible concern with this scenario, and of similar work in other regions, is an unintended return to a more typological approach. First, occasionally single samples are used to represent large regions of a continent. Although such representation may be unavoidable due to sample availability, great caution must still be exercised when interpreting results. Second, population data are often condensed into a single statistic, which then forms the basis of assumed cladistic relationships. Also, clusters based on these data are dependent upon which samples are added to the analysis, whether as likely ancestors or outgroups.

Although strong genetic basis exists for discrete dental traits, parallel evolution may account for similar patterns (e.g.,

when dental reduction occurred independently). After data are condensed into single statistics, individual variation needs to be reevaluated to assess which traits are responsible for statistical similarities. One cannot assume shared ancestry accounts for close relationships.

In sum, analysis of populations does not necessarily equal populational thinking, as illustrated here with Nubia, and in other areas within biological anthropology.

#### Birth and growth factors influencing size and body composition in 9-year-old black and white urban South African children.

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Whilst inter-ethnic differences in body composition of pre-adolescent children are well documented from anthropometric studies in developed countries, few studies have been undertaken in *developing* countries. In particular, longitudinal studies in developing countries that allow an investigation of the birth and growth factors that influence size and body composition status in late childhood are rare. Such studies are important in view of the economic and nutritional transition occurring in some developing countries that result in high fat, high carbohydrate, low fibre diets and reduced physical activity. This combination of factors is recognised as raising the risk profile for morbidity in adulthood and its aetiology is of some significance.

This paper reports on a cross-sectional study that investigates the historical and current factors influencing body composition in an inter-ethnic cohort of 9-year-old children (N=540; black = white; male = female) from the Birth To Ten longitudinal study which began in 1990. Investigations included anthropometric measurement of growth status, BMI and body fat distribution. Socio-economic, nutritional and health status, physical activity, and dietary intakes were assessed from historical records and by interview.

Initial results indicate that urban black children were shorter and lighter than white children, in addition they possessed lower BMI and less subcutaneous fat. Analyses of the factors affected the acquisition of this physical status will be conducted as data emerges during 2000/01.

#### Copulatory behavior of free-ranging black-handed spider monkeys (*Ateles geoffroyi*).

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During a 15-month study of free-ranging black-handed spider monkeys (*Ateles geoffroyi*) on Barro Colorado Island, Panama, 16 copulations were observed. While all five adult males were seen to copulate at least once, only four of seven adult females and one of three sub-adult females were observed copulating. The majority (15 of 16) took place at least 50 m from other adult males. All copulations were performed in a dorso-ventral with absolutely no vocalization by the copulating pair position previously described for this genus. The average length of intromission was 19.1 minutes (N = 10, s.d. = 3.64, range = 12.77 to 23.9 minutes). Hormonal data obtained via analysis of fecal samples indicate that 92.8% of all copulations observed involved a reproductively cycling female. However, only 40% of those recorded occurred during the peri-ovulatory period of the female participant. Analysis of photographs and video of several of these copulations has clarified male penile morphology. In addition, an alternative hypothesis regarding the current function of the pendulous clitoris found in this genus is postulated.

#### MtDNA variation among the Western Anasazi.

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The prehistoric Anasazi inhabited large portions of the US Southwest from around 1 to 1300 A.D. While there is a uniform cultural entity known as "Anasazi," there is also evidence of ethnic and archaeological regionalization.

The simplest regional division places the Anasazi into two main groups, the Eastern and Western, perhaps reflecting ethnic differences among the modern Eastern and Western Pueblos.

To clarify prehistoric population structure among the Western Anasazi, four restriction site polymorphisms (RSP) were assigned to identify the four maternal haplogroups (A, B, C, D) known to be polymorphic in Native American populations. The mtDNA haplogroups are defined by the presence or absence of four primary restriction sites and one length polymorphism (9 bp deletion).

Preliminary analysis reveals that several population clusters (Grand Gulch region, Canyon de Chelly, Mesa Verde region) that fall within the Western Anasazi definition do provide a relatively uniform genetic profile. Twenty seven Western Anasazi samples exhibited a high frequency of the 9 bp repeat and, hence, haplogroup B (78%). Haplogroups A and C are observed at moderate frequency (11% each), while haplogroup D is absent.

This haplogroup distribution does not appear to be caused by temporal effects, as the rare haplogroups (A, C) are found

among both the Basketmaker and Pueblo Anasazi.

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**Environmental effects on population genetics models: A test of Australian microevolution since the Late Pleistocene.**

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The role of the environment has long been acknowledged by paleoanthropologists as important in the development of cranial and postcranial skeletal features (see Churchill, 1998). The environment, however, receives little attention in population genetics models, in part because we are unable to define the relative contributions of environmental and genetic variation to the overall change in phenotype. This study uses complexity theory to simulate microevolution in Australian craniofacial morphology from the Late Pleistocene to the Holocene. A matrix of known environmental parameters, (temperature, humidity, precipitation, altitude, vegetation, etc.) will be paired with a number of microevolutionary processes to determine the most likely combination of factors contributing to Holocene craniofacial morphology.

While climatic changes at the Pleistocene-Holocene boundary were not as dramatic in Australia as they were in other parts of the world, the continent's inhabited regions did experience increases in temperature, humidity, precipitation, and size of temperate forests. Archaeological and paleoclimatological records of Australia are also excellent for this time period, making it a good region on which to test the model of environmental contributions to microevolution.

Preliminary results indicate that there is no single "best" scenario for describing the microevolution of craniofacial morphology; rather, the contribution of genetic and environmental factors varies when testing different microevolutionary processes. This study concerns only craniofacial morphology, but future work will consider the environmental effects, if any, on dental morphology and genetic marker distributions. While these three types of data may not provide the same results in terms of genetic versus environmental contribution to the observed variation of Holocene individuals, each will show quantifiable environmental influence that has thus far eluded population geneticists.

**Predicting mammalian walking gaits from optimized support polygons.**

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It has long been known that primate gait patterns differ from those of other mammals, but few studies have detailed the relationship between fore and hindlimb support patterns, interlimb coordination, and gait. The symmetrical gaits of quadrupeds are often described in terms of two variables: duty factor (S = the stance period of one foot, as a percentage of the gait cycle) and diagonality (D = the percentage of the cycle period by which the left hind footfall precedes the left fore footfall). In walking gaits (S>50, D>50 in most primates; in most other mammals, D<50).

We show mathematically that support polygons are optimized during walking—that is, the percentage of the locomotor cycle spent standing on only two feet is minimized—for the diagonal-sequence, diagonal-couplets walks characteristic of primates (50<D<75) when D = [hindlimb S]; for lateral-sequence, lateral-couplets walks (0<D<25) when D = [hindlimb S] minus 50; and for lateral-sequence, diagonal-couplets walks (25<D<50) when D = 100 minus [forelimb S]. To determine whether animal behavior is optimal in this sense, we examined 346 symmetrical gait cycles in 45 mammal species, including 19 primate species. We videotaped our subjects moving freely and quantified both diagonality and duty factor. Our empirical data show that mammalian locomotor behavior, including that of primates, approximates the theoretical optima.

**Species concepts, populations and evolutionary models in paleoanthropology.**

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Over the last century and a half species concepts in paleoanthropology appear to have changed significantly; there are periods in the history of the field when many species are recognized, and other times, most notably between the 1950's and the mid 1970's when "lumping" seemed to prevail and considerable variation was subsumed into single species. It is sometimes argued that the populational thinking inspired by the synthesis dominated paleoanthropological thought over this period. The phylogenetic approach and the new focus on evolutionary patterns predicted by punctuated equilibrium initiated a pendulum shift in the 1970's toward the recognition of multiple species in the human fossil record, even extending into the late Pleistocene, where the domains of prehistory and paleontology merge and blur.

This paper explores the influence of populational thinking on paleoanthropology. It is shown that, in fact, populational thinking never prevailed in the his-

tory of field. While there was a tendency to view variation as intraspecific in the post-synthesis years, populational models were not generally applied or accepted. Intraspecific variation was conceived of and modeled by many of the most prominent scholars in terms of trees, heuristic devices that effectively treat all variation as specific. The essentialism at the core of our pre-Darwinian understandings of human variation was transferred into evolutionary thinking through branching models, and paleontology, the other influence on the field, never adopted populational thinking as critical to the discipline. Partially due to a focus on systematics that relies on type, small sample sizes, and the general lack of resolution necessary to deal with intraspecific processes, paleontology remains one of the most typological sciences within evolutionary biology. It is argued that the recent focus on species level processes represents very little in terms of new thinking; rather it provides a rational context for the essentialist thought that has always dominated the field.

**Standardize decomposition rates of human surfaces remains in the West Texas environment.**

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The estimation of time since death by forensic anthropologists is a difficult endeavor because of specific environmental influences. It has been widely suggested that specific standardized decomposition rates be established for specific regions (Bass, 1997). Yet, this has not been put into wide practice.

In the past decomposition rates established by Galloway et al. (1989) for the dry, hot Arizona region have been used in West Texas to determine time since death for decomposing bodies. While useful, this standardized decay rate does not fit specifically to the West Texas high plains conditions. To remedy this, we set out to study the decomposition rate of human tissue far the West Texas high plains.

Fourteen human limbs were placed in wire rabbit hutches laid directly on the ground. They were located on range land with a natural plant community consisting of grasses, forbs, and shrubs. This uncultivated land had limited human access and disturbance. This allowed access of the tissue by insects, small carnivore, and rodents.

Data was collected on the type of animals and insects present and their impact on the decomposition process. We also collected weather and climate data for the months of March through September.

Our study shows that skeletalization of the remains is directly affected by amounts of shade, vegetation, insect and mammal



feeding activity. Skeletalization began 2 weeks after the study was started and became completed by the third month.

Application of this study will contribute to an accurate estimation of time since death for human remains found in the West Texas area.

#### **Validation of waist to stature ratio and waist circumference for community based obesity screening in Mexican American women.**

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Traditionally, in addition to Body Mass Index (BMI) as a general measure of obesity, the Waist Hip Ratio (WHR) is used as a measure of central adiposity for community based obesity screening. Recent studies in Japan and Turkey indicate that the Waist Stature Ratio (WSR) and Waist Circumference (WC) are potentially more useful than WHR for obesity screening for the purposes of early detection of coronary risk factors. This research examines the association of these three measures of centralized obesity with several indicators of coronary risk factors (CRF) in Mexican American women.

Cross-sectional baseline data on 390 overweight Mexican American (i.e., with BMI between 25 to 40 kg/m<sup>2</sup>), aged 18 to 64 years, collected during a weight-loss study, were used for this validation study. Crude and age-adjusted correlation coefficients were computed for the four obesity measures: BMI, WHR, WC, and WSR, and the five CRF variables: systolic and diastolic blood pressures (SBP, DBP), total cholesterol (CHL), triglyceride (TRG), and plasma glucose (GLU).

Age was significantly correlated with all three measures of centralized obesity, but the proportion of explained variance was modest; the highest observed was 9.4% for WHR. All four measures of obesity are highly correlated ( $r$  between 0.27 to 0.97;  $p < 0.001$  for all pairs), but WHR appear to be somewhat weakly correlated with the others ( $r = 0.27$  with BMI; and 0.67 and 0.68 with WC and WSR, respectively). Age-adjusted as well as crude correlations of SBP, DBP and GLU and the four measures of obesity are significant at the 5% level, but BMI and WC are not significantly associated with CHL and TRG. In contrast, both WHR and WSR are positively correlated with all five CRF variables ( $p < 0.01$ , even after age-adjustment). In summary, in Mexican American women, WHR appears to be significantly more associated with the CRF variables, independently of BMI, while WC and WSR do not perform equally well.

#### **Signatures of recurrent mutations at single nucleotide polymorphism sites in the hypervariable domains of the mitochondrial control region and their implications for evolutionary studies.**

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The human mitochondrial control region contains two hypervariable domains, HVS1 and HVS2, where numerous sites exhibiting single nucleotide polymorphism (SNP) have been found in worldwide data. Analyzing over 5,000 HVS 1 and HVS2 sequences, encompassing over 15 populations, we document that recurrent mutations, and not recombination, are prevalent at these SNP sites.

Three lines of evidence support our conclusion. First, over 15% of the SNP sites in the HVS1 domain, and over 6% sites of the HVS2 region exhibit 3 or 4 segregating nucleotides. Clearly, these are caused by more than one mutation at every such site. Second, the four gamete test, performed for the other segregating sites, shows the presence of all four haplotypes, caused by the pattern of polymorphism of over 20% of the HVS 1 and at least 12% of the HVS2 sites. These are also ascribed to reverse mutations, since the distribution of base-pair distances of these sites is identical to that of the remaining segregating sites, ruling out recombination as the cause. Third, signatures of recurrent mutations are highly correlated with site-specific nucleotide diversity ( $r = 85%$  for HVS 1 sites, and 79% for HVS2 sites), suggesting that the higher the mutability, greater is the chance of recurrent mutations at a SNP site.

Together, these observations suggest a gross violation of the assumption of the infinite site model (ISM) of mutations for the HVS 1 and HVS2 domains. Consequently, the number of mutation events during human evolution is underestimated in data interpretation with the ISM, more so at sites with higher rates of nucleotide substitutions. (Research supported by NIH grants GM 41399, GM 45861, and Keck's Center for Computational Biology, Rice University).

#### **What are species anyway?**

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A fundamental debate in paleoanthropology concerns the number of

taxa represented in the fossil record. Whether the record is interpreted as being composed of many taxa (splitters) or few (lumpers) the basic question remains the ways by which variation is evaluated. Ideally, fossil hominine taxa should be treated analogously to extant species that are primarily identified on the basis of reproductive isolation.

Fossil hominine samples are normally distinguishable by time and geographic space as well as by morphology. Moreover, morphologically defined species cannot be assumed to have biological significance; studies of both primate and non-primate taxa do not consistently support the correlation of morphological distinctiveness and speciation.

Regardless of how they are defined, the operational taxonomic units of most paleontological studies are essentially artificial taxa (Smith and Patterson 1988) and these are notoriously unstable (Hughes and Labandeira 1995). They were not species - or if they were, we lack the ability to recognize them as such. In this sense, the naming of paleoanthropological species lacks objective foundation.

A possible solution to this problem is to shift from an emphasis on identifying species in the fossil record, and making all the assumptions that come along with species status, to identifying clades, wherein the sole criterion is that the members of the clade are all more closely related to each other than they are to those outside of the clade. In a sense, this would involve only a tighter application of the same criteria used to identify paleospecies - time, space and morphology.

#### **Age-associated bone loss in an Imperial Roman population.**

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Bone loss is a universal phenomenon, afflicting individuals regardless of sex, socioeconomic class, and ethnicity. Modern populations of European descent are most vulnerable to bone fragility and osteoporosis. In particular, present day Italians have one of the highest hip fracture incidences (169.6/100,000 for females) in southern Europe with an increasing rate in incidence.

How far back in time one can observe cross-cultural variability in bone loss is unknown, due to the paucity of skeletal collections amenable to research. Although age-associated bone loss has been observed in past populations, the incidence of bone fragility and fractures, which are pathognostic of osteoporosis, is relatively low in archaeological populations. Such conclusions, however, are based primarily on non-Western pre-industrial populations.

A study sample from the Isola Sacra necropolis near Rome offers a unique op-

portunity to study an urban European archaeological population. The biology and health of ancient Romans are largely unknown.

When compared to a modern European-American sample, Isola Sacra ribs exhibit a higher OPD, smaller mean osteon size, lower activation frequency and bone remodeling rate, and a larger relative cortical area. Mean osteon size, activation frequency, and bone remodeling rates observed for Isola Sacra are similar to non-Western pre-industrial archaeological skeletal samples, while OPD and relative cortical area are greater. The implications of these findings for understanding age-associated bone loss and the apparent lower incidence of osteoporosis in archaeological skeletal populations are discussed.

#### Calculation of isonymy from census and marriage records: A comparison from antebellum Georgia.

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Studies of random isonymy in historical populations have relied upon two different types of data: census records and marriage records. Censuses, as well as tax lists, militia rolls, and other directories, sample a single moment in time. Marriage registers provide a list of couples over a period of time. The first has the advantage of synchronicity and completeness; the second of equal representation of males and females. Few studies have used both methods, so their relationship is unclear. In the United States, historical studies of Massachusetts populations have used marriage records, while others of Pennsylvania and New York have used censuses. To compare the methods, records spanning the years 1795-1859 were examined from three counties in Georgia: Bulloch, Camden, and Tatnall.  $I_{ii}$  was calculated for each county from each decennial census and from three different arrangements of marriage records. First, each census was compared with a ten-year span of marriages centered on that date ( $N = 14$ ), and then with the spans before ( $N = 13$ ) and after ( $N = 14$ ) it. All three correlations were strong ( $r > 0.8$ ); the strongest was that between marriages and midpoint censuses. When separate lists of male and female names were derived from the marriage registers, female  $I_{ii}$  exhibited a slightly greater correlation with census  $I_{ii}$ , despite the fact that these censuses only record male heads of household. This indicates that patterns of male and female marital migration were not different enough to invalidate calculations based solely upon the male names in the census.

Values of  $I_{ii}$  steadily increase over the period studied. The 1805 and 1810 samples represent first and second generation migrants; by 1850, population structure had had one or two more generations to de-

velop. The highest values of  $I_{ii}$  reach 0.012, higher than has been reported from western Pennsylvania in 1800, but lower than 18<sup>th</sup> century Brooklyn, New York. This follows what is known about the culture history of these populations: Antebellum Georgia was less culturally and ethnically diverse than early Pennsylvania, but far more so than the homogeneous Dutch settlements of western Long Island.

#### Early Pleistocene dates and sedimentary cycles for new Bapang Formation hominins, Central Java, Indonesia.

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The Sangiran dome, in Java's Solo basin, has yielded nearly 80 *Homo erectus* fossils, around 50 of which have known findspots. With a  $1.66 \pm 0.04$  Ma  $^{40}\text{Ar}/^{39}\text{Ar}$  date on pumice reportedly associated with S27 and S31 (Swisher *et al.* 1994 - Science 283: 1118-1121) the dome may offer evidence that early *Homo* dispersed to East Asia during the earliest Pleistocene. Unfortunately, this pumice was sampled at Jokotingkir Hill, a central locality with complex litho-stratigraphic deformation and dubious specimen provenance (Larick *et al.* 2000 - *Int. J. Primatol* 21: 731-759).

We address the sedimentary framework and  $^{40}\text{Ar}/^{39}\text{Ar}$  age for *Homo erectus* in the dome's SE quadrant, where fossiliferous Bapang (Kabuh) sediments have their largest exposure, least deformation, most complete tephro-stratigraphy, and greatest number of hominin findspots. At five locations, we identify a sequence of sedimentary cycles in which 28 hominin fossils are associated with epiclastic pumice. Eight hornblende separates produce  $^{40}\text{Ar}/^{39}\text{Ar}$  plateau ages ranging from  $1.51 \pm 0.08$  Ma at the Bapang/Sangiran Formation contact zone, to  $1.02 \pm 0.06$  Ma for the top of the hominin-bearing sequence. An intermediate level, which produced S17 and three nearly complete new crania, has an  $^{40}\text{Ar}/^{39}\text{Ar}$  age of about 1.25 Ma.

The newly dated crania are from the following locations: Tanjung, Tjg-1993.05, comprising the calvarium, most of the maxilla with four teeth, and separate left temporal; Grogolwetan, Gwn-1993.09, conserving the left frontal, the sagittal part of the right frontal, parietals, posterior temporals and the occipital; and Sendangbusik, Sbk-1996.02, consisting of the temporals, portions of the parietals, and the occipital.

The Bapang Formation represents an aggraded fluvial system built up on a num-

ber of energetic cycles. The new  $^{40}\text{Ar}/^{39}\text{Ar}$  dates are consistent within cycles and the sequence of dates matches the stratigraphy. Finally, new taphonomic evidence derived from the cycles suggests that *H. erectus* was living at or adjacent to areas where its fossils are found.

#### Presence of mother and juvenile dispersal in free-ranging howling monkeys (*Alouatta palliata*) in the tropical dry forest of Costa Rica.

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While the "rule" in mantled howling monkeys is that juveniles of both sexes emigrate from their natal group, occasionally an animal does stay in its natal group. Thus, it was unusual when two juveniles remained in their natal social group until adulthood. Both of their mothers had died before the juveniles reached the usual age of emigration. To verify if this pattern occurred regularly, emigration records in 5 social groups of howling monkeys living in both riparian and upland habitat on Hacienda La Pacifica in the tropical dry forest of Guanacaste, Costa Rica were analyzed. These groups had been regularly censused for 28, 20, 15, 12 and 11 years. From 1972 to 2000, there were 80 juveniles for whom presence/absence of mother and emigration histories were known. Sixty-six juveniles had mothers in the group, and 64 emigrated. Fourteen juveniles did not have mothers in the group and 6 emigrated ( $C^2_{df=1} = 30.9$ ,  $p < .0001$ ). These emigrants, however, left the group at an older age than the norm for the group, staying 1-4 years longer. This suggests that the lack of a mother in the natal group gave them extra years of group membership which presumably could shorten the species-typical solitary phase before permanently joining a different social group. There were no differences in patterns for upland or riparian groups. Animals that remained in their natal group had to "join" the group in the same manner as an immigrant, i.e. become the dominant female or dominant male. The migration "rules" haven't changed, but it appears that the presence of the mother does have an effect on when or if a juvenile will be forced out of its natal group. Since juveniles are chased, and frequently hurt, by nonrelatives prior to emigration, we suggest that juvenile emigration is perhaps better understood as competition between adult females, competition which ceases to exist when the juvenile's mother is no longer in the group.

#### A comparison of human and non-human primate vocal tracts.

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Humans are considered to have an enlarged vocal tract compared with other primates (Lieberman *et al.* 1992). In all non-human primates there is almost no supralaryngeal portion of the pharynx. Few studies however, exist to show the comparative lengths of the vocal tract in various primate species. The human vocal tract is regarded as having a smaller oral cavity than those found in non-human primates. However, it is rare that this is quantified either absolutely or relatively. Indeed descriptions and assertions are numerous but very few studies have looked at the comparative length of the vocal tract, oral cavity or tongue.

In this study the length of the vocal tract, oral cavity and tongue are measured across humans and a wide range of non-human primates. The measurements are compared to bodymass. The relationship between component parts of the vocal tract is compared across humans and non-human primates.

There is an isometric relationship across all non-human primates in this study between the length of the vocal tract, oral cavity and tongue and bodymass. Humans have a longer vocal tract than either their bodymass or oral cavity would predict. The human tongue is also longer than bodymass or oral cavity would predict. The oral cavity in humans contributes less to the total length of the vocal tract than in non-human primates. The reorganisation of the human vocal tract has altered the contribution of the component parts of the vocal tract to total length.

#### **Behavioral and genetic correlates of male-infant interactions in a captive group of rhesus macaques (*Macaca mulatta*).**

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Among nonhuman primates, behavioral interactions between adult males and infants range from intensive male caretaking to avoidance or aggression. Although models of kin selection and inclusive fitness have been proposed to account for individual variation in adult male-infant interactions, in most cases, paternity has been assumed or based on patterns of behavior and residence, rather than on genetic information. In this study we examine relationships between paternity, social dominance, and adult male-infant interactions in rhesus macaques.

From June through July, 2000 data were collected on social interactions and spatial proximity in a group of 47 rhesus macaques. The study group consisted of 3 adult males, 14 adult females, 16 subadult females, 3 subadult males, 1 yearling, and 10 infants. These animals were housed in a 3600 square foot field cage at the LABS of Virginia, Inc. Nonhuman Primate

Breeding Facility in Yemassee, SC. Data presented here represent 112.9 hours of adult male focal animal observations collected at 4 minute intervals. In addition, blood samples were obtained on group members, and paternity exclusion analyses were conducted using 14 human-derived primers. These primers provided a cumulative mean paternity exclusion probability of .99 in a previous study (Ely *et al.*, 1996)

Our results indicate a linear dominance hierarchy among group males. The alpha male's nearest neighbor was an infant in 51.1 % of all observations. In contrast, infants were nearest neighbors of the beta (28.5%) and gamma (28.0) males significantly less often ( $p < .01$ ). The alpha male also maintained closer proximity ( $< 1$  m) to infants than did other males. In addition, each adult male was found to associate with particular infants more than expected ( $p < .05$ ). In some instances these were the same infants. In the case of the alpha male, however, 2 of 4 infants in greatest proximity to him, were not found in close proximity to other males. Additional relationships between kinship, paternity, and male-infant interactions are discussed.

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#### **Child care-taking and maternal activities in a Toba community, Formosa, Argentina.**

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Cross-cultural studies have shown significant use of allomothering in a majority of societies examined. Alternate care-taking has been examined for its effects on child psychological development, the socialization process, and daily activities. This study attempts to provide a more accurate description of strategic and cultural use of allomothering.

This study was conducted in Namqom, a Toba village in Formosa, northern Argentina. An analysis of demographic surveys indicated that the availability of potential care-takers is dependent on residential composition and the ages and responsibilities of household members. A total of 75 breastfeeding mothers and their infants were observed in their homes for 2-hour sessions; amounting to nearly 2000 hours. These data convey the usage of alternate care-takers and maternal activities at different times of day and year. In Namqom, the mother is the primary caretaker, the husband is the primary alternate caretaker, and allomothering is used 22.7% of the total observation-time.

More detailed analysis explores what

effects the age of subject, age of child, time of year, and time of day have on the delegation of care. An analysis of the daily activity recording may explicate the impact of allomothering on maternal energy expenditure. In turn, this will provide a clearer understanding of maternal decision-making, divisions of labor, and reproductive outcomes. The results will supply a portrait of the constraints on a subject in designing her care-taking strategy and the consequent constraints and freedoms on her daily activities and energy expenditure.

#### **mtDNA hypervariable region-1 variation in Central Africa**

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As a part of a long term project on molecular variation in Central Africa ([www.scienzemfn.uniroma1.it/labantro](http://www.scienzemfn.uniroma1.it/labantro)), we have sequenced the hypervariable region-1 of mitochondrial DNA in a Pygmy population from the Central African Republic (C.A.R), the Mbenzele Pygmies, and two Bantu-speaking 51 populations, the Bamileke and Ewondo from Cameroon.

Concerning intrapopulation diversity, two results are worth noting. Firstly, the Mbenzele Pygmies have one of lowest within-population variability reported to date. In fact, smaller values of gene diversity have been reported only for the Hadza, Herero and the !Kung. A possible explanation is in the fact that mtDNA gene flow between Pygmies and neighbouring populations occurs mostly by marriages between a Pygmy female and a Bantu male, an event favored by the low bride price that the husband must pay. Thus, while the relatively small size of Pygmy make them prone to the loss of genetic variability, this is not counterbalanced by gene flow from external populations. Secondly, the examined groups differ substantially in their subsistence economy, since Pygmies are hunter-gatherers, while the two groups from Cameroon are descendants from farmers and pastoralists. As a matter of fact, this difference is reflected by their patterns of nucleotide pairwise differences.

The most striking results provided by the analysis of interpopulation diversity is in the marked genetic differentiation between the Ewondo and Bamileke. This finding is in contrast to a previous microsatellite study. Pygmy-to-Bantu gene flow seems to play a role in this finding. In fact, there are three mtDNA lineages shared between Ewondo and Mbenzele. All these sequences are much more frequent in the Pygmy than 10) in the Bantu popu-

lation and considering other Africans they are found only in the Biaka Pygmies from C.A.R. On the other hand, the Ewondo live in south Cameroon near the Cameroon Pygmies (who are closely related to the C.A.R. Pygmies) and they traditionally have no taboos against mixed marriages. By contrast, Bamileke and Mbenzele Pygmies shared no mtDNA sequence. This is to be expected since ethnic endogamy is rigid in the Bamileke and prevents mixed marriages with other Pygmy and Bantu groups.

#### Phylogenetic analysis of landmark data and the evolution of ateline skull form.

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This study proposes a new method for analyzing shape variation within an explicitly phylogenetic framework. It is based on a recent modification of Euclidean distance matrix analysis (EDMA) for the recognition of shape-conservative landmark cliques (substructures) in proteins. However, the clique-finding method is now used to "map" morphological landmark cliques onto a cladogram, in combination with algorithms that are broadly similar to the Farris, ACCTRAN and DELTRAN methods of character-state optimization. The method is both coordinate-system invariant and scale-invariant. It does not require the investigator to gap-code measurements or to ignore the correlations between them. It requires no knowledge of cladogram branch lengths and can be used with cladograms that are not fully resolved. Finally, because it uses a heuristic algorithm for recognizing similar shapes, the method is computationally expedient.

The method is applied to an analysis of skull form in extant atelines, using *Cebus* as an outgroup, Rosenberger and Strier's ateline cladogram, and 60 three-dimensional landmarks. In terms of plesiomorphic features, *Lagothrix* retains the most primitive shape, particularly in the cranial base. The *Lagothrix Ateles Brachyteles* clade retains a symplesiomorphic mandibular corpus shape, in spite of dietary differences. *Ateles* and *Brachyteles* share few primitive features not also seen in *Lagothrix*. In terms of synapomorphic shapes, *Ateles* and *Brachyteles* share derived similarities in the shape of the palate and midface (again, despite differences in diet). The *Lagothrix Ateles Brachyteles* clade is characterized by a few similarities in the shape of the orbit, zygoma, and cranial base. *Alouatta* exhibits the most extensive shape autapomorphies, while there are very few shared-derived shape features that characterize the ateline clade as a whole. When homoplasies are examined, *Alouatta* and *Brachyteles* share a number of localized similarities of the facial skeleton that may

have evolved in parallel as correlates of folivorous diets. Supported by NSF, the Wenner-Gren Foundation, and the Field Museum of Natural History.

#### Middle ear morphology in primates and its relationship to hearing.

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The relationship between the bony morphology of the ear and the auditory environment in primates remains poorly studied despite the importance of hearing for communication and both predator and prey detection. The middle and inner ears are ideal regions on which to focus since they are often preserved in the fossil record.

In a hearing system with high impedance, like that of mammals, the ratio of the area of the tympanic membrane to the area of the oval window is one factor determining the degree of acoustic amplification. In this study, the dimensions of the oval window and tympanic ring were measured in 139 ears of 15 genera of primates to determine how these structures vary in relation to each other and to size. The geometric mean of four cranial measurements was used as a surrogate for size.

The long and short axes of the oval window consistently have a 2-1 ratio while those of the tympanic ring are closer to a 1-1 ratio, yet more variable. Very little variation was found between the right and left ears of a single specimen and the mean of these values was used as a single datum point. The areas of both the tympanic ring and oval window scale with negative allometry. The ratio between these two structures ranges from 26-to-1 to 42-to-1. Although the primates with the largest size had the smallest ratio, the ratio did not change in a predictable pattern in relation to size across the entire study group. There also does not appear to be a clear phylogenetic or behavioral signal in these data.

The complex integrated nature of the components involved in hearing may obscure the significance of changes in isolated parts of the entire system. However, the negative allometric scaling of the tympanic membrane may be related to frequency reception as much or more than acoustic amplification. The conservative changes in the area of the tympanic membrane may allow for a wide range of reception across all sizes. This idea is in need of further testing along with quantitative analysis of other areas of the auditory system.

#### Phylogenetic utility of higher primate postcranial morphology.

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Higher primate postcranial features are assumed to be less phylogenetically informative than their craniodental counterparts. We tested this assumption using 73 postcranial and 96 craniodental characters recorded on the five extant hominoid genera.

Each data set was subjected to a bootstrap analysis, and the resulting cladogram compared with the group's molecular phylogeny which is widely accepted as accurate. The relative phylogenetic utility of the data sets was assessed by the percentage support for clades in the bootstrap cladogram that matched the molecular phylogeny. The data sets were also subjected to parsimony analysis and then fitted to a cladogram with the same topology as the molecular phylogeny. Relative phylogenetic utility was evaluated by calculating the percentage difference in length between the most parsimonious cladogram and the fitted one.

The postcranial bootstrap cladogram contained a single well-supported clade compatible with the molecular phylogeny. In contrast, the single well-supported clade yielded by the craniodental data was incompatible with the molecular phylogeny. In the fitting analysis, the most parsimonious postcranial cladogram was only 3% shorter than the fitted cladogram, whereas the equivalent craniodental cladogram was 13% shorter than the fitted cladogram.

This study suggests that postcranial data may be more reliable for phylogenetic reconstruction among higher primates than craniodental data. This finding has important implications for our understanding of the phylogenetic relationships of extinct higher primates, especially the Miocene apes.

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#### Bioarchaeology of William's Landing (1JA306) and Widow's Creek (1JA305), Jackson County, Alabama.

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Prehistoric lifeways in the southeastern United States underwent significant shifts in health and activity patterns in the past several thousand years, particularly with regard to the transition to agriculture. Furthermore, recent evidence suggests that women played a more essential role than once imagined during this transition. Most information, however, has come from large centers, such as Etowah and Moundville. Rarely have rural, continuously occupied sites been examined in

this context. William's Landing and Widow's Creek, two small sites in northern Alabama with continuous occupation from the Archaic through Mississippian periods, offer an opportunity for such study.

A total of 61 individuals was examined from the two sites in order to reconstruct health patterns over time. Indicators observed include porotic hyperostosis, caries, toothwear, linear enamel hypoplasias, infection and arthritis. Relatively high rates of infection and a significant amount of anemia are present, which indicate a compromised immune system. The correlation of linear enamel hypoplasias bolsters this finding, and the rates of these pathologies seem to be consistent throughout the occupational period. Other health conditions, including treponemal disease, are also seen. In addition, significant rates of cervical and lumbar osteoarthritis indicate a heavy work load among male and female alike.

This pattern of disease and nutrition markers is inconsistent with expectations of better health at smaller sites due to increased foraging opportunities and decreased population density. A number of possible explanations for this pattern are discussed, suggesting analysis of smaller sites lends further clarification of the changing culture in the rural prehistoric Southeast.

#### Transitions in eastern Arctic coastal diets.

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The importance of bowhead whales in eastern Arctic coastal diets has been a topic of long standing debate. With the advent of Neo-Atlantic warming, late in the first millennium A.D., a group of high-latitude foragers migrated eastward from Point Barrow, Alaska. Their occupation of the eastern Arctic is thought to have been facilitated by the dog sled and open sea hunting of bowhead whales. Classic Thule winter villages (ca. A.D. 1000) are located on low coastal ridges with expansive views of bowhead sea lanes. Whalebone comprises the superstructure of winter houses and whaling gear has been recovered from their interiors. Some researchers argue that reliance on whaling continued until the onset of Neo-boreal cooling. With a shorter ice-free season and fewer shore leads, emphasis on bowhead whaling was replaced by breathing hole sealing and a subsistence economy similar to that practiced by the historic Inuit. Other researchers contend that bowhead whales were scavenged, not actively hunted, and never made a significant contribution to eastern Arctic diets.

Preliminary results from a radiocarbon and stable carbon and nitrogen isotope

study with burials from two Thule winter villages, and burials representing earlier Dorset and later Inuit adaptive strategies, are consistent with the argument that an economic transition took place at the Classic Thule interface. While intake of marine resources remained high, Classic Thule foragers subsisted on lower trophic level diets than either Dorset or Inuit foragers. Given that bowhead whales are planktivores and ringed seal carnivores, reliance on the former constitutes a trophic level decline in subsistence.

#### Differences in habitat type of *Otolemur crassicaudatus* and *Galago moholi* in the Makapan Valley, South Africa.

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It has been observed that *Otolemur crassicaudatus* (thick-tailed greater bushbaby) and *Galago moholi* (southern lesser bushbaby) exist sympatrically throughout much of Southern Africa. Closely related sympatric species usually have niche differences that allow this close association without strict competition. Differences in diet are one factor in the sympatric association of *O. crassicaudatus* and *G. moholi*. Differential use of adjacent habitat types may be another. This study was conducted to determine if there is an observable difference in the type of habitat used by each species in the Makapan Valley of South Africa.

A Q-beam light was used to locate subjects. Once located, the species of galago was identified and the tree in which the subject was sighted was marked. Marked trees were later identified at the species level. Surrounding areas and the types of habitat were determined (closed woodland, open woodland, riverine, etc.).

The distributions of *O. crassicaudatus* and *G. moholi* were analyzed with reference to tree species, habitat type and geographic location. Fifteen *O. crassicaudatus* and seven *G. moholi* were observed. Significant differences in the type of habitat utilized by each species were identified. Fourteen of the fifteen *O. crassicaudatus* were found in closed woodland systems including riverine habitats while six of the seven *G. moholi* were found in open woodland habitats. A strong relationship also emerged between galago species and tree species as well as between galago species and geographic location. However, these are believed to be a reflection of the correlation between galago species and habitat type.

While there have been recorded differences in the diets of *O. crassicaudatus* and *G. moholi*, there also appears to be a differential use of habitat type. Along with resource partitioning, this geographic partitioning by habitat allows the two closely-

related species to exist sympatrically and indeed share much of the same range throughout Southern Africa.

#### Row, row, row your boat: activity patterns and skeletal robusticity in a series from Chirikof Island, Alaska.

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The Chirikof series probably represents an eighteenth century work party left on the island to hunt marmots. Ethnohistorical sources suggest that most men will have spent considerable time rowing large ocean-going boats, or *bidarkas*. Commingled skeletal remains include 55 scapulae, 142 humeri, 91 radii and 110 ulnae. Metric sex determination was used to define male and female components. Section points are based on sex ratios determined for the crania and innominates. Sex misassignment is likely for these elements, but its effect will be to lessen apparent dimorphism in activity related changes.

Midshaft robusticity, joint surface diameters, muscle markings and joint surface modifications are reported. Correlations among these variables are examined. We review the sports medicine literature on rowing, and apply the results to the male-specific features of upper limb morphology in the Chirikof collection. A rowing syndrome defined for *bidarka* users is contrasted with patterns reported for the *Mary Rose* and central Alaskan populations who used kayaks.

Coastal adaptations are diverse, and technology is perhaps the most important aspect of activity-related changes in the skeleton.

#### Nonhuman primates as models of variation in human evolution.

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Alpha taxonomy has always been a primary concern for those interested in human evolution. The recognition of species in the human fossil record is often intertwined with a particular pattern of human evolution in mind. However, except for our closest hominoid relatives, inter- and intraspecific variation in nonhuman primates is rarely considered when recognizing species of *Homo*. Variation in other primates provides a broader context in which to interpret variation in the human fossil record.

This study applied several multivariate and univariate techniques to analyze patterns of intro- and interspecific variation in samples of closely related nonhu-

man primates. Using craniodental metric data for a number of species, variation among sympatric and allopatric species was examined. Samples included some from more substantial geographic ranges than others.

The results indicate that, except of course for the degree of sexual dimorphism, single species samples within relatively restricted geographic areas show generally similar degrees of variation. As noted in previous studies, patterns of geographic variation within species differ widely among taxa. It can often mimic interspecific variation. Because many of the controversies surrounding species recognition in the human fossil record involve the interpretation of geographic variation, this result is an important consideration. It is probably easier to make a strong case if multiple sympatric species are present.

As methodologies are improved and the nature of infra- and interspecific variation in a variety of primate taxa becomes better known, this knowledge should be taken into account when recognizing species of *Homo*.

**Morphological dental traits to reconstruct phenetic relationships between Late Pleistocene-Ancient Holocene human groups from Eurasia and North Africa.**

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An ongoing research on dental morphological traits (ASU System) has identified a dental complex for the Upper Paleolithic European populations that clearly distinguishes them from the more ancient ones. Seventy-nine dental morphological traits (39 used here) allowed to characterize the earlier groups which consist of 94 pre-wurmian remains prior to the Neandertals from Croatia (Krapina, Vindija), France (Biache, Lazaret, Malarnaud, Montmaurin), England (Pontnewydd), Italy (Saccopastore), Spain (Atapuerca, Banolas), 80 wurmian European Neandertals from Belgium (La Naulette, Sclayn, Spy), France (Arcy sur cure, Ban de l'Aubesier, La Chapelle aux Saints, La Ferrassie, Hortus, La Masque, Montgaudier, Moulin du milieu, Marillac, Roc de Marsal, Monsempron, Macassargues, Le Moustier, Pech de l'Azé, Le Petit Puy moyen, Les Peyrards, La Quina, Regourdou, Saint Cesaire), Italy (Grotta Breuil, Circeo, Le fate, Monte Fenera, Maglie, Poggio, Taddeo), Czech Republic (Kulna, Ochoz), Spain (Agut, Devil's Tower, Forbes Quarry, Zafarraya), Hungary (Subalyuk), and 18 Neandertals from the Middle East (Amud, Dederiyeh, Kebara, Shanidar, Tabun, Teshik Task). These samples have been analyzed in com-

parison with 26 AMH Levantines (Qafzeh and Skull), 145 European early Upper Paleolithics (Aurignazian, Gravettian and Perigordian), 198 European late Upper Paleolithics (Magdalenian, Solutrean, Epigravettian, Cheddarian), 228 late Upper Paleolithic Natufians from Palestine, 100 late Upper Paleolithics from North Africa (Iberomauresians), and 31 European mesolithics. Principal Component Analysis and Maximum Likelihood method (the latter tested by the bootstrap analysis) have been applied to the percent frequency of the traits. Both analyses reveal a clear separation between the Neandertals (both pre-wurmian and wurmian), and the anatomically modern humans (both Middle and Upper Paleolithics). The first axis of the PCA (47.3% of total variance) indicates that 20 traits out of 39 show statistically significant differences. A bootstrap value of 100 separates the two groups in the ML. The Neandertal group itself is split into the pre-wurmians and wurmians by a bootstrap value of 75. Although being clearly close to the Upper Paleolithics, the Middle Paleolithic Levantines, as well as the North African Iberomauresians, show indeed a tendency towards the Neandertals. This work was supported by the "Progetto Finalizzato Beni Culturali" CNR CU99.03787 and MURST COFIN99.

**Ontogenic patterning and phylogenetic significance of mental foramen number and position in the evolution of Late Pleistocene *Homo sapiens*.**

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Recent investigations (Trinkaus, 1993; Coqueugniot, 1999; in press) have shown that number and position of mental foramina in Neandertals represents a plesiomorphy rather than a unique character trait of that group. However, Coqueugniot's (1999) demonstration that a shift in mental foramen number comprises part of a developmental-evolutionary cascade within the anterior mandible through the late Pleistocene suggests that this anatomical complex might provide important clues regarding the evolution of modern lower facial morphology and thus merits further scrutiny from the prospective of evolutionary developmental biology.

Data on mental foramen position relative to the tooth row; height above the basal mandible; number of foramina direction of foramen aperture orientation; and metric data for a variety of mandibular corpus and lower dental dimensions, were collected from 55 Middle - Late Pleistocene immature hominids from Europe, North

Africa, and Central/Western Asia. Specimens ranked in age at death from < 1 year to adulthood. Comparative data were collected from 800 recent modern immature mandibles. Absolute and relative frequencies of variation for each component of mental foramen morphology were compared between Neandertal, Middle Paleolithic associated modern humans, Upper Paleolithic associated modern humans, and recent modern humans and assessed in terms of the developmental anatomy of the mental foramen complex as known from modern human embryology and postnatal ontogeny.

Results suggest that reduction of mental foramen number is, in part, an artifact of bone remodeling around terminal nerves and vessels due to changing mandibular and dental dimensions through the Late Pleistocene. The effect of such changes on shift in anterior-posterior and vertical mental foramen position, and possible implications for the gradual appearance of the chin in the Late Pleistocene hominid fossil record, are discussed.

**Changes in social networks over the lifespan in male and female rhesus macaques.**

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This study investigates age-based changes in rhesus social networks by looking at the relationship between age and the kinship affiliations of social partners. Social networks, or the identity and number of others an individual spends social time with, may change over an individual's lifespan. Further, these changes may occur in response to a variety of influences. Demographics, for instance, would predict an age-dependent reduction in cohort size due to natural attrition. Also, individuals may become generally more or less social with increasing age. Still other changes within personal social networks may occur as individuals advance in years. An individual may, for instance, exhibit a shift with age in initiative to social contact, preferring older social partners rather than younger, related individuals. Or, an individual may spend more time with closely related individuals, regardless of partner age, than with unrelated age mates.

Observational data (624 hours) were obtained on Cayo Santiago to investigate the relationship between chronological age and social behavior in male and female (N=42) rhesus macaques (*Macaca mulatta*).

Analysis showed that network size decreases with female age, while male network size increases with age. Additionally, 'old' females are less social than others, while 'old' males are more social than other males. Analysis also showed a strong tendency across all female age classes for social contact to be with daughters. In males,

both young and middle age classes spend a majority of social time with adult females, while 'old' males select yearlings as their preferred social partners. No evidence of generational homophily (the tendency to interact with age mates rather than others) was found in adult females. Old males show a tendency to interact with fewer age groups than others, but their partners are not age mates.

#### **A study on the taxonomic validity of *Homo heidelbergensis*.**

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*Homo heidelbergensis* as a taxonomic designation has, after nearly a century of disuse, been applied again to the fossil record. Specimens including Petralona and Kabwe have been reassigned to *Homo heidelbergensis* on the grounds of apomorphic traits not present in *Homo erectus*. This study tests the validity of such a reassignment.

Because no consensus has been reached concerning the distribution of the species, African and European representatives are included, as are similarly distributed *Homo erectus*. The two Middle Pleistocene hominid samples, *Homo erectus* and *Homo heidelbergensis*, are compared to a sample of seventy four modern humans of similar geographic distribution. Ten nonmetric cranial features previously outlined as diagnostic of *Homo heidelbergensis* are analyzed, such as a divided supraorbital torus, the shape of the squamous temporal, proportions of the parietals, and a vertical nasal margin. Features claimed as diagnostic of the species but consistently found outside those crania allocated to the new taxon undermines the definition of *Homo heidelbergensis* as it is currently written. The current definition also employs features, such as increased cranial capacity and increased robusticity, which may be considered not diagnostic, but rather points along a continuum.

Based on the degree of variation found to exist between all three samples, *Homo erectus*, *Homo heidelbergensis*, and recent modern humans, no concrete evidence to support reassignment of various Mid-Pleistocene crania to *Homo heidelbergensis* is found. Therefore, *Homo heidelbergensis* must be considered an invalid taxon.

#### **Gross pathology of human skeletal remains from a predynastic Egyptian cemetery.**

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Impending destruction of an important pre-dynastic cemetery (HK43) located in central Egypt called for the immediate salvage recovery of the burials at the site.

In two field seasons (1996 & 1997), 62 burials total were excavated, analyzed and documented.

The sample includes 24 males, 25 females, 7 subadults, and 6 non-sexed adult fragmented burials. The males range in age from 15-50 years, the females range from 15-50 years, and the 7 subadults range from 0-15 years. All macroscopic dental and skeletal pathologies were documented in the field.

The sample suggests an overall relatively healthy skeletal group with no discernable patterns of sex differences in regard to pathology. The frequent presence of tendon sheath hypertrophy and the overall robusticity of muscle attachments indicate a vigorous, active population. The muscular nature of the sample is in keeping with the knowledge that HK43 was a burial ground for the lower working class citizens of Hierakonpolis.

Comparative bioarchaeological studies have shown that the overall relative health of the HK43 cemetery inhabitants is similar to other sites of the same approximate time and location. In most ancient Egyptian lower class cemeteries, dental health is poor. Osteoarthritis is the most commonly encountered postcranial pathology. Fractures of the ribs, clavicles, humeri, radii, and ulnae are often seen, and are usually attributed to accidental trauma. A relatively low rate of infection among the HK43 sample is interesting and could possibly be the result of naturally occurring tetracycline in the diet of the ancient Egyptians. The possible influence of the "osteological paradox" in this situation, however, should also be considered.

#### **Functional adaptations and phylogenetic affinities of the distal radius of *Kenyapithecus africanus* from Maboko Island, Kenya.**

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The distal radius of *Kenyapithecus africanus*, discovered in 1997 on Maboko Island, Kenya, is the first fossil specimen of a middle-late Miocene large-bodied hominoid that furnishes information on the inferior radioulnar joint (McCrossin *et al.*, 1998a, b). Analyzing its morphology is of particular importance due to 1) claims that the postcranial remains of *K. africanus* exhibit morphological features indicative of semi-terrestriality in a number of regions and of knuckle-walking in the inferior radioulnar and metacarpophalangeal joints, 2) the recent resurrection of the notion that knuckle-walking is a derived characteristic of the African ape and human clade, and 3) the conflicting views regarding the phylogenetic relationships and current taxonomic placement of *K. africanus*.

A preliminary analysis found that the distal radius of *K. africanus* is markedly similar to hominoids in a number of features, including the curvature of the ulnar articular facet, depth of the articular surfaces for the scaphoid and lunate, and strong volar slant (McCrossin *et al.*, 1998a). Erosion of the styloid process, however, renders many of the standard measurements inapplicable for the *K. africanus* specimen. Thus, in the present analysis, new measurements were devised to exclude these areas in order to compare more accurately the fossil specimen with extant taxa. These measurements were applied to the distal radii of *Ateles geoffroyi*, *Cercopithecus aethiops*, *Erythrocebus patas*, *Macaca nemestrina*, *Papio hamadryas*, *Hylobates lar*, *Pongo pygmaeus*, *Gorilla gorilla*, *Pan paniscus*, *Pan troglodytes*, *Homo sapiens*, *Proconsul africanus*, and *Australopithecus afarensis*.

The distal radius of *K. africanus* provides a body weight estimate of 18.2 kg ( $r=0.87$ ), which is within the range based on molar and postcranial dimensions of *Kenyapithecus* calculated in an earlier analysis (17.3-36.2kg) (McCrossin, 1994). *K. africanus* bears a strong resemblance to *Pongo*, *Pan*, *Gorilla*, and *Homo* in aspects of the distal-most portion of the shaft, and to *Pongo*, *Pan*, and *Homo* in the region of the palmar radiocarpal ligament insertion. *K. africanus* is, however, clearly dissimilar to *Pongo* in the orientation of the ulnar facet. These and additional data will be used to evaluate previous claims (outlined above) regarding the functional adaptations and phylogenetic relationships of *K. africanus*.

#### **Human molar drillings in the 8<sup>th</sup> millennium B.C. Neolithics from Mehrgarh, Pakistan: First cases of dental care?**

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Dental mutilations for decorative purposes are well known archaeologically worldwide. But very little evidence is so far known of dentistry activity for therapeutic reasons in osteological assemblages. During the January-February 2000 archaeological field season of the Neolithic site of Mehrgarh, Balochistan, Pakistan, dated back to the VIII-VII millennia B.C., two permanent molars were recovered from two individuals, single primary positions, showing clear evidence of artificial drilling on their occlusal surface. Both individuals, adult males, had all their teeth still in the maxilla and mandible, including the drilled ones, despite the bad state of preservation due to soil acidity. This clearly excludes that the two teeth were ornaments hanging on necklaces or simi-

lar. The two molars (maxillary first right molar, and a mandibular first left), show a clear unfilled perforation on their occlusal surface. A SEM analysis carried out on both specimens rules out any possible natural cause for such modifications, since clear striations are visible on the borders as well on the inside of the two round cavities. Also, on the bottom of the perforations, notches due to the point of the drill are visible. An enormous quantity of perforated beads recovered in the site testifies the technical skill to produce small and perfect holes with tiny stone-point drills.

Both molars show some degree of occlusal wear, with exposure of the dentine below the enamel. Both drilling occurred on the buccal side of the occlusal surface, in areas that were no longer covered by the enamel cup. The position of the perforations, as well the teeth that were perforated, induce to exclude that the treatment was carried out for decoration since it is too back in the mouth to be visible anyway. Rather, it is likely that both molars were treated for possible dental care. The holes do not seem to be associated with any caries, even though the perforations themselves might have erased and smoothed the walls of the caries. The extremely poorly preserved bones did not allow to score any possible other oral pathology that could justify the treatments, even though one of the authors (AC) personally excavated the bones. But unless very extensive, caries are not bound to be associated with abscesses, therefore it may also be likely that no abscesses were present. Nevertheless, this case represents an important as well as one of the most ancient evidences of dentistry so far known in prehistoric populations.

#### When forensic anthropology is disturbed by population derived assumptions.

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One of the fields of biological anthropology where the notion of the population has been problematic is Forensic Anthropology. Although this science deals mainly with individual cases, in many instances it applies criteria derived from population studies. That is, characteristics which have been defined as representative of a particular population are applied to a skeleton which is really nothing more than a set of dried bones. When this is done, many assumptions are implicitly accepted, which can be problematic. This paper, using some practical cases of forensic anthropology, will discuss whether this can be done and whether there are any alternatives. Can affiliation of individual cases really be assigned on the basis of a set of characteristics derived from an entire population?

And, most importantly, how is "population" actually defined for forensic purposes? Is the set of characteristics that is used to determine affiliation based on a typological model similar to that of the ancients, or on Darwin's model of variation within a given group of individuals? (Mayr 2000 *Scientific American* July: 67-71).

#### Craniometric relationships between Paleoamericans and Archaic Indians.

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Recently, theories involving the peopling of the Americas and the genetic contribution of Paleoamericans to later Amerindian groups have been hotly debated. In both debates, craniometric studies comparing Paleoamericans to modern groups have played an important role. But, while Paleoamericans have been assessed in terms of their relationships to modern groups, their similarities to Archaic Indians have not been fully considered. In this study, we address this issue by comparing Paleoamerican and Archaic Indian crania with each other as well as with a worldwide sample of modern groups using multivariate methods.

In accordance with previous studies, our results indicate that while some Paleoamericans have a resemblance to modern Amerindian or South Asian groups, others have no resemblance to these groups. In fact, they would be considered extremely atypical members of any modern group to which they have been compared. Archaic Indians have resemblances with modern Amerindian groups, as well as with European, Easter Island, Tasmanian, and Pacific Rim populations. The relationship of some Paleoamericans to Early Archaic specimens appears to be a relatively close one, however the connection of Paleoamericans and Mid/Late Archaic specimens is more tenuous, with frequent wide divisions seen in canonical plots.

Some anthropologists contend that Paleoamericans and Early Archaic Indians were replaced or assimilated by more recent immigrants, while others argue for continuity from the most ancient Americans to modern groups. The question of exactly when the modern pattern of Native American morphology became established can help solve this debate. The Archaic specimens that most strongly and consistently resemble modern Amerindian groups appear between 3,000 and 4,000 BP, supporting the contention that immigrants ancestral to today's Amerindians arrived into the New World after the Paleoamericans were already established.

#### Effect of small home range size on use of memory.

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The ability to remember the location of resources allows many primates to minimize the distances they travel between resources. Primates living in the largest home ranges can benefit the most from reduced travel costs. For this reason, most studies of memory have focused on primates with large home ranges. The present study examines the use of memory in *Pithecia pithecia*, a species that typically inhabits small home ranges.

In this paper I discuss use of memory by a group of *Pithecia* in Guri, Venezuela during a period of relative food abundance. *Pithecia's* movements are analyzed with the help of a) a predictive computer model, b) a computer model that simulates movements and c) logistic regressions. Charles Janson created both models.

Results of data analysis support the hypothesis that *Pithecia* remember not only the location of resources, but also the productivity of resources. *Pithecia* travel to "goal resources", efficiently, as would be expected in a primate that uses memory to determine a route. *Pithecia's* choice of "goal resources", however, is surprising. *Pithecia*, on average, travel almost three times the expected distance to a "preferred resource". Their choices may be explained by the need to maintain dominance over important distant resources and to frequently monitor resources spread over their entire home range.

*Pithecia* seem to consider multiple factors when deciding on a travel destination. Because they inhabit small home ranges and have lower travel costs than primates living in larger home ranges, they do not use memory to minimize distance by traveling to adjacent resources. They are willing to travel further for resources of greater value. *Pithecia* tend to select more productive resources. They may also consider factors such as intergroup social competition and the need to monitor the phenological state of resources in their home range. *Pithecia* behavior does not reflect a simple short-term strategy of maximizing caloric intake while minimizing energy expenditure, but rather suggests a more complex decision-making process.

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#### Dental variation in Bridger B *Omomys* from the Bridger Basin, WY, and the taxonomic integrity of *Omomys carteri*.

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The middle Eocene omomyoid primate *Omomys* was one of the first North American fossil mammals identified by paleon-



tologists (Gazin, 1968). However, despite large samples of dental material, it has received limited attention from students of primate evolution (e.g. Gazin 1958, 1962). In recent years, the *Omomys* hypodigm has greatly increased, and has grown to include a significant amount of posteranial material. This in turn has resulted in the genus receiving renewed attention (e.g. Covert and Murphey, 1994; Coupar, 1996; Payseur et al., 1999; Anemone and Covert, 2000). In light of this interest, and based on an analysis of newly recovered dental specimens, I present data on the patterns of dental variation in Bridger B *Omomys* from the Bridger Basin, WY.

A series of 15 measurements was collected from a sample of 150 *Omomys* dental specimens recovered from numerous localities in the Bridger Basin. A set of 9 morphological traits was also scored for the sample. Lower molar coefficients of variation range from 4.0 for both  $M_1$  and  $M_2$  length ( $n = 69$ ,  $n = 80$ , respectively) to 6.7 for  $M_3$  talonid width ( $n = 57$ ). In terms of the morphological traits scored, including those previously discussed as diagnostic for *Omomys carteri*, none exhibit 100% presence in the sample. For example,  $P_4$  paraconids are present in 34% of the specimens ( $n = 47$ ) in the overall sample, while the same trait is present in only 17% of the specimens ( $n = 6$ ) at a single locality (DMNH 868). These CVs and trait percentages are comparable to those for both geographically dispersed and spatially restricted samples of small-bodied extant primates such as *Galagoidea* and *Microcebus*.

Therefore, based on comparison with extant samples, this analysis supports a single species diagnosis for the Bridger Basin *Omomys* sample, and concurs with the conclusions of earlier workers (Gazin, 1958; Coupar, 1996). These data also indicate that significant amounts of morphological variation can be expected in both geographically dispersed and spatially restricted fossil samples.

#### Geographic variation of skull size and shape in *Tarsius syrichta*.

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Three subspecies of Philippine tarsiers have been named: *Tarsius syrichta syrichta*, from Leyte and Samar; *T. s. fraterculus* (Miller, 1911) from Bohol; and *T. s. carbonarius* (Heude, 1898) from Mindanao. The existence of identifiable subspecies was doubted by both Hill (1953, 1955) and Niemitz (1984), and with small sample sizes, none could be established on morphometric grounds (Niemitz, 1977; Musser and Dagosto, 1987).

To test the hypothesis of systematically meaningful geographic variation within *T. syrichta*, a principal components analysis on the covariance matrix of log-trans-

formed cranial and dental variables was performed on a sample of 67 specimens of Philippine tarsiers. This analysis indicates that Davao Gulf tarsiers (Southern Mindanao) have lower PCA1 scores than Philippine tarsiers from other localities. The first principal component is often a size factor, indicating that Davao tarsiers are small. Indeed, specimens from Samar, Dinagat, and Leyte do have skulls in the upper range of values for length and for geometric mean. In addition to size, however, high PCA1 scores also indicate relatively large upper and lower first molar area in non-Davao tarsiers.

This analysis indicates that there is geographic variation in both skull and molar size and shape within *T. syrichta*. It is, however, premature to cite this as evidence for subspecies because of the small sample sizes for non-Davao tarsiers.

#### Forelimb anatomy and foraging strategy in *Leontopithecus rosalia*.

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*Leontopithecus rosalia* is distinguished by its extremely long forelimbs. Previous authors (esp. Stafford, *et al.* 1994) have associated this forelimb elongation with its extractive, manipulative foraging. *Leontopithecus* probes and sifts through leaf litter and bark crevices for concealed, non-mobile prey. While the adaptive value of elongated distal forelimb segments (e.g., metacarpals and phalanges) for manipulative foraging seems obvious, it is less clear that longer proximal elements (humerus and radius/ulna) may also be a result of this foraging strategy.

We examine the potential role of elongation of different limb and digit segments in foraging through a comparison of the morphology of *Leontopithecus* to other callitrichids, primates, and mammals, particularly other manipulative foragers. Measurements were taken of the lengths of long bones, manual ray 3, and pedal ray 4. These were corrected for body size and compared using ANOVA.

Results show the following: (1) *Leontopithecus* is unique among manipulative foragers in having elongation of all forelimb elements. (2) Forelimb dimensions actually mirror those of *Ateles*, despite their manifest differences in behavior. (3) *Leontopithecus* also appears to have elongated pedal rays. Thus, if the degree and pattern of forelimb elongation in *Leontopithecus* is indeed a response to manipulative foraging, it is a unique response. Alternatively, it may be the result of other selective pressures. The potential role of transaxial bounding and other possibilities are explored.

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#### The first-ever described intact cranial base of *Paranthropus robustus*.

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No intact cranial base of *Paranthropus robustus* has been described, thus the cranial base morphology for this species is poorly known. We present here the first complete cranial base ever recovered for this species. The specimen, SKW 18, is a moderately weathered but well-preserved cranial base recovered from the Hanging Remnant of Swartkrans in 1968 by C.K. Brain. The specimen had not been removed from its surrounding breccia, and thus it was not described. SKW 18 was recently prepared in order to examine the internal cranial fossae as well as the basicranium. After completion of preparation it is discernable that SKW 18 is from a male *P. robustus* and is most probably associated with SK 52, a male *P. robustus* maxilla with dentition. In this poster the morphology of the SKW 18 basicranium is discussed and comparisons are made with more fragmentary specimens of *P. robustus* and other early hominid taxa.

#### Are some species smarter than others? A meta-analysis of primate cognition studies in the 20<sup>th</sup> century.

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Recently, much attention has been focused on identifying domain-specific cognitive adaptations, such as enhanced spatial memory in food-caching species. In contrast, less effort has been put into investigating whether domain-general adaptations also exist, such that one taxon might be termed "smarter" than another. This lack of effort largely reflects the difficulties in persuasively demonstrating the existence of domain-general variation.

Here I tested whether there is domain-general cognitive variation in primates by conducting a meta-analysis of all relevant published studies. Within each of 10 experimental paradigms where interspecific variation has been previously documented, I grouped studies according to their procedures and the characteristics of the study subjects (e.g., only comparing subjects of similar ages and experience). I then combined the results of different procedures into overall taxonomic indices within each paradigm. Finally, using latent variable methods similar to those developed for multi-rater ordinal models (Johnson VE & Albert JH 1999. Ordinal data modeling. Springer-Verlag: New York), I tested whether taxonomic differences consistently held across paradigms.

Results indicate that taxonomic differences do indeed exist: great apes perform better than monkeys, which in turn do better than prosimians. These patterns cannot be readily explained by perceptual biases or any other contextual confound. Instead, the patterns suggest that, at least in primates, domain-general cognitive differences exist. These results help explain observed taxonomic differences in complex behavior and also may provide a foundation for comparative studies assuming a correspondence between cognition and the size of brain structures.

#### Prehistoric migrations to the Himalayas: Insights from the Y chromosome.

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To trace the origin and prehistoric expansions of the Sino-Tibetan speaking populations and especially for understanding the peopling of the Himalayas, we studied 19 biallelic polymorphisms and 3 microsatellite markers on the Y chromosome in 31 indigenous Sino-Tibetan populations from East, Southeast and South Asia. Haplotype distribution and age estimation using the microsatellite markers outline an interesting picture of Sino-Tibetan expansion. Our results are consistent with historical records and literatures on the origin of the Sino-Tibetans. We found a high prevalence of a T to C mutation at the M122 locus in majority of the populations, indicating a strong genetic affinity within the language family. Around 30,000 years ago, a population with dominant M122C Y chromosome had reached the Upper and Middle Yellow River basin. By around 6,000 to 5,000 years ago several migrations had taken place from this area, one of which occurred towards the west and then to the south of the Himalayan ranges resulting in the peopling of Bhutan, Nepal and Northeastern India. Lately, after having a substantial admixture with a population with YAP+, possibly from Central Asia/Southwest Siberia, one branch entered the Himalayas and expanded all across Tibet.

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#### Crushing seeds and gouging-trees: the impact on mandibular and zygomatic arch strengths.

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Different feeding behaviors result in different mechanical loads and magnitudes of stress imposed on the masticatory system. The primary goal of this study was to investigate the relationship between feeding behavior and bending strengths of the mandible and zygomatic arch in different species of New World monkeys. We hypothesized that feeding behaviors involving high *posterior* loads would rely heavily on the masseter muscle, and that mandibular and zygomatic strength would be highly correlated. In contrast, we expected that feeding behaviors involving high *anterior* loads would rely more on the temporalis muscle, and that mandibular and zygomatic strengths would be less highly correlated.

Four species of New World monkeys were examined: two pitheciines with high posterior-load feeding (*Chiropotes satanas* and *Pithecia pithecia*) and two callitrichines with high anterior-load feeding (*Callithrix penicillata* and *Saguinus fuscicollis*). From each species, three males and three females were examined. Cross-sectional properties of the zygomatic arch (including the section modulus) were calculated using caliper measurements and a solid beam model. Mandibular properties were calculated from CT scans (scanner donated to NMNH by Siemens Medical Systems) taken between M1/M2 and analyzed using NIH Image, which derived section properties from internal and external borders.

Our results indicated that there was an isometric relationship between mandibular and zygomatic strength from the smaller, anterior-loading taxa to the larger, posterior-loading taxa, but little correlation between these variables within either group. However, among the posterior-loading pitheciines, we found that *Pithecia* had significantly greater zygomatic strength proportional to mandibular strength than *Chiropotes*. We attribute this finding to the greater average and maximum crushing forces in food items utilized by *Pithecia*, relative to *Chiropotes*, as reported in the literature, resulting in greater use of the masseter muscle. Among the anterior-loading callitrichines, we found that *Callithrix* had significantly greater mandibular strength relative to zygomatic strength than *Saguinus*. This may be explained by the greater anterior loads produced by tree-gouging in *Callithrix*, relative to the more insectivorous *Saguinus*, and the associated reliance on the temporalis muscle rather than the masseter. We suggest that relative mandibular and zygomatic strengths may distin-

guish different magnitudes of loading in both anterior and posterior-loading feeding behaviors.

#### Wolff's Law in sheep's clothing: limb joint response to experimentally induced mechanical loading.

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Is Wolff's Law—the principle that bones adapt to their mechanical environments—applicable throughout the skeleton? Wolff's Law is often evident in long bone shafts, where mechanical loading causes significant changes in cross-sectional geometry. But how does Wolff's Law apply to joints, whose size and shape are more static during ontogeny? Understanding joint responses to mechanical loading is important, because joint size and shape are often used to reconstruct body mass and positional behavior in fossil species, including hominins. Joints undergo widely varying degrees of stress, depending on their size and the forces applied, and it is reasonable to ask whether these variations are reflected in aspects of joint morphology.

This study tests the hypothesis that mechanical loading causes changes in joint morphology by comparing articular surface area and internal trabecular structure in joints of exercised and sedentary sheep of different ages. Bone growth during the experiment was labeled with fluorochrome dyes. If epiphyses respond dynamically to loading, then the joints of exercised animals should have larger external articular surfaces and/or more internal trabecular bone growth than those of controls.

Internal trabecular growth was evaluated using serial histological sections to measure rates of growth ( $\mu\text{m}/\text{day}$ ) in functionally comparable trabecular struts. External articular surface area was measured using digitized latex casts. Where appropriate, measurements were standardized by body mass.

Non-parametric analyses (Mann-Whitney U tests) indicate that there are no significant differences in metatarsal articular surface area between the exercised and control groups in response to exercise. However, juvenile sheep in the exercised group have significantly ( $P < 0.05$ ) higher rates of trabecular bone growth than do controls. These results indicate that Wolff's Law is reflected in joint morphology through changes in trabecular dimensions, but not in articular surface area. Since even moderate exercise causes significant changes in trabecular bone growth, trabecular bone size and shape may be useful indicators of activity levels and patterns in an individual.

### **Ranging behavior and foraging ecology of lowland woolly monkeys (*Lagothrix lagotricha*).**

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Primate behavioral ecologists have long been interested in how ecological variables influence ranging patterns. Numerous studies have shown that for a given species range sizes are typically larger, and day range lengths longer, for groups living in low quality habitats, a pattern that presumably results from gross differences in food availability between habitat types. Conclusions about how ecological conditions influence ranging behavior within the same social groups over time are not so straightforward. The few empirical studies that have examined ranging behavior in relation to temporal changes in food availability have failed to find a consistent pattern. In some species, animals seem to increase their foraging efforts during periods of scarcity-ranging farther each day and visiting additional food patches-while in other species, individuals instead opt to minimize energy expenditure by ranging less.

I studied the ranging behavior and range use patterns of a population of lowland woolly monkeys living in the Amazon region of eastern Ecuador and examined how these were related to seasonal changes in food availability. In this population, home range sizes and the degree of home range overlap between adjacent groups were smaller than has been reported for woolly monkeys elsewhere in their geographic range, while day range lengths were longer and population density was much greater. During periods when ripe fruit-the principal component in the diet-was most scarce, woolly monkeys neither allocated additional time to movement nor increased their travel rate, either of which could have allowed them to visit more food sources each day. Rather, woolly monkeys visited fewer feeding trees during periods of resource scarcity but spent more time in each of those trees. This suggests that woolly monkeys seek to minimize energy use during periods of low food availability, a suggestion consistent with other aspects of their foraging ecology.

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### **Deterioration of health and early agricultural dependence in southern coastal Peru.**

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It is widely accepted that agricultural dependence occurred along the southern Peruvian coast by the beginning of the Early Intermediate Period (EIP), approximately 2200-1400 B.P. It is hypothesized that health deteriorated when people became dependent on agriculture for the majority of their calories. This paper explores the influence of an early agricultural economy on the health of an EIP skeletal population from the southern coast of Peru.

The Pisco river valley may have been under the constant control of more powerful neighbors. However, more recent research argues that the Pisco valley supplied much of the agricultural subsistence base for the population centers of the Paracas and Nazca cultures (Paul 1990). If this is true, the Pisco valley may have played a major role in south coast prehistory.

Chongos is one of the major archaeological sites in the lower Pisco valley. Ceramic sequences support two occupations at Chongos, dating to the EIP and the Late Intermediate Period. For this paper, I will discuss a skeletal series from the EIP occupation (n=55). Dental health and phytolith analysis indicate reliance on maize. Seasonal variation in diet will be established by trace element analysis of serial sections of abundant hair in subsequent research. The strenuous activities associated with agriculture were evident in the vertebral column and joints. Overall community health is estimated using non-specific indicators of stress. Taken together, these data demonstrate that the Chongos skeletal population was fully dependent on agricultural resources at the beginning of the EIP. In addition, comparison with pre-agricultural skeletal populations from the central coast of Peru indicate that the community health at Chongos may have declined with increased reliance on agricultural resources.

### **Maxillary sinusitis as related to dental infection.**

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In 1984, The Monroe County Parks Department in the Highland Park section of Rochester, New York, unearthed human skeletal remains while expanding a public facility. It is believed the cemetery was associated with the Monroe County Poorhouse, in use from approximately 1826 to 1855. As part of an ongoing investigation to assess the general health of this nineteenth century skeletal population, maxillary sinus infections were studied to determine the relationship between dental health and maxillary sinusitis.

Maxillary sinuses are the largest of the air sinuses and are commonly affected by infections of the upper respiratory tract such as the common cold. However, they may also be affected by dental infections,

e.g. caries, abscesses, and periodontal disease. Given the close proximity of the roots of the maxillary molars to the floor of the maxillary sinus cavity, dental infections may contribute to the incidence of maxillary sinusitis.

The maxillary sinuses of 103 skeletons were examined for evidence of infection. Each sinus was scored as healthy, pitted, spicular, or remodelled spicules based on a method developed by Boocock et al. (1995). The degree of bone remodelling was graded from healthy to severe. The incidence, location, type, and extent of dental infections were also recorded.

The percentage of individuals exhibiting bone remodelling in the maxillary sinus was 55%. Maxillary sinusitis was observed in 63% of the males and in 55% of the females. Dental infections were observed in 58% of individuals. Infections were seen in 84% of the males and in 72% of the females.

In comparing the two, it was found that a strong positive correlation existed between the incidence of sinusitis and dental infection. The relationship between maxillary sinusitis and dental infection is consistent with that reported in the clinical literature.

### **Cross-sectional geometry and biomechanics of the mandibular symphysis in Middle and Late Pleistocene *Homo*.**

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Based on biomechanical studies of extant great ape and human mandibles, Daegling (1993) hypothesized that decreased wishboning stress at the symphysis in conjunction with maintained levels of vertical bending stress was important in the origination and evolution of the human "chin" or mentum osseum. The purpose of the present study is to test this hypothesis using a large sample of fossil hominid mandibles spanning the Middle and Late Pleistocene, the time period during which the mentum osseum evolved.

32 mandibles (9 Middle Pleistocene hominids, 13 late archaic humans, and 10 early modern humans) were scored for mentum osseum expression on a five-point ordinal scale. Second moments of area ( $I_x$  and  $I_y$ ) were calculated from cross-sectional contours of the symphysis using a 2-D digitizer and program SLICE. Least squares regressions of  $I_x$  and  $I_y$  on the appropriate moment arm estimate for each (bi- $M_2$  arch width for  $I_x$  and mandibular length for  $I_y$ ) were performed following transformation of all data to natural logs. Finally, differences in relative stress patterns between fossils grouped according to mentum osseum expression and sample affiliation were assessed separately by means of ANOVAs with residuals as data.

There are no significant differences in

symphyseal rigidity against vertical bending or wishboning stress in hominid mandibles through the Middle and Late Pleistocene, given either mentum osseum expression or sample affiliation. This result supports one aspect of Daegling's hypothesis (the maintenance of vertical bending stress levels), while refuting the other key element (decrease in wishboning stress levels). From this, we conclude that factors other than facial/mandibular proportions and/or habitual bite force levels were important in the origin and early evolution of the "chin."

**A view from the coast of ancient Maya childhood health: Marco Gonzalez and San Pedro, Belize.**

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Living on Ambergris Caye, off of the northeastern coast of Belize, the Postclassic Maya inhabitants of Marco Gonzalez and San Pedro hosted centers of maritime trade in Central America. Both sites had strong cultural ties to the inland ceremonial center of Lamanai, yet little is known of how coastal living may have affected the health of their occupants. This paper uses evidence of linear enamel hypoplastic (LEH) defects to evaluate whether juvenile health at these coastal sites was experienced differentially compared to other Maya centers located on the mainland.

An examination of 81 individuals and 1236 teeth from Marco Gonzalez and San Pedro indicated that juvenile health at these sites was relatively good by ancient Maya standards. Eighty-three per cent of individuals at these sites manifested LEH defects of the permanent dentition, a comparatively low ancient Maya value. The fact that these coastal sites share a lack of sex and age-at-death differences, as well as a similar age of peak LEH formation with mainland sites helps to narrow down the key factors influencing the appearance of better juvenile health along the coast. Evidence regarding the ethnohistory, archaeology, palaeopathology, stature, and diet of these skeletal samples support the LEH data discussed here.

As suggested by the LEH data presented, and despite sharing cultural norms with their mainland trading-partners, something unique to the coastal environment benefited childhood health on the Cayes. Possible factors (e.g. marine diet) influencing juvenile health along the coast will be discussed in the hopes that regional variation and adaptation to coastal environments will be better understood for Maya groups just prior to Spanish contact.

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**Ulnar shaft curvature in early hominids.**

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The complete *A. afarensis* ulna, A.L. 438-1, appears relatively straight while other early hominid ulnas, such as L40-19 and OH 36, appear curved. An anteroposteriorly straight ulnar shaft is often cited as a derived trait for hominids, an interpretation that probably results from the observation that modern *Homo* has a relatively straight shaft compared to that of other African apes. Asian apes are also often described as having a straight shaft. This study has two objectives. First, to establish if ulnar shaft curvature correlates with locomotor mode among extant hominoid species. Second, to compare variation among the fossils to that of extant species in order to test the significance of that trait in assessing the fossil's locomotor mode.

Alternative methods of measuring curvature and controlling for size can yield different results. Curvature, when measured as the maximum distance from the anteroposterior mid-point of the shaft to a line drawn between the proximal and distal articular surfaces of the ulna (AC), is partly a function of the anteroposterior shaft diameter. This dimension varies greatly in humans due to the variable size of the interosseous crest. For this reason, curvature measured on the dorsal edge of the shaft is preferred (DC).

When controlled for size, DC is smaller in humans than in the suspensory species. Quadrupedal cercopithecoids also appear to have relatively straighter ulnas than suspensory species. The three hominid specimens studied all fall in the suspensory group, with A.L. 438-1 lying closest to the human distribution. AC does not differentiate species or locomotor groups as well since their distribution all overlap to various degrees.

The coefficient of variation of the three fossils considered is compared to bootstrapped samples generated from extant species samples. This shows that, as a group, the three fossils are not more variable than any hominoid species studied. This suggests that although it appears dramatic, differences in shaft curvature as observed in these early hominids could be accommodated within a single species.

**Mortuary patterning and skeletal health at Town Creek, a South Appalachian Mississippian community.**

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The purpose of this research is to describe and interpret the relationship between social rank and health in a large,

late prehistoric community. Spatial analysis of structures containing burials at the palisaded single-platform mound and village site of Town Creek (Mg2 and Mg3) on the Piedmont of North Carolina reveals a pattern of increasing internal segregation of elite burials. Early burials predating the building of the mound, those in the vicinity of the earth-embanked lodge, and several other spatial clusters of burials contain few artifacts. Beginning with the construction of the mound and culminating with the creation of at least one internal screened area within the palisaded village, several areas of the site were reserved for the burial of elites while non-elite individuals were buried in groups in the floors of houses. Patterns of the spatial distribution of artificial cranial deformation and artifacts of exotic materials further supports that these areas were distinct.

The sample consist of 256 skeletal individuals. The following attributes were analyzed: dental caries, linear enamel hypoplasia (LEH), cribra orbitalia/porotic hyperostosis (CO/PH), cranial and postcranial trauma, periostitis of the tibiae, and artificial cranial deformation. This analysis revealed that overall, the inhabitants of Town Creek exhibit a high prevalence of LEH, tibial periostitis, and CO/PH compared to other Mississippian sites. The results for each spatial cluster reveal patterns of differential health and nutrition within the site. Many of those identified as elite did not exhibit lower rates of infection, malnutrition, or trauma.

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**Is eight enough? A comparison of eight aging methods on a juvenile skeletal sample from the Dakhleh Oasis, Egypt.**

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The determination of age at death for juveniles in osteological and forensic studies is based on an understanding of child growth patterns. Recently, the necessity of utilizing population specific standards for estimating age at death has become increasingly apparent. One of the difficulties with this is that specific standards do not exist for every population. Comparisons of standards to estimate dental age and age estimates based on long bone lengths can help to determine if existing aging standards are appropriate.

This study reports the preliminary results of the comparison of dental and long bone age estimates from a sample of juve-

niles from the Dakhleh Oasis, Egypt. The individuals were excavated from the Kellis 2 cemetery, dated to the Roman Period (ca. AD 100-450). One standard was used to determine age based on dental eruption, two standards were used to determine age based on dental formation, while five standards were used to determine age at death using long bone lengths.

Preliminary results suggest minimal differences in age estimations based on different dental criteria. There is, however, discordance between dental estimates and ages estimated from long bone lengths. Most of the ages derived from long bone lengths consistently under-age individuals in comparison to their dental ages. Of all the methods used to determine age from long bones, standards based on ancient Slavic and Anglo-Saxon populations provide the closest approximations of age. These preliminary results speak to the necessity of developing unique standards for the estimation of age at death for this population.

#### **Metaphyseal angular morphology and primate locomotion.**

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The growth plate of mammalian long bones serves as the site for all longitudinal growth and bone modeling. Mechanical stress in the local environment can alter bone shape by differentially stimulating cells of a single growth plate, thereby laying down bone in specific parts of the metaphysis (bone in direct contact with the cartilaginous growth plate). To test the hypothesis that differences in behavior (e.g. habitual posture and limb use) are reflected in metaphyseal morphology, angular measurements and linear morphometrics were taken from juvenile skeletal material of behaviorally and phylogenetically divergent primates ( $n = 23$  individuals of Ceboidea,  $n = 43$  Cercopithecoidea) representing different locomotor categories (terrestrial quadrupeds, arboreal quadrupeds, suspensory species). Samples were obtained from the AMNH, the Field Museum, and the Smithsonian. Metaphyseal angles were recorded in the anteroposterior and mediolateral planes. Linear measurements were used to determine size and shape parameters of the skeleton. The anteroposterior inclination of the distal femoral metaphysis is significantly greater in cercopithecoid arboreal quadrupeds than in ceboid arboreal quadrupeds ( $t$ -test  $p < .001$ ). These differences are observed throughout ontogeny regardless of size. Additionally, among cercopithecoids, locomotor groups (arboreal quadrupeds, terrestrial quadrupeds, and suspensory species)

display significantly distinct AP angulation of the distal femoral metaphysis (ANOVA  $p = .035$ ). The difference in orientation between these groups may, in part, reflect differences in gait and/or positional behavior between them - a more bent-kneed gait would require a more posteriorly inclined distal femoral growth plate to minimize shear across the plate. Results of this study demonstrate important relationships between locomotion and juvenile metaphyseal spatial orientation that may prove useful in the interpretation of fossil specimens.

This research is supported by grants from the Leakey Foundation, Sigma Xi, American Museum of Natural History, and Kent State University GSS.

#### **Is the fetus from Elizabeth Mound 3, Lower Illinois River Valley an achondroplastic dwarf?**

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A Middle Woodland fetus was recovered from the Lower Illinois River Valley in a burial with a female achondroplastic dwarf. It is highly likely the fetus came from the adult female; however, barring genetic testing this is not a certainty. Achondroplasia is an autosomal dominant disorder. It usually results from a new mutation; however, it is possible to pass between generations. Unfortunately, prior to the advent of the cesarean section procedure, a female achondroplastic dwarf would not have been able to give vaginal birth due to the malformation of the pelvis.

Burgess (1989) suggested that, based on morphological characteristics like metaphyseal flaring and rhizomelia, it is highly likely that the fetus was also an achondroplastic dwarf. She did not attempt a differential diagnosis of the fetus's condition. Few cases of achondroplastic dwarfism have been recovered in the archaeological record and there are no examples of achondroplastic infants.

This paper presents the results of metric observations used to test the hypothesis that the fetus is outside the range of normal variation for this time period and geographic area. The fetus was compared to a "normal" infant sample ( $n=46$ ) ranging in age from 8 fetal months to 3 years and from roughly the same geographic area and time period. Small sample sizes were available in each age category; therefore, 26 ratios were compared using a  $z$ -score. Twelve of the 26 ratios indicated that the fetus was significantly different from the "normal" sample. These include ratios that described the shortened basioccipital, a normal diaphysis diameter in contrast to a shortened diaphyseal length of the bone relative to its normal diaphyseal diameters, and rhizomelia of the long bones.

These results support the hypothesis that the fetus is outside the range of normal variation in terms of the size and shape of the long bones and basioccipital and may be an achondroplastic dwarf. However, a differential diagnosis is necessary to rule out other diseases (e.g., metaphyseal dysostosis or rickets) or skeletal dysplasias before definitive conclusions may be drawn.

#### **Hominid phylogeny: morphological and molecular measures of diversity.**

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During the century following publication of Darwin's *Origin of Species*, 10 or more taxa of fossil hominids commonly were recognized, with the numbers of genera and species ranging to as high as about 14. Surprisingly, given the great advances made over the last several decades in numbers of known fossil hominid specimens, abundance of comparative morphological data available on extant nonhuman primates, and extensive analyses of genetic variation, the present situation accepted by some paleoanthropologists appears to be one of conceptual stasis.

The last fifteen years have encompassed a systematic program of genetic distance studies among numerous groups of large mammals, with much of the work having been carried out by Stephen O'Brien and his colleagues. These data provide a context for testing hypotheses about the numbers of hominid taxa that might have existed over the past several million years. A baseline is established by the genetic distance between extant humans and common chimpanzees ( $D = 0.244$ ). If this distance is apportioned among 14 hypothetical hominid taxa, the average estimated distance among hominid groups would be less than the distance between Bornean and Sumatran orangutans ( $D = 0.025$ ), which interbreed freely. Even if the distance between extant humans and common chimpanzees is subdivided among only 5 taxa, a number of species commonly postulated to be on a direct line from the common ancestor of hominids and chimpanzees to extant humans, the estimated distance among hypothetical hominid taxa is less than half the genetic distance between lions and tigers ( $D = 0.121$ ), which also are interfertile.

If other mammalian groups provide a valid general standard, then the large numbers of hypothetical hominid taxa recognized on morphological grounds cannot have differed from each other very much in genetic terms, raising questions about the nature of relationships among hominid populations. Conceptually, a shift away from formal taxonomy would coincide with the increasing recognition that several

important attributes of species (such as morphological distinctiveness and genetic isolation) very commonly do not coincide.

**A possible regulatory role for a cluster of Alu repeats found within the first intron of the gene encoding the human L1 cell adhesion molecule.**

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We have identified an unusual cluster of Alu repeats within an important regulatory region of the human gene encoding L1, a cell adhesion molecule that is critical for neuronal fasciculation and axon pathfinding. Mutations in the L1 gene are associated with the CRASH Syndrome, a suite of pathologies which includes mental retardation, spastic paraplegia, hydrocephalus, and adducted thumbs. Using DNA-protein binding assays, we found that a sequence motif within the Alu cluster bound the homeodomain proteins of the orthodenticle family, OTX1 and OTX2. Given the combined observations, first, that Alu clusters can regulate specific patterns of gene expression, and second, that OTX proteins are an important class of developmental transcription factors, we are currently investigating the role of this unusual Alu cluster in the transcriptional regulation of the human L1 gene using cellular cotransfection experiments. In addition, we are performing PCR-based analyses across a number of primate species to determine if species-specific differences exist within this Alu cluster. Finally, we are examining the functional significance of such differences in the transcriptional regulation of L1 across primate species.

**Population extinction and recolonization in human demographic history.**

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A primary objection, from a population genetics perspective, to the multiregional model of modern human origins, is the small effective population size suggested by genetic data. A variety of genetic systems consistently yield estimates of effective population size on the order of 10,000. Although the relationship between effective size and census size is complex, effective size is often equated with the number of breeding individuals, and it has been argued that 10,000 breeding individuals could not have occupied much of the Old World for nearly one million years and re-

mained a cohesive species via gene flow. However, this argument is not valid if population extinction is considered. Using a model of population extinction and recolonization and applying parameter estimates taken from the ethnographic literature, we show that a large census size is consistent with an effective size of 10,000 if the extinction rate is relatively high, the migration rate low, and the colonization process involves a small number of colonists or kin-structured migration. We also speculate that the late Pleistocene population expansion detected in mtDNA and microsatellite data is not necessarily reflecting an increase in census size - although this explanation is not mutually exclusive - but may reflect a decrease in extinction rates in the late Pleistocene.

**Visual monitoring by *Macaca fascicularis* at Padangtegale, Bali, Indonesia.**

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Visual monitoring may relate to dominance among primates who are known to have hierarchical social systems. Chance (1967) proposed that "attention structure", or the amount of attention paid to and by individuals within a group, relates to rank order and social position among primates. In this study we focus on visual monitoring in *Macaca fascicularis*. Our goal is to assess what these macaques are visually monitoring and how it addresses the attention structure hypothesis.

This study was conducted at Padangtegale, Ubud, Bali, Indonesia, on three groups of long-tailed macaques (*Macaca fascicularis*) totaling approximately 132 individuals during the months of June and July in 1999 and 2000. This site is located in an area of very high human density.

A total of 842 hours of behavioral data were collected. Both male and female macaques visual monitor other macaques significantly more often than they do humans ( $\chi^2=125$ ,  $df=1$ ,  $p<.05$ ). Adults monitor sub-adults and juveniles more than expected, and infants less than expected ( $\chi^2=26$ ,  $df=2$ ,  $p<.05$ ). Both male and female adults visual monitor adult males significantly more than adult females ( $\chi^2=53$ ,  $df=1$ ,  $p<.05$ ).

Even though humans are prominent at this forest site, these macaques pay more visual attention to conspecifics, and do not differentiate between the different human groups (Balinese, tourists, and researchers).

These results neither support nor refute the attention structure hypothesis. It may be that sub-adults and juveniles are

receiving more visual attention because they are often more active and louder than adults. Our results suggest that the behavior of visual monitoring relates to both the social hierarchy and activity patterns.

**A simple reason why Neanderthal ancestry can be consistent with current DNA information.**

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There is strong fossil evidence, that Neanderthals are among the ancestors of modern Europeans. However, in genetic studies, it seems that all, or almost all, Neanderthal genes have disappeared in today's population (a candidate for an exception being genes related to cystic fibrosis). One explanation for this apparent contradiction is that the Neanderthal population was small, so when mixed with a much larger population only a small proportion of the genes in the mixed population were Neanderthal genes. Together with the effect of genetic drift, there is a fairly high probability that, i.e., all Neanderthal mtDNA has disappeared in today's population.

Here we will suggest a different explanation for the apparent disappearance of most Neanderthal genes: Reproductive instabilities between different regions, which lead to migrations of people. If, in a region, every mother has, on average, less than two surviving children, then population size may be kept up by migration into the region and genes neutral to selection will disappear at an exponential rate. Over time this will be much faster than disappearance by genetic drift, even if that effect is combined with the mixing of a large and a small population. Many cities provide examples of regions at a reproductive disadvantage. It is reasonable to assume that Europe - with several major climate changes taking place - has been at a reproductive disadvantage for parts of the last 40000 years. We propose that explains the disappearance of most Neanderthal genes in today's population. But it is an ongoing process that effects genetic variation in later populations as well. Thus, we also propose the same process explains the fact that most of the current European gene pool is Neolithic in origin. We show that the natural phenomenon of reproductive instabilities between regions also provides alternative interpretations of other parameters in population genetics - like Tajima's D.

**Sex typing of primate field samples by amplification of the nuclear gene amelogenin.**

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The ability to identify the sex of individuals from non-invasive samples can be a powerful tool for field studies. It can often be difficult to identify the sex of primates in the field because of subject inaccessibility, lack of habituation, or the absence of morphological cues. This information can be essential in determining, for example, sex differences in diet.

Amelogenin, a nuclear gene proximate to the pseudoautosomal region of the X and Y chromosomes of mammals, has a 6 base pair size difference in humans that can be PCR-amplified using published human primers; the product can then be sized to distinguish male from female DNA. The location of this gene rarely allows for recombination, and therefore this sex-specific difference is conserved. These primers also allow for a positive control in a single PCR reaction, which is more efficient than existing primers that amplify loci specific to the Y-chromosome for the purpose of sex identification.

We examined whether these primers can be used to identify sex from different DNA sources across 10 nonhuman primate taxa. We were able to amplify extracts from hair and feces, as well as from more invasive samples, and the results were successfully used as a diagnostic sex test for five of the 10 nonhuman primate species tested. These included all three great ape species tested, one of three Old World monkey species tested, and one of three New World monkey species tested. The results of this study indicate that this test can be used as a diagnostic tool to identify sex across a range of primate taxa, using a variety of biological materials.

#### **Why Cupa Ectocranialis Eburneum (CEE) and not Button exostosis (BtE) or Button Osteoma (BtO)?**

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The present study investigates in detail a lesion on the cranial vault, known as button osteoma (BtO). The frequency of BtO is similar in modern (37.6%) and archaeological (41.1%) populations, in blacks and whites and in males and females. The frequency of BtO rises from infancy to early adulthood, and remain constant thereafter. The majority of skulls with button osteoma (64.1%) had only one button osteoma, 20.4% had two and 15.4% had multiple button osteomas. Microscopically,

BtO is composed of well-organized dense lamellated bone, poorly vascularized with very few osteocytes. It forms a dome-shape roof to an underlying diploized area. As this structural pattern differs from that of exostosis or osteoma, and considering its unique nature (hamartoma), and demographic characteristics, we suggest a new name for this disorder: Cupa Ectocranialis Eburneum (CEE). Its possible etiology will be discussed.

#### **The genetic prehistory of California's Central Valley.**

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At the time of European contact, California Native Americans displayed an exceptional degree of linguistic diversity. However, this diversity is non-random. Linguistic and archaeological evidence suggests that a proto-Penutian language entered California replacing older Hokan languages between 4500 to 5000yBP in the Central Valley. Analysis of modern and ancient DNA from California Native American groups has been used to test hypotheses relating to the proposed entry of Penutian languages into California and the consequential replacement of older Hokan languages (the Hokan-Penutian hypothesis).

The mitochondrial DNA of Native Americans contain polymorphisms consisting of the gain or loss of restriction sites or the presence of a 9 base-pair deletion and associated control region (CR) mutations. These mutations characterize at least five distinct haplogroups (maternal lineages). Modern Native American groups differ with respect to the frequency distribution of these five haplogroups. Analysis of the mtDNA distribution in the California sample can be used to assess the Hokan-Penutian hypotheses. Additionally, a comparison with samples from the neighboring Great Basin, and the Columbia Plateau can assess the likelihood of an extra-Californian homeland for the Penutian languages.

#### **Temporal variation in prehistoric Nubian skulls.**

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Studies of the skeletal remains of Lower Nubian populations have described the *in situ* evolution of the skull from a distinctive long, low form during the Mesolithic (8,000-11,000 YBP) to a shorter, more globular form by the Christian period (1500-900 YBP). Analyses excluding the Mesolithic populations (not ancestral to the later groups [Irish, 1993]) and starting with the A and C Groups (5400-3200 YBP) still support this directional transformation in shape.

All of these studies have dealt primarily with anterior-posterior dimensions and have pooled sexes in their analyses. Separating the sexes and adding a width dimension demonstrates a different pattern of variation between the A/C Groups and the Christians. In males there was a significant increase in skull length, a significant decrease in skull width a measurable decrease in skull height and a significant decrease in the cranial index. In females there was a measurable decrease in skull length, a measurable decrease in skull width and a significant decrease in skull height. The overall trend was not to a shorter, rounder skull but to one that was actually longer and narrower.

During the A/C to Christian period there were important changes in subsistence patterns along the Nile which lowered functional demands on the masticatory system and allowed a decrease in the size of its components-muscles, jaws and teeth. This led to an antero-inferior rotation of the face. The lengthening and narrowing of the skull found in this study may be associated with these changes or they may result from climatic adaptation, drift or gene flow-all possibilities which will be discussed.

#### **Genetic diversity at the FMR1 locus in 10 ethnic groups of Indonesia.**

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Indonesia is inhabited by >200 million people constituting more than 350 ethnic and tribal groups which can be classified into 2 ethno-linguistic groups; Austronesian or Malay-Polynesian (AN) and non-Austronesian (NAN) speakers. NAN speakers are restricted to the northern Halmahera (Malucca) island group that includes Ternate, Alor, Timor and the majority of West Papua. The expansion of (CGG)<sub>n</sub> trinucleotide repeat in Fragile X Mental Retardation-1 gene (FMR1) has been identified as a major factor contributing to fragile X syndrome.

One approach to understanding the origins of the Indonesian population is to study the genetic structure of alleles such as those at the *FMR1* locus and its linked microsatellites, DXS548 and FRAXAC1. These polymorphisms were studied in 1,008 unselected males from 10 ethnic groups.

Significant differences were found between the Indonesian population and other Asian, Caucasian and sub-Saharan African populations at *FMR1*, DXS548 and FRAXAC 1. Greater allelic diversity was

identified at FRAXACI and at DXS548 than previously reported for an Asian population. An odd numbered allele of DXS548 was found at high frequency in all Indonesian populations. AMOVA determined that the vast majority of the genetic variation at the *FMRI* locus in Indonesian populations occurs within populations, and that ethno-linguistic criteria and geography do not explain a significant percentage of the variance. Cladograms were derived that showed clustering of *FMRI* haplotypes in Australo-Melanesian Indonesians and Malay-Indonesians into two Glades, but with some interleaving of populations. This is the first study of genetic diversity in a large number of Indonesian populations using microsatellite loci, and our findings are consistent with the view that Island Southeast Asian populations arose from admixture of Austronesian and Australo-Melanesian groups.

#### Recent advances in the bio-archaeology of the Prehispanic Sican on the North Coast of Peru.

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Studies of well preserved human remains from central and peripheral Sican (900-1100 AD) burial contexts from the North Coast of Peru indicate that both ecological and social factors significantly shaped the health and quality of life of these people. The Sican Culture can be characterized as a prominent, state-level, Prehispanic culture that held sway over much of the North Coast of Peru. In this study we compare multiple social classes of individuals from the Sican capital with those from the more peripheral site of El Brujo in the Casma Valley.

Multivariate statistical analyses including principal components and general linear modeling have indicated that status differences are present in developmental health indicators at Batan Grande but not at the more genetically homogenous site of El Brujo. These analyses also indicate a significant reduction in non-specific indicators of stress compared to early Central Coast sites. It is likely that the prehistoric inhabitants of the North Coast of Peru were better equipped to adjust to ecological oscillations such as El Niño, due to the mosaic of available ecological zones that included fertile river valleys and marine upwelling areas. Another buffering factor may have been extensive trade networks.

#### Models of sex-specific mortality for paleodemographic analysis.

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Differentials in male and female age-specific mortality are universal in human populations. Although the detailed patterns differ across preindustrial populations, most display elevated female mortality during the early reproductive years and again during early post-reproductive life, set against a background of high overall male mortality and population-specific features reflecting differences in activity levels, occupation, and access to resources. Such differences are of fundamental importance for paleodemographic studies of morbidity and mortality. But because most skeletal samples are small, it has seemed imprudent to subdivide them by both age and sex. Thus the scope for paleodemographic analysis of sex-specific mortality has appeared to be limited.

This paper presents a parametric model of the sex differential that can be estimated from a combined sample of male and female skeletons using modifications of the Bayesian approach of Konigsberg and Frankenberg (*Am J Phys Anthropol* 89:235-56, 1992). As a basis for choosing a parametric specification, we review life-table data on the sex differential from recent studies in developed and developing countries and from historical demographic reconstructions. These data suggest that, while the details of the differential vary substantially across populations, there does appear to be a fairly simple "universal" underlying age pattern when the differential is measured as  $\ln [m_1(a)/m_0(a)]$ , where  $m_i(a)$  is the hazard of death at age  $a$  in the  $i$ -th sex (0 = males, 1 = females). We propose several model specifications to capture this pattern, with parameters ranging in number from two to five. We also show how the parameters of the models can be estimated from skeletal data by maximum likelihood.

#### Sex differences in habitat use of western red colobus (*Colobus badius badius*) in the Ivory Coast's Tai National Park.

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Habitat use is a fundamental element of primate socioecology. Virtually all aspects of behavior are integrated with or determined by how animals use their environments. While many habitat use studies have focused on either males or females, comparatively few have examined habitat use by both sexes in the same forest. Further, those studies dealing with sex differences have usually attributed variation in habitat use to body weight sex di-

morphism. Examining sex differences in habitat use in red colobus monkeys provides an interesting case study since, compared to most cercopithecids, this species is relatively monomorphic.

Data on male red colobus monkeys were collected in the Ivory Coast's Tai National Park from June to September 2000. Data on female red colobus were collected by WSM on the same social group from June 1993 to August 1994. We used an instantaneous time point sampling regime at five (males) and three (females) minute intervals. On each time point we recorded the maintenance activity, stratum, absolute height, tree zone and support characteristics of each focal animal. In order to avoid temporal autocorrelation in our data, we did not sample any individual within 15 minutes of itself.

Our data suggest that habitat use in male and female red colobus monkeys at Tai differs in a number of fundamental ways. For example, we determined that female red colobus are less likely to be found in tree zones exposed to aerial predators than are males (7.2% vs. 36.7% of total observations). These results are discussed within the context of other aspects of red colobus behavioral ecology including anti-predator strategies, activity budgets, nutrient requirements and social behavior.

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#### Late Pleistocene North American biogeographic zones, linguistic differentiation, and the origin of Native American genetic diversity.

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Genetic diversity among Native North Americans at European contact reflected both the processes of initial colonization of the continent and subsequent microevolution. Similarly, linguistic distributions developed by analogous historical processes.

Rogers, Martin and Nicklas (1990) have pointed out the correlation between several North American language families and late glacial biogeographic zones. Founding language communities would have entered the continent along the coast and occupied unglaciated areas prior to the end of the Wisconsin, only expanding to their later ranges with the retreat of the ice.

This scenario has markedly different implications for Native American genetic diversity from the long established view that settlement occurred in a wave of rapid expansion across the entire continent. The 'Blitzkrieg' colonization model implies extreme local differentiation with overall loss of continental genetic diversity resulting from repeated founder effects. In contrast, isolation imposed by glacial barriers would have promoted both linguistic and genetic



differentiation over broader regions and maintenance of continental diversity.

The aim of this paper is to evaluate these contrasting models through computer simulation. A previous model of coastal colonization is extended to include colonization of interior refugia, isolation, and expansion to post-glacial ranges. Simulation results from this model are congruent with evidence of substantial local and continental genetic variation.

#### **Greater sciatic notch variation between American Indians and Whites.**

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The purpose of this research is to determine whether or not any significant variations in the greater sciatic notches of White males exist and thus establish the utility of the greater sciatic notch as an accurate skeletal marker of both race and sex. The motivation for this research came from a 1995 *American Journal of Forensic Sciences* article where Gill noted that approximately half of the White male skeletons he observed showed a wider, more female-like notch. The two sample populations for this study came from the University of Wyoming's human remains collection and from the Maxwell Museum of Anthropology's documented collection at the University of New Mexico. A total of 143 individual specimens were measured. The samples included 38 Plains Indians and 105 Whites. By establishing the sex differences of the Plains Indian sample and comparing to those of the White sample, significant variations in the notch widths of White males are apparent. More than half of the White male notch widths are well within the width range established by the Plains Indian and White females. Therefore, the variation in the notches of White males is a useful osteological characteristic for distinguishing Whites from Plains Indians, for at least half of all cases. Further study with additional populations is needed before the forensic utility of the greater sciatic notch can be fully described.

#### **Fluctuating asymmetry and aggression in an American Indian population.**

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Fluctuating Asymmetry is normally distributed deviations from perfect symmetry in a bilaterally expressed trait. Fluctuating Asymmetry has been linked with "fitness" in a wide range of species and recently been correlated with aggression in human males but not in human females. In this paper I describe a study designed to test this association between relatively high aggression in human males and less Fluctuating Asymmetry in a prehistoric

American Indian population. High aggression is measured through achieved status in a society where warfare and aggression are believed to be valued and the most significant contributor to high status. Specifically I measured the Fluctuating Asymmetry of a series of skeletal traits on adult males of a well-studied Oneota burial population, Norris Farms, and compared the results with status indicators in the form of burial goods.

#### **Female strategies to reduce sexual coercion in the Sumatran orangutan, *Pongo pygmaeus abelii***

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Orangutan social organization is characterized by an operational sex ratio strongly skewed toward males. Male-male competition and solitary ranging habits create a social environment in which intersexual mating conflict may inflict costs on females. This study examined the costs of mating conflict for female Sumatran orangutans and counterstrategies that females employ to reduce these costs. Research was conducted from 1994-1996 at the Suaq Balimbing Research Station, Indonesia.

Subadult males forced females to participate in consortships for up to one week. Most forced copulations by subadult males occurred in the context of these forced consortships. Females in forced consortships incurred energetic costs as measured by foraging efficiency. Costs were highest during periods of low food availability. Rates of harassment varied in relation to the local abundance of subadult males and female reproductive state, with potentially cycling females receiving the preponderance of harassment.

Females employed different strategies to attempt to reduce harassment. Direct resistance was usually ineffective. Females effectively sought protection by initiating spatial proximity to an adult male, which provided a significant reduction in the success rate of subadult male mating attempts. Females sought protection from resident and non-resident adult males and did not invariably mate with the protecting male, suggesting that adult female/adult male associations serve a dual function: (1) mating opportunities between the associating pair and (2) protection for the female.

These results demonstrate that females strategize to reduce the costs of intersexual conflict, particularly by seeking protection from adult males. As such, females receive direct services from some males. The influence of direct services on female mate choice is discussed.

#### **An ongoing study of the female copulation call in long-tailed macaques (*Macaca fascicularis*)**

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Previous studies examining the female copulation call of different nonhuman primate species have resulted in several hypotheses proposed to explain the function of this call. Females may call to: 1) synchronize orgasm with the male, 2) reduce harassment of the caller by other females, 3) alert dominant males who in turn displace subordinates, and 4) promote sperm competition. The goals of this project are to further test these functional hypotheses and to add to the database of male and female long-tailed macaque (*Macaca fascicularis*) behavior patterns surrounding the female copulation call.

Data were collected at the Padangtegal Monkey Forest in Bali, Indonesia during the months of June and July in 1999 and 2000. The behavioral patterns of 13 adult males and approximately 50 females from three troops were recorded and scored in one of six categories. Out of 376 copulations where the presence and absence of calls was noted, females called 75.3% of the time. The first hypothesis suggests a correlation between male ejaculation and female calling. Ejaculation occurred in 45.9% of the copulations, however results do not show that males ejaculated more often when females called. There also was no significant difference between females calling with adult males compared with subadults and juveniles, and no consistent correlation between male rank and female call. These results fail to support hypotheses 3 and 4. With only four cases of aggression to the caller by other females in two data collection seasons, the second hypothesis is difficult to test.

With failure to support at least three of the four functional hypotheses, results of this ongoing study suggest further research into aspects of the female copulation call as a physiological and/or situational response to copulation.

#### **A mtDNA perspective on Austronesian and Papuan relationships in the Pacific.**

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We are carrying out an intensive survey of mtDNA variation in New Guinea and Island Melanesia, areas of notoriously high genetic variability. To date, the mtDNA haplogroup diversity in the region is consistent with the following scenario of ancient migrations:

1. A series of human movements into the region of considerable time depth (perhaps as old as 30,000 years), suggested by a few distinctive haplogroups in restricted regions in the eastern regions of New Guinea and Island Melanesia;

2. An old population expansion within New Guinea and adjacent regions, perhaps associated with the Trans New Guinea phylum of languages;

3. A more recent introduction into the region of an Austronesian language-associated mtDNA haplogroup, that is also present elsewhere in Asia, the New World, and Polynesia. The "Polynesian motif" forms a part of this haplogroup, but its variation within Island Melanesia and New Guinea is more extensive and suggests complicated migration patterns there.

#### Assessing the effects of artificial cranial deformation using Elliptic Fourier Analysis.

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Artificial cranial deformation is known to have been a widespread cultural phenomenon throughout the world. Although the question of how intentional reshaping of the cranial vault modifies the architecture of the whole skull and in particular the face and the base has been frequently addressed with various metric approaches, including standard linear as well as Finite Element techniques, the resulting observations remain in part controversial.

The present study compares samples of intentionally deformed and undeformed human crania using Elliptic Fourier Analysis (EFA). This method appears to be particularly appropriate for the given purpose of characterizing the shape of 2D cranial outlines and associated shape change. The results of canonical discriminant analyses, using Fourier coefficients as variables, confirm previously observed basicranial flattening in case of circumferential deformation, together with an increased anterior and inferior facial projection. Antero-posterior deformation, on the other hand, appears not to be subject to the same morphological effects. Our observations show that basicranial flexion tends to remain stable in this type of deformation, or even to increase in this group, whereas facial

projection shows a slightly different pattern from what is seen in circumferential deformation. While differences between our results and previously published studies can also be related to differing analytical designs, such as sampling with regard to geography or measuring basicranial flexion, it is argued that the common classification of deformation types as well as the use of conventional metric approaches to questions of shape variation are not satisfactory.

#### New fossil Cercopithecidae from the Early Pliocene site of Aramis in the Middle Awash Valley, Ethiopia.

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The Middle Awash Research Project has collected a large sample of fossil cercopithecids from the Aramis, Kuseralee, and Sagantole drainages in the Awash River Valley, Ethiopia. This sample is from the Sagantole Formation between the Gaala Tuff Complex (GATC) and the Daam Aatu Basaltic Tuff (DABT) which, have been radiometrically dated to  $4.39 \pm 0.03$  and  $4.39 \pm 0.05$  Ma respectively (Renne *et al.*, 1999). The size of the sample, precision of the age, and limited time span make this one of the best-documented Pliocene cercopithecoid assemblages.

WoldeGabriel *et al.* (1994) documented three cercopithecoid species from Aramis based on a limited sample (and preliminary identifications by Delson). These included cf. *Paracolobus* sp., cf. *Colobinae* sp. "A" (*sensu* Eck, 1977) and cf. *Parapapio* sp. Based on the vastly expanded sample, craniodental material now supports the diagnosis of two distinct new species.

Of these, the cercopithecine is distinctive from other African papionins in the combination of cranial, mandibular, and dental morphology preserved. It lacks the diagnostic facial features of *Parapapio*, as well as the flattened muzzle dorsum, facial fossae and maxillary ridges of *Papio*. Moreover, it does not possess any of the derived dental and cranial specializations of *Theropithecus*.

The second species, a colobine, is larger than all modern African colobines, but smaller than the largest extinct genera of the Pliocene and Pleistocene. While it is similar in size to the colobine from Leadu, it is distinctive in its symphyseal, corporal, and gonial morphology.

This early Pliocene sample fills in a temporal gap between the terminal Miocene and later Pliocene sites and documents the existence of two new cercopithecoid taxa, increasing known diversity in the family.

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predoctoral fellowship from the Smithsonian Institution, Evolution of Terrestrial Ecosystems Consortium.

#### The behavioral ecology and distribution of long-tailed macaques (*Macaca fascicularis*) in Bali, Indonesia.

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While many studies of *Macaca fascicularis* have been conducted in captivity and on free ranging groups in Southeast Asia, the large population of these macaques on the island of Bali (*M.f. submordax* or *M.f. mordax*) remains poorly documented. Bali provides a valuable opportunity to examine an island population of nonhuman primates that has co-existed with large human populations and substantial habitat alteration for at least 1000 years. Here we report on the preliminary findings of the first three years of the Balinese Macaque Project, a collaborative investigation into macaque behavioral ecology and human-nonhuman primate interconnections.

We are currently monitoring 44 sites on Bali containing one or more *Macaca fascicularis* groups. Four of these sites are the focus of ongoing specific behavioral studies. *Homo sapiens* are sympatric at a majority of the sites and a minority also contain *Trachypithecus auratus*. Macaque behavioral and ecological profiles vary across the sites. Levels of human interaction range from provisioning and management to occasional overlap in forest use. Macaque group size ranges from 15 to 100+ individuals and site populations range from 15 to 300+ individuals. Habitat types vary from sea level scrub forest, to village temple forests, to secondary and primary rainforest, and reach into >2000m montane forests on active volcanoes.

Preliminary results indicate that tool use, such as social grooming with leaves and using sticks as nasal probes, and a range of object manipulation is present in many of these macaque groups. Assessment of intestinal parasites for sympatric humans and macaques at four sites indicate nearly identical parasitic fauna and parasite loads in both species.

We propose that the *Macaca fascicularis* in Bali exhibit adaptations to co-existence with humans such that human behavior and landscapes have become an integral component of the macaques' behavioral ecology.

#### The effect of the essentialist paradigm on health care.

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The two major perspectives used by researchers in their analyses of human groups, past and present, are the essentialist and the populational perspectives. The traditional essentialist perspective has a long history of use in medical research and health care. The more recent populational perspective is less frequently used in medical research and health care.

The essentialist perspective partitions variability into discrete groupings, arbitrarily defining the division markers between groups. While the populational perspective views variability as both a normal and necessary component of a group, not as a reason to subdivide the group.

The two major essentialist methodologies used in the medical field are the type specimen and race. Until quite recently, medical research was primarily based on the type specimen of the "average man," defined as a 170-pound white male. Variations from this "norm" were frequently viewed as deviations.

A concept of biologically-valid races was not only prevalent in past medical research, but continues to be used, particularly in the search for genetic markers of disease. This persists despite comparative DNA research indicating there is less genetic variability in the entire human species than in one subgroup of chimpanzees; and that the phenotypic variability between any two humans is probably the result of less than 0.01 percent of their genes.

The result of these two methodologies of the essentialist paradigm is that over time many in the health care field came to believe that normal variation was in some way deviant if it did not occur at high frequency in white males; and that there were major biological/genetic differences between phenotypically dissimilar individuals who had been *a priori* grouped into the arbitrary categories of "races." Further, that these genetic differences explained (or would explain when the correct genes were identified) the differences in health outcomes between groups.

The effect of the essentialist paradigm on health care is that, too frequently, continuities among groups have been downplayed while variability within groups has been ignored. The result is a health care system that is less effective than it could be.

### Modeling the birth weight distribution: Additive versus multiplicative processes.

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Statistical examination of birth weight distributions using Gaussian mixture models indicate that birth cohorts are composed of two or more sub-populations. One sub-population appears to account for the normal process of fetal development while

the other may represent fetuses disturbed in some way during development. Previous research has also shown that these models underestimate the frequency of low birth weight births, and indicated that log-normal distributions might provide superior results. This paper compares the fit of mixtures of Gaussian and log-normal distributions to four observed birth weight distributions.

The model used consists of a two component mixture model in which the components are defined as a "hybrid log-normal" distribution:

$$df = \left( \frac{1}{\sqrt{2\pi}} \right) (a/x + b) \exp \left( - \frac{(a \ln x + bx + y)^2}{2} \right)$$

if  $a=0$  the density is Gaussian, but if  $b=0$  the density is log-normal. All four possible combinations of Gaussian and log-normal mixtures were examined in addition to the full "hybrid" model. The data consisted of 70426 White male, 15492 Black male, 66476 White female, and 14954 Black female infants born in New York State in 1988. Standard maximum likelihood procedures were used to fit and compare models.

The results indicate that a mixture of two Gaussian distributions provides a better fit than any of the models incorporating a simple log-normal distribution except in the case of Black females. The model incorporating a Gaussian for the "disturbed fetal growth" sub-population and a log-normal for the "normal fetal growth" sub-population is second best in all cases except for Black females, where it fits better than the Gaussian mixture model. On the other hand, a mixture of two "hybrid log-normal" distributions fits significantly better than the competing models in all four cases ( $p < 1.3e-11$ ). These results suggest that the factors contributing to birth weight are predominately additive, although, there are significant multiplicative influences as well.

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### Continuity and change in Late-Prehistoric Germany.

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This communication presents the results of an analysis into the nature of skeletal variation over time. We focus our analysis on the postcranial skeleton of the earliest inhabitants of the MittleElbe-Saale valley who lived during the period c. 4500 BP to 1700 BP. The archaeological evidence suggests that we are dealing with a single, temporally homogenous 'deme,' with no significant population migration. As such, the null hypothesis is that any significant morphological change (if it ex-

ists), reflects micro-evolutionary processes, rather than population replacement.

We conducted a statistical analysis of a series of variables reflecting overall body size and body shape (e.g., lumbar height, linear dimensions of the various long bones and bi-iliac diameter) in three chronologically inclusive populations. Analyses of variance produced results that were not statistically significant in most cases. Contrary to the prevalent pattern, the distal limb segments demonstrate significant directional variation through time, a result consistent with the findings of other researchers.

A series of discriminant analyses conducted on the preserved articular regions yield results that were congruent with the univariate study. On the whole, the samples do not display marked heterogeneity, but subtle morphometric differences exist. An integrated analysis of a suite of size standardized variables taken on the upper limb (scapula, clavicle, humerus, radius and ulna), uniquely, discriminates the chronological samples in multivariate space. These differences appear to be the result of localized changes in absolute and relative size that may be functional in origin.

### Age-related changes in lumbar vertebral dimensions.

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Lumbar vertebral size and morphology exhibit age related changes in response to loss of bone mineral density. The present research focuses on the second and fifth lumbar vertebrae.

Samples were randomly selected from the Terry collection, National Museum of Natural History (Smithsonian Institution). One author (JJS) measured all vertebrae. Measurements focused on the vertebral height, body surface, dimensions, facet size and projection, spinous process and neural arch. Scaled photographs of superior surface areas were taken, digitized and measured using UTHSCSA ImageTool. Location of expansion was noted from the photographs.

The sample contained 39 females and 48 males. Sex differences were evident in almost all fields except anterior vertebral height, facet projection, neural arch depth, L2 lateral interfacet distance and L5 pedicle height. All other measurements were significantly different at the  $p < .01$  level.

Age significantly correlates to vertebral body inferior and superior surface dimensions and area of L2 and L5 as well as to spinous process length of L2. Age does not correlate with vertebral body height and neural arch nor to most measurements of the facet.

It is postulated that expansion of these lumbar surfaces directly relates to trabecular bone loss within the vertebral body. Formation and increased size of osteophytes increase surface area, dissipating body weight and lowering fracture risk in older individuals who have experienced significant bone loss.

#### Scaling and size reduction in tamarins.

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Studies of growth and development in New World monkeys offer important insight into the evolutionary bases of size variation in higher primates. This reflects the fact that among several platyrrhine lineages, closely related taxa are characterized by marked differences in adult body weight. In the case of tamarins, for example, adult body weight ranges from 350 gms in *Saguinus fuscicollis* to 570 gms in *Saguinus mystax*. However, little is known regarding the ontogeny of size and shape variation within the genus *Saguinus*. In this study, we evaluate the hypothesis that, among tamarins, ontogenetic scaling, or shifts along a shared relative growth trajectory, account for size and shape variation. Specifically, we focus on comparisons of limb segment length among smaller- and larger-bodied tamarin species, and examine evidence for age and sex-based differences in growth.

Somatometrics representing *S. fuscicollis*, *S. geoffroyi*, *S. labiatus*, and *S. mystax* were analyzed. These species are represented by 250 wild-trapped, tranquilized, weighed, measured, and released individuals from Panama, Peru, and Brazil. Animals examined ranged in age from infant to adult. Allometric analyses of twelve variables describing limb and body proportions were conducted using reduced major axis regression.

Our results indicate that, in general, ontogenetic scaling accounted for size differences among tamarin species. Thus, *S. fuscicollis* followed relative growth trajectories comparable to those of larger tamarin species, but followed these to smaller size ranges. However, there also was evidence for shape differences between species. Specifically, arm span in *S. fuscicollis* exceeded values for all other tamarin species, indicating relatively long forelimbs across a range of sizes during ontogeny. This is consistent with differences in patterns of positional behavior and feeding ecology that characterize *S. fuscicollis*. Evidence of sex-based differences in tamarin growth trajectories also is discussed.

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#### An analysis of the pathology of the Krapina Neandertals.

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This study presents an analysis of skeletal pathologies in the Krapina hominid collection from the Husnjakovo rock shelter, located 40 kilometres north of Zagreb, Croatia. Generally, the majority of the bones present in the sample represent osteologically healthy individuals, although several exceptions are noted. Previously unrecognized subtle changes to cortical bone surface that are idiopathic in nature are reported, in addition to cranial and post-cranial trauma, non-union (or possible amputation) of an ulna, post-traumatic lesions, and degenerative joint disease.

The Krapina sample, although comingled and fragmentary, represents the best example of a population of Neandertals. An assessment of the pathologies was completed by examining patterns of anatomical distribution, with specific reference to trauma and post-traumatic degeneration. The results of the distribution patterns were found to parallel trauma patterns in modern agricultural workers that frequently come into contact with large ungulates. This modern population was found to provide a better model than rodeo riders. Therefore in the treatment of the sample as a specific Neandertal population, this study of pathology patterns is informative in increasing our understanding of Neandertal behavior and health.

#### Diet and mobility in medieval Greece based on bone stable isotope ratios

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Historical documents have allowed the key items in the medieval Greek diet to be identified. However, a number of important factors remain open to debate. These include the importance of marine resources to the diet, the question of geographical variability, and the impact of ethnic affiliation on resource use. This study examines resource use in several medieval Greek communities through stable isotope analysis of human bone. Greek Christian communities of the Late Byzantine era from inland, coastal and island locales are examined to address the problem of geographical variability. In order to study the question of ethnic variation, samples from Frankish and Ottoman Turkish cemeteries are compared to the grouped Byzantine sample. The results of the  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  analyses suggest that marine resources generally played a small role in medieval subsistence regardless of geographic locale, apparent ease of access to

marine resources, or ethnic affiliation. Clear differences in  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  separate the Ottoman populations from those of the Byzantine era, with the Ottoman remains displaying enriched mean values and greater dispersion. Rather than a difference in diet, this pattern appears to result from an increase in residential mobility in the Ottoman period. Such an increase would be in agreement with historical evidence for increased trade and movement in the Ottoman era. These results illustrate the potential of stable isotope analysis of human remains to study changes in Mediterranean residential mobility over time and their relationship to other factors, such as trade.

#### Haplorhine evolution in the mid-Eocene of Asia.

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We describe the tarsal remains (n=47) from the 45 million year old Shanghuang fissures from China. These tali and calcanei document four distinct groups of small haplorhine primates co-occurring at the Shanghuang fissures. Two groups appear to be "prosimian" taxa, likely Tarsiidae and a new omomyid-like group. The other two haplorhine groups are "anthropoid-like". The first anthropoid group (Eosimiidae) is very transitional in nature bridging omomyid and anthropoid tarsal morphologies. The second anthropoid group is more advanced and is phenetically most similar to platyrrhine primates. In this presentation, we will discuss the morphology and the evolutionary implications of each haplorhine group, especially the evidence pertinent to anthropoid origins in Asia. Lastly, the diversity of Shanghuang tarsal sizes and shapes among the four groups suggests as many as sixteen small haplorhine species (all below 125 gms).

#### Omo-323-1976-896: a robust australopithecine from Member G of the Shungura Formation, Ethiopia.

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Several aspects of the evolution of the robust australopithecines remain unclear. In the first place, there is no consensus on whether these taxa form a monophyletic group or not. Secondly, concerning the East

African robust australopithecines, there is a clear divergence between those workers who place KNM-WT 17000 in *A. aethiopicus* and those who assign it to *A. boisei*, concluding that the range of variation in the latter species is still acceptable for a paleontological species. Some have taken an even more extreme position by proposing that *A. boisei* is not directly related to *A. aethiopicus* (Skelton and McHenry, 1992; Ramirez-Rozzi, 1993). For those who accept the existence of a continuous East African lineage, the modalities of morphological changes within the lineage are not completely understood. To do so, a thorough description and analysis of fossil specimens is necessary in addition to finding new specimens.

In this paper, Omo-323-1976-896, a partial cranium of a hominid from the Member G, Unit G-8 of the Shungura formation, Lower Omo Basin of Ethiopia is described. It is dated to circa 2.1 Ma. It consists of fragments of the frontal, temporal, occipital, parietal and maxilla. It is attributed to *Australopithecus boisei*, thus representing the oldest cranium of this species. Some features of the specimen are shared with *Australopithecus aethiopicus* (KNM-WT 17000). This study supports the existence of a continuous East African robust lineage between circa 2.6 and 1.4 Ma. Omo-323 preserves some features that have not been observed in other *A. boisei* specimens before. Therefore the specimen also increases the known interspecific variability of the species.

#### **Reproductive performance in captive male rhesus macaques (*Macaca mulatta*) differing in cerebrospinal fluid 5-hydroxyindoleacetic acid concentrations.**

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In rhesus macaque males, lower than average cerebrospinal fluid (CSF) concentrations of the principle metabolite of serotonin, 5-hydroxyindoleacetic acid (5-HIAA), have been linked to impulsivity, involvement in escalated aggression, failure to elicit consort relationships, production of fewer sperm plugs and a relatively early age of mortality. Given these potential fitness costs, the present study evaluated the relative reproductive outcome for group living adult male rhesus macaques (N=24) varying in concentrations of CSF 5-HIAA. An average measure from three samples was calculated for each subject. By identifying the males present during the time when conception most likely took place (offspring birth date-165+/-14 days), comparisons of CSF 5-HIAA concentrations between sires and non-successful males could be drawn. DNA fingerprinting analyses determined paternity for 147 offspring.

The results of this study suggest that as serotonergic function affects many aspects of behavior and survivorship, it may also affect reproductive performance. Binomial proportion tests revealed that sires exhibited higher concentrations of CSF 5-HIAA than non-successful males ( $N_1=94$ ,  $N_2=53$ ,  $p=0.001$ ). While older males were overall more likely to reproduce than younger males ( $N_1=56$ ,  $N_2=35$ ,  $p=0.036$ ), amongst males of low CSF 5-HIAA concentration, younger males were more likely to sire offspring ( $N_1=17$ ,  $N_2=1$ ,  $p=0.000$ ). Potential fitness consequences for these relative age differences for males varying in CSF 5-HIAA concentrations will be discussed.

#### **Patterns of spatial proximity in red-fronted brown lemurs *Eulemur fulvus rufus* from Western Madagascar.**

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Patterns of social relationships in group-living *Eulemur* species continue to be debated. Some researchers have suggested that multimale multifemale groups are based on special male-female relationships developed for infanticide protection; other studies have not supported this view. Here, I present data on patterns of spatial proximity in wild *Eulemur fulvus rufus* for further consideration of social relationships in group-living *Eulemur* species.

Two groups of wild red-fronted brown lemurs *Eulemur fulvus rufus* were studied at Anjamena, Madagascar. Animals were individually identified; nearest neighbor identity and distance were recorded for focal individuals. An association index was calculated for each pair of individuals in each group, considering frequency and distance as nearest neighbor. Some male-female pairs had high association indices indicating a high degree of spatial proximity; these relationships were not exclusive or stable across time. Individuals could have more than one partner of the opposite sex with whom they showed high association indices in the same or a different time period. Some males showed aggressive affiliation with females as seen in other brown lemur populations. Dyads of other age-sex composition, including some male-male and male-juvenile pairs, showed high association indices as well.

These findings do not support the idea that group-living *Eulemur* social structure is based on special male-female relationships or that male-female relationships have developed for infanticide protection. This research suggests that a variety of social relationships are important to group social organization. Individuals in red-fronted lemur groups have a variety of relationships that may be based on relatedness, affiliation, and mating concerns. One or several individuals in each group, particularly males, may have important, so-

cially central positions.

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#### **Balancing tools and language on the head.**

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Washburn's broad, synthetic intellect led him to explore the evolution of varied anatomical and behavioral structures and to envision holistic interconnected systems where others see distinct, unrelated traits. He stated, for instance, that tools, language, and social behavior evolved together as an adaptation to the hunting way of life. He thought that tool-use resulted in reduced tooth and jaw size, and he considered that the combination of small jaws/teeth and enlarged brains was a primary factor resulting in cranial base flexure and in changes of the balance of the head. The increasing specialization of recent decades has produced few scholars of Washburn's breadth and led to debates about the relative importance in human evolution of various behavioral systems that Washburn saw as interrelated complexes (e.g. social versus technical intelligence). This paper focuses on the cognitive foundations of human versus ape tool-making, language, and social intelligence. It suggests that expansions in brain-size mediated, mental constructional capacities played critical roles in the evolution of each behavioral domain. These similar cognitive foundations lend support to Washburn's view that they evolved together as a common behavioral complex. Discussions of the mechanisms of cranial base evolution are outside the purview of the present contribution. The approximate temporal coincidences of enlargement of the brain, manufacture of Acheulian hand axes and beginning cranial base flexure (as delineated by Laitman) in *Homo erectus* are, however, compatible with Washburn's views of relationships between cranial structure, tool-making, and increased brain size. They are also compatible with his views that enhanced mental and social behaviors evolved in relationship to new foraging patterns.

#### **Dental variation and biological affinities among three modern ethnic groups in Malaysia.**

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The human populations of Malaysia form a rich mosaic of cultural, linguistic and biological variation. The biological relationships between the three major eth-

nic groups the Malay, Chinese, and Indian, and their underlying population structure remains largely unexplored. Some researchers maintain that these three groups remain distinct despite up to 1500 years of intermittent contact.

Dental morphological trait variants and marriage data are used to explore the biological relationships between the three major ethnic groups currently inhabiting urban Malaysia. Four generations of marriage patterns for 3,576 individuals are examined, based on information from 447 Malaysian nationals born between 1956 and 1984. The permanent dentition of the present day participants are analyzed for 75 morphological traits. Rogers and Harpending's unrestricted migration matrix model was applied to all four generations of marriage data to derive migration rates and Wright's  $F_{st}$  values, which are compared for temporal and sub-group variation. Pairwise comparisons of the biological distances and the migration rate data are performed using correlation analyses. The migration rates are relatively low, and decreased over time according to the marriage data. The overall genetic differentiation of these populations as suggested by the marriage data, is low, due perhaps to large effective population size, high systematic pressure and low-level consistent migration between sub-groups.

This study applies population genetics models to marriage data and dental morphological distances, a largely unexplored relationship, in a region which has had little attention from dental anthropology. Data from this research can help to form a baseline of dental information for this region.

### **Populational thinking in forensic anthropology.**

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Forensic anthropologists are required to provide pertinent information in medico-legal contexts relating to both skeletal trauma and personal identification. In the personal identification process the skeletal assessments most often requested by law enforcement agencies are four: age at death, sex, race and living stature.

Over the past decade as racial terminology and the entire race concept has come under attack within the field of anthropology, three-fourths of forensic anthropologists still support the race concept and nearly 100% still utilize traditional racial categories when submitting case reports. Many anthropologists outside of forensic anthropology brand this as an unjustifiable retention of outmoded typological thinking in an age of increasing quantification and populational thinking in biological anthropology.

It will be argued here that rather than falling behind the rest of physical anthro-

pology in their populational thinking that the forensic anthropologists have in many instances led the discipline in research pertaining to populational trait frequency distributions. Over the same decade that forensic anthropologists have been most maligned for a lack of populational thinking they have contributed more to its progress and development than ever before. The reasons for the perceptions are many, and the entire problem quite complex. Yet, part of the problem is clear. Forensic anthropologists are required to articulate their research results to law enforcement and the rest of contemporary society. This necessitates bringing modern populational thinking into an old, traditional scheme of racial classification - one that predates evolutionary thinking itself and is quite encumbered by past association with unsophisticated typological concepts. This has not been an insurmountable limitation in the communication between forensic scientists and society. The much more serious communication problem exists between scientists. The time to open up communication between the different groups of biological and social scientists is now, before a serious problem grows even worse.

### **Fluctuating odontometric asymmetry in the adult dentition of the Punjabi population of Chandigarh, Northwestern India.**

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This study reports on the bilateral asymmetry in the tooth crown measures of the Punjabi population of Chandigarh. The material includes dental casts of 168 adult subjects (M=103, F=65), ranging in ages between 18-40 years. Asymmetry in the mesio-distal and bucco-lingual diameters of both maxillary as well as mandibular teeth is observed to be non-directional with 12 of the 32 comparisons being biased towards the right. Though statistically insignificant, asymmetry was found to be greater in males than in females.

Though statistically not significant, interjaw comparisons reveal greater bilateral asymmetry for maxillary than for mandibular teeth. Greater asymmetry in the mesio-distal diameter than bucco-lingual diameters is revealed in the maxillary but not the mandibular teeth. Odontometric asymmetry does not show any affiliation for side, jaw and sex; and thus is fluctuating or random in nature. Further the pattern of odontometric asymmetry within morphological tooth classes exhibits greater asymmetry for the distal than the mesial members. Considering the dentition as a whole, greater asymmetry

is observed in the posterior teeth, i.e., premolars and molars.

### **Paleopathology of the prehistoric Maya from Caves Branch Rock Shelter, Belize.**

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From 1994 to 1995, excavations were conducted within the Caves Branch region of Belize. The Caves Branch Rock Shelter represents an ossuary estimated to include the remains of over 150 prehistoric Maya. Most remains were commingled as the result of burial practice and the prolonged continued use of the site for ossuary activities. Few indications of trauma-related death were noted, suggesting that the burials represented individuals who had died of illness or other natural causes. Demographic information on age, sex, and stature was collected when possible. The data indicated the presence of both sexes and individuals of age varying from infancy to old age.

All recovered bones from the Caves Branch Rock Shelter were examined for anomalies and conditions of paleopathology. Frequency statistics were calculated for the incidence of healed trauma, infectious disease, and metabolic disturbances. The frequency of pathological conditions of the dentition such as hypoplasias, abscesses, calculus deposition and dental attrition were also calculated.

Results of the analysis indicated a population with a relatively low occurrence of infection, but a considerable amount of metabolic disturbance in dental development as a result of environmental stress. Non-intentional trauma was restricted to healed fractures, most occurring to the phalanges of the hand and foot, and degenerative joint disease. Only one individual exhibited intentional trauma, whereby, stone inlay modification occurred to the anterior teeth.

This research was made possible by the Department of Archaeology, Belize.

### **Paul Methuen's sleeping treasure: Subfossil lemurs in the zoological collections of the University Museum, Oxford.**

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In 1911, Paul Ayshford Methuen embarked on a mission to Madagascar to collect subfossil lemur specimens for the University Museum of Natural History, Oxford. He visited two subfossil sites in Southwest Madagascar, Tsivonohy and

Taolambiby. For nine decades, the specimens he delivered to Oxford were never properly studied and, as of the summer of 2000, they still bore original tags. Because in 1911 the associations of crania and postcrania of extinct Malagasy mammals were largely unknown, many original identifications were incorrect. Bones of *Palaeopropithecus* were allocated to *Archaeolemur*; *Megaladapis* to *Palaeopropithecus*; *Plesiorycteropus* (Bibymalagasia) to *Cheirogaleus* sp. Methuen's errors were repeated in the catalogue of the Oxford Museum and in Jenkins' 1987 *Catalogue of Primates in the British Museum (Natural History) and Elsewhere in the British Isles*.

A survey of the subfossil specimens collected by Methuen and others at Taolambiby reveals a rich diversity of extinct and extant species. Skeletal remains of elephant birds, hippos, and the large extinct carnivore, *Cryptoprocta spelea*, are in the Methuen collection. The collection contains species never before reported at Taolambiby, which now rivals the richest of southwestern Malagasy subfossil sites (Tsirave, Ankilitelo) in primate species diversity. Six extinct primates (*Mesopropithecus globiceps*, *Pachylemur insignis*, *Palaeopropithecus ingens*, *Archaeolemur majori*, *Megaladapis madagascariensis*, and *Megaladapis edwardsi*) occur here. The extant primates include species that still survive in the Southwest (*Propithecus verreauxi*, *Lemur catta*, and *Lepilemur leucopus*). Jaccard's similarity indices confirm a marked resemblance of the Taolambiby primate paleocommunity to others in the Southwest. Microwear analysis of the teeth of the Taolambiby primates reveals a diversity of diets, and confirms that *Archaeolemur* had the coarsest diet, while *Lepilemur* was the most committed folivore.

#### **Relationship between mineralization density, age and mechanical adaptation of the human mid-shaft femur.**

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One of several microstructural variables known to affect the mechanical properties of bone is the degree of mineralization of the bone matrix, which in turn is a consequence of time since formation, and hence remodeling rate. This study sought to determine whether mineralization density variation is spatially organized in relation to specific bending forces at the mid-shaft femur, and whether such organization varies with age.

Mid-shaft femur cross-sections were prepared from an autopsy sample (n=40) of adult individuals collected from the Victorian Institute of Forensic Medicine, Australia. Montaged grey-scale images of en-

tire cross-sections were obtained using backscattered electron microscopy (BSE), employing a standard to control for instrument drift over time. Using an automatic routine, BSE images were divided into 48 segments according to anatomical position. Average grey values were quantified for each segment, and one-way ANOVA with Tukey HSD post-hoc tests were applied to assess differences in average mineralization between segments. Degree of mineralization was considered relative to preferred collagen fiber orientation data previously obtained from the same sections, and to the location of second moments of area of each cross-section.

Results showed low overall variability in mineralization density. Mineralization and age were negatively correlated, and individuals in the 45-64 age group were significantly less variable than either younger or older individuals. Degree of mineralization was significantly lower in the antero-lateral aspect, indicative of higher osteonal turnover, relative to the postero-medial aspect. Collagen fiber orientation data from this sample has indicated a predominance of longitudinally oriented collagen fibers in the antero-lateral aspect, and of transverse collagen fibers in the postero-medial aspect. These organizational differences were found to relate to the location of  $I_{max}$  and are consistent with our present understanding of bending forces at the mid-shaft.

The combined analysis of bone material and structural properties illustrates continued mechanical adaptation in the human femur throughout life. Age differences may reflect changing mechanical usage and efficiency. Examination of these variables in different temporal and geographic populations may be useful for studies of activity and behavioral variability in modern humans.

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#### **Craniometric variation and peopling of the Americas: R matrix analysis and matrix permutation.**

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The aim of the present study was to estimate the variability observed in Asian and American skulls in order to adjust the data obtained to different models of peo-

pling-and dispersal into-the New World.

Data came from variables given by Howells for East Asia, North America and South America. Five samples from the Fuegian-Patagonian region, and a Paleoamerican one (Lagoa Santa) were also employed. The R matrix method, directly based on the genetics of quantitative characters, was employed to estimate the intra- and inter-population variation, more specifically, the Fst values. Three published and well-stated models for peopling of the Americas were represented in hypothetical design matrices. Furthermore, permutation matrix analyses were done to quantify the adjustment of data to a) the geographic distance among the samples, and b) the models of peopling.

The minimal Fst for the samples was of 0.166. When only the South-American populations were analyzed, the Fst value raised to 0.176. The Asian samples, at variance, gave an Fst of 0.046. These results pointed out the high level of heterogeneity of the South-American populations. The permutation matrix analyses suggested that the four migration model fits the observed variability better than the others proposed, even after deleting the effects of the geographic distances.

#### **Musculoskeletal pain in women of menopausal age.**

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In a study of menopausal symptoms in the city of Puebla, Mexico, women were asked what complaints they associated with the end of their menstruation. "Dolores de huesos" or bone pain was reported by 48.5% of the first 435 respondents, second only to hot flashes, reported by 53.8%. In addition, women were asked to indicate the "everyday complaints" that they experienced during the two weeks prior to interview. Back pain was the third most common complaint (56%) and joint stiffness was the fifth most common complaint (52.6%), after tiredness (71%), nervous tension (64.9%), and sadness or desire to cry (52.7%).

Participants were recruited from all parts of the city, from a variety of sites, including markets, small stores, public parks, and from a waiting area outside of a hospital. Women reported a mean age of 50.3 years (s.d. 6.2), with a mean level of education of 8.4 years (s.d. 4.7). Of the first 450 women surveyed, 157 were pre-menopausal, 99 reported a history of hysterectomy, and 192 had undergone a natural menopause. Women who were no longer menstruating were more likely to report joint stiffness (57.4% vs. 42.9%, p<.01).

In this presentation, back pain, bone pain and joint stiffness are examined in relation to early age at menopause, use of hormone replacement therapy (13.5% of respondents used HRT at time of interview),

use of supplemental calcium, diet (e.g., milk, meat, coffee), smoking habits, occupation, household and leisure activities. The physiology of bone loss will be discussed in relation to the musculoskeletal pain associated with the menopausal transition.

#### DNA evidence for our place in a phylogenetic taxonomy of primates

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Molecular phylogenetics, a coupling of molecular biology to Hennig's phylogenetic systematics, is bringing about a twofold shift in paradigms, one in systematics and the other in how we view our place in nature. The new paradigm in systematics disbands the traditional use of taxonomic grades with their polyphyletic and paraphyletic taxa and, instead, as proposed by Hennig, favors strictly genealogical (i.e. cladistic) classifications in which all taxa are monophyletic and are arranged in a hierarchical scheme that reflects the time course of phylogeny. The second new paradigm rejects the traditional anthropological view that we humans are greatly different from all other animal species and instead emphasizes how much we hold in common with other species, such as with our closest living relatives, the common and bonobo chimpanzees with whom we share more than 98.3% identity in typical noncoding DNA and probably more than 99.5% identity in the active coding sequences of functional nuclear genes. Phylogenetic analysis of noncoding DNA orthologues, with their accumulation of selectively-neutral changes, depicts chimpanzees as the sister-group of humans in a highly resolved phylogenetic tree of primates that overall is congruent with the extant and fossil osteological evidence on primate phylogeny. The primate classification based on these results places all living apes and humans in subfamily Homininae. In turn at about 18 Ma Homininae divided into Hylobatini (common and siamang gibbons) and Hominini, the latter at about 14 Ma into Pongina for *Pongo* (orangutans) and Hominina for *Gorilla* and *Homo*. *Homo* itself at <6 Ma divided into the subgenera *H. (Homo)* for humans and *H. (Pan)* for common and pygmy chimpanzees. Even on disbanding *Australopithecus* and *Ardipithecus* by placing their species into *Homo (Homo)*, the presumed genealogical relationships of these extinct species to each other and to living humans can be depicted by how the species are listed and identified under the subgenus rank. Clearly this classification argues for having the larger brain *Homo* fossils in a single species.

#### Sexual size dimorphism in primates: Consideration of relative variation between sexes.

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Quantitative genetic models have proven useful in generating predictions for evolution of sexual size dimorphism. However, studies on non-primate taxa in recent years have cast doubt on the descriptive power of these models. Also, quantitative genetic models that assume that individual additive genetic effects have constant magnitudes in both sexes ignore implications of differences in growth trajectories of males and females for the magnitude of additive genetic effects on phenotype. Additive genes may affect growth trajectories as well structural proteins in primate species, in which case addition of one additive unit will have a proportionally larger effect on phenotypic body size at larger sizes than at smaller sizes for a given species.

A new set of descriptive models for the evolution of sexual size dimorphism is proposed. In these models additive genetic effects are assumed to have an additive effect that is proportional to sex-specific body size, rather than a constant additive effect. This assumption is consistent with processes which extend or accelerate growth in one sex relative to the other.

Preliminary models based on selection dimorphism, variance dimorphism, and a combination of the two are outlined. Predictions based on each of these models are presented for the degree of relative variation between male and female body size in sexually dimorphic species.

Predictions were tested based on data collected from three African primates: *Gorilla gorilla*, *Pan troglodytes*, and *Papio cynocephalus*. Body sizes were calculated using geometric means of linear measures of multiple regions of the postcrania for each species. Modified Fligner-Killeen tests were used to compare the relative variation present in male and female body size distributions for each species.

Results from these three species are consistent with the proposed selection dimorphism and combined variance dimorphism/selection dimorphism models. These results are not consistent with the proposed variance dimorphism model. This first step introduces a promising avenue of research into the evolution of sexual size dimorphism in primates.

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#### Analysis of a 13-year demographic study on ringtailed lemurs at the Beza-Mahafaly Reserve, Madagascar.

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Over the past few decades, long-term demographic studies of both strepsirhine and haplorhine primates in their natural habitats have provided us with valuable information on population stability and life-history variables such as life-spans, mortality, natality, dispersal patterns, and the effect of the environment on these variables. Over a period of 13 years (1987-2000) we collected census data on a population of individually identified (collared and tagged) ringtailed lemurs at the Beza-Mahafaly Reserve, Madagascar. A significant difference was found in population size over the 13-year period, likely related to recurring droughts in this area. Group sizes have ranged from 3 to 15 adults plus immatures. Overall average female to male sex ratio is 1.12:1. In 2000, 3 of the originally collared females still survive, aged 15 (n=2) and at least 16 (n=1), although the majority of collared females died before reaching this age. Male longevity is more difficult to determine, since males in this population occasionally disperse to groups outside the reserve; however none of the 63 males collared between 1987-1990 still exist in the reserve, and only 3/18 collared in 1995 (last collaring season) still reside in the population, compared with 13/72 females collared between 1987-1990 and in 1995. This suggests that males may have shorter life spans, which may be related to female priority of access to resources and extreme seasonal fluctuation in food availability. One group, living in the drier western part of the reserve, fissioned 3 times in the 11 year period and 3 of the original groups no longer exist. This study provides the first information on probable life-span of female ringtailed lemurs, and the fate of males in the wild, and also contributes to our knowledge of environmental effects on primate populations over time.

#### Seasonal variation in the diet of *Hapalemur griseus griseus*.

C. GRASSI. The University of Texas-Austin.

In this study I evaluated seasonal influences on the diet of *H. griseus* at Ranomafana National Park in Southeastern Madagascar. The two main study areas within the park differ in altitude, degree of habitat disturbance, forest composition, and primate fauna. For one year I studied three groups of *H. griseus*: two at a site with less habitat disturbance, Vato, and one at Tala, a more disturbed site. Three distinct climatic seasons were identified: rainy (Dec.-Apr.), cool-dry (May-Aug.) and dry (Sept.-Nov.). Food availability (FA) was calculated based on monthly monitoring of botanical plots in the home ranges of each group. I examined seasonal



patterns of food availability and how the percent of time feeding on plant parts varied with climatic season and food availability.

Although availability of primary foods (mature leaves, bamboo shoots) did not vary seasonally, the availability of supplementary food items such as new leaves and fruit did. Peaks in availability occurred during the rainy season for new leaves ( $p < .01$ ) and fruit ( $p < .05$ ). Furthermore, the proportion of the diet dedicated to mature leaves and bamboo shoots did not vary seasonally, nor was this correlated with availability. In contrast, the proportion of the diet dedicated to new leaves varied seasonally ( $p < .05$ ), peaked during the rainy season, but did not correlate with availability. Finally, ripe and unripe fruit intake also varied seasonally ( $p < .05$ ,  $p < .05$ ), peaked during the rainy season, and correlated with fruit availability ( $p < .001$ ,  $p < .05$ ). Fruit availability also varied between groups and was of particular importance to the Tala group, which fed a large proportion of the time on guava.

*H. griseus* is a bamboo specialist. Although this is a "low quality diet", resources are constantly available throughout the year as this study shows. Variation in bamboo shoot intake is likely determined by variation of higher quality foods, such as fruit and new leaves. Traditionally "seasonal" resources such as fruit play an important role in the diet of *H. griseus*. When these higher quality foods are available, *H. griseus* will use them to supplement their mostly folivorous diet. These foods are utilized during the rainy season, which is the time that adult females are lactating and weaning fast-growing infants. These supplementary foods may provide 1) a nutritional boost to adult females and 2) easier to digest foods to growing infants at this time.

#### **The Dakhleh Oasis Project: A preliminary report on mtDNA research in Dakhleh Oasis, Egypt**

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Molecular genetic research is being conducted as part of the Dakhleh Oasis Project (DOP), an international and multidisciplinary research initiative in the western desert of Egypt. Mitochondrial DNA (mtDNA) is being analyzed within an ancient human population sample associated with the Roman period town of Kellis (100 to 450 AD) and contemporary inhabitants of the Dakhleh Oasis. The primary objectives of this research are to derive paleogenetic information about the inhabitants of ancient Kellis, and to develop a picture of change over time within this desert oasis. Preliminary mtDNA restriction site data and control region sequence

variability suggest significant genetic differences exist between ancient and modern oasis populations.

#### **Mapping modern mtDNA haplogroup frequencies of Native North Americans ancient Native American homelands utilizing GIS.**

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In this study, we utilize a Geographic Information System (GIS) to examine the distribution of haplogroup frequencies found in Native Americans. We have constructed a 5-layered map of the five major Native American haplogroups generated by interpolating known point samples of haplogroup frequencies across the whole of the United States, Canada and Mexico. The map generated relies on the assumption that haplogroup frequencies change as a function of linear distance. We then use this map and mtDNA haplogroup frequencies from ancient populations to examine population movements and events in North American prehistory.

#### **The effects of age and trace elements on bone mineralization.**

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There is a continuous loss of bone tissue after our skeleton has reached its peak bone mass. This loss is slow but can be accelerated by the menopause and by some pathological conditions. Beside this quantitative loss of bone mass, there are also changes in the quality of bone as a tissue which occur with aging and are referred as bone quality. One of the most important factors in determining bone strength beside its structure is the degree of mineralization of the bone, often referred as mineralization profile which described the way the apatite crystals of bone are packed in the collagenous matrix. These changes in the structure of bone and in its material properties lead to an increase in bone fragility and as a consequence to fractures. Some of these changes can be related to specific events such as the menopause where bone turnover increases leading to loss of bone and of connectivity in the trabecular structures of the vertebrae and to the vertebral fractures that characterize postmenopausal osteoporosis. Age related osteoporosis, in the other hand is characterized by a slow turnover, an increase in cortical bone porosity due to osteonal remodeling and finally an increase in the mineralization of bone. This slow increase in mineralization can lead to an increase in stiffness of the bone but it also leads to a bone material which is more fragile (less

ductile). This increase in mineralization can also be accompanied by an increase in microdamage of the cortical bone, which can provoke fatigue fractures. Some trace elements, such as strontium, can have some effects on the structure of the bone mineral which resemble those of increased turnover with its decrease in mineralization. By decreasing the apatite lattice stability and increasing its solubility strontium can mimic high bone turnover and may lead to osteomalacia at high dose. Other trace elements, such as fluoride, have the opposite effect which resemble the slow increase in mineralization induced by aging. By increasing the apatite lattice stability and by decreasing its solubility fluoride can mimic low bone turnover and may lead to hypermineralization at high doses. In conclusion we can see that bone turnover is the major determinant of bone mineralization, that trace elements by substituting in the apatite lattice can also modify the degree of mineralization of bone which is an essential factor in determining bone quality and ultimately bone fragility.

#### **The timing of hypoplastic events in gibbons.**

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Previous studies have assessed the prevalence and expression of enamel hypoplasia in samples of gibbons but have not addressed the timing of hypoplastic defects. By analyzing ages at defect formation and the intervals between them, it is possible to gain insight into potential relationships between aspects of life history and physiological stress. This study focuses on estimating the age at which hypoplastic defects form, and the time intervals between them, in a sample of wild-shot specimens of *Hylobates lar carpenteri* housed at the Museum of Comparative Zoology (MCZ) at Harvard University.

Ages at defect formation were determined for defects on 78 lower canines of the MCZ sample using measurements from the CEJ to each defect and information from growth increments in histological sections of canines from two *Hylobates lar* specimens from the New York University skeletal collections. An estimated age at completion of canine crown formation was determined by combining information from the two specimens. Measurements from the CEJ to each defect were multiplied by the average rate of lateral enamel formation and subtracted from the estimated age at completion of the canine. A minimum, maximum, and mean age of formation were determined for each defect in each specimen. Inter-LEH intervals were determined on a sub-set of the sample restricted

to individuals who had two or more matching adjacent defects on a canine antimeric pair. Intervals were calculated by multiplying the distance between defects in mm by the average rate of lateral enamel formation.

Based on this analysis, most hypoplasias appear to form at 1.8, 2.3, and 2.5 years of age, with a mode at 2.3 years. The median interval between defects is 0.41 years, just over five 28-day months. These results will be discussed in relation to post-weaning stress and in the context of defect intervals reported in studies of LEH in other non-human primates.

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#### **Determinants of gregariousness in a nocturnal primate.**

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Interspecific comparisons of mammals and primates suggest that the major determinants of gregarious behavior are the distribution of food resources in space and time, predation pressure and infanticide avoidance. This study of gregarious behavior in the spectral tarsier, *Tarsius spectrum*, suggests that all three may be important in understanding the relatively gregarious nature of spectral tarsiers. To test whether predation pressure was the major determinant of sociality for this species, I mimicked predation pressure by utilizing predator models and playback predator vocalizations. In response to increased predation pressure (rubber snakes) the family group was observed mobbing the predator. When plastic bird of prey models were placed throughout the tarsier's territory the adult group members often increased their distance from one another. No significant response was made by the spectral tarsiers in response to playbacks of predator vocalizations.

To test whether infanticide avoidance was the major determinant of sociality for this species, I compared the distance between adult males and females for 3 reproductive phases. When adult females were lactating adult males were observed to decrease the distance between themselves and the adult female, while the female often attempted to increase the distance. There was no major difference in the gregariousness of adult group members when females were pregnant and non-reproductive (cycling).

To explore whether the temporal distribution of resources was the major determinant of sociality in spectral tarsiers I collected insects hourly. Distance between group members closely followed hourly and monthly changes in insect abundance. During hours when abundance was high, distance between group members decreased and vice versa. Additional

long term and more fine-grained data need to be collected to ascertain the relative importance of resources, predators and infanticide in determining sociality in the spectral tarsier.

#### **North Pontic populations in the Mesolithic-Neolithic: Osteological, dental, subsistence, and cultural factors.**

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Human skeletal and cultural remains from Dnieper River Basin cemeteries provide the basis for resolving physical anthropological, dietary, and cultural differentiation of the Mesolithic and Neolithic tribes.

The Mesolithic population of the North Pontic region was made up of broad-faced massive Proto-Europeans, narrow and high-faced dolichocephalic gracile Mediterraneans, and Ancient Mediterraneans. People with the Mediterranean suite of features completely disappeared from the North Pontic populations in the Neolithic Era, when this territory was inhabited by the bearers of the Dnieper-Donets culture. The Neolithic people exhibited a unique complex of features (thick cranial vault bones, massive and fairly large skulls, and postcranial robusticity) and are generally classified as protomorphic or hypermorphic Proto-Europeans. Dental morphological trait analysis supports population heterogeneity through time and expected patterns of reduction in relative cusp size and numbers of cusps, although metric analysis (Jacobs, 1994) of four of the samples shows an increase in mesiodistal and buccolingual dimensions.

Subsistence of the Late Mesolithic and Early Neolithic populations of the Dnieper Rapids region was based primarily upon a hunter-gatherer-fisher regime (Telegin, 1968). Although the Dnieper Rapids populations may have been focusing on cereal/grain-intensive subsistence economy as early as 7,300-6,220 cal BC (Jacobs, 1994) a near lack of caries indicates that grains may not have been processed. A broad range of plant resources was available during the Mesolithic (Clark, 1978) and wild grains were present in the Pontic region (Dennell, 1983; Zvelebil, 1994). New stable isotope values are consistent with a fisher-hunter-gatherer subsistence in the late Mesolithic-early Neolithic. Yet, cases of Mesolithic violent deaths (Nuzhnyi, 1990, 1995) indicate that the time many not have been a peaceful one.

#### **Demographic adaptation and blood pressure regulation in urban Caribbean-Americans.**

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Multiple blood pressure (BP) readings, demographic data, and medical histories were collected from a probability sample of 255 adult Caribbean-born permanent residents of Miami, FL who had been transplanted for an average of 15.3 years. Mean BP values (mean=134.9/87.0 in males and mean=127.1/81.8 in females) were significantly lower than in comparable samples from the 16 Caribbean countries of origin that were represented. BP level was positively correlated with age, and this is also generally the case in indigenous Caribbean populations.

While immigrants in urban areas in a new country typically experience a long-term rise in BP, the present subjects have resourcefully adjusted to the stresses of an unfamiliar new environment through several demographic and cultural adaptations. They exhibit later ages at marriage, reduced fertility, lower morbidity, higher employment rates and salaries, more frequent physical conditioning/exercise, and relatively fewer divorces/separations than age-matched counterparts in Caribbean countries. Gender differences in the Caribbean-American BPs are not statistically significant and contrast with Caribbean populations where hypertension prevalence is generally greater among females. Relocation to Miami has also provided desalinated drinking water, dietary diversity with reduced seafood intake, and the increased availability of biomedical healthcare facilities including access to prescription anti-hypertensive drugs.

#### **Man's place in cladistics: an assessment of the efficacy of the cladistic methodology in hominid systematics.**

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Reconstructions of hominid evolution have been augmented by the cladistic methodology, first outlined by Willi Hennig in his 1966 seminal work, *Phylogenetic Systematics*. Since then, multiple analyses have used this approach to interpret the divergent patterns of the human evolutionary past. While cladistics is a potentially powerful tool, it does have its constraints, which unfortunately are often overlooked by those speculating on hominid phylogeny. Most pertinent of these limitations has to do with the correlation of characters that result from common developmental pathways or similar/identical functional morphologies. Aside from the recent work done by Collard and Wood (2000), little has been done to test the appropriateness of cladistics for assessing the phylogeny of homi-

nids based on morphological characters.

In this study, the efficacy of cladistics was tested using cranial morphological characters of a phylogenetically "known" sample, modern *Homo sapiens*. The use of modern *Homo sapiens* as a control group was aimed at elucidating the appropriateness of cladistics as it is used to group fossil hominids, specifically those pertaining to the Early and Middle Pleistocene.

Two similar but different analyses were conducted using the following groups: Native American, Egyptian, Asian, Peruvian, and Maori. The first analysis was used as a model that pertains to the highly varied and geographically dispersed group of specimens characteristic of the Middle Pleistocene. In this analysis, each specimen was treated as its own operational taxonomic unit (OTU), along with some Plio-Pleistocene hominids as OTUs. The second analysis was a model pertinent to the cladistic studies as they have been frequently applied to *Homo erectus sensu lato*. This analysis grouped the individual specimens into geographic regions/populations, using Plio-Pleistocene hominids as outgroups.

In neither analysis did modern *Homo sapiens* form a strict monophyletic group. The implications are that the characters traditionally used in hominid systematics are inappropriate, and therefore in need of revision. Moreover, it appears to be a perilous endeavor to apply species designations to fossil hominids based on the results of the cladistic methodology.

#### Primate origins: role of evolutionary change in limb pattern formation.

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The fossil record has recently yielded early primate skeletal remains that preserve most bones of the hands and feet. These fossils reveal that the first primates share with extant lemurs, anthropoids, and tarsiers derived hand proportions not observed in the forelimbs of their close relatives, the tree shrews (Scandentia) and plesiadapiforms. Specifically, early primates have proximal phalanges that are long relative to their palm giving them a prehensile hand—an evolutionary innovation enabling primates to more effectively grasp not only slender branches but also small food items such as insect prey.

Limb development was studied in staged mammalian embryos to investigate the role of digital ray patterning in the evolution of mammalian hand proportions. Limb pattern formation was examined in serially sectioned embryos of *Microcebus murinus* from the Hans Bluntschli collection and in cleared and stained developmental series of rodents (*Rattus*), artiodactyls (*Sus*), and marsupials (*Didelphis*, *Monodelphis*, and *Caluromys*). Compar-

ative analysis shows that the derived finger proportions of primates are generated during the early phases of digital ray patterning and segmentation, when the interzone cells marking the presumptive metacarpal- and interphalangeal joints first appear. In contrast, *Rattus*, *Didelphis*, and *Sus* all have metacarpals that are much longer than the proximal phalanges following digital ray segmentation. Variation among higher taxa in relative digit proportions therefore has high developmental penetrance; that is, adult differences are observed at early ontogenetic stages.

Experimental research on digital ray segmentation in model organisms indicates that the relative lengths of the phalanges and metapodials vary according to proximodistal variation in the expression domains of signaling molecules involved in either chondrogenesis or joint interzone formation and apoptosis. The paleontological, comparative, and developmental data are therefore consistent with the hypothesis that the early Cenozoic origin of primates involved an evolutionary change in digital ray pattern formation ultimately yielding a grasping, prehensile hand.

#### The frequency of tuberculosis and treponematoses in a new Middle Mississippian sample from central Illinois.

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One of the most important and enduring contributions of paleopathological research is the emphasis on the dynamic interaction between human and pathogen biology and culture change. This study represents the first step in understanding the biocultural ramifications of infectious disease in a moderately sized agricultural Mississippian population from west-central Illinois. Here we compare the frequency of skeletal tuberculosis and treponematoses in the adult skeletal sample from the Orendorf site (AD 1150-1250), with cases documented from regional Mississippian, Late Woodland and Oneota samples.

Using a differential diagnosis model, skeletal occurrence is divided into two categories based on the confidence of the diagnostic result: cases that fully satisfy the diagnostic criteria of tuberculosis or treponematoses, such as those that exhibit "classic" markers of the disease, and cases that are possibly affected by these diseases as suggested by the differential diagnosis but lack classic skeletal signs. A total of 117 adults are examined, and when the categories are combined, 2.5% (3/117) have evidence of tuberculosis and 6% of the individuals (7/117) exhibit evidence of treponematoses.

While comparative studies remain problematic since many publications report the presence of infectious disease by individual case or based on the number of elements affected rather than within an epidemiological framework, the rates found at Orendorf seem consistent with contemporary Mississippian populations. Factors that serve to support infectious disease load at Orendorf likely include population size, sociopolitical interactions, warfare-related stress, and non-infectious disease load.

#### Time scales for genetic diversity in Melanesia: A look at some evidence for estimates of 100,000 years or more.

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Studies of genetic diversity at the DNA level provide data for estimating time scales related to population history. These estimates are not very reliable, however, because so little is known about the right models to use. It is not just a matter of using the correct mutation rate because the demographic assumptions of the model can also make large differences. Demographic assumptions are unspecified for phylogenetic analyses but are critical to age estimates based on genetic diversity sampled within species.

Most analyses of genetic diversity in Oceania suggest ages generally consistent with archaeological and fossil evidence that date back to not more than 50,000 years ago. Genetic time-scales estimated by phylogenetic analysis of mitochondrial DNA (mtDNA) and population genetic analysis of diversity on the Y chromosome, with the explicit assumption of exponential population growth, provide concordant estimates. But, as these analyses have assumed minimal drift, the time depth may have been underestimated.

Other studies have also provided evidence of much older DNA variants in Oceania. A global survey of diversity in the beta-globin gene region revealed an allele that was present only in PNG, Vanuatu, and aboriginal Australians. This allele is ancestral not only to substantial allelic diversity found in the rest of Asia, but also to a minor component of the diversity found in Europe and Africa. Assuming a moderate level of genetic drift the age of this allele was estimated at approximately 200,000 years. Unlike mtDNA and Y chromosome diversity, beta-globin diversity shows no signal for population expansion. But, what are the consequence of assuming a population expansion model, as was done for the Y chromosome data? To what extent are age estimates dependent on model assumptions, and to what extent are they given by data?

### Arch growth and development in American Black children.

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Size and shape of the dental arches are dynamic: Size and shape change from the deciduous to permanent dentitions, but also systematically within the two dentitions. Information to date is, however, based only on samples of European extraction. The present study reports on the longitudinal changes in arch size in 52 American black children from middle Tennessee studied longitudinally between 3 and 18 years of age. Homologous landmarks were located on the deciduous and permanent dentitions, namely 1) the midpoint at the occlusal-facial aspect of the central incisors; 2) the crown's heel of dm2 and P2; and 3) the mesiolingual cusp of dm2 and P2. Data were collected as Cartesian coordinates, with measurements generated trigonometrically. Analysis of variance was performed using generalized linear models to account for the longitudinal nature of the data, with appropriate within- and between-group error terms. Overall, sexual dimorphism was substantially less than reported for Caucasoids, though arch dimensions did tend to be larger in males. Arch depths did not change systematically during the deciduous phase (ca. 3-10 years), but they were shorter and decreased significantly during adolescence (ca. 10-18 years). Arch widths increased significantly during the deciduous dentition, but there was no patterned change within adolescence. Arch form (the ratio of depth to width) decreased significantly with age within the deciduous dentition and again within the permanent interval. That is, both arches got shorter in relation to width, evidently due to tooth drift and change in axial inclinations. All of the arch dimensions in these American blacks were significantly larger than in Caucasoids at all ages.

### Hand use preference and other lateralized behaviors in *Lemur catta*.

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The existence of hand preference in prosimians may reflect the beginnings of brain lateralization in anthropoid evolution. Handedness has been studied in several prosimian species including the ring-tailed lemur, a species native to Madagascar. Ring-tailed lemurs are diurnal, live in multimale/ multifemale troops, and are partly terrestrial.

For this study, fourteen ring-tailed lemurs were observed at the Duke University Primate Center. The lemurs were housed as two separate troops, one caged and one semi-free ranging. In contrast to other studies that relied primarily on ar-

tificial feeding, hand preference and other potentially lateralized activities were studied during daily behaviors such as foraging and locomotion. Variables included reaching, holding, initial locomotion, whole body turns, scent marking, and head and tail positioning during rest periods.

Based on z-scores, 3 lemurs had a right hand preference for reaching and holding monkey chow, 7 showed a preference for whole body turns to the right, and 2 lemurs preferred to rest their tails to the right of the branch, while 1 showed a preference for the left side. Of the 7 males, 1 consistently initiated scent marking with the left arm and 6 showed no preference.

Duke University Primate Center #722.

### Behavior of a black and white colobus group during intergroup encounters.

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This research attempts to describe the behavior of a black and white colobus (*Colobus guereza occidentalis*) group during intergroup encounters and to test the hypothesis that group members perform more social behaviors during intergroup encounters. Observations were taken over an eight week period in the summer of 2000 in the Kibale National Forest of Uganda.

Ten intergroup encounters were witnessed, only four of which were aggressive. Only adult or large subadult males participated in intergroup aggression.

Scan samples taken every fifteen minutes both during and not during intergroup encounters reveal that a significantly higher percent of adult females, subadults, and juveniles were within five meters of an adult male during intergroup encounters and that a significantly higher percent of individuals groomed and played during intergroup encounters. A significantly lower percent of individuals were inactive during intergroup encounters and there was no significant difference in the percent of individuals engaged in agonism or feeding/foraging behavior. Implications of these results will be discussed.

### Limb preference in *Pan paniscus*.

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The study of handedness is important in that it can give insight into the evolutionary development of the human brain. The predominant use of a particular limb is an effect of increased complexity and compartmentalisation of the brain important in the development of language and other cognitive abilities. When the species-level right limb preference found in modern humans evolved is debatable. It has been suggested that its antecedents can be found in the earliest hominids or possibly

even earlier. Reconstruction of tool manufacture by early hominids (1.9 mya) and more recent tool uses (0.3-0.4 mya) suggest a right hand preference. Inferential models based on extant nonhuman primate behaviour can supplement the limited fossil evidence. Extant apes do not show a species-level hand preference when picking up objects or while performing simple reaching tasks. However, species preferences have been recorded during more complex tasks e.g. carrying, object manipulation and leading limb in locomotion.

The majority of research on ape handedness has focused on *Pan troglodytes*. In the present study limb preference in the bonobo (*Pan paniscus*) is examined. Twenty one individuals (9 adults, 5 subadults and 7 juveniles) from 3 groups located in Berlin, Stuttgart and Twycross (U.K.) were observed for at least 25 hours each, with all of their daily routine covered. All types of limb use were recorded by focal sampling. Preliminary results suggest that strong individual preferences are present in *Pan paniscus* for certain tasks which is similar to the pattern found in *Pan troglodytes*. There is a tendency for individuals to be strongly lateralised for tool use in particular with other tasks showing much more variability.

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### Analysis of Neanderthal temporal bone morphology using geometric morphometrics.

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The temporal bone is the location of several traits thought to differentiate between Neanderthals and modern humans, which have been studied either qualitatively or with traditional multivariate methods. This study has applied three-dimensional geometric morphometrics to the complex morphology of the temporal bone in order to quantify traits that cannot be measured linearly, to evaluate the proposed autapomorphies and to discern phylogenetic relationships.

Fifteen temporal bone landmarks were recorded using the Microscribe 3DX digitizer. The specimens studied include 9 Neanderthal individuals and 240 modern humans, the latter representing eight populations of 30 spanning the extremes of the modern human geographical range and a time depth back to the Epipaleolithic. The analysis was conducted in two complementary steps so as to include as many landmarks and as many fossil specimens as possible. The first step included 4 fossil specimens and all 15 landmarks, while the second included all 9 fos-

sils and 13 landmarks.

The specimens were superimposed under Generalized Procrustes Analysis using GRF-ND and Morpheus. The fitted coordinates were analyzed statistically by PCA and DA. A better resolution between Neanderthals and modern humans is achieved in both PCA and DA in the second step of analysis. A highly significant but very small size-related effect is observed in step 1, but not in step 2. Although the modern groups overlap extensively with each other, they do show some geographic clustering. The closest modern group to Neanderthals is Greenland Eskimos while Europeans are second (step 1) and third most distant (step 2).

The traits that drive the separation between Neanderthals and modern humans are: the difference in height between the mastoid process and the juxtamastoid eminence; the more medial placement of this eminence in Neanderthals; the more lateral position of lateral landmarks and the more medial position of medial ones in the fossils; the more coronal orientation of the vaginal plate of the styloid process in the fossils; the smaller size of the mastoid portion of the bone both antero-posteriorly and supero-inferiorly; and, in step 1, the more robust zygomatic process of Neanderthals. Supported by NSF (Dissertation Improvement and NYCEP RTG), AMNH, and Onassis and CARE Foundations.

#### **Morphological variability through ontogeny of the modern human chin.**

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Persistence of a prominent mental eminence throughout ontogeny has been touted as a distinguishing characteristic of Late Pleistocene modern humans. Although variability in the prominence of the chin in modern humans is recognized by those who use its presence as a phylogenetically relevant characteristic, the variability in the development of the chin has not been documented. In order to assess the validity of predicting adult morphology from juvenile mandibles this study documents variability in mental eminence development at various ontogenetic stages.

Morphologic variability of the mental eminence and projection of the symphysis are documented through 54 metric and non-metric data points on 50 mandibles between 1 year and 20 years of age (at death) from the Hamann-Todd Osteological Collection. Correlations are found between age and degree of mental eminence expression ( $r=0.80$ ) and between age and maximum depth of the *incurvatio mandibulae* ( $r=0.76$ ). These results indicate that the anterior symphyseal surface morphology of juvenile mandibles is an accurate predictor of adult morphology when any evidence of structures associated with a hu-

man chin is present in a juvenile and these structures will become more pronounced with age. Although symphyseal angle does not correlate with age ( $r=0.36$ ), 28.5% of the sample falls within the range of European Neanderthals for the symphyseal angle. Therefore, when considered relative to ontogenetic stages the degree of mental eminence expression and maximum depth of the *incurvatio mandibulae* may be more phylogenetically relevant characteristics than symphyseal angle.

#### **Diet, dental wear, and artificial cranial deformation: the significance of cranial shape in determination of dental wear patterns.**

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Recent research has indicated that dental wear patterns are a reflection of craniofacial morphology rather than of the subsistence adaptations of past human groups (Glantz, 2000). Relatively wide and, to a lesser extent, weakly flexed cranial bases co-occur with flat planes of wear on first molars, regardless of the group's subsistence classification. In the present study, the connection between craniofacial morphology and dental wear patterns is further investigated in a sample of individuals with various types of artificial cranial deformation. The extreme morphology that is the result of artificial deformation practices is expected to elucidate the relationship between dental wear and craniofacial configuration. Two competing hypotheses are tested. The first hypothesis states that variations in cranial breadth, particularly in bi-auriculare, will be reflected in the pitch of the occlusal table. The second assumes that the degree of basicranial flexion is a strong indicator of occlusal plane pitch. The use of artificially deformed crania in this study is also intended to address the possible co-variance between cranial breadth and basicranial flexion.

The sample includes artificially deformed crania ( $n=60$ ) from archaeological populations from Peru and Bolivia. These groups are compared to non-deformed individuals from the same sites and from other areas such as Europe, North America, and the Near East ( $n=60$ ). Subsistence adaptations are known and include hunter/gatherers and agriculturalists. Occlusal wear plane angles, cranial deformation types, and fifteen measurements of the cranial base and inferior aspects of the craniofacial skeleton were recorded. Analysis of variance and regression analyses were performed.

Preliminary results indicate that as inferior aspects of the craniofacial skeleton become wider, occlusal planes of wear become flatter and this pattern of interac-

tion is independent of subsistence classification. The relationship is more complex with regard to the degree of basicranial flexion. These results confirm past research on the etiology of dental wear patterning in that craniofacial morphology better explains dental wear patterns than diet or para-masticatory behavior.

#### **Pleistocene *Homo* and the genetics of speciation.**

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The problem of delineating species among Pleistocene hominids has, been repeatedly addressed from the perspective of species definitions. Typical among these treatments have been rampant applications of cladistic methodology, and discussions about species along these lines typically degrade into arguments about "good" homologies and "bad" symplesiomorphies. Such discussions lack any recognition that the methods of phylogenetic systematics, whose ability to falsify hypotheses of relationship depend on the underlying branching process of speciation, are methodologically vapid when applied to the process of speciation itself. The proper study of speciation and its dynamics is evolutionary genetics, which provides the only mechanism for falsifying statements about the specific validity of fossil groups.

This paper discusses the genetics of speciation and the ways that fossil evidence can test species hypotheses among Pleistocene hominids. Any species definition based on reproductive isolation between species and gene flow within them makes testable predictions about the morphological variability within and between fossil populations. I demonstrate by means of computer simulation that the vagaries of heritability and drift, even in the face of strong selection, ensure that most discrete phenotypic traits among closely related species will not conform to the autapomorphic expectations of a phylogenetic species concept. This expectation is confirmed by an empirical example, from the relationships of Plio-Pleistocene *Australopithecus* and *Homo*, where the pattern of speciation cannot-even in principle-be recovered with phylogenetic methods, because the refutationist criteria of cladistics cannot be met by the evolutionary genetics of the organisms.

In contrast, we can apply population genetics to identify speciation events with clear falsificationist criteria based on reproductive isolation. Such methods actively use information about both discrete trait frequencies and continuous trait variances that phylogenetic methods have no choice but to discard. Quantitative genetics provides clear predictions about the genetic and phenotypic relationships of groups under partial and complete isola-

tion, and I have extended these predictions, using computer-intensive resampling, to apply to limited sets of fossil data. I applied computer simulation to derive the limits of such methods, which are surprisingly robust to limited evidence. Finally, I apply genetic methods to the question of speciations in Pleistocene *Homo*, with worked examples from the Middle Pleistocene and Late Pleistocene. These tests show that no speciation within Pleistocene *Homo* can at present be substantiated by fossil evidence. Further, for the geographic group with the most fossil evidence, the European Neandertals, speciation is refuted by the data.

**Ancestor descendant relationships in North American Arctic prehistory: Ancient DNA evidence from the Aleutian Islands and the Eastern Canadian Arctic.**

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The genetic relationship between the bearers of prehistoric cultures is the subject of many heated academic arguments and the North American Arctic is no exception. This region's prehistory is characterized by several cultural replacement events that arguably also represent genetic replacement events. To assess the congruity between hypothesized cultural and genetic replacements, ancient DNA was extracted, and amplified from pre- and post-transition archaeologically recovered skeletal remains. One length and six restriction site polymorphisms were analyzed to determine the mtDNA haplogroup frequencies for each prehistoric "population."

In the Eastern Canadian Arctic >40 individuals were typed. The post-transition population, the Thule (100% A), is significantly different ( $p=0.006$  and  $p=0.003$ , respectively, 2-sided Fisher's exact test) from both the pre-transition population, the Dorset (100% D), and a hypothesized proto-historic Dorset remnant population, the Sadlermiut (46% A, 54% D). This result suggests a genetic replacement did coincide with the cultural replacement that occurred ca. 1000 AD. From the western Arctic, >35 prehistoric Aleut individuals were typed. The pre-transition population, the Paleo-Aleut (46% A, 54% D), is not significantly different ( $p=0.433$ , 2-sided Fisher's exact test), from the post-transition population, the Neo-Aleut (27% A, 73%D). This result is inconsistent with coincident cultural and genetic replacement events ca. 1000 AD.

The haplogroup frequencies were also used to assess the genetic affinities of these prehistoric groups when compared to published data from contemporary Arctic populations. The prehistoric Aleuts appear to share closer maternal ties with Northwest Coast Indians and Kodiak Eskimos than other Eskimos or Siberians. The

Dorset, or Paleo-Eskimo, appear to share maternal affinity with the Aleuts.

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**Size distributions of living and fossil primate faunas.**

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Body size is an important variable in primate paleobiological research because it covaries with virtually all significant ecological, physiological, locomotor, and life history traits. As such, body size distributions are a useful (albeit highly approximate) comparative measure of the relative breadth of adaptive diversity in fossil primate faunas. Previous studies have suggested that the size distributions of several primate faunas from the middle Miocene on reflect those of modern communities.

In this study, data on lower  $M_1$  crown area (a correlate of body size), age, and locality were compiled for 280 fossil and 100 extant primate taxa in order to reassess the range and distribution of sizes throughout the Cenozoic. In addition, relative age of origination and cladistic rank of higher taxa were included to evaluate the congruence between the primate fossil record and reconstructed phylogenetic history.

Whereas the size distributions of early Cenozoic primates were dominated by small taxa, large taxa dominated the primate record for the second half of the Cenozoic. Results indicate that there has been a successive increase in the mean and upper limit of body size ranges from the early Miocene to present. However, with few exceptions, the lower ranges of size distributions are truncated from the late Oligocene onward. This suggests that either small-bodied primates (those roughly below Kay's threshold) were extremely rare (8.3% of all the fossil primate taxa) or that a major taphonomic bias has drastically affected the primate paleontological record for this time-period. This analysis indicates a strong bias against small-bodied taxa in the latter half of the Cenozoic.

**Assessment of mobility among the prehistoric inhabitants of the Great Salt Lake wetlands.**

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Anthropologists often debate whether human populations seek to abandon mo-

bile lifeways in favor of sedentism whenever possible. The Fremont complex (c. 2100-500 B.P.) of the eastern Great Basin and western Colorado Plateau features initial widespread maize horticulture, proliferation of ceramics and enhanced architectural investment. Most scholars view this complex as a highly variable and opportunistic transformation of local foraging bands into a series of horticultural villages. Nevertheless, the nature and degree of mobility practiced by Fremont inhabitants of the Desert West remains largely unknown.

This research employs analyses of osteoarthritis prevalence to assess the degree and types of mobility practiced by Fremont period inhabitants of the Great Salt Lake (GSL) wetlands. Overall prevalence and velocity of polyarticular affliction of 12 major joint regions among 28 GSL adults is compared to 67 hunter-gatherer adults from the western and northern Great Basin as well as to 153 preagricultural and 287 agricultural adults from the Georgia coast.

Results indicate differential affectation among GSL males and females. Both sexes feature lower prevalence and slower velocities than other inhabitants of the Great Basin, but higher prevalence than Georgia coast samples. It appears that the introduction of cultigens among Fremont populations lead to a reduction in overall mobility, but not to the levels of sedentism enjoyed by Georgia Coast samples. Despite overall reduction, gender-based differences in mobility persist.

The data indicate that subsistence strategies used by Fremont period inhabitants of the GSL wetlands featured logistical utilization of the uplands by males and tethering to lowland marshes for females.

**Variability of brain size and body size during the last two million years of the evolution of *Homo* does not reflect postulated taxonomic diversity.**

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Taxonomy of hominins is based on studies of morphology of often fragmentary fossils. It is difficult to obtain sizeable samples of data for quantitative resolution of taxonomic uncertainties. Brain size (CC) and body size (BW) can be estimated from various parts of skulls and skeletons thus providing uniform data for a large number of individuals. BW and CC are also used in reconstructions of ecological and behavioral characteristics of earlier humans. The number of species of *Homo* is still debated between those who postulate presence of just a few chronospecies and those who advocate existence of many often coeval and sympatric species. We have compiled all available estimates of brain size and body size of the hominins. Follow-

ing consideration of the errors of estimates and uncertainties regarding dating and taxonomic attributions we were able to use estimates of cranial capacities (CC) and body weights (BW) of 177 individuals (not always the same for each variable) attributed to *Homo* and dated from 1.9 Ma to 10 Ka. For this analysis they were grouped into five "taxa": *H. habilis*, *H. erectus*, "archaics" (including *H. heidelbergensis* sensu lato), Neandertals and "anatomically moderns". Variances and coefficients of variation (CV) were established for CC and BW in each "taxon" and compared to those of living people and to those obtained by grouping data by time period irrespective of taxa. Variances of residuals around exponential regressions of entire data samples on date were also calculated. CV values of CC by taxon varied from 7.4% in "archaics" to 16.4% in *H. erectus* while those for groupings of coeval individuals extended from 11.1% for the period 300-10 Ka to 17.1% for 1.8 - 1.3 Ma, neither being significantly different from modern humans (11.6%). For BW the situation was similar though CV-s were higher (15.8%-23.8%) due to larger errors of estimates. The variance around the regression of BW on date was practically the same as in living people (SD = 13.1). Taxonomic diversity of the genus *Homo* cannot be proven by the analysis of the largest existing sample of basic quantitative characteristics of ecological and possibly behavioral significance.

#### Identical twins from Neolithic site Llord (Castellar de la Ribera) in Catalunya, Spain.

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While twins were undoubtedly present in early human populations, no physical evidence in the form of human skeletal remains has been described to date. Comparison of dental crown morphology, which is under strong genetic control, provides one means of determining twin zygosity with a high degree of reliability (around 95%).

During the examination of dental remains of approximately 50 individuals (535 teeth) from the 17 Neolithic sites near Solsona in Catalunya in Spain, a striking similarity of the dentitions of two individuals from the site Llord (cast tomb 1) has been observed. The radiocarbon date of the site is 4290±130 BP.

The morphology of 25 permanent teeth of the 16-18 year-old individual I-A has

been compared to that of 24 permanent teeth of the individual I-B of the same age. Nineteen non-metric traits observed separately on the left and right side, enamel colour, tooth diameters, wear patterns and shape of the mandibles have been compared. The z-score profiles of the mesiodistal diameters (MD) of teeth of the individuals I-A and I-B on the means and standard deviations of the entire sample have been calculated.

Seven out of 36 non-metric traits present in both I-A and I-B dentitions rarely occur in the entire sample. Both individuals have large cusps 7 (grade 4) on the lower M1 and also on the lower M2 (grade 3) on both sides. The trait is absent in the rest of the dental sample while the frequency of the cusp 7 in Europe is low (<10%). Forty out of 45 non-metric traits are concordant between individuals I-A and I-B. Mirroring occurs in the number of lingual cusps and position of the main lingual cusp on the lower second premolars. The individual I-A has 2 cusps on the left P2 and 1 cusp on the right P2, while the opposite occurs in individual I-B, thus accounting for four discordant traits. The patterns of z-score profiles for MD tooth size were similar for both individuals. The pattern of dentine exposure on both dentitions was also similar.

The results suggest that the individuals I-A and I-B from Llord are twins and most probably monozygotic. Supported by Australian Research Council small grant.

#### Foraging, feeding and defecation site selection as a parasite avoidance strategy of *Alouatta palliata* in a dry tropical forest

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Human and agricultural use of the dry tropical forests at the Ometepe Biological Field Station on Ometepe Island, Nicaragua has heavily fragmented the habitat of the mantled howling monkey, *Alouatta palliata*. As a result, the resources available to *Alouatta* have been limited. Since fruits and leaves that *Alouatta* regularly exploit represent possible intercepts for contaminated fecal matter, this study was conducted to determine whether *Alouatta* has developed strategies to avoid parasite infection for the maintenance of individual and group health.

Canopy position, canopy density, and tree type data were collected at sites of defecation and foraging and feeding over sixty-four hours of observation in May-June 2000. Twenty-five fecal samples were also collected and analyzed to assess parasite load. Ova of pinworms, and flukes, were commonly seen upon fecal analysis. While these endoparasites can be beneficial, as they can aid in digestion and help mix the gut contents in the cecum, an in-

roduction of an overwhelming abundance of these parasites to the feeding environment of *Alouatta* may be harmful. Consequently, *Alouatta* has employed site selection strategies to avoid soiling its food supply.

Results indicate that *Alouatta* foraged and fed at higher canopy positions than it defecated. While 59% of its foraging and feeding activity occurred in the upper quarter of the canopy, only 15% of its defecation activity occurred there. The lower quarter of the canopy was never used by *Alouatta* during foraging and feeding. The results also indicate that *Alouatta* defecated at more peripheral canopy positions than it foraged and fed. Over 66% of its defecation activity occurred in the outer third of the canopy, while only 26% of its foraging and feeding activity occurred there. In addition, the foliage density at sites in which *Alouatta* foraged and fed was much greater than the foliage density at sites in which it defecated. The results demonstrate the ability of *Alouatta* to minimize contact with soiled vegetation during foraging and feeding.

#### Changes in dietary behaviour over the life span and its impact on a French late Medieval population health (Saint-Laurent de Grenoble, France)

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In order to assess the diet and the changes in dietary behaviour during historical periods, a joint study including a paleoepidemiological investigation and an isotopic analysis of nitrogen and carbon (15N/14N, 13C/12C) has been conducted on a population of late Medieval from Saint-Laurent cemetery (Grenoble, France, XIIIth to XVth centuries A.D.). The studied sample consists in 25 individuals, ranging in age from neonate to adult stages. The aim is to establish the individual chronological sequence using an original procedure of sampling. This strategy provides two isotopic signals for each individual corresponding with two different periods over the life span. We specially designed a sampling protocol based on the growth and the development process of teeth and alveolar bone in order to assess changes around weaning period. Afterwards, it is possible to discuss the evolution of dietary behaviour during the lifetime and to determine the weaning status for each child by comparing the signal just before death to the signal averaging a longer period before death.

Results concerning the weaning period show that changes in 15N/14N occur around 3-4 years old. For the 5-9 years stages, a 'breast feeding-like' enrichment

in 15N has been observed. The hypothesis of physiological stress could explain this original observation.

This work was supported by Institut Danone.

### **A preliminary analysis of the birth records for slave women from the Bremono Plantations, Fluvanna County, Virginia.**

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General John Hartwell Cocke was a wealthy Virginia landowner in the late 18<sup>th</sup> and mid 19<sup>th</sup> century known for his anti-slavery sentiments. His home, the Bremono Plantations in Fluvanna County, offer undisturbed archaeological remains and an extensive collection of archival data.

The reproductive records of 25 slave women between the years 1791 and 1811 were analyzed. A total of 76 children were born, but only five infant deaths were recorded in these documents. Women spent an average of six years involved in child-birth (range:1-15 years). The number of children born ranged from one to seven per women (with a mean of three). Birth intervals ranged from one to four years (with a mean of two).

Other slave records at Bremono listed the tasks these women performed on the plantation. There were six field hands, four house servants, two cooks, two spinners and one spinner/cook. Tasks were unknown for 10 women. Bremono slaves work an estimated 12 hr. day. Field hands were allowed 45 minutes to nurse infants, while those working closer to the quarters (i.e. house servants) were only allowed 15 minutes. However, it is uncertain how often women were allowed to feed infants during the workday, or if infants' diets were supplemented with artificial formulas.

Documentary evidence suggests that the diet of slave women consisted largely of salt pork and corn meal, with other vegetables such as potatoes and peas. These data also suggest that little or no prenatal care was provided to slaves at Bremono.

It is likely that the burden of bearing and raising children placed additional strain on slave women, many of whom were working long hours at strenuous tasks. Also, low birth weights may have been common among infants here. Future work will focus on searching these archives for more data on diet, infant care and infant mortality.

### **Patterns of alveolar crest height change in postmenopausal women treated with estrogen.**

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After menopause, women lose postcranial and oral bone. Hormone/estrogen replacement therapy (HRT/ERT) reverses these losses. Whether alveolar crest height (ACH) change attributable to HRT/ERT occurs at specific sites within the alveolar processes or is generalized throughout the processes is unknown. The objective was to determine the pattern of ACH changes in women treated with HRT/ERT. The sample consisted of 49 healthy postmenopausal women, who received HRT/ERT for 3 years. Full-mouth vertical bitewing radiographs were taken of each patient. Measurements of ACH were made from the cemento-enamel junction to the alveolar crest on the digital images of dental radiographs. Postcranial bone mineral density (BMD) measurements of the femur and spine were made with dual energy x-ray absorptiometry. Measurements were made from baseline and year-three images. A mean ACH change was calculated for each patient. In addition, for each patient, the sites with the greatest, 2<sup>nd</sup> and 3<sup>rd</sup> greatest changes were determined. Measurements of ACH change were tested for correlations (r) with the BMD measurements.

Over the 3-year study, the mean change in ACH had an average correlation of -0.24 with postcranial BMD change. The site of maximum ACH change had a correlation of -0.23 with BMD change, but the correlations dropped off rapidly for the sites with the 2<sup>nd</sup> and 3<sup>rd</sup> greatest changes (-0.14 and -0.12). The correlations for the site-specific changes were substantively weaker than were the correlations for generalized change. The results suggest that ACH change attributable to HRT/ERT is generalized and not site specific. In studies, of the effect of HRT/ERT on ACH, multiple ACH measurements should be made to minimize errors associated with site-specific measurements.

The study was supported USPHS grant DE09861, with additional support from Wyeth-Ayerst Laboratories and Smith-Kline Beecham.

### **Preservation of skeletal remains in European Pleistocene caves: changes to the protein and mineral components of fossil bone.**

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A potential solution to the important questions of modern human evolution and dispersal lies in the use of genetic information from Pleistocene fossil humans, but

the retrieval of authentic biomolecular material from these fossils has only rarely proved successful. The extraction of mitochondrial DNA from the Neanderthal individuals from Feldhofer and Mezmaiskaya has been encouraging, however these are isolated results and failure to recover biomolecular material from fossil human remains is much more common.

What makes the successful bones special? The answer lies in several factors affecting diagenesis, principally the biological processes of decay, the burial environment and the cumulative climatic history of the site. We have examined a series of Pleistocene and Holocene skeletal samples in an attempt to establish the unique attributes of specimens that contain well-preserved DNA. Thermal models based on the theoretical rates of decay of DNA provide a baseline for predicting which geographical regions and localities are more favorable for biomolecular survival.

The samples themselves have been subjected to a suite of well-established tests to determine the porosity, crystallinity, histological alteration and collagen content of the bone. The phenomenon of better preservation in caves compared with open sites is being investigated through careful sample selection and thermal monitoring of cave sites. Our results indicate that DNA survival exceeds predictions from theoretical models in particular burial environments.

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### **Alternative measurements for recording tooth crown size.**

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The traditional mesiodistal and buccolingual diameters of the crown record useful information about crown size, but they are very strongly affected by tooth wear. Even the slightest approximal wear reduces the mesiodistal diameter considerably. Many fossil specimens have to be excluded from study for this reason. It is therefore important to find alternative measurements that are less affected by wear.

One alternative is to measure the maximum diameters of molar crowns along two diagonals, from the mesial/buccal corner to the distal/lingual, and from the mesial/lingual corner to the distal/buccal. This avoids approximal wear facets at the contact points, whilst still recording at least some of the information in the traditional mesiodistal diameter. Another possibility is to measure the diameters of the crown at its cervix along the cement-enamel junction. In this position, there are no contact points to guide the definition of the mea-



surements, but there are other ways in which they can be standardised.

In developmental and morphological terms, there is no particular reason to prefer the traditional diameters over the alternatives, but it is clearly important to see how closely they are related and to assess their relative reliability in use. In order to make a fair test of their relationship, it is necessary to take the measurements on a series of completely unworn teeth. The opportunity for this came with a collection of 50 Medieval children's dentitions from the Royal Mint site in London. All were isolated permanent teeth which were either unerupted or had not been in occlusion very long. Preliminary trials allowed clear definitions for the measurements to be drawn up. Once this had been done, the alternative measurements were found to have intra- and inter-observer errors as low as the traditional diameters. It was also found that all the measurements were strongly related to one another in most teeth. This implies that they are indeed recording similar aspects of crown size.

#### **Length of time in U.S., acculturation status, and overweight and obesity among Latinos in two urban settings.**

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With obesity reaching epidemic proportions in the U.S., there is increasing interest on its environmental influences. The goal of this study is to examine the association of length of time in the U.S. and acculturation status with overweight and obesity among low-income Latino adults from Hartford, CT and Tampa, FL.

We collected data on acculturation status, including primary language, birthplace, attitudes and beliefs, and cultural practices, and took weight, height, and skinfold measurements.

In general, adults from both samples were overweight or obese. For example, the average Body Mass Index (BMI; weight-for-height<sup>2</sup>) was 27.63 ( $\pm 5.51$ ) in the Tampa sample, with 68% of subjects being classified as overweight or obese, according to the Centers for Disease Control and Prevention BMI cut-points. After adjusting for age, there was a statistically significant positive association between length of time in the U.S. and BMI. In Tampa, BMI was 24.29 ( $\pm 4.4$ ) for subjects living in the U.S. for one year or less and 29.26 ( $\pm 5.58$ ) for those who had been in the U.S. five or more years ( $p = 0.01$ ). Moreover, Adults who had been in the U.S. for five or more years were more likely to be classified as overweight or obese, while those in the U.S. one year

or less were more likely to be classified as underweight ( $p = 0.021$ ).

These findings document an association between length of time in the U.S. and overweight and obesity among two samples of low-income, inner-city Latino adults. In this presentation we will examine some of the differences between the two study samples, the role of acculturation status on overweight and obesity, and the possible environmental influences (e.g., changes in diet and physical activity) on weight gain.

#### **Costs and benefits of spatial position in primates: The feeding competition model.**

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Individuals that live in social groups often have different fitness costs and benefits depending where they are located in the group. Within-group spatial position is determined by three major factors; 1) food distribution, 2) predation, and 3) social factors. Since most primate studies have not simultaneously investigated both feeding competition and spatial patterns, few studies have determined the effect of food distribution on spatial preferences. Based on theoretical considerations and observed behavior, a feeding competition model was developed and subsequently tested with published reports of primate spatial patterns.

Two measures of food distribution are predicted to have the strongest effects on spatial position; 1) food depletion rate and 2) food abundance. When foods are depleted quickly, within-group scramble competition is prevalent and dominant individuals should prefer locations at the front edge of the group. Foods distributed in large rare patches should promote within-group contest competition, and dominant individuals should prefer central spatial positions. When food resources have medium depletion rates, producer-scrounger relationships can arise. Producer-scrounger models predict that dominant individuals will be located in the front-center of the group in order to both monitor food discovery by conspecifics and to reduce the distance between themselves and individuals who discover food. This relationship changes if primates have prior knowledge of food distribution. When rare food resources are known, individuals should prefer the vanguard position in order to be the first individual at a food patch.

Published reports of primate spatial patterns support the hypotheses predicted by the feeding competition model. However, in some species the presence of infants was an even more important determinant of spatial position. Because infants

are more susceptible to predation and are attractive to conspecifics, this pattern illustrates that predation and social factors also play a major role in determining spatial preferences in primates.

#### **Microwear of the mandibular third premolars of Japanese monkeys (*Macaca fuscata*).**

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Dental microwear has revealed dental use of human and non-human primates (Hojo, 1996; Ryan, 1979; Ryan and Johanson, 1989; Teaford, 1988; Walker, 1984; Williamson, et al., 2000). Japanese monkeys (*Macaca fuscata*) have sloped and sector-shaped mandibular third premolars (P<sub>3</sub>s). The sector-shaped P<sub>3</sub>s have two occlusal regions; the elongated sloping crests on the mesial side and the shorter sloping area on the distal side. In the present study microstriations and micropits on the occlusal surfaces of P<sub>3</sub>s of Takasalcayama Japanese monkeys were investigated. High-resolution impressions were made from the occlusal surfaces of the P<sub>3</sub>s using "President Light Body" polyvinylsiloxane (Coltene/ Whaledent). The sputter-coated epoxy resin casts of P<sub>3</sub>s made from impressions were examined using micrographs of an ABT SX40A scanning electron microscope at the magnification ranging from 10X to 500X. Regarding the microstriations on the elongated sloping crest on the mesial side, the first sample showed longer and thicker (171.5  $\mu\text{m}$  long and 14.5  $\mu\text{m}$  wide on average) and the second sample showed shorter and narrower microstriations (114.8  $\mu\text{m}$  long and 12.0  $\mu\text{m}$  wide on average). These small regions showed the differences of microwear. As for the first sample, the short sloping region on the distal side next to the elongated sloping crests consisted of two different parts; the micropitted part, and the parallel-microstriated part. On the occlusal surface of the former the micropits were 33, about 45.3  $\mu\text{m}$  long and 30.3  $\mu\text{m}$  wide on average, and on the occlusal surface of the latter the microstriations were 20, about 196  $\mu\text{m}$  long, and about 26.9  $\mu\text{m}$  wide on average. The microstriations on the distal crest were longer than those on the mesial. These results were obtained using "Microwear image analyzing software" (Ungar, 1995). The micropits of P<sub>3</sub>s of Japanese monkeys might be caused by hard grains in their diets, and the part full of micropits might be used for crushing hard foods. The parallel microstriations on the elongated crest might be mainly caused by contact between the sharp edges of the upper canine and the P<sub>3</sub> by honing (canine/premolar complex) during threat manifestation.

### Multivariate assessment of body shape in A.L. 288-1 ("Lucy").

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The partial *Australopithecus afarensis* skeleton A.L. 288-1 ("Lucy") has played an important role in the assessment of the locomotor repertoire of early hominins. Specifically, it has been argued that "Lucy" possessed shorter femora than *Homo*, making her a less efficient biped than members of our own genus. This study compares "Lucy" to a sample of African ape (n=53) and recent human (n=731) skeletons. Skeletal trunk height (STH), tibial length (TL) and radius length (RL) were predicted for "Lucy." TL was predicted from human and nonhuman hominoid regressions; RL was predicted from an ape regression only, since forearm foreshortening occurs relatively late in human evolution (Asfaw *et al.*, 1999). Predicted TL, RL, and their associated 95% confidence limits were then included with femoral head diameter (FH), femoral length (FL), humeral length (HL) and STH in a PCA. Results indicate that in body shape "Lucy" is more similar to African apes than to humans. Her ape-like affinities are largely the result of two phenomena: 1) a long RL, and 2) the allometric consequences of small body size.

Bivariate allometric plots reveal that A.L. 288-1 has an FL (and HL) of the length expected for a human of her body mass. Humans show slight positive allometry in FL to body mass - unusual, since most mammals, including the African apes, exhibit a subisometric relationship of FL to body mass. As Franciscus and Holliday (1992) first suggested, "Lucy" lies near the confluence of the ape and human lines, and thus cannot resolve the issue of lower limb elongation in *Australopithecus*. However, larger specimens referred to *A. ("Paranthropus") boisei* fall clearly among early and recent *Homo*, and not among African apes. Thus, it is predicted that larger *Australopithecus* individuals, even members of a species as early as *afarensis*, will tend to have relatively longer femora than both African apes and smaller congeners such as "Lucy".

Data collection supported in part by NSF (#SBR9321339) and the L.S.B. Leakey Foundation.

### Studying the brain with Washburn: some reminiscence.

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Having always regarded myself as the "black sheep" of the Washburnian fold, I have never agreed with his publications regarding the terminal role of the brain in

human evolution. Rather, I have always believed that the brain was a continuously evolving organ from the beginning of hominid evolution. Bipedal locomotion could not have evolved without changes in the brain. Part of our disagreements grew out of his rejecting me as a student when I decided I had to take some neuroanatomy courses before understanding human evolution. Washburn believed that I would not become a physical anthropologist if I immersed myself into neuroanatomy, and would be instead caught up in neurological details. He was wrong, but also prescient in that neuroanatomy simply wasn't a viable or popular undertaking in physical anthropology, and even today remains one of the least studied areas of the discipline. If I hadn't stayed in Physical Anthropology at Columbia and taken up league with the devil brain endocast, I would have perished. Despite our disagreements, and eventual rupturing of relationships, I remain grateful for the support that Washburn gave me early in my graduate career. Otherwise I wouldn't be here to share these and other anecdotes.

### Dental maturation assessment using computed tomography in *Pan paniscus*. Implications for early hominid studies.

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An important amount of data about "chimpanzees" (*Pan troglodytes*) have improved the earlier scheme of ape dental development. These data include age estimates at which calcification of tooth crowns and roots may be observed. However, *P. paniscus* is always absent from "chimpanzees" cross-sectional samples. This situation possibly biases the interpretation of early hominid dental maturation when one aims to see whether patterns documented for fossil hominids demonstrate features in common with humans, with apes, or are unique using possible discriminating criteria. Indeed, Kinzey, in his study on dental eruption in *P. paniscus*, noticed its tendency for the eruption of lateral permanent incisors to be delayed, compared to the common chimpanzee. Importantly, this distinction within chimpanzees does not exist between extant humans and *P. troglodytes*.

Using computed tomography, we undertook the first study on permanent tooth crowns and roots calcification in the numerous *P. paniscus* specimens housed at the "Musée Royal de l'Afrique Centrale." We found that some currently-used discriminating criteria between *P. troglodytes* (supposed to represent "chimpanzees") and extant humans may not be useful at all as long as *P. paniscus* dental maturation is

not documented. For example, we found that overlapping crown formation between permanent molars (MI/M2 for example) is not demonstrated by all pygmy chimpanzees, as it frequently occurs in extant humans (individuals or populations). This is an important point to emphasize because molars delay has often been cited to mark the prolonged developmental period of extant humans. These results mean that further investigations are needed before interpreting early hominid developmental patterns and putative differential life histories (i.e., "more human" or "more chimpanzee").

### One or many species?: A method for comparing Middle Pleistocene and modern human morphological variation.

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The hypothesis that multiple species of hominids lived in the Middle Pleistocene (MP) is based, in part, on the premise that morphological variation during this period exceeds that present within any single known related species, including extant *Homo sapiens*. However, this hypothesis is difficult to test for a number of reasons, two of the most important being:

1. The number of fossil specimens is limited, making accurate, comparative estimates of variation problematic.
2. MP hominids lived for hundreds of thousands of years longer than have modern humans (MH) from the Late Pleistocene/Holocene, leading to a possible temporal bias when comparing the two groups.

To redress these problems, we developed a simulation model that tests whether MP variability exceeds that found in MH.

First, we measured 21 metric and 16 non-metric traits for all complete or nearly complete MP and MH crania, as well as a sample of recent humans from diverse locations. We then used computer simulation to repeatedly sample equal time "slices" from the MH and MP groups. A multivariate index of morphological variability, based on all 37 measured traits, was calculated from all specimens within each time slice. This procedure was repeated 1000 times to generate a distribution of variability for both samples. In the final step, we compare these two distributions, using standard resampling techniques, under a null hypothesis of no difference in morphological variability between MH and MP hominids. Here, we report the results of this work.

### Frontal sinus size: Sex, population and metopism affinities.

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The relationship of frontal sinus size to sex differences (Hanson and Owsley, 1980) and climatic influences (Koertvelyessy, 1972) have been noted but not fully investigated. We assessed the correlation of frontal sinus features between sexes and among selected population groups including a re-assessment of frontal sinus size associated with metopism.

A complete survey of the Terry collection resulted in the identification of 78 individuals (4.5%) with metopism, similar to metopism frequencies in European populations. Radiographic examination indicated bilateral presence of sinuses in 83.3% of the metopic crania. A comparative random non-metopic control sample (N=77) was collected. All Greenland Eskimo crania in the NMNH collections (N=90) and a series (N=52) of crania from the Peruvian collections were also radiographically investigated. The latter two samples are not random representations of their respective populations; thus no metopic expression frequencies were quantified.

Results from the Terry Collection indicate that metopism does not infer the absence of frontal sinuses. There are observable differences in frontal sinus size between individuals with and without metopism, but these differences are statistically weak. There are size differences between Blacks and Whites in the Terry Collection, Black males being larger than White males, but White females being bigger than Black females. Sinus size differences by sex are seen all population groups studied, the Peruvians having the greatest difference, followed by the Greenland Eskimo. This variation may be influenced by the complexity of the internal sinus structures, females having these features to a greater degree. The results of this study show that the Greenland population possesses the smallest frontal sinuses, the mid-altitude Peruvian sample possesses a lower end intermediate sinus size, and the Terry Collection individuals have the greatest range in size, shape and asymmetry.

#### **An assessment of method in the study of developmental integration using the adult human cranial base.**

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Alterations in the rate or timing of developmental events that may cause phyletic changes when acted upon by natural selection are constrained or allowed by the *integration*, or covariation of characters. Studies of morphological and developmental integration are increasing in number

but are inconsistent in method and experimental objectives. Some investigators identify integrated characters in an *a posteriori* fashion, seeking to delimit independent phenotypic characters for use in systematics. Using a deductive approach, others test *a priori* functional and developmental hypotheses of a given structure. With landmark data from a sample of adult human basicrania, this study will compare analytical methods to characterize appropriate experimental objectives.

The most prominent methods found in the literature are matrix similarity tests, confirmatory and exploratory factor analysis and graphical modelling. Methods will be compared to discern the following: 1) Are the results method-driven? 2) What experimental schemes and objectives are most appropriate for the examined method? 3) Which methods might best address hierarchical patterns of integration? 4) Which methods allow for indices of integration?

Debate concerning the functional meaning of basicranial form has a long and important tenure within paleoanthropology. Invested in the debate are several well-developed functional and developmental hypotheses. Proposed functional complexes overlap and observed integration is hierarchical, making the basicranium an excellent structure to examine competing or complimentary methods.

By answering the above questions, methods may be placed in experimental contexts. In doing so, this study will allow a better understanding of the appropriate methodological definition of morphological integration.

#### **The role of osteocyte lacunae populations in interpreting loading history of bone.**

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Introduction: Regional variation in osteocyte lacuna population density (OLPD) has been proposed as a useful characteristic for interpreting loading history and metabolic state in limb bone cortices. However, this important hypothesis has not been rigorously examined in the context of *in vivo* strain data. We tested this hypothesis in a comparative context in five mammalian long bones, each with well established *in vivo* strain distributions: deer, sheep and horse calcanei (n=13), horse radii (n=10) and horse third metacarpals (MCIII, n=9). These bones experience habitual bending in a manner similar to what has been *inferred* for many anthropoid long bones. Two diaphyseal sections (50% and 65% of length) were examined using backscattered electron images (100X), and OLPDs (no./mm<sup>2</sup>), the fractional area of secondary bone, and porosity were quantified. Predominant col-

lagen fiber orientation (CFO) was determined using circularly polarized images of ultramilled sections of horse bones.

Results: Regional variations in OLPDs did not consistently correlate with the habitual strain distributions. Although all calcanei demonstrated significantly higher OLPD in compression vs. tension cortices (Horse: 650+/-71 vs. 599+/-110, Elk: 732+/-55 vs. 644+/-62, Sheep: 710+/-65 vs. 609+/-64; p<0.05 for all comparisons), MCIII demonstrated greater OLPD in tension versus compression (533+/-91 vs. 425+/-77). The horse radius showed greater OLPD in compression versus tension (522+/-128 vs. 478+/-138), though these variations were not statistically significant. Additionally, OLPDs did not correlate with trans-cortical strain magnitudes. Regression analyses between OLPD and other microstructural parameters revealed that the only R value exceeding 0.400 was with CFO in the horse MCIII (R=0.408, p<0.0001).

Conclusion: These data demonstrate that OLPD is not a useful characteristic for interpreting loading histories that involve strain magnitude, mode and distribution. However, this and previously published studies demonstrate that predominant CFO may be a useful characteristic for interpreting strain-mode-specific (i.e., tension vs. compression vs. shear) loading history. This warrants further study since the limb bones of many anthropoids may receive such loading but are not amenable to *in vivo* strain measurements.

#### **Natal dispersal in the monogamous owl monkey, (*Aotus azarai*) of Formosa Argentina.**

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Monogamous primates are widely reported as living in small groups of an adult pair and one to three juveniles who are assumed to disperse soon after sexual maturity. Given the scarcity of long-term demographic data on monogamous primates, the ultimate causes of dispersal, as well as the age at which dispersal occurs, have not been systematically examined. This study investigated age of juvenile dispersal in ten groups of *Aotus azarai* in Formosa, Argentina. Survival analysis techniques for censored data were applied to 42 months of observations to construct age-specific probabilities of remaining in the natal group. Our results show that approximately 50% of the young dispersed around 24 months of age while the other half remained in the natal territory with the natal group for more than 36 months. Dispersal in *Aotus* has previously been

characterized as applying uniformly to all offspring within a set age range. Our results suggest a more complex social structure existing alongside a monogamous mating structure and raise the possibility of selective bequeathal of the territory to the offspring. The ultimate causes of delayed dispersal may be analyzed from the perspectives of offspring and parents. Offspring that do not leave the natal group after maturity may delay their reproductive lives but gain the advantage of prolonged access to, or inheritance of, the territorial resource. Parents that tolerate their offspring in the group beyond their age of maturity may increase the possibility that their territories will be inherited by their own offspring. Patterns of dispersal in this monogamous species may therefore reflect the reproductive value of a capital resource: a territory.

#### **Correlations between genetics and ethnology in the Pacific: A Y-chromosomal perspective.**

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Polymorphic markers on the human Y chromosome represent a cogent record of paternal lineage evolution. The analysis of extant diversity at these markers is an invaluable tool for deciphering human prehistory within the context of evidence from multiple disciplines. Hitherto, archaeological and linguistic records have dominated discourse on Southeast Asian prehistory and the colonisation of the Pacific. These different records are not competing but complementary. Genetics has largely confirmed ideas of Southeast Asian ancestry for Pacific Islanders. Ethnological classifications of Pacific islands swiftly followed the earliest European contacts and remain largely unaltered, although alternative classifications better encapsulating archaeological horizons have been proposed.

It has recently been suggested that extensive trading contacts have resulted in male lineages being substantially less geographically differentiated than female ones in the Pacific. This hypothesis explored here using Y-chromosomal data comprising 420 individuals from 18 populations throughout Southeast Asia and the Pacific. Analysing the data in a genealogical fashion allows potentially confounding post-contact admixture to be excluded from further analysis. Populations that demonstrate substantial European admixture are confined to the Eastern hinges of Oceania. The data clearly show that whilst trading contact can be visualised genetically, the distribution of paternal lineages'

throughout the Pacific largely retain the signal of initial settlement. Furthermore an analysis of molecular variance (AMOVA) recapitulates precisely the ethnological boundaries of Polynesia amongst other Oceanic islands

#### **Erfkroon: A new Florisian fossil locality in the Western Free State, South Africa.**

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While the presence of open air Pleistocene age fossil bearing sites in the Free State, South Africa has been documented, their occurrence was originally perceived as sparse by previous researchers due to these deposits association with rare or unusual taphonomic events. Research began in 1997 by Lee Berger, Steven Churchill, and James Brink has recognised within the Free State extensive open air Quaternary deposits rich in fossil-bearing sites. This study reports on one of a series of seventeen fossiliferous Middle to Late Pleistocene localities containing evidence of human occupation at the site of Erfkroon (28° 52'S, 25° 36'E), a farm on the Modder River 65 kilometres North-Northwest of Bloemfontein, South Africa.

Research conducted at Erfkroon (EFK) Locality 1 (28° 52' 07.3" S, 25° 35' 39.6" E) has focused on uncovering a palaeo-surface containing *in situ* deposits in the upper strata of the site. This palaeo-surface consists of hearth-like structures accompanied by Robberg type microlithic stone tools, charcoal, and burnt/processed bone. While the overall age of Erfkroon spans the Late Pleistocene from 200kyr - 10kyr, this stratum (1.2 - 1.3 5 bd) has been dated to 25 +/- 1.2kyr, a significant transitional MSA/LSA temporal period within central southern Africa, all dates currently based on IRSI dates. There are numerous deposits of this type in the Free State, yet until the present study neither Middle Stone Age, nor Late Stone Age open sites had been excavated or dated. Such sites show great potential to yield hominid remains that would give us important new insights into a poorly understood temporal period within Sub-Saharan Africa.

#### **Postcranial robusticity and rugosity patterning in modern humans.**

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Human skeletal material recovered from archaeological investigations is frequently so fragmentary that bone lengths and standard indices are hard to produce. Gathering information that does not rely

on generally complete skeletal elements would be useful, if the relationships between surface features and the underlying bone were better understood.

We report here the results of an analysis to relate the patterning of musculoskeletal markings (MSM) to classic indices of robusticity in modern human long bones. A scoring system was developed and tested to assess postcranial MSMs from selected sites on the long bones and clavicle. This non-metric system was used alongside classic metric measurements to collect data from a variety of populations from the UK, Americas and Africa, from a range of time periods.

Multivariate and factor analysis showed that the metric and non-metric data provided subtly different information about the skeleton, and that the correlations and disjunctions between the two sets of data allowed the distinction of groups in terms of ethnicity and sex. This shows that MSMs can provide useful accessory information to the common range of techniques for exploring human morphology.

We also discuss the extent of variability in the modern human postcrania and explore the possibilities for distinguishing the different effects of genetic history and ethnicity from lifetime activity on the modern human postcranial skeleton.

#### **Pathogenesis of dental root caries: biocultural approach.**

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The incidence of dental root caries differs spatially and temporally. Prehistoric people are reported to have suffered more dental root caries than modern people. However, the increasing number of elderly people in modern society has led to a rise of dental root caries incidence. This study reviews the incidence and nature of dental root caries in various populations, both from clinical data and from archaeological reports. Results show that specific behaviors and conditions lead to high dental root caries incidence, e.g. bad oral hygiene, narcotic addiction, frequent irradiation treatment among cancer patients, weighty soda consumption, and coca leaf chewing. Considerable differences in shape and location of dental root caries occur from different specific conditions and behavior. From this survey of dental root caries incidence in various populations, the author suggests the pathogenesis of dental root caries. This biocultural perspective on dental root caries sheds light on the relationship between cultural behavior and oral biology.

### Tyrosinase gene polymorphisms in global populations.

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We have analyzed two bi-allelic loci in the tyrosinase (TYR) gene located on chromosome 11q21, the codon 192 polymorphism (Y/S 192) and the -199C/A polymorphism in 13 ethnically and geographically diverse human populations of European, Asian, and African origins. Additionally, we have also analyzed a sample of albinos from Andhra Pradesh, India.

Allelic distribution at the Y/S 192 locus shows a characteristic pattern, with majority of the populations having a very high frequency of the A2 allele (>90% in 11 populations). The Spanish sample (the only European population in this study) shows a frequency of 48% of the A2 allele, which agrees with earlier published reports. Interestingly, the South Carolina Black population shows a high frequency of the A1 allele (31%), which is either absent or present in very low frequencies in the other three African populations studied. The reasons for this elevated frequency is not known, considering that the South Carolina Blacks have a low level of European admixture. The -199C/A locus is highly polymorphic in all populations and frequency of the D1 allele varies from 57% (New Guinea Highlander) to 95% (Chinese). Average heterozygosity for both loci was highest for the Africans (0.44) and lowest for Asians (0.05). Coefficient of genetic diversity is higher at the Y/S 192 locus (34%) compared to the -199C/A polymorphism (18%). Genetic distance analysis shows a clustering of populations of common ethnic and geographic origin.

The albino sample showed higher frequency of both A1 and D2 alleles compared to the non-albino South Indian sample, though they were sampled from the same region. Although these two polymorphisms at the TYR gene have not been confirmed to be associated with the albino phenotype, their functional implications will be discussed.

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### Preliminary report on Neolithic human remains from Nabta Playa, Egypt.

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With the Aswan High Dam Project as a catalyst, many human skeletal samples of Late Paleolithic (ca. 18-12,000 BP) and post-Neolithic (5400-650 BP) Nubians have been recovered. These samples have provided a wealth of physical anthropological data. Conspicuous by their absence are remains from the vast intermediate Neolithic period (ca. 9800-5400 BP). These peoples are little-studied, either archaeologically or osteologically. One major exception involves the archaeological research of the Combined Prehistoric Expedition (CPE) to the Nubian Desert of Egypt and Sudan. Discoveries at Neolithic sites near Bir Kiseiba and Nabta Playa suggest the inhabitants had a complex social system involving cattle worship and sacrifice. They were also builders of stone shrines, megalithic alignments, and calendar circles. However, their skeletal remains are generally lacking, and those that were recovered are poorly preserved. Thus, to date, studies pertaining to the remains are few in number-being limited to worn teeth and partial skeletons.

Recently, the CPE intensified efforts to recover and analyze human remains at Nabta. As a result, sample size increased, and the amount of dental, osteological, paleopathological, and other data obtained multiplied accordingly. These efforts culminated in the discovery of a unique Final Neolithic (5650-5400 BP) cemetery 30 km west of the main settlements.

This presentation will provide an initial description of the recently recovered remains. Standard physical anthropological observations will be presented, along with more specialized data pertaining to preliminary estimates of biological affinity-on a continent-wide and regional scale. These observations are intended to help better understand and characterize an enigmatic people, who inhabited a consequential yet little known time and place in North African prehistory.

Funding for the first author was provided by the Hierakonpolis Expedition (Dr. Raymond and Beverly Sackler, and the Friends of Nekhen) and the CPE.

### Cranial morphology of Dederiyeh No. 2 Neandertal child from Syria.

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In addition to the many Neandertal anatomical features reported before (Akazawa et al., 1999), the cranial bones show following morphology.

A lambdoid ossicle, 11.7mm in maximum diameter, was present on the right side. The maximum squamosal length and height were 47.4mm and 28.4mm, respectively, with the length-height index being

60.0. Superior to the external acoustic meatus is a possible suprameatal depression, extending 3 by 5mm. The articular and postglenoid tubercles are well developed. The mastoid process of the right side is 12.7mm in width and 13.1 mm in length. A rounded mastoid protuberance (Santa Luca, 1978), or anterior mastoid tubercle, was not recognized. The internal acoustic meatus was circular on the left side. The maximum occipital length was estimated at approximately 114mm. The lower limit line of the occipital torus, that is, the superior nuchal line curves and runs laterally. The frontal arc and chord are 99mm and 81.5mm, respectively, with the index being 82.3. The frontal curvature angle is 125.2°. Dederiyeh No.2, therefore, has a bulging frontal bone in sagittal section. The temporal lines and postorbital constriction were clearly recognized on the right frontal. The supraorbital notch is present on the right side with the supraorbital foramen on the left.

In comparison with Dederiyeh No. 1 child of almost the same age, Rock de Marsal, Pech de l'Aze and Skhul 1, we inferred some cranial variations among the Neandertal children.

### Prehistoric treatment of the dead: bone handling in the southeastern United States.

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The archaeological record from the Southeast shows that Native Americans were not averse to handling human remains. Indeed, some of these instances may have been related to ritual activity involving certain individuals who performed a specific function within the prehistoric society. However, other instances of bone handling involved individuals from the remainder of the community. The acts of trophy taking, the use of human bone as tools, the movement of skeletons, and the exhumation of remains with selective extraction of human parts point to some habitual use of human bone by certain members of prehistoric southeastern Native American groups.

This paper reviews artifacts from several southeastern states that clearly show modification of human skeletal elements into items of cultural significance within the disparate social contexts. At what point do the deceased cease to be viewed as human and become transposed into a spiritual icon and/or an item of utilitarian function? Given the present situation of NAGPRA, items such as these shed a different light on the perception of the sacred condition of the human skeleton by prehistoric Native Americans.

### The effects of recumbency and sleep on the blood pressure of women employed outside the home.

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The change in blood pressure (BP) from waking to sleep (commonly referred to as dipping) may be a risk factor for cardiovascular morbidity, particularly among women. Specifically, women whose BP does not dip may be at greater risk. The drop in BP is probably a function of both recumbency and sleep, but few studies have evaluated the relative contributions of these factors or assessed their reproducibility under real life conditions. The purposes of this study were to compare the relative effects of recumbency and sleep on the daily BP of women, and then to evaluate the reproducibility of these effects. The subjects of this study were 221 women (112 Caucasian, 71 African American, 38 Other; mean age = 37.8 ± 8.8) who wore an ambulatory BP monitor during a work day up to 3 times over the course of a three month period, with one month between repeat monitorings. BP's were converted to z-scores using the means of each individual monitoring. To evaluate the effects of recumbency and sleep, the standardized pressures were compared using ANOVA. Separate models were evaluated for the 3 monitoring periods. The results showed that during the first and second monitoring periods, recumbent awake BP's were significantly lower than the 24 hour mean BP ( $p < .05$ ), but substantially higher than the sleep BP's ( $p < .0001$ ), which averaged about one standard deviation (SD) below the 24 hour mean. During the third monitoring, recumbent systolic BP was not different than the mean 24 hour BP, but both systolic and diastolic recumbent BP's remained higher than sleep BP's ( $p < .0001$ ). Sleep BP's were consistently lower than recumbent awake BP's by 7 to 9 mmHg (assuming an SD of 10) over the 3 monitoring periods. These results suggest that while both recumbency and sleep lower BP, sleep has a substantially larger effect. They also suggest that when evaluating the extent of dipping, the bulk of the difference in awake and sleep BP is most likely due to the quality of sleep.

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### Nucleotide diversity at autosomal, Y-chromosomal, and mitochondrial loci of African apes and humans.

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The amount and pattern of genetic diversity in a species provides information on past population sizes and on the systematic relationships among populations and subspecies. Comparisons among maternally inherited mitochondrial DNA (mtDNA), paternally inherited Y-chromosomal DNA, and biparentally inherited autosomal DNA can reveal effects specific to each genetic system, such as sex-specific demographic histories or effects of selection. Here we provide comparative data from the African apes and humans in order to compare levels of diversity and examine the effects of selection and social structure across species.

We sequenced four unlinked noncoding autosomal loci (each ~1Kb), one Y-chromosomal locus (~3Kb), and ~350bp of the mtDNA 16S ribosomal RNA locus from humans, chimpanzees, bonobos, and gorillas. Sample sizes varied among loci and species, but were generally between 10 and 100 chromosomes. We also analyzed previously published mtDNA D-loop sequences.

Estimates of nucleotide diversity ( $p$ ) were calculated for all species and at all loci. Chimpanzees have greater autosomal  $p$  than gorillas, who in turn possess more than humans. Chimpanzees have much greater Y-chromosomal  $p$  than humans, while gorillas completely lack variation at this Y locus. Gorillas have the most mtDNA diversity, followed by chimpanzees and then humans. The different levels of diversity in the three systems are intriguing, particularly that gorillas have the highest levels of mtDNA diversity but the lowest Y diversity, suggesting a much smaller male versus female effective population size, consistent with their single-male, multi-female mating system. Implications for understanding the demographic histories of humans and our ancestors will be discussed.

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### Demographic analysis of the Voegtly Cemetery sample, Pittsburgh, Pennsylvania.

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The cemetery at the German Evangelical United Church (Voegtly Church) in Pittsburgh, PA was in use between 1833 and 1861, with a parish consisting primarily of Swiss-German immigrants. During this period, the Pastors recorded details of each burial, in the most extensive cases noting the decedent's name, country of ori-

gin, spouse, parents, cause of death, and dates of birth, baptism, death, burial, marriage, and immigration. In some cases only the minimum information was given, such as individual's name and date of burial.

The data given in the records were entered into a Paradox database and analyzed in an attempt to reveal demographic patterns within the burial population. Of the 896 parishioners who died during this period, 823 were buried at Voegtly. Of these, age at death data were available for 799. Three hundred and eleven (311) individuals were less than 1 year of age at death; 192 were between 1 and 4.9 years of age, 66 were between 5 and 19.9 years of age, and 230 were 20 years of age or older. The sex ratios were approximately equal. The most common cause of death given was stillbirth, followed by cholera, various unknown illnesses, and consumption.

Life tables were constructed for the population represented by the burial records. While the life expectancy at birth was quite low, (14.7 years), if one survived to 35, he or she could expect to live a relatively long life; as 80 of the individuals died after the age of 50.

Life tables were also constructed for the recovered skeletal sample and for the individuals represented by archaeological data (e.g., presence and size of coffin). Only 544 individuals were represented by skeletal remains, with a life expectancy at birth of 13.6 years. Two hundred children under the age of 5 listed in the archival records were not represented by skeletal remains. The calculated life expectancy was low because only 26 individuals were skeletally identified as being 50 years or older. The discrepancy in life expectancy at birth values probably reflects the likelihood of taphonomic destruction of both infants and older adults and problems of estimating age in the latter. The addition of individuals represented only by cons raises the number of burials recovered to 687.

While not noted in the archival records, spatial analysis of burials suggests age segregation, with children clustered in the northeast quadrant of the cemetery.

### Variation in South Indian caste populations: A comparison of genetic and morphometric data.

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We report an analysis of genetic and morphometric data in 250 members of 8 South Indian caste populations. The genetic data include 411 bp of HVS 1 mtDNA sequence, 8 Y chromosome polymorphisms, and 40 *Alu* insertion/deletion polymor-

phisms. A Mantel matrix comparison test yields a significant correlation between inter-individual differences in caste "rank" and genetic distance ( $p < 0.001$ ).

The caste genetic data were compared with genetic variation in worldwide populations (143 Africans, 78 Asians, and 119 Europeans). For the mtDNA data, all caste populations showed greatest affinity with Asians and least affinity with Africans. For the Y chromosome and *Alu* polymorphisms, upper castes were most similar to Europeans, while lower castes were most similar to Asians. This difference is statistically significant ( $p < 0.05$ ) for the *Alu* genetic distances. This pattern is consistent with historical data that suggest an early episode of immigration into India from the Fertile Crescent region (ca. 10,000 years ago), establishing the Dravidian-speaking population, followed by a second major episode of immigration from West Eurasia (ca. 3,000 years ago) consisting of Indo-European speaking populations. These results support a scenario in which the second wave of immigrants occupied higher positions in the caste system. The difference in mtDNA, Y chromosome, and *Alu* patterns suggests that the second wave consisted primarily of males (or at least that members of this group contributed a disproportionate number of Y chromosomes).

The morphometric data consist of 14 commonly used measurements and were recorded for five of the caste populations. Although there is some correlation between caste rank and morphometric distance, it is not as clear-cut as for the genetic data. Most of the morphometric measurements do differ significantly among castes, but there is substantial overlap between castes (as is also the case for genetic data). A discriminant analysis of the morphometric data classified 46.1% of the individuals into the correct caste population.

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#### **Working with ancient DNA: NAGPRA, Kennewick Man and other ancient peoples.**

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In 1990 the Native American Grave Protection and Repatriation Act (NAGPRA) was passed. This act requires that the disposition of Native American remains discovered on Federal lands or curated by Federal agencies be determined by 'culturally affiliated' living Native Americans, if they can be identified. Cultural affiliation is to be determined by "a preponderance of the evidence based upon geographical, kinship, biological, archaeo-

logical, anthropological, linguistic, folkloric, oral traditional, historical, or other relevant information or expert opinion" (NAGPRA, Section 7a(4)). Unfortunately, in many cases these lines of evidence support conflicting hypotheses of cultural affiliation, or do not lend support to any specific cultural affiliation. In particular, cultural affiliation of extremely ancient remains is difficult to determine because there are more gaps in the archaeological record, there are often few cultural remains which survive, it is difficult to assume that no population movement occurred over such large time frames, linguistic evidence becomes unreliable beyond a few millennia, morphological changes cannot be ruled out over thousands of years, and often range of variation is inaccessible because only one individual is represented. Increasingly, the recently developed techniques of ancient DNA (aDNA) analyses are being applied to these remains.

The authors' aDNA analyses of Kennewick Man, an ancient Native American discovered near Kennewick, WA, and other extremely ancient individuals will be discussed. The probability of successful extraction and analysis of ancient DNA from prehistoric remains, the difficulties of establishing cultural affiliation using genetic data, the utility of aDNA from these individuals in testing a variety of archaeological and linguistic hypotheses, and issues of conservation will be assessed.

#### **Biodistance and regional subsistence patterns for the Late Woodland North Carolina coast.**

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Recent investigations of pre-contact Native American coastal populations of the eastern United States have centered on the impact of two major lifeway transitions: the intensification of domesticated plants, and the intrusion of Europeans and epidemic diseases. Pre-contact migrations of people from elsewhere bringing new cultural traditions and technologies have been under-emphasized. In conjunction with new research on the population dynamics of North Carolina coastal groups, this paper explores the biological relationships and subsistence patterns of a number of Late Woodland skeletal populations of differing cultural affiliations.

Archaeologists have divided the North Carolina Coastal Plain into three cultural regions-Algonquian, Iroquoian, and Siouan-generally coinciding with linguistic groups present at the time of European contact in the late 17th century (Phelps 1983). Reconstructions of these "local cultures" have typically emphasized the dis-

tinct material and social cultures that accompanied the linguistic divisions. Though gross morphological differences between the groups have been observed, no systematic skeletal and dental indicators have been analyzed to evaluate the biological relationships between these populations.

Six Late Woodland skeletal populations are profiled in this investigation: 3 interior riverine populations (31C05/Hollowell, n=90; 31BR7/Jordan's Landing, n=43; 31BR5/San Souci, n=33) and 3 outer coastal populations (31CK9/Baum, n=204; 31DR38/Hatteras Village, n=112; 31CK22/West, n=134). Dental metric and nonmetric data illuminate some biological difference between the groups, and caries prevalence, dental health and stable isotope data indicate that reliance on maize varied across the region during this time period. These differences may represent contrasting lifeways and environmental conditions associated with the respective coastal and terrestrial settings.

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#### **Heritability of responses to novel objects among pedigreed baboons.**

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Behavioral response to novelty represents a fundamental aspect of temperament that has been studied extensively in both human and nonhuman primates. We examined the heritability of variation in response to novel objects among 259 baboons from a single pedigree maintained by the Southwest Foundation for Biomedical Research. Adult animals (both males and females) were exposed individually to two plastic toys and a mirror, and their behavioral responses recorded. Significant heritability ( $h^2 = 0.30 - 0.55$ ,  $p$ 's  $< 0.05$ ), demonstrating genetic variation for responsivity to novel stimuli, was obtained for more than 10 individual behaviors. These genetically influenced behaviors represented a variety of emotional states (e.g., attentive, antagonistic, fearful). In addition, based on the distribution of responses to the two plastic toys, we constructed a single novelty index that subsumed four behaviors related conceptually to "anxiety" (latency to touch object, yawn frequency, duration close to object, cage slap frequency); this index was significantly heritable ( $h^2 = 0.32$ ,  $p < 0.002$ ). These are the first heritability estimates for behavioral responsivity using quantitative genetic methods on primates from

a multigenerational pedigree. Taken together, these data provide evidence that several aspects of temperament in primates have a substantial genetic component. Partial support was provided by a Southwest Foundation Forum grant to A.G.C. and NIH grant P51-RR13986 to J.R.

**www. eSkeletons. org: A web site for the study of human and primate comparative anatomy.**

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The study of primate comparative anatomy is a subject taught at many colleges and universities that have good collections of primate skeletons. Unfortunately, students at other schools lacking these materials may not have the opportunity to study this interesting and important subject. The web offers nearly unlimited possibilities for the sharing of data within the format of a digital library, and therein offers a remedy to this dilemma. We present here our latest efforts with eSkeletons (www.eSkeletons.org), a web site devoted to the study of human and primate comparative anatomy.

Recent advances in hardware and software have made it practical to scan and archive complexly shaped skeletal elements for inclusion in the eSkeletons digital library. The core of the site contains all of the elements of the human skeleton as 2-D images, 3-D animations about a fixed axis, 3-D VRML animations, and 3-D animations of joint complexes; text narratives that include useful information about morphology and function; label overlays for landmarks, muscle origins and insertions, and joint surfaces; tips about how to identify the various elements; and self-quizzes. The user has the ability to navigate through the various regions of the skeleton and view six different orientations of each element. Similar 2-D and 3-D data are available for the baboon as well as the gorilla, chimp, and orangutan. Other species will be added to the digital collection in the near future.

eSkeletons permits the student to compare data from these species by providing windows with dual views of selected elements as 2-D images and 3-D animations. In this way the student has instant access to the complete digital skeletal collection, and with the simple click of the mouse can view data that are comparable to those of museum or teaching collections. This aspect of the site is especially useful with regard to rare or endangered species that are not often included in teaching collections.

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**A history of Siberian native people from the perspectives of male lineages.**

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We genotyped 46 biallelic polymorphisms on the non-recombining portion of human Y chromosome (NRY) to test hypotheses on the origin and migration patterns of Siberian populations. Our Siberian samples consisted of >800 males from 15 Western, Central and East Siberia populations. The Siberian NRY data were compared with a global database to understand the genetic affinities among indigenous ethnic groups in Siberia, as well as their relationships to other Asian, European, and Native American populations.

Unlike the case for Native American populations, Siberian populations were not characterized by a discrete set of founder NRY haplotypes. Native Siberian populations differed greatly in their haplotype composition and exhibited one of the highest FST values for any region of the world. This pattern of reduced haplotype diversity within populations and elevated levels of differentiation among populations may be a feature of indigenous groups that have been isolated for long periods of time.

In contrast to classical and mtDNA markers, "European-specific" NRY haplotypes were not found at higher frequencies in western Siberian populations. Haplotypes shared with Europeans were geographically widespread at low frequencies across Siberia. There was a straightforward correspondence between linguistic association and NRY-based genetic structure for Tungus- and Mongolic speakers of the Altaic language family; however, Turkic- and Samoyed-speakers did not cluster genetically with populations speaking closely related languages.

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**Nutritional stress and femoral cortical thickness among Plains Indians.**

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Archaeological and historical information reveal that external constraints such as climate, intertribal conflict, and disease were responsible for nutritional stress among Indian tribes living on the Northern and Central Plains from the Plains Village period to the Reservation period. Plains research has demonstrated that high levels of nutritional stress result in low values of femoral cortical thickness. This study explores this relationship us-

ing a larger sample and increasing the number of groups.

Cortical bone thickness (C) is found by subtracting the width of the medullary cavity (M) from the total subperiosteal diameter (T). M and T were measured directly from radiographs of femora. The general linear models analysis of variance statistic was used for evaluation of the primary and derived variables.

Statistical results for the Northern Plains reveal hypothesized patterns of nutritional stress. Cortical bone thicknesses decreased during the Protohistoric and Historic periods. Expected mean differences were also observed in Central Plains archaeological variants, but these differences were not statistically significant. Central Plains tradition and the Initial Middle Missouri (IMM) variants demonstrated lower levels of nutritional stress than expected. A small IMM sample may explain the results for this variant. Another possibility is that prehistoric groups maintained high levels of activity counteracting potential bone loss caused by nutritional stress. Fortunately, methods such as radiogrammetry allow for study of repatriated remains. However, the permanent loss of these skeletons precludes supplementary analyses (i.e., femoral functional morphology or isotopic signatures) that could help explain the unexpected results.

**Parent-daughter somatotype correlation's and assortative mating in the Punjabis from Northwestern India.**

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Parent-daughter somatotype correlation's were assessed in 226 Punjabi nuclear families of middle socio-economic background. Each family consisted of one daughter (in the age range of 9-15 years), mother and father, residing in Chandigarh and surrounding areas. The results show no specific trends in the spouse correlation's, according to daughter's ages separately as well as averaged. Total correlations between parents and daughters are found to be 0.54, 0.20 and 0.36 for endomorphy, mesomorphy and ectomorphy respectively. In the absence of assortative mating, these values would correspondingly have been 0.48, 0.18 and 0.32. The differences are statistically non-significant indicating an absence of significant assortative mating. This can be attributed to the prevalent practice of arranged marriages in Northwestern India.



### Ritual or just plain warfare? Trophy heads of the Julio C. Tello collection from Nasca, Peru.

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While iconography depicting head-hunting is known from many ancient Peruvian cultures, the populations that lived in the Nasca region of southern Peru (A.D. 1-700) carried this activity to an obsession. Trophy heads are detached skulls with a frontal hole cut for a carrying cord and a widened foramen magnum. Cutmarks associated with defleshing are also found. Actual trophy heads are commonplace finds among sites that date to the Nasca culture.

These heads have been variously deemed evidence of warfare, or a manifestation of ritual activity, or of a combination of both. As evidence for warfare, some investigators point out that the vast majority of trophy heads are young males. However, other researchers emphasize the probable religious and ritual activity of head-taking because trophy head samples include women and children. In addition, the majority of trophy heads exhibit the same type of cranial modification as the rest of the population. A hypothesis that is a combination of both of these explanations deals with competitive ritual battles. These battles, known from the ethnohistoric literature, were endemic in the Andes, and involved whole communities in sometimes fatal combat that fulfilled ritual, military, and political functions.

Physical anthropological analyses of the Nasca portion of the Julio C. Tello skeletal collection (approximately  $n=300$ ) curated at the National Museum of Archaeology, Anthropology, and History of Peru in Lima reveal that approximately 6% ( $n=18$ ) are trophy heads. The majority are young adult males ( $n=13$ ), but three are subadults younger than 15 years of age. None are definitively female, and there seems to be little evidence of the typical Nasca cranial modification. Most of the trophy heads are cut in a "mask" style, superior to the lambdoidal suture. A few are also cut on the sagittal line.

Since subadults are included in this collection of trophy heads, this analysis of the Tello collection from the Nasca region of southern Peru lends credence to the possibility that these trophy heads were taken as part of competitive ritual battles well-documented in the ethnographic literature of the Andes.

### KMH2 and the comparative morphology of the hyoid bone.

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Fossil hominin hyoids were unknown until 1988 when a hyoid [KMH2] was recovered from the Neandertal site at Kebara, Israel. In the original study [Arensburg et al, 1989] the Kebara hyoid was compared only with that of modern humans; therefore, the null hypothesis, that KMH2 is dissimilar to that of other mammals, could not be rejected. Moreover, the small size of the original control sample [ $n=48$ ] did not adequately determine the range of variation in modern human hyoids. In this study we have enlarged the comparative sample of modern humans [ $n=173$ ], added 18 primate species, and several other species of mammals. Statistical analyses included both bivariate and multivariate techniques. After controlling for variation due to size, it was found that the morphology of the hyoid was remarkably similar in all the species studied. This study has achieved two important goals. First, we have shown that the morphology of the hyoid cannot be used to determine the presence of language capability in fossil humans and second, we propose a methodology which will more effectively quantify this bone.

### A global perspective on genetic variation in modern *Homo sapiens*.

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Over the past few years our lab has assembled a collection of cell lines on over 30 populations including at least three populations from each of the major geographic regions of the world. To date we have a complete set of allele frequency data on 14 haplotyped loci (46 sites total, two to six sites per locus) and 9 single-site loci on 30 distinct populations with an average sample size  $n@50$ . This complete dataset of 23 independent loci on 30 distinct populations has now been analyzed for genetic distances, etc. The  $F_{st}$  values for the 55 individual sites across the 30 populations range from 0.04 to 0.41, with a mean of 0.16. The smallest value occurred at one site at the D4S 10 locus but the haplotypes for D4S 10 had an  $F_{st}=0.17$ . The largest value occurred for a single SNP in the ADH gene cluster. PCA analyses give four main clusters of populations corresponding to Africa, Europe and Southwest Asia, East Asia, and the Americas. In tree analyses, the Africa-Europe pair is separated by a long branch from the East Asia-Americas pair. Three populations do not fall clearly in any of these clusters: Nasioi Melanesians, Micronesians, and Yakut Siberians. The overall pattern is consistent with an out-of-Africa model; indeed, some of the haplotypes included-CD4, DRD2, DM, PAH-have been used on subsets of these populations to argue strongly for that model. The additional data at those and

the other haplotyped loci continue to be consistent with the existence of a significant founder effect associated with the expansion out of Africa and accumulating drift and loss of variation from West to East across Eurasia and then from North to South in the Americas.

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### Non-homogeneous infinite sites model under demographic changes of population size: Application to mitochondrial DNA data.

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We developed a mathematical model, which makes possible to predict joint distributions of numbers of mismatches in two or more regions of the genome, based on the Infinite Sites Models, under mutation-drift equilibrium or various patterns of population growth. One of the predictions is different correlation between numbers of mismatches in the two regions, depending on the pattern of the past population growth (constant, slowly growing, or rapidly growing). In this way, the method provides additional insights into the demographic history of the populations. Also, we developed expectations and variances of sample statistics under different growth scenarios.

As an application, we used a sample of mitochondrial sequences from hypervariable regions 1 and 2 (HV 1 and HV2), representing all major world populations (Europeans, Asians and Africans). The patterns of joint distributions of numbers of mismatches markedly differ from one population to another. In addition, there is a considerable variability in the proportion of numbers of mismatches between HV 1 and HV2 sequences. The patterns of bivariate distributions from the HV 1 and HV2 data are similar to those generated by the model involving a stepwise change in population size. (Research supported by NIH grants GM 41399, GM 45861, and the Keck's Center for Computational Biology, Rice University).

### An innovative method for estimating fluctuating asymmetry calculated from 3D cranial and facial coordinates.

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Traditional methods of measuring population stress include paleodemography and paleopathology. An alternative approach utilizes the concept of developmental stability (i.e. the degree to which an individual is able to resist disruptions to growth during development such as infectious disease or nutritional stress). Fluctuating asymmetry (FA) is a measure of developmental stability and has been used an indicator of both individual and population health and reproductive fitness. A variety of skeletal and soft tissue traits have been used in asymmetry studies, however anthropological studies have primarily used dental asymmetry as a measure of stress during transitions from hunter-gatherer to agricultural modes of subsistence. We offer an innovative approach to measuring developmental stability among the Arikara through the use of fluctuating asymmetry derived from 3D cranial and facial coordinates. Previous research has shown patterns of nutritional, developmental, and other health related stress and instability throughout the Extended Coalescent to Historic periods. To verify these findings and provide a new method of measuring FA, varying levels of fluctuating asymmetry among the Larson (39WW2), Leavenworth (39C09), Mobridge (39WW1), Sully (39SL4), Norvold (39C032-33), and Rygh (39CA4) sites are compared. Bilateral cranial and facial measurements are calculated from 3D coordinates. Both directional [?(R-L)] and fluctuating asymmetry | (R-L) - ? | are estimated and differentiated. Further, patterns of FA between age groups and males and females are compared. Finally, the applications of this method in Plains skeletal biology research are discussed.

#### The once and future baboon: a source of analogies for earliest hominid adaptations.

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In the early 1960s Sherwood Washburn inspired widespread use of common baboons as a source of data for the reconstruction of early hominid adaptations. Over the years various reasonable and unreasonable objections accumulated, resulting in the decline of the baboon "model" and declaration of its demise.

This paper reexamines those objections in logical and empirical terms. It divides them into two broad categories: (1) absolutist arguments that simply reject the use of baboon analogies and (2) relativistic arguments in favor of ostensibly better alternatives, including other primate species, generalized ecological models, and archeological evidence.

The first conclusion is that there is no good scientific reason for categorical exclu-

sion of baboon data from the reconstruction of earliest hominid adaptations. The second is that alternative sources of information are better for some purposes but not all. Recent findings in paleoanthropology have strengthened ecological analogies between baboons and early hominids. Greater knowledge of baboon behavior has provided new opportunities for the reconstruction of mating and other social patterns in early hominids. Used in conjunction with other approaches, baboon analogies can still offer valuable information to the study of earliest hominid adaptations.

#### Phylogenetic and adaptive information in the pattern of ontogeny of a fossil primate (*Archaeolemur* sp., cf. *edwardsi*).

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Among the best-known of recently-extinct Malagasy lemurs is *Archaeolemur*, which is represented by many hundreds of specimens. The phylogenetic affinities of this taxon are unclear, especially in light of recent preliminary analysis of ancient DNA which does not support its previously accepted close relationship with the living Indridae. We examined the nearly-complete skeletons of two adults and one juvenile and other less complete specimens, to reconstruct aspects of the ontogeny of *Archaeolemur*. To compare the development of *Archaeolemur* to that of living strepsirrhines we collected data on *Propithecus verreauxi*, *Eulemur fulvus*, and *Lemur catta*. Additionally, because *Archaeolemur* exhibits some morphological convergences with distantly-related papionins, we tested for convergence in the developmental patterns of *Archaeolemur* and *Macaca fascicularis*. Data include the status of tooth eruption, craniofacial sutural closure, and postcranial epiphyseal fusion, as well as linear measurements. We used discriminant function analysis and other tools to explore ontogenetic similarities and differences.

Our analysis shows that *Archaeolemur* displays a clear strepsirrhine pattern of development with only minor macaque convergences. Among the Strepsirrhini, *Archaeolemur* is slightly more similar developmentally to *Eulemur fulvus* and *Lemur catta* than to *Propithecus verreauxi*. The phylogenetic and adaptive significance of ontogenetic information is discussed.

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#### Behavioral and electrophysiological evidence for lack of ultraviolet sensitivity in strepsirrhine primates.

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In 1976, Alfieri, Pariente, and Solé (Doc. Opth. proc. ser. 10:169) presented electroretinographic (ERG) evidence that *Eulemur mongoz* may be able to perceive long-wave ultraviolet (UV) light. These authors found that a monochromatic UV light of 364 nm generated a gross retinal potential that was greater than the potential elicited by 407 nm (violet) and 589 nm (yellow) light. Alfieri et al. attributed this ERG response to UV light to fluorescence of tapetal riboflavin.

In order to evaluate the possibility that diurnal and cathemeral strepsirrhines are able to perceive UV light via tapetal fluorescence, we undertook behavioral and electrophysiological studies of three lemur species at the Duke University Primate Center. In the behavioral tests, *Eulemur mongoz* (n=1) and *Lemur catta* (n=1) were given forced-choice discrimination tasks that required individuals to visually distinguish between UV-reflective and UV-absorbing stimuli in order to receive food rewards. High ambient levels of UV illumination were provided by fluorescent UV lamps, and experiments were conducted under both photopic and scotopic conditions. 23 days of testing (~35 trials/individual/day) failed to reveal any capacity to visually distinguish between UV-reflective and UV-absorbing stimuli. By contrast, control experiments using black and white visual cues evinced an almost immediate ability to prefer food-reinforced stimuli.

In the electrophysiological tests, the gross retinal response of *Propithecus verreauxi* (n=2) to monochromatic light was measured using ERG flicker photometry. These studies revealed a precipitous and smooth decline in sensitivity as test wavelengths were decreased in 10 nm steps from visible wavelengths (lmax=470nm) into the near-UV (lmin=370nm). No evidence for a secondary peak in visual sensitivity within the UV range similar to that reported by Alfieri et al. (1976) was found. *Ad libitum* observations suggest that previous reports of UV sensitivity in *E. mongoz* may have been influenced by lenticular fluorescence. The adaptive significance of tapetal retention in most diurnal strepsirrhines thus remains unclear.

#### Inferring African ancestry of African Americans.

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While the history of Africans in the Americas predates institutional slavery, it is notably marked by the brutal period of kidnapping and mass transport of millions of indigenous Africans during the transatlantic slave trade from ~1619 to 1850. Thus, the vast majority of contemporary African Americans are descendants of enslaved Africans. The voluntary immigration of Africans to the Americas before and after the enslavement period contributed significantly less to the African American gene pool.

Human identity is usually shaped in relation to ancestry. However the vast majority of African Americans know little about their specific African ancestry. This is why it has been extremely important to African Americans to get a better understanding of potential contributors to their ancestry. Historical shipping and trade documents provide some insight on the ethnic and geographic origin of enslaved Africans. The sources of enslaved Africans encompassed a wide geographic range consisting of eight coastal regions from Senegal south through the Cape of Good Hope and north along eastern Africa to Cape Delgado. The accumulation of genetic data namely, nonrecombining, lineage-defining markers such as mtDNA, Y-chromosome, and autosomal haplotypes from indigenous African populations has sparked major interest in the possibilities of DNA tests for African ancestry. A recent web-based poll of African Americans revealed that 80% view it important enough to determine their African ancestral heritage through DNA testing. Until recently, large geographic gaps existed in genetic samples from Africa, leading to poorly defined areas (i.e., Angola, Gabon, Congo, and Zaire) where limited sampling of indigenous African populations occurred.

Currently our laboratory has amassed genetic data from over 52 indigenous populations representing 21 contemporary African countries. Here we discuss the ethical and social issues related to the construction of the African ancestry genetic database and the broad range of responses from the African American community to the possibilities of DNA testing for ancestry.

#### **Bone remodeling and bone loss.**

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Throughout life bone undergoes remodeling with removal of old bone (resorption) and replacement with new bone (formation). The bone remodeling cycle is the coupling between resorption and formation with the major stimulus to bone formation being prior bone resorption. Resorption is regulated by osteoclasts and formation by osteoblasts. Remodeling is most rapid during infancy with formation exceeding resorption and resultant positive skeletal

balance. By age 6 or 7 this process slows down, only to accelerate briefly at puberty with formation again outstripping resorption for continued positive skeletal balance. From early adult life until the sixth decade remodeling is slow, resorption and formation are equal and there is no net gain or loss of bone. After age 50, for as yet unexplained reasons, resorption begins to exceed formation with net negative skeletal balance that continues negative (if left without intervention) for the rest of life.

In women the decline in estrogen production at menopause stimulates bone resorption, increases the rate of remodeling but with resorption still exceeding formation. This results in a limited period (5-10 years) of accelerated bone loss in the early menopausal years. Many diseases/conditions/medications stimulate bone resorption and accelerate bone loss. These include hormone excess (cortisol, parathyroid, thyroid), hormone deficiency (estrogen, androgen, calcidiol, calcitriol), malabsorption/malnutrition, and immobilization. The process of bone remodeling can be monitored biochemically and the levels of these biochemical markers of remodeling have been shown to predict rates of bone loss in women.

#### **Factors affecting infanticide: a model.**

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Occurrence, frequency, and risk of infanticide appear to vary considerably across nonhuman primate species and populations. Because of the absence or low prevalence of infanticide in some populations, the explanatory power of the sexual selection hypothesis is still being questioned. In contrast, supporters of the sexual selection hypothesis seek to explain the observed variation by confounding factors particularly infant protection by males in multimale societies. In order to explain variation in observed rates of infanticide across species and populations, we developed a model incorporating various factors assumed to influence the occurrence of infanticide and allowing to calculate expected frequency and risk of infanticide.

Apart from male immigration rates, timing of immigration and mating skew, the frequency of infanticide depends on female group size, gestation, and weaning age, while the risk of infanticide depends on weaning age only. The model's equations were subsequently used in two ways. Holding risk of infanticide constant, we calculated expected frequencies of infanticide for virtual primate populations varying in female group size and weaning age. It turns out that infanticide is unlikely to be observed under particular conditions, because of low expected frequencies (virtual gibbons) contrasting with circumstances where infanticide might be ob-

served frequently (virtual Hanuman langurs). Furthermore, we calculated expected frequencies and risks of infanticide for given populations varying in social organization (one-male versus multimale). We demonstrate that the observed prevalence of infanticide is in fact considerably lower than expected in species where males defend infants.

In conclusion, the model demonstrates that strong variation in the prevalence of infanticide is to be expected, because of variation in demography, life history traits, and male defense across primate species and populations. Moreover, females may indeed gain from association with protector males, because male defense may reduce the risk of infanticide.

#### **Vulnerability and stress in Mongolia: the adaptive significance of *yadargaa*.**

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Current anthropologic literature tends to emphasize cultural change and lifestyle practices contributing to stress. Indigenous paradigms of stress and socially-mediated adaptations to reduce vulnerability have been less closely investigated. This study addresses these issues in Mongolia by examining the etiology, diagnosis, and treatment of the syndrome *yadargaa*.

*Yadargaa* literally translates as 'tired'. A study of 126 individuals (34 in a clinical setting and 92 in the community) self-diagnosed with *yadargaa* revealed no single specific symptom constellation. Of the sample 56% did not qualify for any other physiologic or psychiatric diagnoses. Of the 54 individuals with comorbid conditions, 19 presented with cardiovascular disease, 6 with migraine headaches, 6 with diabetes, and 5 with a psychiatric disorder. Common complaints of pure *yadargaa* included fatigue, headache, anxiety, and generalized body pain. These diseases and symptoms are characteristic outcomes of chronic stress.

This study argues that diagnosing *yadargaa* encourages preemptive intervention. Thus illness is addressed in a prodromal stage when it is easiest to combat. *Yadargaa* sufferers employ a variety of interventions to lower the risk for disease. Typical interventions comprised change in workload, altering diet, and stress-reduction therapies such as massage, acupuncture, and saunas. Individuals with comorbid diseases claimed that their failure to successfully treat *yadargaa* led to the development of secondary disorders.

This process of treating vulnerability states such as *yadargaa* before the onset of clinical conditions is adaptive by reduc-

ing disease incidence. It is especially valuable in societies without ambulatory medical technology. This study calls to attention the need to explore how cultures minimize vulnerability to illness through socially-mediated processes.

Work in part supported by Muhlenberg College.

**Allele: phenotype associations in alcohol dependence and alcohol-related disorders,**

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A major obstacle in the study of complex diseases is the identification of significant associations between genetic variants (alleles) and symptoms or conditions of the disorder (phenotypes). In this study, the association between genetic variants of two alcohol dehydrogenase genes (ADH2 and ADH3) and diagnoses of alcoholism and alcohol-related disorders were investigated using recently developed cladistic analytic methods of linkage disequilibrium. ADH gene products interact to form heterogeneous tetramers that catalyze the first step of alcohol metabolism in humans and, therefore, are uniquely interactive and ideal targets for the isolation of original and compensatory mutations.

Five ADH variants were assayed in DNA extracts from participants belonging to a Southwest American Indian tribe (N=489). Each subject underwent a clinical interview for diagnosis of alcohol dependence and other psychiatric conditions, as well as evaluation of symptoms related to physiological response to alcohol. Detailed haplotypes were constructed using an expectation-maximization algorithm and verification by family transmission. ADH variants were also assayed in three Asian populations (Siberian, N=25, Mongolian, N=28, Chinese, N=32; no clinical diagnostic data) in order to provide an evolutionary context for the genes and variants. The present analyses do not support a role for ADH2 or ADH3 in vulnerability to alcohol dependence or symptoms related to alcohol metabolism for this Southwest American Indian population.

This research was supported by the NIH intramural research program.

**Ontogenetic variation in the Dederiyeh Neandertal children: Postcranial evidence.**

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Recent excavations of the Dederiyeh Cave in Syria have yielded two partial skeletons of child Neandertals, Dederiyeh 1 and 2. The developmental stages of these two children are almost the same, estimated to be about two years based on the dental development. Although they share similar morphological characters in both cranial and postcranial bones, the dimensions and robusticity are greater in the Dederiyeh 1 than in the Dederiyeh 2. These differences are assessed in the context of variation in three modern human populations and some other middle to late Pleistocene immature fossils.

In the growth profile of femoral length vs. age for modern humans, the Dederiyeh 1 reaches the upper limit while the Dederiyeh 2 falls in the midst of the range of variation. The difference is, however, not significant in consideration of the variation range of a single modern population. As for the robusticity, the femoral and tibial cross-sectional properties of Dederiyeh 1 exceed the modern averages (sometimes statistically significant), while those of Dederiyeh 2 fall below the means of 1 to 2-year-old moderns. In comparison of the femoral circumference / length, Neandertal children tend to be more robust than the early moderns (Qafzeh-Skul/Upper Paleolithic). However, the position of the Dederiyeh 2 approaching the average of modern humans makes a great overlap between Neandertals and early moderns.

The growth variation detected on Neandertal postcranial morphology does not exceed the modern human ranges, at least, during early childhood. In addition, postcranial robustness is not so conspicuous in Neandertals of this early developmental stage because the great variation in child Neandertals produces a significant overlap with the modern humans and early modern fossils.

**Modern statistical computing in "R" and "WinBUGS" for physical anthropology.**

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Physical anthropologists have largely made a transition from using proprietary statistical computer packages on mainframe computers to using similar packages on desktop computers. As a consequence, researchers have considerable freedom to explore different analytical techniques and approaches to their data. However, many of the proprietary packages, whether used on mainframes or desktop computers, are beginning to show their age. Most lack many of the modern statistical methods that have grown out of the development of "computer intensive" applications, give short shrift to Bayesian methods, and do not provide much capacity for writing new

functions and developing new methods tailored to the problems at hand.

Two newer packages ("R" and "WinBUGS") do not suffer from the problems listed above. In this poster we present a few examples of analyses from physical anthropology using "R" and "WinBUGS." "R" is a general statistical computer package (modeled after "S"). It is available for a number of different computer architectures, and includes both a large base library of functions, as well as a plethora of contributed libraries written by statisticians and other researchers. An additional advantage to "R" is that, like "S," it has a very extensive collection of graphics routines, which could easily suffice for most publication (and dissertation) needs. "WinBUGS" is a more specialized package specifically intended for Bayesian analyses, and its output can be post-processed using one of the "R" libraries.

While neither "R" nor "WinBUGS" may meet all of our needs for the future, in the final analysis, both packages are extremely useful and the price is right. Both can be downloaded for free. Links to "R" and "WinBUGS" can be found at <http://konig.la.utk.edu/501.html>

**Hand and body position during locomotor behavior in the aye-aye.**

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Aye-ayes (*Daubentonia madagascariensis*) have unique hands among primates, with greatly elongated fingers. In order to avoid high stresses on these long appendages, aye-ayes may adjust their hand and/or body position during locomotion, particularly during head-first descent (Curtis and Feistner, 1994). No data on body position exist, and the little existing data on hand position present conflicting results. Lemelin (1996) found that aye-ayes grip branches during locomotion, except during head-first descent when they instead dorsiflex the wrist and curl the fingers. In contrast, Oxnard et. al. (1990) reported finger curling during both head-first descent and horizontal locomotion. This study attempts to document hand position and changes in body position in relation to substrate orientation in the aye-aye.

The hand and body position of three captive aye-ayes was examined during head-first descent, ascent, and horizontal locomotion. Video data were collected at the Duke University Primate Center and analyzed in the Duke University Vertebrate Movement Laboratory. Substantial variation in hand position is found among individuals. During ascent, aye-ayes always use full grips, which are typical of other strepsirhines during climbing or clinging. During horizontal locomotion and

descent, our results show that aye-eyes do not alter their hand position, and consistently use either full or partial finger curling. In contrast, the body angle in relation to substrate is significantly reduced during descent (9.7 degrees versus 17.3 degrees during horizontal locomotion), suggesting that changes in body position may help reduce stresses on the digits. This mechanism of moderating loads by altering body position, instead of hand position, may represent an important functional aspect of arboreal locomotion in an animal with disproportionately long hands.

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### **The correlates of metabolic energy expenditure in humans walking: Velocity, leg length and body mass.**

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Quantifying the energy expended by modern humans during ambulation has been a long-standing priority among exercise physiologists and some anthropologists, but difficulty in reconciling theoretical predictions with empirical observations abounds. The metabolic energy used in bipedal walking in modern humans has generally been empirically shown to vary with velocity and body mass, while mechanical analyses predict that the energy used to walk should be dependent on, among other things, the relative proportions of the body segments. Increasing one such proportion, leg length, has been shown to theoretically increase the energy needed to walk. Empirical research has not, however, found such a correlation. I recently proposed that one possible reason for this apparent discontinuity between theory and empiricism might be that the empirical reports do not eliminate enough of the known individual variation in such measures as resting metabolic rate to allow the effect of leg length to be discerned.

To test this proposal, I combined data from the literature with some recently developed in our lab. I found that when individual variation in resting metabolic rate was accounted, a model which uses velocity, leg length and, possibly, total body mass as independent variables can predict approximately 90% of the variation in energy expenditure. Velocity remains the strongest and most significant predictor of energy expenditure, but longer legs are associated with higher energy expenditure than shorter legs are at natural walking velocities.

This result confirms the prediction from mechanical analyses and points to the need to explain the increased leg length seen in *Homo* relative to *Australopithecus* as an accommodation based on selective pressures other than increased mechanical efficacy.

### **The postcranial evidence for primate superordinal relationships.**

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Cladistic analysis has often been used as a tool for investigating primate superordinal relationships. Ideally, characters chosen for analysis should be independent, each taxonomic unit should exhibit only one state for every character, and missing data should be minimized. Previous studies of primate higher-level relationships utilizing postcranial characters have, in many cases, included non-independent (correlated) characters, failed to account for polymorphisms within taxonomic units, and employed many characters that could not be scored for fossil taxa.

The purpose of this study is to reassess the postcranial evidence for primate superordinal relationships. Skeletal characters identified by previous authors were examined for accuracy of coding, variation within taxonomic units, and character independence using a comparative sample. Non-independent characters were combined into a single functional complex and taxonomic polymorphism was taken into account. In addition, corrections were made in cases of erroneous character state assignments. The data matrix of 20 characters was analyzed using PAUP version 4.0. Following previous studies, the tree was rooted using a hypothetical outgroup in which all characters display the primitive condition.

An exhaustive search produced five equally parsimonious trees with a length of 39 and consistency index of 0.82. Results provide strong support for the monophyly of Chiroptera, and bats and colugos form a monophyletic clade (Volitantia) in all five of the most parsimonious trees; however, the bootstrap support for Volitantia is relatively weak (54%). Additionally, primates, plesiadapiforms, colugos and bats consistently form a clade with tree shrews as a sister taxon. The bootstrap results provide relatively strong support (74%) for the primate - plesiadapiform - dermopteran - bat clade. None of the trees produced in this analysis provide support for Primatomorpha (primates - plesiadapiforms - dermopterans).

### **Shape and growth differences between Neandertals and modern humans: Grounds for a species level distinction?**

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Many studies compare adult morphological patterns between Neandertals and modern humans. However, analyses of juvenile morphology and growth patterns allow a crucial opportunity to compare the

*growth processes* that contribute to the observable differences in adult Neandertal and modern human morphological types.

This study analyzed craniofacial shape and growth patterns in Neandertals and eight geographically diverse recent modern human samples. Three-dimensional landmark coordinate data were collected from 69 landmarks on the face, neurocranium and basicranium and were analyzed using Euclidean Distance Matrix Analysis (EDMA) and principal coordinates analysis (PCOORD).

Results of this study show that Neandertal craniofacial shape differs from modern human craniofacial shape at all postnatal ages. Neandertals and modern humans show many differences in craniofacial growth patterns, especially those contributing to distinctive craniofacial features of Neandertals (such as increased midfacial prognathism and facial projection) and modern humans (such as increased neurocranial height). Lastly, shape and growth patterns consistently differ between Neandertals and modern humans regardless of which modern human population is used as a comparative sample. These results show clear morphological and developmental differences between Neandertals and all recent modern human populations.

It has long been known that Neandertal craniofacial shape is outside the range of modern human variability. This study shows that the growth processes that create those differences in shape are also outside the range of modern human variability. If it is possible to say that genetic differences between species are phenotypically expressed through unique growth processes, then the observed growth differences between Neandertals and modern humans probably reflect species level distinctions between these groups.

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### **Warfare in the Late Prehistoric Southeast: A multi-site osteological analysis from west-central Tennessee.**

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The Mississippian period in the Southeastern United States was characterized by settlement hierarchies, intensive agriculture, and population growth. Each of these characteristics are argued to have led to endemic patterns of warfare within Mississippian communities. Though archaeological evidence in the form of warrior iconography and fortifications appears to support the notion of frequent, widespread warfare in the late prehistoric Southeast, osteological data is largely lacking. Only two single-site analyses have been conducted to date pertaining to Mis-

Mississippian warfare activities.

This analysis examines the osteological and mortuary data from 13 sites, including 521 individuals, within a geographically confined area of west-central Tennessee in order to provide a more holistic view of warfare activities during the Middle and Late Mississippian periods. Evidence for trophy-retrieval, embedded projectile points, stabbing, and blunt force trauma were each assessed, though only a total of 14-18 individuals (2.7-3.4%) demonstrate evidence for possible warfare injury. Not only does the low overall frequency of warfare contradict the theoretical arguments for endemic warfare activities, but patterns have also emerged regarding inter- and infra-regional variation. Frequency varies considerably by site (0-80%) and location to presumptive political boundaries. Furthermore, males are the most prone victims of warfare, followed by subadults, and then by females. Types of trauma sustained also differ from other regions within the Southeast, indicating possible cultural variances in warfare practices. This study not only demonstrates the utility of osteological research in warfare studies, but also demonstrates the importance of assessing several sites for the purpose of attaining prehistoric activity patterns.

**An assessment of deciduous tooth mineralisation in chimpanzees (*Pan troglodytes*).**

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Comparative studies of dental development in extant and extinct hominoids and hominids have largely focused on the permanent dentition. Similarities in relative developmental patterns of permanent teeth in earlier growth periods have confounded attempts to characterise fossil hominid developmental patterns in comparison to chimpanzees and humans.

This study aims to clarify dental developmental differences between apes and humans by documenting deciduous tooth development in chimpanzees. Deciduous tooth mineralisation stages were assessed from intraoral radiographs of 59 chimpanzees (30 M, 29 F) ranging in chronological age from 3 months to 5 years. Radiographs were collected in 1989-90 during previous research by the first author.

The developmental status of each deciduous tooth was assessed according to an 8-stage scoring system developed by Demirjian for permanent teeth. Root resorption was scored as 'present' or 'absent'.

Much of deciduous tooth development occurs prenatally, and stages of crown development were not well represented in this sample. Mean ages of root completion were between 2.5 and 4.0 years for all tooth

types, with SD's of approximately one year. The overall sequence for completion of tooth mineralisation was dm1 i1 i2 dm2 c, which differs from the documented sequence of tooth emergence (i1 i2 dm1 dm2 c).

The greatest differences between chimp and human deciduous tooth relative developmental patterns appear to involve the dm1 and dm2. In particular, root completion is completed relatively earlier in chimpanzees. Development of the deciduous canine is relatively delayed in the chimpanzee.

**Fetal programming of lipid metabolism: long-term implications of fetal growth in Filipino adolescents.**

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Attention is now focused on the hypothesis that poor nutrition *in utero* or during infancy 'program' heightened risk for developing cardiovascular disease and its precursors, including hypertension, diabetes, and lipid abnormalities. While hundreds of studies have documented inverse relationships between fetal growth and adult blood pressure, far less is known about the relationship between fetal growth and later lipid metabolism. Cholesterol and fats are important substrate precursors for cellular growth, energy storage, and steroid hormone synthesis, demands for which vary widely based upon growth pattern and developmental stage. As such, plasticity in lipid metabolism in response to fetal exposures could have adaptive implications, in addition to more widely-acknowledged consequences for cardiovascular disease development.

This paper presents evidence for long-term changes in lipid metabolism in relation to fetal growth in a sample of 310 male and 311 female Filipino adolescents enrolled in the Cebu Longitudinal Health and Nutrition Survey (CLHNS), a one-year birth cohort study begun in 1982-1983. Multiple follow-ups were conducted during pregnancy, infancy, childhood, and adolescence, providing a lifetime of data for each respondent, including information on diet, activity level, socio-economic indicators, and growth patterns. Biochemical outcomes for the present analysis come from the Cardiovascular Risk component of the survey, which measured blood pressure, plasma lipid profiles, insulin, glucose, and leptin in 1998, when respondents were a mean age of 15 years old. In this population, individuals born thin, as indexed by BMI at birth, have alterations in lipid metabolism as adolescents, which will be explored in relation to postnatal growth patterns and future risk for cardiovascular disease.

**Patterns of joint size dimorphism in the elbow and knee of catarrhine primates.**

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Highly size-dimorphic taxa may be useful for examining the effects of body mass on skeletal design without the influence of adaptive and/or phylogenetic variation. The examination of sex-based differences within modern taxa also provides a crucial empirical background for the evaluation of variation within fossil assemblages. Large body size differences between sexes may necessitate structural differences in limb joints (e.g., positive allometry of articular size) as a means of maintaining comparable joint stress levels. This study examines variation in joint size dimorphism (JSD) among extant catarrhines to: 1) determine whether taxa exhibit JSD beyond that expected to simply maintain geometric similarity between sexes, and 2) to test whether taxa differ in patterns of relative JSD with respect to differences in habitual limb use and/or phylogeny.

For 23 taxa, "joint size" of the distal humerus and distal femur was quantified as the geometric mean of a number of linear dimensions. Analysis of variance was used to test for differences between sexes (in relative joint size) and among taxa (in patterns of dimorphism). Multiple regression was used to examine differences in JSD among taxa after accounting for variation in body size dimorphism (BSD) and absolute body size. JSD was also considered in light of "adjusted" BSD values to account for the larger effective female body mass associated with bearing offspring.

For the large majority of taxa, the degrees of humeral and femoral JSD are virtually the same. Interspecific variation exists, however, in the extent to which *both* joints are dimorphic relative to BSD. While most size-dimorphic cercopithecoids exhibit relatively high degrees of JSD (i.e., positive allometry), non-human hominoids exhibit degrees of JSD closer to isometry. The difference between the two superfamilies reflects interspecific trends and may be related to the relatively larger, more mobile joints of hominoids. Interestingly, modern humans exhibit relatively high JSD in both joints, despite lack of forelimb use in weight support. Estimates of body size dimorphism based on fossil limb bones will vary as one considers different extant analogies.

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**Mechanisms of species coexistence in a community of catarrhines: resource switching and dietary flexibility.**

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Primate communities often contain multiple species occupying broadly similar trophic niches. A general tenet in feeding studies holds that demands for food resources often exceed availability and that there is both intra- and inter-specific competition for these so-called limiting resources. One potential means by which to mitigate competitive feeding interactions is to shift to less-favorable foods not under contest by other animals. In this paper, I evaluate the degree to which digestive tract anatomy and physiology influence a species' capacity to switch from a preferred food resource to other, more abundant resources during either seasonal scarcity or when in the presence of feeding competitors.

The feeding behavior of *Pan troglodytes* (chimpanzee), *Cercopithecus mitis* (blue monkey), *Cercopithecus ascanius* (redtail monkey), *Lophocebus albigena* (grey-cheeked mangabey), and *Procolobus badius* (red colobus) was studied in the Kibale National Park, Uganda, between 1993 and 2000. Because cercopithecines have relatively long digestive retention times, but lack the specialized stomach found in colobines, they have the capacity to consume both low fiber/high soluble sugar foods when available, as well as lower quality foods which require longer retention times for fermentation (Lambert, 1998). As such, the *Cercopithecus* spp. and *Lophocebus* were predicted to exhibit the greatest dietary diversity and frequency of resource switching. Like cercopithecines, chimpanzees have a simple stomach, but have relatively shorter retention times; this species was thus expected to exhibit less dietary diversity and a lower frequency of resource switching than the cercopithecines. *Procolobus badius* was predicted to exhibit the lowest frequency of resource switching and dietary flexibility—at least in part as a result of their specialized gastrointestinal anatomy.

Over 10,000 hours of data were collected. Preliminary analyses of a sub-set of these data indicate that, overall, the cercopithecines consumed the greatest diversity of both plant species and broad dietary categories (e.g., fruit, petioles, leaf buds, mature leaves, flowers, insects, etc.). Compared to the colobine and ape, the cercopithecines were also more likely to switch to alternative food resources when their feeding spheres became smaller as a result of reduced inter-individual distance (e.g., with increasing number of individuals/feeding patch). Implications of resource switching and dietary diversity for community species richness and abundance will be discussed.

#### **Building a head and body from parental directives: Sexual dimorphism under fetal constraint.**

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The evolutionary scenario surrounding when sexual dimorphic size ratios characteristic of modern humans originated has been a point of debate. The primary focus of these considerations has been reconstruction of fossil evidence and sociobiological extrapolation. Less attention has been directed to exploring the nature of the mechanisms that might control variability in size based on sex.

With the aim of considering the role that in utero growth and reproductive constraint may place on sexual dimorphism, fetal growth data were investigated together with parental anthropometrics. Longitudinal ultrasound data from 40 fetuses were collected at weekly intervals on 14 parameters (PJ) for whom parental anthropometrics were known.

Parent-specific effects are documented for limb, organ and head growth in terms of both timing and magnitude. These observations fill a research gap as few previous studies have reported parent of origin effects on in utero growth. These observations are examined for the data they provide on links between brain and skeletal growth, and the implications for genetic growth control mechanisms. The relationships documented in this sample illustrate that adult size and fetal growth patterns are synergistically tuned and imply that an adult size differential limit is set by growth rates that are compatible with reproductive viability.

#### **Male provisioning and the sexual division of labor.**

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In the 1960's Sherry Washburn proposed the paradigm of "Man the Hunter" as the keystone for the evolution of the human adaptation. The paradigm proved to be far more controversial than he had anticipated. This paper takes a fresh look at the male role in the division of labor between male hunting and female gathering and childcare. Using demographic (mortality, fertility, and birth-spacing) and resource accrual data from modern foragers and chimpanzees, the role of men in underwriting human reproduction is assessed.

#### **The ethics of bioarchaeology.**

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Since the first half of the nineteenth century, anthropologists and others have acquired and studied thousands of skeletons and other remains from archaeologi-

cal settings worldwide. These remains are used to document and interpret the biological history of our species, especially population relationships, health, activity, and lifestyles of our ancestors. Today, some native groups and religious denominations—especially in North America, Australia, New Zealand, and Israel—view this scientific research on their ancestral remains as disrespectful, sacrilegious, and immoral.

In many areas, bioarchaeologists are increasingly being pressured to alter their activities to accommodate the values of such groups. In response to these social forces, bioarchaeologists are beginning to formulate a series of commonly accepted ethical principles that they can use to guide their research and teaching: (1) human remains should be treated with dignity and respect; (2) descendants should have control over the remains of their relatives; and (3) remains represent the only biological record of the past, making it imperative that collections of archaeological human remains be preserved. The preservation ethic embodied in the latter principle has resulted in much of the current climate of conflict between scientists and indigenous communities. Although difficult, the conflicts that arise between the preservation ethic and descendant rights are resolvable and not necessarily inherent. In a number of settings, agreements have been reached whereby the remains of "culturally affiliated" individuals are available for scientific research in museum repositories under the control of descendant groups. Oftentimes, such solutions develop when direct communication between scientists and descendants are established and maintained over extended periods. Thus, part of the ethics of doing bioarchaeology is a commitment to foster conflict resolution through better communication with descendant groups.

#### **Evolution and body shape: Somatic adaptation in the Australian Central Desert.**

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Body shape includes measures of relative lengths of the limbs and trunk, breadths of the shoulders and hips, as well as body circumferences. Together these can provide a profile of somatic adaptation to climate, especially for extreme environments such as the Central Desert of Australia. However, very little is known about the developmental etiology of somatic adaptations to tropical desert environments except that similar body shape is evident in the adolescent African *Homo erectus* specimen KNM-WT 15000.

This paper reports results from two years of data collected during an ongoing collaborative longitudinal growth and community health study of a Warlpiri commu-

nity located approximately 290 kilometers NW of Alice Springs, NT. Measures of limb and trunk lengths, diameters and circumferences are available for 176 persons aged 3 months to 56 years, including recent second-year repeat measures on 55 babies, infants and children.

Our preliminary results from analyses of relative limb lengths show that adolescent and adult Warlpiri have significantly longer limbs relative to stature than comparative populations living in non-desert climates. Similarly shoulder, chest and hip diameters are comparatively narrow, providing a profile of body shape that results in greater body surface area per unit of stature. Thus, this desert population is in compliance with Allen's Rule despite the fact that adults are not exceptionally tall in stature (Male mean = 176.5 cm; Female mean = 162.1 cm).

Although data on limb and trunk proportions are absent in newborns and infants, Warlpiri children appear to develop this suite of shape characteristics primarily during the juvenile growth period. Young Warlpiri children are not comparatively different in limb proportions from children living in Melbourne.

This project was supported in part by grants from the Australian Research Council International Exchanges, the Dept of Anatomical Sciences of the University of Adelaide Medical School, the University of Rhode Island Foundation and URI Faculty Development Fund.

#### **Genetic and demographic structure in a population of white sifaka (*Propithecus verreauxi verreauxi*).**

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Genetic relationships within a primate population have usually been inferred from field observations of matings and spatial proximity among individuals and groups. This is generally a safe inference because social and spatial patterning is known to bring about differentiation at the genetic level. However, the correspondence between demographic and genetic structure is not direct, because behavioral factors (e.g. mate choice and competition) can impinge on gene-flow, independent of an animal's current spatial location or group membership. In this study, our goal is to specify more clearly the relationship between demographic and genetic structure for a free-ranging primate population.

We employed six highly polymorphic, unlinked, microsatellite loci to assess individual and group relationships for an entire population of free-ranging white sifaka at Beza Mahafaly Special Reserve, Madagascar. This population has been studied for sixteen years and the database includes behavioral, morphological, and demographic information for individually

marked animals. Our preliminary results (based on genotyping 200 animals) indicate discernable substructure in the population. Genetic relatedness was higher between social groups within a demographically defined "neighborhood". Additionally, females are more closely related than males within groups and within group-neighborhoods. These data are consistent with socio-demographic observations based on census data. The behavioral and life-history variables correlated with this genetic and demographic structure will be discussed.

This study was supported by an NSF Doctoral Dissertation Improvement Grant (DEB-9902146) to RRL and an NIH Grant (GM58433) to MAR.

#### **Sex dimorphism and bilateral asymmetry: modeling developmental instability and functional adaptation.**

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The following premises vary in degree of empirical support, but are by and large established in the literature. 1. Males are larger than females. 2. Female buffering mitigates growth disturbance from environmental stress. 3. Increased stress leads to increased fluctuating asymmetry (FA). 4. Stressed individuals compensate for lower energy intake by reducing activity levels. 5. Directional asymmetry (DA) reflects activity bias favouring one side. Therefore, high levels of sexual dimorphism can be considered a measure of good health / low stress, and an absence of need to mediate energy expenditure. In addition, when asymmetry is high, we expect it to be directional and positively correlated with marked sexual dimorphism. Conversely, low asymmetry should demonstrate weak or no direction and occur in tandem with reduced sexual dimorphism.

This paper tests these hypotheses using size and shape data (length, total area, midshaft circularity) from paired second metacarpals from a 'healthy' EuroCanadian 19<sup>th</sup> century settler (ES) sample from Ontario (N=169) and a 'stressed' late Thule/Inuit (IN) sample from the central Canadian Arctic (N=61). Sexual dimorphism was greater among the ES males and females for all measures; asymmetry showed direction and strength favouring the ES sample for total area, but only for ES females for length and circularity. These departures from the hypotheses are explainable in terms of methodology and sample specific characteristics.

#### **New hominin discoveries from the Nachukui Formation, west of Lake Turkana.**

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Vertebrate evolution is characterised by speciation events and the radiation of taxa following the appearance of new adaptive strategies. Bipedality in humans is known to have appeared prior to 4.1 Ma. It would therefore be expected that multiple species would be evident in the African hominin record between 4 and 3 Ma. This time period is nearly exclusively represented by finds from East Africa, and these have all been assigned to a single species, *Australopithecus afarensis*, and its possible ancestor, *A. anamensis*. This unexpected lack of diversity markedly contrasts with the increasingly bushy evolutionary tree evinced by the hominin fossil record from later deposits, and makes the time interval between 4 and 3 Ma a particularly interesting one for further study.

In Kenya Pliocene sites older than 3.0 Ma are poorly known and relatively few hominin fossils have been recovered. Among these a single fragmentary cranial specimen, from the Koobi Fora Formation in the Turkana Basin and dated between 3.3 and 3.2 Ma, is assigned to *A. afarensis* by some. Specimens from earlier strata at Allia Bay (3.9 Ma) and Kanapoi (4.17 and 4.07 Ma) are referred to *A. anamensis*.

Given the importance of investigating hominin evolution in the period between 4 and 3 Ma, fieldwork in the Turkana Basin in 1998 and 1999 was focussed on sites of this age in the Nachukui Formation, west of Lake Turkana. The resulting new hominin discoveries, dated between 3.5 and 3.0 Ma, fill an important gap in the fossil record. These specimens will be described and comparisons made with *A. afarensis* and Plio-Pleistocene taxa known from elsewhere in Africa.

#### **A comparison of spinal pathologies in northern and southern native Alaskan skeletal populations.**

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Differences in subsistence patterns between northern and southern Alaskan Native groups should produce differential use wear pathologies of the spine. Skeletal samples from Golovin Bay, Alaska, located on the south side of the Seward Peninsula (64° 30" north and 163° west), and Nunivak Island, off the southwest coast of Alaska (60° north and 166° west), were examined. It has been reported that the subsistence bases for these two populations were distinctly different with a greater reliance on caribou at Golovin Bay and intensive usage of sea resources on Nunivak Island. Biomechanical studies suggest that the stresses on the vertebral column associated with following caribou herds over long distances are greater than



those involved with usage of a kayak or umiaq. Osteoarthritis and intervertebral disc herniations are two good indicators of the stress placed on the spinal column during an individual's lifetime. This study explores subsistence related spinal pathologies using data collected on samples from each of these locations. Specifically, differences in the frequencies of osteoarthritis and intervertebral disc herniations (Schmorl's nodes) were examined.

This research was funded in part by the Smithsonian Institution Office of Repatriation. A special thanks must also be made to the people of Golovin Bay and Nunivak Island for allowing this research to be conducted at the University of Alaska.

### **Ontogeny, phylogeny, and heterochrony in human evolution.**

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Heterochrony, the study of evolutionary changes in size, shape, and the timing of development within clades, plays a crucial role in understanding evolutionary transformations. However, heterochrony has had a complicated and frequently controversial history when used in human evolutionary studies. Inconsistently applied heterochronic theories and methods have limited our understanding of human growth and life history evolution. Consequently, this study attempts to delineate and extend heterochronic approaches to human evolution. Heterochrony is discussed and critiqued in light of comparative ontogenetic data. The importance of heterochrony for understanding the relations between development and evolution is also considered.

Heterochronic approaches are illustrated with ontogenetic data representing both *Homo erectus* and anatomically modern *Homo sapiens*. Cranial measurements, including linear dimensions and angles, are used to compare ontogenetic size and shape trajectories between taxa.

Investigations within the genus *Homo* document heterochronic transformations over the course of recent human evolution. Specifically, anatomically modern human adults exhibit a neurocranial shape comparable to that of juvenile *Homo erectus*. However, changes in the relations between cranial size and shape during early post-natal development are evident in these data. Alterations in early growth trajectories carry a number of important implications for human life history evolution. Specifically, shifts in brain size growth trajectories may have increased substantially the metabolic costs of early growth. Despite major alterations in size trajectories at early points in development, shape changes are relatively conservative, suggesting that straightforward heterochronic transformations can account for the observed patterns.

This research was supported by the University of Illinois.

### **Convergence in gait mechanics between primates and woolly opossums: The origins of primate locomotion can be traced back to a fine-branch niche.**

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Three characteristics distinguish the locomotor behavior of primates compared to that of other mammals. During quadrupedal walking, primates use mainly diagonal sequence gaits, protract their arms more at forelimb touchdown, and generate lower substrate reaction forces on their forelimbs relative to their hindlimbs. The emergence of the first two features have been linked to the invasion of a fine-branch environment in the earliest primates. The relationship between the force distribution pattern unique to primates and fine-branch locomotion remains however unknown. We examined gait mechanics in *Caluromys philander*, a marsupial with primate-like grasping extremities that moves primarily on fine branches, to test by analogy the link between fine-branch arborealism and the evolution of these three locomotor qualities in primates.

Three captive woolly opossums were videotaped while walking across a force platform mounted in a walkway or attached to a small pole. For each step, the sequence of footfalls, degree of arm protraction at forelimb touchdown, and peak vertical forces for the fore and hindlimbs were recorded. For all 88 steps recorded on both substrates, woolly opossums were primate-like in the way they always used diagonal sequence walking gaits and protracted their arms beyond 90° relative to horizontal body axis. Moreover, like primates, peak vertical forces on the forelimbs were significantly lower than on the hindlimbs (78% of hindlimb force). This kinetic pattern has never been reported before for any nonprimate mammal.

Our data show the convergence of primate-like locomotor traits in a nonprimate mammal that moves and forages on fine branches. This evidence strongly supports the hypothesis that the locomotor traits distinguishing primates from most other mammals evolved in the earliest primate ancestors for the requirements of locomotion on fine branches.

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### **Declining growth status of indigenous Siberian children in Post-Soviet Russia.**

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Much recent evidence indicates that human health status in Russia is sharply declining. The massive social changes that have taken place since the fall of the Soviet Union in 1991 have resulted in increasing morbidity and mortality rates. However, very little information is available on the changes in health and disease patterns of Russia's many indigenous populations. The present study examines anthropometric measures of growth status of young children (< 6 years; n =155), a sensitive index of population health, in three indigenous Evenki communities of Central Siberia between 1991 and 1995.

Children of the 1995 sample are significantly shorter, lighter and leaner than those measured in 1991 and 1992. In 1995, 61 % of Evenki children were growth stunted (HAZ < -2.0), as compared to 33% in 1991 and 1992 (P < 0.001). Similarly, the prevalence of low-weight-for age (WAZ < -2.0) in the 1995 sample was more than double that of the 1991 / 92 sample (43% vs. 17%; P < 0.001). The levels of growth retardation observed in 1995 are comparable to those seen among impoverished third world populations and are consistent with the high rates of infant mortality previously reported in these communities. These results indicate that increased economic marginalization is having a profound effect on the health and well-being of indigenous Siberian groups.

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### **Duration of breastfeeding, parasite load, growth, fluctuating asymmetry, and cortisol profiles.**

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We investigate the effects of duration of breastfeeding on parasite load, growth, fluctuating asymmetry, and cortisol profiles among 146 children in a rural Caribbean village.

Age at weaning was evaluated using retrospective reports from mothers, cross-checked with direct observation and medical records. Intestinal parasite loads were investigated from stool samples preserved in PVA and 10% formalin, prepared using Trichrome slides and formalin/iodine sedimentations. Growth measures included height for age, weight for age, and body mass index. Bilateral anthropometric measures were used to estimate developmental stability. Cortisol profiles were assessed from immunoassay of saliva samples.

Analyses of data indicate that duration of breastfeeding is positively associated

with weight for age, and negatively associated with fluctuating asymmetry, *E. histolytica* infection, and cortisol levels. These results suggest that breastfeeding has important consequences for child growth and development in this population. Supported by NSF BNS 8920569, NSF SBR 9205373, and the MU Research Board and Research Council.

#### **Bipedal walking with elastic loading and its possible role in evolution.**

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In most parts of China and South-East Asia, people traditionally carry loads with a flexible pole made of bamboo or wood. The mid-point of the pole is supported on the shoulder, and the loads are hung on each end of the pole. During walking, the loads can oscillate at the frequency of the step.

A preliminary experiment has shown that with a load of 20-30kg, borne by subjects weighing 60-80kg, the ground reaction force (GRF) is significantly changed; not only the absolute value changes, but also the shape of the force curve. Amongst other changes, the vertical GRF loses its characteristic double-humped shape. The first peak (after heel strike) is prolonged, the second peak (before toe-off) is mostly or wholly absent, and the force depression at mid-stance is greatly reduced. A computer simulation of elastic-loaded walking by *Australopithecus afarensis* (AL288-1 or 'Lucy') using ADAMS/Android, predicted the same result, even though the locomotor kinematics were identical in both the loaded and unloaded models. When a rigid pole is used in the model, however, there is simply an increase in the magnitude of the vertical GRF, proportional to the applied load, but no change in the shape of the curve.

It is considered that the femoral shaft of Lucy was much better at resisting A-P bending than that of modern man (Ruff, 1998). If Lucy was routinely carrying a flexible load (such as a dead animal), even in a fully erect posture, our experiment has shown that both GRF and joint torques would have been very different from our own, resulting in different stress patterns, which required a femoral shaft strong in the A-P direction. Thus, this study offers an explanation for Ruff's findings.

#### **Morphogenetic differences in facial projection between *Homo Sapiens* and *Homo neanderthalensis*.**

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Most efforts to define *Homo sapiens*, *H. neanderthalensis* and other taxa of the genus *Homo* focus on patterns of unique derived and primitive morphologies. *H. sapiens* and *H. neanderthalensis* are typically defined or diagnosed on the basis of a long list of derived craniofacial features in adult specimens. Such diagnoses are problematic, however, because the majority of these features may not be independent when viewed from a developmental perspective. Without an understanding of the developmental processes that generate patterns of morphological differences it is difficult to test hypotheses about speciation and hybridization. We therefore ask the question: What developmental *processes* make the skull of "anatomically modern" *H. sapiens* different from that of archaic *Homo* (e.g., Neanderthals)?

Using comparative ontogenetic data from chimpanzees, fossil hominids, normally-growing humans, and humans with craniofacial growth disorders, we show that the contrasting craniofacial patterns between "anatomically modern" and "archaic" taxa of *Homo* are likely derived to a large extent from differential growth processes in the basicranium. The pre-chordal cranial base flexes relative to the post-chordal cranial base approximately 15° more in *H. sapiens* than in archaic *Homo*. Increased cranial base flexion causes variations in facial projection by reorienting the middle cranial fossa and the position of the face relative to the anterior cranial fossa. Comparative morphometric analyses further indicate that facial retraction is responsible for a suite of other unique, derived features of *H. sapiens*. These characters, however, are not independent and should not be treated as separate characters in phylogenetic analyses.

These results suggest that a morphogenetic shift in cranial developmental processes characterizes the origin of *H. sapiens* and may help to test systematic hypotheses about human origins. The extent to which this shift is an example of evolutionary "tinkering," or instead represents a major adaptive shift remains unclear. Future research is needed to understand the genetic basis of increased cranial base flexion.

#### **Variation in deciduous tooth formation in humans.**

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The aim of this study was to document variation of deciduous tooth formation and eruption. The material is 128 individuals of known or estimated age (using tooth length) from Spitalfields in London. Other material from two medieval Scottish archaeological sites (Whithorn, N=74 and Newark Bay, N=59) and radiographs of 51

living children was also investigated. Stages of crown and root formation as well as eruption were assessed for each developing tooth by direct vision and/or radiographs where available. Age of attainment for individual stages was computed using probit analysis and these data are also adapted for use in estimating age. Analysis of data relative to the first and second molars at stages D (crown complete) and F (root length  $\geq$  crown height) allowed comparison with the Scottish material. No significant differences were observed between population groups for tooth formation or eruption. Alveolar eruption of all deciduous teeth occurred when initial root growth was present, while all teeth half way between alveolar and occlusal level were in stage E (root length < crown height). The attainment of the occlusal level occurred once the root had reached stage F and all teeth with more mature roots were fully erupted.

These results support the view that the developing deciduous dentition is highly stable and little affected by environment with little evidence of secular change over time.

#### **Sexually dimorphic morphology in immature chimpanzee and human mandibles: A continuum for fossil hominids.**

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In 1992, the authors noted clearly visible sex differences in the anterior mandible of human skeletons from about 6 months to about 4 years. Testing these morphologic characteristics resulted in an average accuracy of 81%. Recent tests on a sample composed of 11 known sex forensic cases and CT scans extended the age range to 6 years and yielded an accuracy of 82%. All mandibles less than 6 years were correctly identified. The only specimens missed were 2 females of at above 6 years. After observing the same dimorphic morphology in immature australopithecines, the authors deemed it necessary to determine if this trait was also manifest in the most closely related non-human primate, chimpanzees. The sample consisted of 47 known sex *Pan troglodytes* (from birth to the eruption of the permanent M1) housed at the Anthropological Institute and Museum, University of Zurich-Irchel, Switzerland. SRL observed the same differences in the shape of the inferior border of the symphysis and outline of the body as in the human samples. The male chin base extends steeply downward relative to the adjacent body coming to a point or (less commonly) squaring off at the symphysis. In females, the symphysis gradu-

ally descends to a more rounded base. Overall accuracy was 79%. As in humans males were more accurately identified than females.

In conclusion, the fact that these morphologic traits are indicators of sexual dimorphism both in modern hominids and chimps creates a continuum that can validly be applied to australopithecines manifesting these same features. Thus, since early hominids appear to have followed the same pattern, this provides considerable support for the authors' earlier findings that Sk 61 is male, Sk 3978, female, and the Taung child is a boy.

The senior author is most grateful to P. Schmid for access to the primate collection. This research was funded by an RDP grant from the University of Pretoria.

#### **Patterns of age-related craniofacial change: Implications for choosing adult human comparison samples in craniofacial studies.**

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Craniofacial studies have traditionally used adult human comparison samples of unknown age. These studies are based on the assumption that adult morphology of the vault, upper face and basicranium does not change significantly after age 20. Some studies, however, have indicated otherwise. The present study tests the assumption of adult craniofacial stability, and examines detected patterns of age-related change across sex, geographic/ethnic identity, and multiple age intervals.

Three-dimensional coordinate data for 119 landmarks on the skull and mandible were collected from 1054 males and females from the Terry, the Dart, and the Hamman-Todd skeletal collections. Individual skulls were chosen from the following age groups: 20-39yrs., 40-59yrs., 60-79yrs., 80-99+yrs. Both American and S. African Blacks and Whites were included in this sample. The landmark data were then analyzed using Euclidean Distance Matrix Analysis (EDMA), a three-dimensional morphometric method. Form difference was tested between each age interval within each geographic/ethnic identity. Differences in the pattern of age-related change were also statistically compared between these groups. The sexes were always tested separately.

Results point to distinct patterns of age-related craniofacial change across adulthood. These patterns of change differ between the sexes as well as between different geographic/ethnic identities. For example, results from this study indicate that the endobasicranium (a region traditionally considered to be extremely stable) shows significant age-related change that differs in timing and region between the sexes and geographic/ethnic identities.

Many linear distances in the face also show systematic, age-related change that differs between samples. Some of these face changes may reflect the consequences of tooth loss. The identification of significant changes such as these is imperative to ensure the choice of non-biased adult human comparison samples in craniofacial studies.

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#### **Origins and relationships among Polynesians, Micronesians, and Melanesians.**

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The islands of the Pacific have historically been divided into three groups: Polynesia, Micronesia, and Melanesia. Previous studies of mtDNA from Pacific and Asian populations are consistent with an Island Southeast Asian origin and a settlement route into Polynesia along the north coast of New Guinea. A similar, though independent origin and entry into the Pacific is also suggested for central-eastern Micronesians. The Western Micronesian archipelagoes of Palau, Yap, and the Marianas do not fit this pattern. Yap and the Marianas appear to have been settled independently and directly from Island Southeast Asia. Palau contains diverse maternal lineages suggesting a complex prehistory including contributions from Island Southeast Asia, New Guinea, and other islands of Micronesia. Of the three historical groups, Melanesia contains the greatest morphological, linguistic, and genetic diversity. The incongruity of these patterns of diversity remains unresolved. In particular, the languages spoken in Eastern Melanesia and in coastal regions of New Guinea and the Solomon Islands are grouped within the Oceanic branch of the Austronesian language family along with the languages of Polynesia and central-eastern Micronesia. In contrast, speakers of these languages appear morphologically more similar to Papuan speakers from the highlands of New Guinea and the Solomon Islands. One scenario explaining the mismatch between language and biology is an initial settlement of Eastern Melanesia by Austronesian-speaking people morphologically similar to Polynesians followed by gene flow from Western Melanesia. If this gene flow was geographically limited, this scenario predicts a cline in genotypes across Eastern Melanesia. Here we compare mtDNA data from five islands spanning the length of the archipelago of Vanuatu with data from Polynesia, Micronesia, and Asia to evaluate the probability of post settlement gene flow under this scenario. We do not observe a cline in genotypes with respect to distance from Western Melanesia. In contrast, the

mtDNA variation is consistent with linguistic relationships among Oceanic Austronesian languages. These data suggest that the current patterns of language and morphology predate the settlement of Eastern Melanesia.

#### **Functional adaptation of the iliac and upper femoral cancellous network in a bipedally-trained Japanese macaque.**

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Comparative analysis of external bone shape, size, and cortical bone distribution evidenced functional adaptations in the post-cranial skeleton of Japanese macaques (*M. fuscata*) trained for bipedal standing and walking (Nakatsukasa *et al.*, 1995). We investigated the structural organization and site-specific degree of anisotropy of the iliac and upper femoral cancellous network in "Sansuke" (SNK), a male Japanese macaque trained for bipedal standing and walking for about 1-2 hours/day since the age of two years till its death, at ten years.

The reference sample included nine iliac bones and twenty-one femurs from non-trained adult males. All the specimens were radiographed in standard conditions and the films analyzed by means of advanced digital images procedures. Numerical estimates of the "local relative intensity" and "edge count" allowed the quantification of cancellous network densities. In order to assess the orientation of the bundles, the LFD diagrams (Geraets, 1998) have been used.

In SNK, the proximal femur trabecular pattern falls within the normal range of variation. Minor structural differences affect the bundle running from the upper head towards the neck (strengthened in SNK) and the area surrounding the trochanteric fossa (remarkably extended in SNK). Conversely, the iliac cancellous network appears much more structured in SNK and a number of distinctive features are traceable within its blade and corpus. With respect to the normal condition, a thickened bundle is developed in the bipedal macaque along the anterior iliac margin, and a notable structural patterning is found along the sacropubic axis towards the upper margin of the acetabulum. The currently in progress  $\mu$ CTs analysis of the same skeletal sample confirms the radiographic evidence.

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### The femora of *Dryopithecus laietanus*.

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The Late Miocene (9.5 Ma) partial skeleton of *Dryopithecus laietanus* from Can Llobateres, Spain (CLI-18800) is of considerable interest as associated skeletal material for Miocene hominoids is rare. Here we report on the femora from this skeleton, the first unequivocally attributable to the genus.

The right and left femora preserve the proximal epiphyseal and diaphyseal morphology but the distal epiphyses are missing in both specimens. The femora resemble those of great apes in almost all respects and are much more derived than those known for *Proconsul*, *Morotopithecus*, *Equatorius* (*Kenyapithecus?*) or *Siuapithecus*. Features include large size, short diaphysis, expanded, globular femoral head, long neck, high neck/shaft angle, head that is elevated above the greater trochanter, gluteal ridge and the absence of a tubercle on the posterior aspect of the neck. Overall, the *Dryopithecus* femora resemble those of *Pongo* more than any other extant primate.

The femoral features suggest considerable hip mobility and, in conjunction with previously reported aspects of the CLI-18800 skeleton including elongated forelimbs (especially the hands) and a stiff lower back, imply a locomotor repertoire including forelimb-driven suspension and climbing and orthograde postures.

Despite the fact that postcranial features associated with orthograde and suspensory locomotion comprise some of the major characters uniting the extant hominoids, few Miocene hominoids share many derived postcranial similarities with their extant counterparts. Thus far, of those genera that are sufficiently well documented, only the Early Miocene *Morotopithecus* and the late Miocene *Oreopithecus* and *Dryopithecus* are likely to have resembled extant hominoids in significant aspects of their locomotor pattern. The task remains to determine if these similarities are homologous.

### Natural selection and fine neurological tuning.

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Our data indicate that relative to the vermis and the rest of the brain, the cerebellar hemispheres expanded differentially in hominoids over monkeys in the

course of the evolution of the primate brain. The hemispheres are comprised primarily of neocerebellum, which has a chief output nucleus to higher centres, the dentate. The principal inferior olivary nucleus (PIO) projects specifically to the neocerebellum, and also has reciprocal connections with the dentate. These highly integrated structures would be expected to increase proportionally as a unit, whereas differential expansion of some elements in cerebellar circuitry over others would suggest intervening variables beyond allometric constraint.

Using histological sections of 47 monkeys, apes and humans, the volumes of the PIO, dentate, hemispheres, cerebellum, and whole brain were measured. Data were analysed with multiple regression which enabled the grades of hominoid and monkey to be tested for significance. Results showed a much greater expansion of the PIO to dentate in hominoids over monkeys. The PIO increased in concert with the hemispheres relative to the rest of the brain in hominoids, while the dentate did not participate in this positive grade shift. This unexpected pattern is hardly enough to explain the relation between nuclear and cortical expansion in other neurological structures, but would suggest that as some structures such as the cerebellar hemispheres increase beyond predicted allometry, the functions of related structures are selected to produce a qualitatively different neurological system. The climbing fibres of the olive affect the functioning of cerebellar cortex, and the increased information-processing capacity of the hemispheres selected in the common ancestor to hominoids presumably required the co-evolution of the PIO but not the dentate nucleus. This implies a role for natural selection in fine tuning the relative importance of those structures most amenable to the demands of a new ec niche.

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### The pattern of epidemics in Escazú, Costa Rica.

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Epidemics are known to be an important selective agent in agricultural populations. These groups, characterized by sedentism and close proximity among potential hosts commonly experience cycles of epidemic mortality. In this paper we evaluate the presence of cycles of mortality in a small, rural population in Costa Rica.

The data consist of yearly counts of death from 1851 through 1921 recorded at the Parish of Escazú. A visual inspection of the time series indicated various peaks of mortality. Notably, the cholera epidemic of 1856 took a devastating toll in the popu-

lation: in a single month (June) 311 deaths were recorded, an extremely large number of deaths considering that the 1864 census reports that Escazú had 2533 inhabitants (Ministerio de Economía y Hacienda, 1964). Since 311 is such a large outlier, and would have interfered with a successful spectral analysis of the series, the next largest number of deaths was substituted for the datum, as suggested by Lin and Crawford (1983). After removing this mortality peak, the time series did not violate the variance-stationarity and lack-of-trend assumptions. Nevertheless, the data were differenced to smooth the time series, as suggested by Chatfield (1984).

Although a periodogram of the entire differenced mortality series indicated a cycle of 3.5 years, a Fisher test did not reject the null hypothesis of white noise. Since Madrigal (1994) had shown that mortality seasonality decreased in this population in more recent years, a periodogram of the years before 1900s was obtained, but its peak too, failed to achieve significance.

Although cycles of mortality have been assumed to be a common occurrence in agricultural populations, the lack of such cycles in Escazú suggests that this assumption needs to be revisited. We suggest that the small population size of this settlement accounts for the lack of significant epidemic cycles.

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### Patterns of growth in Upper Pleistocene *Homo sapiens*: Comparative analysis between La Ferrassie and Qafzeh immature *os coxae*.

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The hip bone (*os coxae*) is frequently employed to assess anatomical contrasts in the post-cranial skeleton between Neandertals and early Modern Humans. A review of the studies indicates that the Neandertal adult bone is commonly described as having an unusually elongated and slender superior pubic ramus that is morphologically associated with a very shallow greater sciatic notch. However, besides two well preserved pelves found in the Near East, i.e. the Kebara 2 male and Qafzeh 9 female specimens, the evidence used to support this distinction within the Middle Paleolithic Hominid sample consists of a majority of fragmentary bones.

A morphometric and qualitative approach of the pelvic growth in Middle Paleolithic children is crucial to the under-

standing of the adult form. Prior to the recent discoveries of Dederiyeh 1 and 2 juvenile skeletons in Syria (Dodo et al. 1998, Akazawa et al. 1999), and that of Mezmaiskaya in Northern Caucasus (Golanova et al. 1999), as yet described in a preliminary fashion, the evidence documenting the growth and development patterns of Middle Paleolithic pelvises relies primarily on a fossil record from Southwestern Europe and Israel. In fact two sites, La Ferrassie in France and Qafzeh in Israel, provide the richest sample of specimens (N = 6) documenting age-related changes in pelvic growth pattern (Heim 1982, Tompkins and Trinkaus 1987, Majo 1995, Tillier 1999).

Metric and morphological comparative analyses between the fossil children, i.e. La Ferrassie and Qafzeh specimens, and reference skeletal samples of modern children (Majo 2000) were performed. In addition three of the specimens, i.e. La Ferrassie 6, Qafzeh 21 and 10, are sufficiently complete to permit calculation of proportional indices and to evaluate the correlation between hip bone and body sizes. The results of this study bring new insights in the ongoing debate over the presence or absence of differences in development patterns between Neandertals and early modern humans. They indicate that the elongation of the superior pubic ramus is not in fact exclusive to Neandertal children but occurs in other Middle Paleolithic juveniles.

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#### Analysis of ancient and modern mtDNA sequences in western North America.

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All full blood Native Americans belong to 1 of 5 maternal lineages (haplogroups A, B, C, D, & X) defined by mutations in the mitochondrial Control Region or by restriction site gains or losses throughout the mitochondrial genome. Overall, the analysis of these haplogroups in North America reveals a clear pattern of regional and temporal continuity. Discontinuity of haplogroup frequencies is explained by regional culture history, through population intrusions or subdivision of groups. The vast amount of linguistic and ecological diversity in Western North America has prompted linguists and archaeologists to propose a large number of migrations and population divisions in Native American prehistory.

Recent studies of mtDNA haplogroup frequencies in ancient populations of the western Great Basin and the Southwest have shown evidence of mtDNA haplogroup frequency discontinuity and

continuity respectively. This study analyzes the distribution of haplogroup frequencies through time on the Columbia Plateau, another region of western North America. Additionally this study examines the relationship of modern and ancient mtDNA sequences from western North America in order to explain the causes of mtDNA haplogroup frequency discontinuity in this region. Ultimately, this analysis is used to provide insight into the prehistoric population events and dynamics in ancient western North America.

#### Assessing the trade of primates in Indonesia and the collection of non-invasively obtained cytogenetic evidence.

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Asian nonhuman primate populations may be especially sensitive to human based environmental pressures, including the capture of certain species for illegal trade (Eudey, 1999). Understanding the system of trade and systematically documenting its impact is of critical importance to conservationists, primatologists, and anthropologists in general. Previous monitoring has indicated a substantial volume of trade in species protected by Indonesian conservation law, namely members of the genera *Nycticebus*, *Hylobates*, and *Pongo* (KSBK, 1998). This paper presents survey and interview data from 21 animal markets in 10 cities across Java and Bali, Indonesia. Species representation, volume, costs, and conditions of traded primates were recorded. Also, the methods for the acquisition of cytogenetic evidence obtained through the non-invasive collection of hair from gibbons and siamangs (*Hylobates* spp.) are outlined.

The present survey recorded a total of 181 primates for sale in and around the markets. The species represented were: *Macaca fascicularis* (49%), *Nycticebus coucang* (22%), *Macaca nemestrina* (15%), *Trachypithecus auratus* (7%), *Hylobates syndactylus* (3%), *Hylobates agilis* (2%), *Hylobates muelleri* (1%), and *Pongo pygmaeus* (1%). Species representation and interview data reveal southern Sumatra and Kalimantan as especially vulnerable primate source areas. We also discuss trade routes both to and within Java. The analysis of the hair samples may provide scientific support for governmental reports and conservation policies, and aid in the development of a comparative database to enhance the monitoring of trade both within markets and near the sources.

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#### Was the Laetoli G-3 hominid a juvenile?

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Based on the interpretation of the Laetoli G footprints as having been made by three individuals, it is possible that the smallest individual was a juvenile. However, *A. afarensis* has been called a very sexually dimorphic species (McHenry, AJPA, 1992), and if this is the case and if *A. afarensis* made the prints, it may be that the smallest individual was an adult female. Furthermore, if it can be shown that the print maker was indeed sub-adult, the question arises, "How old was it?"

To answer these two questions, one qualitative and one quantitative, data were collected on the change in foot form with age among hominoids. Measurements of the foot bones of 300 hominoids were obtained from museum collections. Species included were: *Pan troglodytes*, *Gorilla gorilla*, *Pongo pygmaeus* and *Homo sapiens*. In addition, an ink pad and paper were used to obtain footprints of modern humans of various ages, resulting in a mixed longitudinal series. From these two datasets, toe index was calculated as (toe length/foot length)x100 for all subjects of known age and sex. These toe indices were then compared to toe indices for Laetoli G-1 and G-3.

It was found that among humans, chimps and gorillas, the toe index decreases with age, whereas orangutans' indices remain fairly constant. Furthermore, although there were no sex differences in orangutans and humans, adult female chimps and gorillas have significantly larger toe indices than their male counterparts. Laetoli G-3 (the smaller individual) has a higher toe index than does G-1. Therefore, using the African ape model, the Laetoli G-3 individual may have been a small, adult female, rather than a juvenile. On the other hand, since the toe indices of G-1 and G-3 are similar to those of modern humans (Tuttle et al., AJPA, 1991), and well outside the range for African apes, perhaps the Laetoli hominid feet should be treated as human feet. Using this model, G-3 was probably a juvenile. If G-3 is considered a juvenile, and if G-1 is taken to be an adult and a good indicator of adult toe index for its species, an estimate of the age of G-3 can be made on the basis of the other hominoids' growth trajectories. The

choice of an appropriate hominoid model and the resulting age estimate(s) are discussed.

**Wild chimpanzees are manually unlateralized: Replicative data from the Mahale Mountains, Tanzania.**

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Ethological study at Gombe National Park, Tanzania showed wild chimpanzees to be unlateralized for all manual behavior except tool use (Marchant & McGrew, 1996, *J. Hum. Evol.* 30: 427-443). In contrast, experimental study of captive chimpanzees seems to show evidence of right side bias. We sought to clarify this apparent disagreement by replicating and extending the Gombe study in another population of wild chimpanzees.

In the Mahale Mountains National Park of Tanzania, we observed all members of M-group's chimpanzees (*Pan troglodytes schweinfurthii*), except babes in arms. Using focal-subject sampling, we recorded 35 categories of hand use, over 3.5 months. These data were analyzed in a 5-level scheme, ranging from Level 1, comprehensive ambilaterality, to Level 5, exclusive use of left or right hand across tasks. The 15 most frequent categories included behavioral patterns of subsistence, sociality, communication, and self maintenance.

Almost 15,000 bouts of hand use were recorded. The overall pooled breakdown of these was 51% Left vs. 49% Right. For the 342 combinations of Individual x Pattern for which there were enough data for statistical analyses, 320 were Ambipreferent, 15 were Left-preferent, and 7 were Right-preferent. No individual chimpanzee showed handedness, that is, consistent use of one hand across tasks; the closest was an old female who showed 5 left biases of 12 tasks. No behavioral category showed task specialization, that is, consistent use of one hand across subjects; the closest was Nose Wipe, which lateralized to the Left for 6 of 38 individuals.

At Mahale, Level 1 (i.e. ambilaterality) results predominated across the manual repertoire, just as they did at Gombe. When combined with data from Tai in Ivory Coast and Bossou in Guinea, these results strengthen the conclusion that wild chimpanzees are behaviorally unlateralized. We hypothesize why this may not be the case for captive apes, e.g. influence of right-handed human caretakers.

**Slave health and nutrition at Bremono, Fluvanna County, Virginia.**

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The Cocke family was a prominent Virginia family during the Colonial period. General John Hartwell Cocke, a close friend of Thomas Jefferson, was considered to be a benevolent slave owner who worked toward the gradual emancipation and expatriation of slaves. His Bremono Plantations have remained in the Cocke family since 1798 and offer not only undisturbed archaeological remains, but also an extensive collection of archival documents. Here these data are examined to determine if Cocke's atypical attitudes toward slavery resulted in an improved quality of life for his slaves.

Documentary evidence suggests that doctors regularly provided medical care to Cocke's slaves. Twenty-nine slave children were vaccinated for small pox in 1836. There were thirty-four receipts from doctors' visits in 1809, 48 in 1833 and 48 in 1834. Other receipts and prescriptions suggest regular doctor visits throughout the decades of the 1840's and 1850's.

Archaeological evidence suggests that the housing for these slaves was atypical of that provided to slaves elsewhere in Virginia. Cabin 3B at Bremono Recess is one of four double cabins approximately 16' x 16'. This cabin had two stories, wooden floors, glass windows and a central stone fireplace. The diet of the Bremono slaves appears to be typical of other slaves of the period. Males received 4.3 lbs. of salt pork, and 1.5 pecks of corn meal. Other dietary supplements include white potatoes, sweet potatoes, turnips and peas. Archaeological evidence also suggests that slaves hunted wild game for food.

Bremono slaves still suffered from infectious diseases associated with poor sanitation and overcrowding, such as tuberculosis, cholera and dysentery. It is likely that General Cocke's public persona of benevolence may not have resulted in an improved quality of life for his slaves.

**HLA genes in Arab-speaking Moroccans: close relatedness to Berbers and Iberians.**

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The Arab-speaking Moroccans gene profile has been compared with those of other Mediterranean populations in order to provide additional information about the history of their origins. Genetic distances, neighbor joining and correspondence analyses have been done after HLA-DNA indirect sequencing. Our HLA data suggest that most Moroccans are of a Berber

(*Imazighen*) origin and that Arabs who invaded North Africa and Spain in the 7<sup>th</sup> century A.D. did not substantially contribute to the gene pool; however, they imposed their advanced culture and their religion. Present day Egyptians are also related to Moroccan Berbers and this supports an ancient Saharan origin for part of the present day Mediterraneans, particularly for the Arab-speaking ones (also Algerians) and also for the *older substratum* of Mediterranean people, which include Iberians (also Basques), Italians, North Africans (from Egypt, Algeria, Morocco), Jews, Lebanese and Anatolians (Turks). Circum-Mediterranean cultural and gene flow have existed in glacial and interglacial periods according to our genetic and linguistic data. Greeks are found in a *more recent substratum* and may have reached the Balkans after 2000 BC. This is supported by historical records: the first Indoeuropean (pre-Mycaenian) Greeks came to the Balkanic Peninsula by the 2<sup>nd</sup> millennium BC.

**Can nuclear genetic loci be used to discriminate between populations in Southeast Asia, Melanesia and Polynesia?**

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The relationship between the indigenous peoples of Southeast Asia, Melanesia and Polynesia has been studied at a variety of genetic loci. The majority of the data reported in the early years of anthropological genetics was obtained from mitochondrial DNA, and supported the "Express Train" model of Polynesian origins, in which a southeast Asian population migrated rapidly through Melanesia and settled the uninhabited islands of Polynesia. This model allowed for little interaction and gene flow between these migrants and the existing inhabitants of Melanesia. As increasing amounts of data from nuclear genetic loci have been acquired, however, the pattern of relationships between these peoples has been shown to be more complex. Globin gene haplotypes and short-tandem repeat (STR) loci show that the major component of the Polynesian gene pool is derived from a recent southeast Asian source, but that there is a substantial contribution (approximately 30%) from the ancestors of present-day Melanesians. Detailed analysis of globin gene haplotypes, gene deletions and linked tandem-repeat alleles in Melanesian populations reveals a complex pattern of gene flow within an extended voyaging corridor that encompasses Vanuatu, New Britain and New Ireland.

Recently, data has become available on Y chromosome variation in Oceanic populations. These data appear to lend more support to the "Express Train" model, as they do not show evidence of Melanesian

Y haplotypes in Polynesians. The differences between autosomal, Y chromosome and mtDNA profiles may reflect the different extents to which demographic events shape variation at these loci. Accounting for such discrepancies is one of the current challenges of anthropological genetic research in Oceania.

### Giving Sherry a hand: Tools and the evolution of the human hand.

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Washburn's premise, that the unique morphology of the human hand is the result of prehistoric tool use, and may have evolved from an ape-like hand, laid the cornerstone for subsequent functional analyses of fossil hominid hands. It was central to Napier's classic study of the Olduvai *Homo habilis* hand bones, which followed Washburn's broad-based approaches of comparative morphological and behavioral observations and experimentation in the assessment of functional capabilities. It has been repeatedly tested by numerous investigators, as newly emerging quantitative techniques have been applied to the identification of features that distinguish among hands of living and fossil species and to the assessment of their possible functional and behavioral correlates. Among the techniques are electromyographic (EMG) studies, biomechanical analysis and stereophotogrammetry. In our laboratory, EMG studies have shown that both the thumb and fifth finger are particularly likely to reveal skeletal stresses associated with strong and repeated muscle recruitment during tool-using and tool-making grips and movements. The analysis of muscle and joint mechanics indicates that large tendon moment arms characterize the human thumb muscles, and that joint morphology and orientation facilitating thumb and fifth finger rotation are fundamental to distinctive human grips used in prehistoric tool activities. Our most recent stereophotogrammetric analysis of trapezio-metacarpal joint morphology reveals a highly significant difference between humans and chimpanzees in rms joint surface curvature, perhaps reflecting differences between them in grip capabilities. Australopithecine and early *Homo* thumb joint surface curvatures fall near the chimpanzee mean and one standard deviation below the human mean respectively. These results are consistent with Washburn's speculations on the interrelations of the history of tools and evolution of the human hand.

### Dynamics of microsatellite genetic diversity in the Indian Subcontinent.

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We have analyzed genetic variation at 13 STR loci (CODIS core loci) in a sample of 16 ethnically and geographically diverse endogamous caste and tribal populations of the Indian subcontinent.

A wide spectrum of allelic distribution at different loci was visible in different geographical and ethnic populations. Overall populations within geographical regions showed greater degree of similarity. Statistically significant differences were observed in a large number of inter-population comparisons. FGA locus was the most polymorphic in a majority of populations with 17 observed alleles. Other highly polymorphic loci in Indian subcontinent include D21S11(15 alleles) and D8S1179(10 alleles). FGA locus had the highest average heterozygosity (86%) and the lowest was observed for TPOX (69%). Average heterozygosity for all loci was 0.79.

Coefficient of genetic diversity showed a narrow range for different loci (0.007 to 0.026) with an average of 1.4%, which indicates that these populations are at an early stage of micro-differentiation. Phylogenetic trees and principal component analysis computed from microsatellite allele frequencies provide support for socio-cultural and geographical assignment of these populations. Comparisons are in progress with other genetic markers including mtDNA and Y-chromosome.

We also computed forensic and paternity statistics. Lowest match probability and highest exclusion probability was observed for the FGA locus. Combined match probability was low (1 in  $8.99 \times 10^{12}$  to  $2.9 \times 10^{13}$ ), and combined exclusion probability was > 99.999%. There was no evidence of association of alleles between loci studied, so these loci seem to comprise a suitable group of markers for population genetic purposes and for paternity and forensic testing.

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### The study of populations in the past.

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Populations in the past usually present themselves as skeletal remains. Morphological analysis can be done on skeletal remains, but it can usually only define the individual to a population level. Molecular analysis can enhance the study of popu-

lations on a finer scale of groups, subgroups and even lineages, families and the individuals if required. The molecular analysis utilises segments of DNA that are highly variable and provide the potential to differ between population groups, subgroups, lineages, families and individuals. Studies on mitochondrial DNA have contributed to the knowledge of populations and genetic diversity of modern populations. This information has been used by evolutionary biologists and anthropologists to support the out of Africa hypothesis in the global population movement of the hominids. This area of study is complex as it involves looking for genetic diversity, frequencies of distribution and coalescence time amongst other features. Problems arise when there are bottlenecks associated with population migrations or stress on the population by external factors like disease. Bottlenecks occurred in the migration into the Pacific, the Americas and even into Asia. These bottlenecks cause modern genetic data to be incorrect when looking at populations in the past. Here we propose the analysis of populations in the past to generate our data for these type of questions that the modern data is being used for, like migrations and population movements. The most difficult task then is to find a collection substantial enough to constitute a population. Here we present the results of this type of study on a population from the archaeological site of Copan in Honduras and the more accurate information that we can generate from the analysis of the populations in the past.

### Molecular archaeology of Pacific commensals - animal models for human migration.

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Biological anthropologists have used a range of classical anthropological tools, from analyses of metric and non-metric skeletal traits to molecular genetic studies of modern human populations, to investigate the settlement of the Pacific. However, when humans moved out and settled the islands of Remote Oceania, they did not arrive alone. Pacific colonists also transported a number of domestic and non-domestic animals, the remains of which appear in archaeological middens. Most of these "commensal" animals were totally dependent upon humans for dispersal across major water gaps. Therefore by identifying the genetic relationships, or phylogenies, of the various Pacific commensals, we can identify the pathways taken by the people who carried them. In addition, by identifying the sources and timing of these introductions, we can better understand the full impact of humans on Pacific island ecosystems. This paper

focuses on ancient DNA analyses of archaeological remains of Pacific commensal animals and discusses results and future applications of molecular archaeology in the Pacific and Southeast Asia.

**Terrestrial nesting by chimpanzees in Bwindi Impenetrable National Park, Uganda.**

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The construction and distribution of chimpanzee nests provide important clues about the behavioral ecology of early hominids. A small percentage of chimpanzee nests in BINP are found on the ground, a rare occurrence in wild chimpanzees. Ground nesting was first documented in BINP by Bolwig (1959), who found 5 ground nests. Ground nesting was recently confirmed by McNeilage *et al.* (1997) during a census of gorillas and chimpanzees in the park.

In the southern portion of BINP, where over 2,000 nests have been documented (Stanford, unpublished), only one has been found on the ground. In a study of approximately 1,000 nests in the northern portion of the park, 5.5% were found to be terrestrial. Two regions of the northern sector were sampled to examine the frequency of ground nests. Ground nests occurred in all areas sampled. The greatest percentage of ground nests (15%) occurred in one area of 3 sq. km. Terrestrial nests were found in clusters of 3 to 5.

The majority of ground nests closely resembled arboreal night nests. They were composed of bracken ferns (*Pteridium equilium*) and sapling trees, and typically used fallen trees as supports for the side of the nest that faced downslope.

While it is unknown whether these are night or day nests, the systematic construction of Bwindi ground nests suggests that they are night nests. This unique nesting culture may be due to the absence of predators and other large mammals, including elephants and gorillas, in the northern sector of BINP.

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**Discrete dental traits and intra and intergroup relationships between burial mounds from the Illinois Bluff Titterington collection, Smithsonian Institution.**

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Recent and on-going studies have used multiple lines of evidence to answer questions about relationships between local

and global populations. Discrete dental traits are of particular interest due to their slow rate of change, growth pattern, and consistency. Many discrete traits are expressed in varying degrees. Several authors have referred to this as quasicontinuous variation. Having a consistent expression of an intermediate grade trait, for example, may be just as relevant as the most extreme expression of a trait. Thus, regional populational variation is determined by sorting out patterns of association.

The population studied here is the Illinois Bluff collection, also known as the Titterington collection, from Jersey County Illinois. This series was from forty-four burial mounds located along the bluffs overlooking the Illinois River, dating from the middle to late Woodland (400-1000 AD).

It is generally accepted that the Illinois burial mounds represent a homogeneous population spanning a considerable, yet continuous, occupation period of the region. Multivariate cluster analyses on forty discrete and/or quasicontinuous dental traits collected are used to determine genetic closeness between and among the mound populations studied. This information will also be used to explore the differences in observed dental and cranial pathologies and anomalies in the context of environmental and cultural variation. Results indicate that the relationships among these variables are more complex than previously recognized.

**A morphogenetic model of craniofacial development: Implications for hominin systematics.**

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The cranial base is the platform upon which the brain rests and from which the face grows forward. Its central position greatly influences the proper development of the face and braincase. Thus defects in chondrocranial growth can cause facial and vault dysmorphologies. The Brachyrrhine (*Br*) mouse provides a model of how a primary cartilaginous defect in the cranial base can influence craniofacial growth disorders.

Heterozygous *Br* mice have severe maxillary retrognathia, possibly caused by a single-point mutation on Chromosome 17. Morphological analyses of the *Br* mouse suggest that the craniofacial dysmorphology stems from a primary cartilaginous defect in the anterior sphenoid. Portions of the presphenoid body and lesser wing anlagen do not chondrify, causing antero-posterior shortening of the cranial base. This affects rostral growth of the

maxilla, resulting in retrognathia similar to Class III malocclusion in humans. The neurocranium is also affected, with antero-posterior shortening of the frontal, parietal, zygomatic, and temporal bones. Regions of the cranium posterior to the hypophyseal fossa are unaffected.

The *Br* mouse illustrates how changes in chondrocranial morphogenesis can affect facial projection, and it highlights the problematic assumption that most craniofacial characters are independent. If facial retraction in *H. sapiens* is caused by a developmental change in the chondrocranium, then many other unique, derived features in *H. sapiens* may be secondary consequences of primary changes in the cranial base. In addition, these changes may have a genetic basis. The *Br* mouse model suggests that future work should be aimed at genetic and developmental studies of the modern human cranial base.

**A longitudinal pilot study of age estimation from dental radiographs.**

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Reduction in size of the dental pulp chamber results from continuous deposition of secondary dentin as a part of the normal aging process. Several studies have measured the decreasing ratio of pulp chamber size to overall tooth size in dental radiographs to develop age estimation formulae. These studies have reported strong correlations with age using cross-sectional data and suggest a relatively simple, noninvasive method applicable to archaeological and forensic cases. However, individual changes may vary considerably from the patterns evident in cross-sectional data.

To permit preliminary evaluation of individual variation in pulp chamber size decrease relative to increasing age and assess the potential for further study, longitudinal series of dental radiographs were assembled for 39 individuals (17F, 22M). Each individual is represented by at least five sets (mean of eight sets) of lateral batwing radiographs, taken for routine clinical examination. A minimum interval of one year between radiographs was required for selection, but most individuals were evaluated at two-year intervals. Individuals range in age from 14 to 88 years. Four measurements were taken for each tooth, all oriented to the cemento-enamel junction (CEJ): 1) cervical breadth at CEJ; 2) crown height; 3) pulp chamber breadth; and 4) pulp chamber height measured from a line placed across the CEJ (coronal pulp chamber height). Tooth size (one pulpal dimension against one tooth dimension) was standardized by least squares regression. The ratio of pulp chamber height to crown height (after Drusini, *et al.*, 1997; Ikeda, *et al.*, 1985) was also calculated for



comparison with previous studies. Standardized values were then used to predict age.

The results of this study suggest more modest correlations between pulp chamber size decreases and increasing age than have been reported in previous studies. The correlation between pulp breadth/cervical breadth and age was consistently higher than other combinations of measurements, particularly those which included crown height. Individual variation was pronounced, with mandibular premolars frequently showing only minimal change in pulp chamber dimensions over time.

#### Testing hypothesized constraints on primate and hominin skull form.

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A multitude of constraints on primate craniofacial architecture have been proposed by recent researchers. These constraints concern the sizes, shapes and spatial relationships of parts of the cranial base, nasomaxillary complex, mandible and pharynx, and are particularly important for determining character independence and reconstructing incomplete fossil crania. However, these hypothesized constraints have not been tested extensively using 3-D data for adequate numbers of individuals from a broad range of species.

In this study, two kinds of constraints are tested. Primary constraints concern the influence of soft tissues such as the eyeball on the size and shape of skeletal tissues such as the orbit. Secondary constraints concern the interactions between adjacent skeletal tissues (e.g., cranial base size and shape is hypothesized to limit facial size and shape). Primary and secondary constraints were tested in an adult interspecific sample of 42 haplorhine and 18 strepsirhine primates. Volumetric data for soft tissue dimensions were taken from the literature, and skeletal dimensions were collected from radiographs and CT scans.

For both primary and secondary constraints, high correlation coefficients and predictable regression coefficients in the bivariate scaling analyses test the correspondence between associated soft and skeletal tissues. Interspecific matrix analyses were used to determine the pattern of relationships among sets of craniofacial constraints, and resulting matrices were then compared to *a priori* matrices based on developmental, functional and structural considerations.

Most hypothesized primary constraints were not rejected, indicating that the sizes and shapes of soft tissues to a large extent limit the sizes and shapes of their associated skeletal tissues. In contrast, most

hypothesized secondary constraints on primate craniofacial architecture were rejected, supporting the hypothesis that interactions between skeletal tissues not associated with soft tissues are weak. A few proposed secondary constraints, however, are fairly invariant interspecifically, including the orientation of the back of the midface relative to the orbits and the orientation of the nasomaxillary profile relative to the cribriform plate. Because they influence facial orientation and are themselves influenced by brain size and shape, these two secondary constraints are important for interpreting differences in craniofacial configuration between highly encephalized hominins such as Neanderthals and *H. sapiens*.

#### Maritime adaptations of Southwestern Alaska: an overview.

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Cold water maritime adaptations may fruitfully be studied in coastal Southwestern Alaska, where marine hunter-gatherers have lived for at least 8000 years. The Holocene of this region, stretching from Kenai Peninsula on the east to Bristol Bay on the west and including Kodiak Island, the Alaska Peninsula, and the Aleutian islands, is characterized by relatively dense indigenous human populations compared to other regions of native North America. Seditism, based on seasonal hunting and collecting of vast food resources and food storage, gave rise to ranked social complexity among many societies. From approximately 3000 B.C. onward, many of the Southwestern Alaskan societies lived in permanent winter settlements, in semisubterranean houses, creating thick middens of shellfish, and subsisting on the combination diet of sea mammals, fish (e.g., salmon, cod, and halibut), sea birds, shellfish and other marine invertebrates, and seaweeds.

This North Pacific-Bering Sea region is geographically unique, with its proximity to Asia, the shallow Bering Sea and former land bridge, and deep Aleutian Trench, but it makes for interesting comparisons to terrestrial and tropical zones which have also given rise to maritime adaptations. With recent coastal cave finds in Southeastern Alaska dating in excess of 10-12,000 years, there is some interest in the southern Alaskan coastal zone as an avenue of early colonization into North America (following K. Fladmark's 1979 suggested roots). While the late Pleistocene relationships to early Holocene peoples of the New World are yet to be determined, the common coastal environments of Northeastern Asia and Northwestern North America give us reason to understand these connections as thoroughly as possible.

#### Dental evolution in the genus *Pan*.

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Systematic comparisons between *P. paniscus* (bonobos) and *P. troglodytes schweinfurthii* (chimpanzees) indicate that bonobos eat more Terrestrial Herbaceous Vegetation (THV) than do chimpanzees. It is thought that an evolutionary history of greater dependence on evenly distributed, continuously available THV underlies the larger group size and greater female sociality of bonobos. Thus far, larger shearing crests on bonobo molars are the only morphological evidence in support of this hypothesis.

We examined permanent incisor size and incisor wear in skeletal samples of *P. paniscus* (n = 41), *P. t. troglodytes* (n = 22) and *P. t. schweinfurthii* (n = 29) collected from natural populations in Congo. Within each taxon, specimens were allocated to one of five Molar Wear Stages (MWSs) and modal patterns of incisor wear were identified within each. In addition, for those specimens assigned to MWS's 3, 4 and 5, the percentage of total incisor crown height remaining was calculated.

Results indicate that, in comparison to chimpanzees, attrition of the bonobo mandibular incisor occurred earlier and at a faster rate. Quantitative data further indicate that whereas reduction of the chimpanzee mandibular incisor crown was delayed relative to that of its maxillary counterpart, in bonobos the mandibular and maxillary incisor crowns were reduced at the same rate. The latter pattern of incisor wear is consistent with the processing of *Haumania liebrechtsiana*, a cane-like stalk that is snapped open with the incisors in order to gain access to the enclosed pith. In bonobos, *H. liebrechtsiana* is the single-most often-eaten species of THV.

In mammals, greater durability of the teeth is often achieved simply by increasing their size. Our results demonstrate that the mandibular central incisors of bonobos are indeed relatively large in comparison to those of chimpanzees. This variation in dental pattern provides compelling evidence of the bonobo's long-term exploitation of terrestrial herbaceous foods such as *H. liebrechtsiana*.

#### New perspectives on *Dryopithecus*, *Ouranopithecus*, and *Oreopithecus*: A critical reassessment of the "Out of Africa and Back Again" model of ape and human origins.

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Controversy surrounds when and where the common ancestor of extant Af-

rican apes and humans originated. Much attention has focused recently on proposals of a middle-late Miocene Eurasian origin, based on the purported presence of supraorbital tori and an African subnasal pattern in *Dryopithecus* and *Ouranopithecus* as well as from modern hominoid postcranial features in *Oreopithecus*. Maximum parsimony analysis of one interpretation of the character states present in the Eurasian material has resulted in proposal of the "Out of Africa and Back Again" model of ape and human origins.

Analysis of European Miocene apes indicates that rather than exhibiting craniodental synapomorphies of African apes and humans, *Ouranopithecus* and *Dryopithecus* actually exhibit plesiomorphic traits, including a large incisive opening between a non-overlapping nasoalveolar clivus and palatal process of the maxilla as well as retention of supraorbital costae from the ancestral catarrhine morphotype. *Dryopithecus* lacks several synapomorphies of the modern hominoid morphotype. For example, *Dryopithecus* resembles *Proconsul* in retaining a heart-shaped distal metacarpal epiphysis and a posteromedial orientation of the humeral entepicondyle. All modern hominoids, in contrast, have quadrate distal metacarpals and medially oriented entepicondyles. In addition to signaling habitual flexion at the metacarpophalangeal joint and quadrupedal monkey-like kinematics of the carpal and digital flexors, retention of these features shows that *Dryopithecus* diverged prior to the last common ancestor of living hominoids. No evidence indicates that Eurasian Miocene fossils are ancestral to living African apes and humans. Evidence for an African origin of the common ancestor of African apes and humans from recent discoveries of *Kenyapithecus* from the middle Miocene of Maboko Island (Kenya) is discussed.

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#### Ecology of iron deficiency and immune function in Northern Kenya.

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In recent years evolutionary ecologists have recognized that anemia, rather than being a pathological condition, often arises as a non-specific immune response to infection. Upon invasion, iron-binding proteins sequester iron and cause low circulating iron (hypoferrremia), thereby limiting iron-essential microbial growth. Hypoferrremia can also result from low dietary intake of iron, possibly leading to a nutritional adaptation in response to endemic disease stress. Previous studies investigat-

ing this possibility have been limited by difficulties in assessing iron status under remote field conditions, and in considering the potential deleterious consequences of low iron intake, particularly with respect to the specific immune response.

This study explores the correlates of low iron status in children from Northern Kenya, and the implications of iron deficiency for cell-mediated immune function. 314 5-10 year-old Rendille children from two rural villages participated in the study. Socioeconomic, demographic, and dietary data were collected from each child's primary caregiver. Anthropometric measures were taken for each child, along with capillary blood for the assessment of hemoglobin (indicator of anemia), zinc protoporphyrin: heme ratio (ZPP:H: indicator of iron deficiency), C-reactive protein (CRP: non-specific marker of infection), and antibodies against the Epstein-Barr virus (EBV: marker of cell-mediated immunity). Thick and thin blood smears were also made to screen for malaria and hemoglobinopathies.

Preliminary analysis reveals that 15% of the sample had elevated CRP, indicating a current or recent infection. These individuals were removed from subsequent analyses to avoid confounding anemia of chronic disease with iron-deficiency anemia. 13.1 % of the sample had iron deficiency anemia (low hemoglobin, elevated ZPP:H, normal CRP), and 19.1 % showed evidence of milder iron deficient erythropoiesis (normal hemoglobin, elevated ZPP:H, normal CRP). Analysis of EBV antibody level is ongoing, and will be used to associate cell-mediated immunocompetence with iron status.

#### Comparison of body composition in a prime adult male lowland gorilla to a female of similar age and a male of similar body mass.

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Body proportions and tissue composition reflect a species pattern, but individuals vary. In a recent paper in AJPA, we analyzed body mass in four adult lowland gorillas in an attempt to characterize a gorilla pattern of body proportions. Here we report new results based on a prime adult male (PM) in excellent physical condition and add information on the influence of age and sex on body composition. His age (26 years) is similar to our younger female (27) and nearly identical in body mass to the older male (PM = 172 kg versus 172.7 kg for the older male, 36 years). The PM has more mass in his forelimbs than do the older male and younger female (PM = 15.9% forelimb relative to total body mass versus 15.0% for the older male and 13.6% for the female) and in his hindlimbs (19.6% versus 18.1 and 17.5%). In tissue

composition PM has 46.4% muscle relative to total body mass compared to 37.9% for the older male and 38% for the female; in body fat, PM has a maximum of 16.7% compared to a maximum of 19.4% for the older male and 24% for the female. These patterns of tissue composition may parallel the human propensity to gain fat mass and lose muscle in the process of aging and may also reflect a primate tendency for females to have more fat and less muscle than males of the same species. Body proportions seem to vary less than tissue composition and may be more constrained by species heritage and locomotor potential.

#### Stable isotope composition in *Propithecus diadema edwardsi* from Ranomafana National Park, Madagascar.

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The isotopic composition of primate hair reflects energy and nutrient cycling in local ecosystems, e.g., the carbon and nitrogen stable isotope composition of primate hair corresponds to habitat use and diet, respectively. This study addresses whether changes in energy and nutrient cycling due to habitat modification are also reflected isotopically to the extent that these changes impact diet and habitat use.

We analyzed the carbon stable isotope ( $\delta^{13}\text{C}$ ) and nitrogen stable isotope ( $\delta^{15}\text{N}$ ) composition of hair obtained in May 2000 from 10 individuals of *Propithecus diadema edwardsi* living in the vicinity of the Talatakey trail system in Ranomafana National Park, Madagascar. Average  $\delta^{13}\text{C}$  was -23.4‰ ( $\pm 0.3$ ) while average  $\delta^{15}\text{N}$  was 2.7‰ ( $\pm 0.3$ ).

*P. diadema edwardsi* hair is low in  $\delta^{15}\text{N}$ , which is expected for a primate that is a frugivorous folivore.  $\delta^{13}\text{C}$  values, however, are higher than would be expected for a closed canopy species such as *P. diadema edwardsi*. In both nitrogen and carbon, *P. diadema edwardsi* is isotopically similar to the Mantled Howler (*Alouatta palliata*), an open canopy frugivorous-folivorous New World monkey.

The occurrence of higher  $\delta^{13}\text{C}$  values in *P. diadema edwardsi* may be related to habitat disturbance in Talatakey. Talatakey, now a protected secondary growth forest, was selectively logged in 1986 and 1987. We discuss the implications of these findings for ecological monitoring in Ranomafana National Park.

#### A survey of forest primates near the Ivory Coast's Ehi Lagoon: Further evidence for the extinction of *Colobus badius waldroni*.

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ogy, The Ohio State University, Mansfield, Ohio 44907.

Continuing surveys over the last ten years reveal that certain primates endemic to the Upper Guinea east forest block are severely threatened by hunting and habitat destruction. Isolated groups of *Cercopithecus diana roloway* and *Cercocebus atys lunulatus* are still present in some forested areas, however no reliable sightings of *Colobus badius waldroni* - Miss Waldron's red colobus - have been made by scientists since the mid-1970s. Results from fieldwork carried out during 1997/1998 suggested that the only unsurveyed area likely to contain populations of this monkey was swamp forest located in the extreme south-east of Ivory Coast.

A survey of this region was carried out during July and August, 2000. The forest of approximately 50 km<sup>2</sup> is located between the Ivory Coast's Ehi Lagoon and the Tano River that serves as the border between Ivory Coast and Ghana. Official maps depict this area as undisturbed continuous forest, however we found that it was being actively logged and that palm and cocoa plantations were replacing existing timber. Access to the region is provided by a number of established logging roads and villages are common on the forest's periphery.

We found small numbers of *Cercopithecus campbelli*, *C. petaurista* and *Procolobus verus* present in forest east of the lagoon. *Cercocebus atys lunulatus*, *Colobus vellerosus* and *C. badius waldroni* were neither seen nor heard although we did collect skeletal remains from poachers. Based on these and prior survey results (see Oates et al. 2000), it is quite probable that *Colobus badius waldroni* is extinct and that the elimination of most - if not all - primates in this area of Ivory Coast may well occur within the next 10 years.

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#### **Local customs in wild chimpanzees: The grooming hand-clasp in the Mahale Mountains, Tanzania.**

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For more than 20 years, the grooming hand-clasp (GHC) has been known to be a behavioral pattern that varies across populations of wild chimpanzees (*Pan troglodytes*). GHC has been recorded in Tanzania, Uganda, Gabon, and Ivory Coast, but it also is absent in other populations in those and other countries, such as Guinea. GHC's emergence and spread also has been

documented in a captive population. Unlike many patterns of behavioral diversity that are environmentally constrained (e.g. dietary preferences), GHC seems to be purely social, hence its label as a custom.

Recently, we documented not only inter-population variation in GHC, but also intra-population variation. Two neighboring unit-groups (or communities), K and M, perform GHC slightly but notably differently. These unit-groups are two of those comprising the wild chimpanzee population of the Mahale Mountains National Park, Tanzania. They have been the subject of behavioral ecological study since 1965 by Nishida and his colleagues. K-group prefers a palm-to-palm GHC, while M-group prefers a non-palm-to-palm (usually wrist-to-wrist) version of the pattern. Here, we add more data that strengthen this conclusion.

GHC is performed by mature individuals, and by both sexes. Social rank also appears to influence its performance: Whenever one hand rests on another, it is the more subordinate of the pair who bears the weight. We hypothesize that its performance will correlate positively with extent of social stress in the group.

This variation on a theme may be analogous to dialect differences in spoken language. We speculate that GHC may also function similarly, that is, to identify group or place of origin when individuals from differing groups meet or immigrate.

#### **The Taung raptor hypothesis: Caveats and new evidence.**

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The Pliocene fossil assemblages from Taung are unique in their faunal compositions, and it has been suggested that a bird of prey may have been largely responsible for the peculiar accumulation of bones and the singularity of the Taung hominid. Here I test the evidence for the 'raptor hypothesis' against the historical record and data from seven years of research and excavation at Taung.

Although two cercopithecoid crania show patterns of damage suggestive of raptor predation, they are isolated in collections from 1919, and are not directly associated with the deposit that yielded the Taung hominid in 1924. There are multiple Pliocene fossil deposits at Taung which are taphonomically distinct, yet the bone assemblages show similarities in the predominance of baboons and small mammals. Whereas raptors may have contributed to one or more of the deposits, it is highly unlikely that a raptor could be implicated for each of these distinct assemblages within the tufa caves of Taung.

The Hrdlicka deposit assemblages, from which most of the cercopithecoid fos-

sils have been derived, are consistent with mammalian carnivore accumulations, such as that of leopards. The fossil eggshells used as evidence for the raptor hypothesis come from the Dart deposits, and are too small to have been from a large eagle. The high clay content of the matrix in which the Taung skull was found is suggestive of a water-lain origin, such as that of the Dart deposits. Moreover, the Taung hominid endocast does not show puncture damage consistent with raptor talons. The cause of death and mode of deposition for the Taung hominid remain obscure, but there is very little supportive evidence for raptor involvement.

The unique composition of the faunal assemblage may reflect local paleoecological conditions as well as taphonomic processes.

#### **Bedsharing/breast feeding mothers and infants: Adaptation or pathology?**

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US Consumer Product Safety Commissioner Ann Brown declared recently "Don't sleep with your baby ...the only safe place for an infant to sleep is in a crib..." Data collected here raise serious challenges to the simplicity and accuracy of these statements and reasons why her over-reaching recommendation should be withdrawn from public record.

This NICHD funded study compares the nighttime behavior of 20 routinely bedsharing and 15 routinely solitary sleeping mother-infant pairs, sleeping together (same bed) and apart (different rooms) over three successive nights in a sleep laboratory.

The data reveal that bedsharing mothers exhibit increased sensitivity to their infants presence in bed, compared with routinely solitary sleeping mothers who bedshare. Compared with solitary infant sleep experiences, bedsharing among breast feeding mothers led to increased breast feeding, use of the safe supine infant sleep position, more infant arousals, more maternal reassurance gestures (patting, hugging, infant directed speech and whisperings) as well as intermittent blanket and bedding re-arrangements i.e. protective interventions by the mother.

We conclude that bedsharing among 35 Latina breast feeding mother-baby pairs appears to promote clinically advantageous behaviors for both mothers and infants, and that, specifically, increased use of the supine infant sleep position, increased breast feeding and the increases in infant arousals associated with bedsharing might reduce the chances of some infants dying from SIDS, a possibility which raises serious questions about the appropriateness of a simple, unquali-

fied recommendation against all bedsharing issued recently by a Federal Regulatory Agency, the Consumer Product Safety Commission.

### Morphological variation among Arikara crania.

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Two- and three-dimensional landmark coordinates are highly effective for capturing information regarding size and shape variation and have been used to successfully analyze morphological variation among humans, hominids and non-human primates. This study employs three-dimensional coordinates from cranial landmarks to investigate morphological variation among subpopulations of humans separated by time and space.

Forty cranial landmarks were recorded as three-dimensional coordinates for 520 individuals from 17 components of the Extended and Post-contact Variants of the Coalescent Tradition from the Middle Missouri Region of the Great Plains. These components are generally attributed to the protohistoric and historic Arikara. The configurations consisting of three-dimensional coordinates were fitted employing general Procrustes analysis. Residuals from this procedure for a subset of 452 configurations comprised of 29 landmarks were subjected to principal component analysis. The first 39 principal components represent 90% of the overall variation and were used as variables for a canonical analysis. The generalized distance matrix generated by the canonical analysis was compared to geographic and temporal distance matrices using matrix correlation tests. Two-dimensional thin-plate spline plots permit visualization of the morphological variation among the samples.

Results from the canonical analysis and multiple matrix correlation tests indicate that geographic distance is the primary factor structuring morphological variation among these samples. Patterns of morphological variation are interpreted in light of the known geographic, temporal and cultural contexts for these samples.

### Morphological affinities of extant and fossil hominoids based on the supraorbital region.

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The supraorbital region is often used in phylogenetic analyses of fossil and extant hominoids. While there is general agreement regarding the distribution of

these character states among the living apes, fossil taxa are the focus of considerable debate. *Dryopithecus*, for example, is described by some as having a supraorbital torus; others suggest a similarity to the costae found in *Pongo*. Fueling this debate is a reliance on verbal description for the diagnosis of these character states. Hominoid supraorbital morphology is typically described as a rim (*Hylobates*), costa (*Pongo*), or torus (*Gorilla* and *Pan*). Traditional morphometric approaches have been used to quantify this region, but fail to incorporate its complex 3D morphology.

This study used a geometric morphometric approach to analyze the supraorbital morphologies of extant and fossil hominoids. *Papio* was also included as an outgroup. Several landmarks and a single ridge curve were collected from extant specimens using a Microscribe 3DX mechanical three-dimensional digitizer. Coordinate data from all specimens were superimposed using a generalized Procrustes analysis. The resulting fitted coordinates were then analyzed using multivariate statistical methods, including PCA, CVA, and DA. These steps were repeated, using only the left side of this region, in order to incorporate specimens of *Dryopithecus* (IPMC 18000) and *Sivapithecus* (GSP 15000).

Results from analyses of extant taxa show a clear separation between *Papio* and the hominoids. Among hominoids, great apes clustered apart from *Hylobates*; *Gorilla* and *Pan* were the most similar, with some overlap in range. No significant size correlation was found. Analysis of the fossil specimens showed clear affinities between *Sivapithecus* and *Pongo*, and between *Dryopithecus* and the African apes. While the former is not surprising, results from *Dryopithecus* offer additional support for grouping this taxon with the African ape clade.

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### Palaeopathology at the origins of agriculture in central Syria.

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The causes of the adoption of agricultural subsistence have elicited much speculation. Most early models portrayed the adoption of agriculture, termed the Neolithic Revolution, as an important positive event in human history. However, palaeopathological research from many regions of the world suggests that agriculture may have had deleterious effects on human health. In the fertile crescent of Southwest Asia, where the earliest archaeological evidence for agriculture oc-

curs, there is limited knowledge concerning the health status of early agricultural populations.

This paper assesses the skeletal consequences of the adoption of agricultural subsistence strategies in a small skeletal sample (N=6) from the Neolithic village of Bougras in the Euphrates valley of central Syria. The site, dated to ca 6,000 BC, is located at the southern-most limits of non-irrigation agriculture.

The skeletal remains were examined with respect to macroscopic lesion morphology and the intra-skeletal distribution of the lesions. Three distinct morphological lesion types, each affecting a different skeletal element, are present. Through differential diagnosis, the possible pathological and/or activity-related aetiologies are assessed. The interrelationships between health status and subsistence strategy are discussed.

### Mitochondrial DNA variation and human population movements in Melanesia.

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We have surveyed mitochondrial DNA variation throughout the full range of island Melanesia, and have HVSI and some HVSII sequence data on 500 island Melanesians as well as over 200 individuals from Papua New Guinea and Irian Jaya. We document a pattern of widespread haplogroups throughout Near Oceania, and a more restricted series of haplogroups for remote Oceania. We discuss these haplogroups in the context of early and late migrations and subsequent gene flow and population movement throughout Oceania. There are a few regionally restricted haplogroups, and the rest seem to be much more widely dispersed. We also document the full range and frequency of the Polynesian motif haplotypes in Melanesia (specifically in Bougainville, New Ireland, New Britain, Ontong Java, highland and lowland Papua New Guinea and Irian Jaya, as well from the remote Oceania Melanesian islands of New Caledonia, Vanuatu, and Santa Cruz).

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### Early *Homo* and the problem of fossil species recognition.

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ment of Anthropology, California State University, Northridge, 91330.

The controversy over the number of early *Homo* taxa is a showcase for many of the problems that plague fossil species recognition (FSR) studies.

The problems encountered in studies of early *Homo* include the following: (1) insufficient characterization of intraspecific variation - which is perpetuated by using small to moderately-sized comparative samples, (2) untested methods of analyses - which can lead to erroneous results, (3) misinterpretation of data - which are used to support conclusions that they contradict, (4) the relevancy of analog species - which, though necessary, are nevertheless nothing like early hominids, (5) small fossil samples - which can pose statistical problems limiting the meaningful interpretation of data, (6) preconceptions about how speciose hominids should be or about the nature of morphological change and speciation - which can influence data interpretation, (7) discrete data - which are often cited but not subjected to rigorous analysis to determine the nature of their variation, (8) sympatric species - which often go unrecognized as a possible source of heterogeneity, (9) the cumulative effect of anagenetic variation - which is almost universally ignored, and (10) the limits of FSR studies themselves - which may not be able, in all cases, to delineate species that actually existed.

Progress in untangling the early *Homo* situation in particular, and in FSR studies in general, is dependent on a thorough understanding of the problems delineated above. Moreover, each of these problems represent areas where more intensive research can benefit FSR studies.

#### Why do chimpanzees hunt and share meat?

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Wild chimpanzees (*Pan troglodytes*) frequently hunt and share meat. Despite widespread interest and considerable study, continued controversy exists regarding the factors that influence chimpanzee hunting decisions and meat sharing. Three hypotheses invoke the importance of ecological, reproductive and social factors. A nutritional shortfall hypothesis suggests that chimpanzees hunt to compensate for seasonal shortages in food availability. A second hypothesis argues that male chimpanzees hunt to obtain meat that they swap for matings. A third hypothesis proposes that males use meat as a social tool to develop and maintain alliances with other males. We tested these hypotheses using observations of an unusually large community of chimpanzees at Ngogo in

Kibale National Park, Uganda. Results did not support the nutritional shortfall or meat-for-sex hypotheses. The Ngogo chimpanzees hunted primarily during times of food abundance rather than scarcity. The presence of estrous females did not predict the tendency of chimpanzees to hunt. Furthermore, meat-for-sex exchanges occurred infrequently, and males did not gain a mating advantage through sharing meat. Additional observations were consistent with the male social bonding hypothesis. At Ngogo, male chimpanzees were likely to hunt when accompanied by other males. Males shared meat non-randomly among themselves, and males exchanged meat for agonistic support. Although several factors are likely to affect chimpanzee hunting decisions and meat sharing, these results indicate that primary causes will not be found through invoking simple energetic or reproductive considerations.

#### Molecular genetic diversity and its possible implications among 4 ethnic groups of Sulawesi, Indonesia.

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The populations of the Indonesian archipelago are among the least studied of human groups in anthropological genetics. Yet the population of over 200 million people comprises hundreds of distinct ethnic and linguistic groups. Nowhere is this cultural diversity more apparent than on the mountainous island of Sulawesi which is located at the junction of the western and eastern islands of the archipelago. Our study aims to investigate i) the extent to which this cultural diversity is reflected in genetic structure and ii) relate the findings to epidemiological issues. We are focussing on 4 groups: the Makassans and Bugis of the south west peninsula, the Torajans of the highlands of the south west, and the Minihasans of the north east.

Y-chromosome markers were used to investigate structure in these groups with both single nucleotide polymorphisms (SNPs) and microsatellites scored in a minimum of 20 unrelated males from each ethnic group. The mix of Y markers used permitted a hierarchical form of analysis involving identification of lineages and diversity within each of them. The majority of all Sulawesi Y chromosomes belonged to one of two lineages, with one being highly preponderant in all groups, (but this may reflect scoring an inadequate number of SNPs). These data show significant differences from published Indonesian frequencies. There was considerable sharing of microsatellite haplotypes across ethnic groups. The majority of variation on the Y-chromosome occurs within populations and neither ethnicity nor geography is of significance.

We also investigated polymorphisms in cytokines TNF $\alpha$  and TNF $\beta$  in these groups because of their role in infectious diseases and in conditions such as Type II diabetes. All known haplotypes were detected in Sulawesi as well as three novel ones. Some allele frequencies are similar to those published, but others are either distinctly lower (-308 A allele) or higher (-163 A). The novel haplotypes at these 2 linked loci were not ethnic-specific, even though their frequencies varied across the groups.

This study was supported by the Australian Research Grants Scheme.

#### Human cranial growth reassessed using New Geometric Morphometrics.

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The sample consists of 31 childrens' crania between 1 and 11 years of age from the 19th century, where the exact age at death and sex of all individuals are known. The unique characterization of sex and age warrants using New Geometric Morphometrics to explore the question whether there are any changes in shape as distinct from size. We digitized the 3D coordinates of 36 ectocranial landmarks per cranium. In order to study shape, we perform a General Least Squares Procrustes superposition. To test for shape change during growth we use multivariate statistical analyses: Permutation Tests and Principal Component Analysis. Shape transformations between mean groups (age groups, sex) are visualised using three-dimensional Thin-Plate-Spline techniques.

All the statistical and visualisation software was programmed by the authors in *Mathematica*. The dataset spans the full range from 1-year-olds to preadolescents; one therefore intuitively expects shape changes due to varying nutrition, locomotion and ossification. Instead we find only small localised shape changes (mainly near closing sutures, and in the maxillary region) yet a dominant affine component.

Using New Geometric Morphometrics in this analysis of preadolescents leads to interesting insights, which, we claim, could not be found with conventional methodologies. Conventional methods provide only inconsistent ways of eliminating size from the analysis (if they do so at all). We think many aspects of human preadolescent cranial shape change are masked by size differences. The methods presented here provide a meaningful way of elucidating shape differences. This study is the first to confirm intuitive notions about human preadolescent cranial growth, and also provides a confidence level for the conclusions presented. We find that most growth is not constant in time and shows local differences in magnitude.

Shape change during growth is small but highly significant ( $P < 0.0001$ ) and is dominated by the growth of maxilla and a rostral shift of the occipital.

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### Ethical issues in the molding and casting of fossil bones.

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High quality replicas of fossil hominid bones have come to serve important functions in both teaching and research. The fabrication of these casts has been strongly influenced by the introduction of highly accurate molding media, especially room temperature vulcanizing (RTV) synthetic rubbers and modern casting resins, especially epoxies and urethanes, replication materials which possess low levels of shrinkage and the ability to capture microscopic details.

There are numerous ethical issues associated with the molding and casting of hominid fossils. For one thing there continues to be debate in the anthropological community about how these casts are distributed and who should have access to these replicas. The fabrication of casts is often an arduous and expensive task; it can even be dangerous to the safety of some fossils. In many instances, only a few high quality casts are produced, with a very limited distribution.

Further, each time a fossil is molded, it suffers some damage. Often, this involves the filling of microscopic foramina on the bone's surface with remnants of the molding rubber. This results in the loss of surface detail, harm that will be of increasing consequence as our interest in these structures develops in the future. Curators of fossil bones must carefully evaluate the potential loss of detail versus the discipline's need for replicas.

Finally, because of the heightened increase of interest in human evolutionary studies, and the expanding number of scholars in the field, the human fossil sample is being subject to increasing amounts of handling and examination. Strong concerns must be expressed about the state of preservation of the human fossil record a hundred years from now.

New techniques, such as laser scanning methods now being applied to some fossils, will hopefully allow us to produce highly accurate replicas without the need to subject the fossils to the hazardous ordeal of present-day molding procedures.

### Brachiation is a dead issue.

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The title is about Sherry Washburn. The paper is about Gombe adult chimpan-

zee skeletons using Washburn's functional perspective. This skeletal series (7M, 8F) allows us to describe, quantify, and explain variation among individuals that represent a local population and were observed when alive. Skeletal data are from the braincase, face, mandible, teeth, forelimb and hindlimb bones, shoulder and pelvic girdles, and vertebral column. Analyses using the per cent difference method show mosaic variation related to a number of factors. Sex: Males have larger teeth (especially canines 30.8% breadth) and bones (except pubic length -5.5%), minimum 1.8% (Numeral length) to maximum 35.1% differences (c7 area). Postcranial lengths (1.8% to 13.5% c7 spine) generally show less per cent differences than do joint areas (3.0% femur head to 35.1%) and mineral indices (27.9% humerus, 16.5% femur). Upper body dimensions show pronounced per cent differences. Year of Birth: Earlier-born individuals have larger braincases (7.9%), but not teeth (M2 length -11.3%). Bone lengths (1.5% ilium to 10.2% scapula) and joint areas (3.3% acetabulum to 12.9% femur head, except c7 area -0.2%) also are larger. Age at Death: Older individuals show more tooth wear, tooth loss, and evidence of traumatic events, but decreased mineralization, especially in females (25.3% humerus, 22.9% femur). Asymmetry: Left-right postcranial asymmetries in aggregated normal skeletons are less than 1.6% (except acetabular area 5.6% and Numeral mineral index 3.3%). Pronounced bilateral variation in individuals can be linked to movement and load bearing during life. Life Story: Unique individual variation sometimes is difficult to explain even with field observations.

The hominoid fossil record has few associated skeletons and unknown species characters distributed across thousands of miles and millions of years. The nature and extent of variation in the Gombe chimpanzee skeletal series from known individuals and a narrow time dimension suggest that interpretation of variation in the fossil record must be approached with extreme caution.

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### New Omomyid (Tarsiiformes) primate from the middle Eocene (late Gardnerbuttean), southwestern Wyoming: implications for the evolution of Utahiina.

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Recent fieldwork in middle Eocene sediments along the eastern margin of the Green River Basin at South Pass, Wyoming, has resulted in the recovery of a diverse assemblage of omomyid primates,

including a new, primitive species of the rare omomyine genus *Utahia*. *Utahia* is known elsewhere only from its type locality in the Uinta Basin (Gazin, 1968). In most characters, such as a lesser degree of molar trigonid compression, more widely open talonid notches, and a lack of molar talonid crenulation, the new species is more primitive than *U. kayi*.

There is general consensus that a group containing *Utahia*, *Stockia*, *Chipetaia*, and *Asiomomys* forms a natural clade (Utahiina), although its phylogenetic position is poorly understood (Szalay, 1976; Honey, 1990; Beard and Wang, 1991; Gunnell, 1995; Rasmussen, 1996). The new *Utahia* specimen allows for re-evaluation of the affinities of this group relative to other omomyines. *Utahia* sp. nov. shares characteristics with washakiins as defined by Honey (1990), thus suggesting that utahiinans are more closely related to Washakiini than to any other omomyid clade. Similarities include details of p/4 trigonid construction, narrow talonid basins of lower molars, anterior position of the paraconid, and widely open talonid notches. *Wyomomys*, *Ageitodendron*, and *Ourayia*, included in Utahiini by McKenna and Bell (1997) along with utahiinans, appear to be more closely related to Omomyini. As such, the tribe Utahiini should be abandoned, and Washakiini (Washakiina, Utahiina) and Omomyini (Omomyiina, Mytoniina) redefined.

The morphological similarity between *Utahia* sp. nov. and primitive *Washakius* suggests an early Bridgerian divergence. This hypothesis is supported by the co-occurrence of *Utahia* sp. nov., *W. izetti*, and a primitive variant of *W. insignis* at South Pass, a marginal area, which has been hypothesized to provide the heterogeneous habitats conducive to the production of successful evolutionary innovation (Gunnell and Bartels, in press).

### The effects of pathology on biological affiliation.

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The cultural affiliation of human remains must be established prior to repatriation, as required by NAGPRA and the NMAI Act. This involves both biological assessment and archival research. Discrepancies in museum records regarding the ancestry of human remains often indicate the presence of unusual specimens that are particularly difficult to classify. Three cases from the Smithsonian Institution provide examples of how pathology can affect the features used to assess ancestry. Three skulls with premature closure of the sagittal suture, including one with nasomaxillary dysplasia (Binder's syn-

drome) exhibit unusual morphology that complicates classification.

A cranium from Pitt River, California (225208), is currently listed in the departmental database as "Black," but original records from the Army Medical Museum identify the remains as those of an Achomawi Indian. Morphologically, the cranium is long and narrow, with a slight sagittal keel. Metric comparisons with Howell's samples show that the cranium classifies into African groups (posterior probability 0.86). When measurements likely affected by scaphocephaly are eliminated, the specimen classifies as American Indian (posterior probability 0.48).

A skull from Tiller Mound, Arkansas (243156) is labeled "Negro" but is listed in the departmental database as American Indian. Museum documentation indicates that Hrdlička believed this individual to be a Black buried with Native Americans, whereas T.D. Stewart believed him to be Native American. Morphologically, the cranium is high and keeled. When compared to Howell's craniometric samples, the skull classifies as an Easter Islander (posterior probability 0.43). Removing measurements affected by scaphocephaly and including a sample from Arkansas results in a classification with the Arkansas group (0.28 posterior probability).

A skull from Quarai, New Mexico (381243) grossly appears to have African ancestry due to an unusually flat midface and nasal configuration as well as alveolar prognathism. Metric and morphological comparisons of this cranium with clinical data indicate that these features are consistent with Binder's Syndrome. Craniometric comparisons with Howell's samples indicate that this cranium is Native American (posterior probability 0.31).

It is highly likely that all three of these skulls are Native American, illustrating the importance of studying pathological changes when assessing biological ancestry.

#### Population relationships and patterns of social integration during the Late Precontact period in Minnesota and adjacent areas.

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Results from a multivariate discriminant function analysis of crania from the Late Precontact period in Minnesota and contiguous areas in Ontario, Manitoba, North Dakota, South Dakota, and Iowa are used to examine the biological cohesiveness of defined archaeological units and evaluate competing transformation models proposed to explain patterns of population interaction. Cranial metric data was collected from mortuary samples representing phases, variants, and complexes within the Middle and Late Woodland,

Middle Missouri, and Oneota Traditions. The complexity of the physical and cultural environment that characterizes the study region offers a unique opportunity to examine patterns of population interaction across the prairie-woodland interface and three major traditions.

Biological cohesiveness of each archaeological unit is assessed using classification results that report the accuracy with which the group of origin is predicted for each individual. Groups with the poorest classification rates, and therefore the least biological homogeneity, are Arvilla, Devils Lake-Sourisford (DLS), and Blackduck. Groups with the highest classification rates are Mill Creek, Great Oasis, Orr Oneota, Big Stone, and Blue Earth Oneota. Plots of the discriminant functions illustrate a tighter clustering of the Middle Missouri and Oneota groups, respectively. The more northern Woodland groups, including Blackduck, Arvilla, and DLS, are not tightly clustered.

Classification and biological distance results indicate significantly different patterns of social integration and network "alliance" formation throughout the study region. These patterns reflect distinctive adaptations to local environmental and cultural landscapes during a period of wide-ranging changes in population size, subsistence practices, and socio-political organization. Tribalization models recognizing the development of a tribal social network within a gatherer-hunter settlement-subsistence lifestyle offer the most reasonable explanation for the patterns of population relationships and biological cohesiveness identified.

#### Functional morphology and scaling of *Nacholapithecus* pedal phalanges.

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*Nacholapithecus kerioi* from the middle Miocene of Kenya exhibits unique body proportions. Its pedal rays are quite long for its presumed body size. We compare the characters and size of pedal phalanges of an adult male *N. kerioi* (KNM-BG 35250) with those of living and fossil anthropoids. *N. kerioi* pedal phalanges exhibit features that indicate resistance to mediolaterally directed shearing forces, suggesting an importance of vertical support use in positional components. These features include a broad articular surface of the distal phalanx (hallux), a transversally well concaved proximal articular surface, deep pits for the collateral ligaments, and a deeply grooved trochlea of the proximal phalanx, deep foveae of the proximal articular surface of the intermediate pha-

lanx, and a large plantar beak of the distal phalanx (non-hallux). Most of these features are also characteristic of *Proconsul* phalanges. One digital ray (presumably third or fourth) is almost intact and is 81.7 mm in the total length. The proximal and intermediate phalanges are relatively slender, but within the ranges of many living anthropoids. The total length of the hallux (46.2 mm) is 56.5% of this lateral digit. This ratio is identical to those of *Cebus* and of *P. heseloni* (KPS 3). If these lengths are scaled on body weight, both *N. kerioi* and *P. heseloni* are positively deviated from most living anthropoid taxa. It is not clear how these fossil hominoids differ from each other in this regard due to a paucity of fossils and body weight estimate errors. However, phalangeal elongation in *N. kerioi* relative to *P. nyanzae* is proved by the comparison of KNM-BG 35250 with KNM-RU 5872 (female adult *P. nyanzae*), where differences in phalangeal lengths are small regardless of the apparent smaller body size of *N. kerioi*.

#### Studies of primates in the field and in captivity: Similarities and differences in ethical concerns

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In any setting, doing research on animals is a privilege. Our own inclinations and the dramatic changes in society's views, laws, and legal precedents concerning animal research over the last quarter century move us to that stance. This privilege entails responsibilities. In either setting, we must minimize harm to the animals we study and weigh the costs to the animal against the benefits of the planned research. In physical anthropology, studies in the field may appear both to be more common and to have fewer costs to the animal than captive work. However, costs to the animals in fieldwork are not negligible, e.g. issues of capture and marking, disturbances due to being observed or to field experiments, changing risks of predation due to study procedures, and conservation issues. Captive studies of primates by physical anthropologists, e.g. studies in biomechanics, diet and digestion, and cognition, raise ethical issues involving housing, husbandry, and study procedures. Both field and captive studies (and indeed some studies of dead animals, e.g. in anatomy) are highly regulated. Using my experience as a member and chair of an Institutional Animal Care and Use Committee (IACUC), I will also address the researchers' responsibilities to be aware of and meet regulations, and to educate their students as well as assisting their home institution in ethical and regulatory issues.

### The bug-eyed slender loris: insect predation and its implications for primate origins.

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Members of the order Primates are characterized by a wide overlap of visual fields or stereoscopy. It has been proposed that exploitation of either insects or angiosperm products on the terminal branches of trees, and the corresponding complex, moving, three-dimensional environment associated with these foraging strategies, account for visual convergence. The most stereoscopic of all the primates are the Asian lorises, *Nycticebus* and *Loris*. Until now, very little was known about the feeding ecology of either genus. In this paper, we examine the feeding behavior of *Loris tardigradus* in relation to hypotheses regarding visual predation of insects.

This study was carried out over 101/2 months in Tamil Nadu, South India. During 1173 field hours, observations of diet were recorded *ad libitum*. Variables recorded included food type, location of animal, method of capture, and size of prey. Statistical analyses were carried out using JMP for Macintosh with  $p < 0.05$ . Of 1238 observations of diet, 0.96 were of animal prey. Lorises showed a preference for branch feeding (0.98), using the undergrowth almost exclusively for hunting of Orthoptera, and the trunk for gum eating. They fed on terminal (0.50) and middle branches (0.48) of small shrubs and trees almost evenly. The type of prey caught on terminal branches (Lepidoptera, Odonata, Homoptera) differed significantly from those caught on middle branches (spiders) ( $X^2 < 0.0001$ ,  $df=56$ ). Consumption of Coleoptera, Hymenoptera and Isoptera did not differ by branch size. Capture techniques also differed significantly ( $X^2 < 0.0001$ ,  $df=12$ ). A two-handed catch often accompanied by a bipedal standing or hanging stance was used almost exclusively on terminal branches (0.84) whereas the more common capture technique of one handed grab did not differ by branch size. The catch was used almost exclusively for flying prey, particularly Lepidoptera. Furthermore, moving prey was tracked by the eyes and ears, whereas many slow moving items, including slugs, ants and beetles were sniffed intensely.

Results of this study do not exclude theories of angiosperm exploitation in relation to visual convergence. However, the extreme stereoscopy found in *Loris* may be related to exploitation of fast-moving insects on terminal branches.

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### A morphometric spectrum of Asian and Amerind relationships.

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Who was in America before European contact and where did they come from? Genetic research suggests ties between Asian and New World populations, pointing to North Asia (the Mongolia-Siberia-Manchuria region) as a probable Old World homeland for people migrating to the New World within the past 20,000 years.

This paper presents the results of analysis of craniofacial morphometric data collected in Mongolia as part of an ongoing collaboration between Mongolian and American physical anthropologists. Euclidean and Mahalanobis distance figures based on 24 craniofacial variables are used in a comparative evaluation of 3000 to 4000 individuals representing the New World, Pacific Basin, Asian Old World, Europe and Africa. The time depth for the samples in this comparison is approximately 4000 to 6000 years.

Our results parallel the genetic findings and support the hypothesis of North Asia as one likely point of origin. A model for tie peopling of the New World from diverse Asian sources is reiterated. New World ties to Jomon Japan are suggested. Western Mongolian samples indicate ties to American Plains groups. Henan and Hebei provinces, China, appear to link with Yukon Valley Athabascans. Inuit link with Chukchi, and back to Manchuria.

### Ethnic differences in bone mass and architecture.

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Advances in methods of bone densitometry have allowed the assessment of bone mineral density (BMD) in a variety of geographic areas and ethnic groups. The most commonly used method is dual-energy x-ray absorptiometry (DXA) which measures several different skeletal sites quickly and noninvasively. In-vivo assessment of bone architecture is more problematic, but DXA data can be used to measure hip axis length and to reconstruct cross-sectional bone geometry.

Data from NHANES III show that African-Americans have the highest BMD and U.S. whites the lowest BMD, with Mexican Americans intermediate. Asian and Native American women tend to have lower BMD than whites. U.S.-born Japanese have a more similar BMD to U.S. whites than do native Japanese, suggesting an important environmental component to ethnic differences in BMD.

There are few bone density differences in native African women compared with

whites in Africa, except in the hip which is higher in S. African blacks. There are significant ethnic differences in the architecture of the proximal femur in the U.S. and S. Africa. The following variables were measured in 238 U.S. and 109 S. African women in regions of the femoral neck and shaft: bone width (WID), cross-sectional area (CSA), section modulus (SM), mean cortical thickness (CTh), and BMD. There were significant differences within and between ethnic groups in both countries ( $p < 0.05$ ). The U.S. groups compared to their S. African counterparts had greater neck and shaft CSA, CTh, and BMD, despite no differences in WID. Blacks in both countries have higher SM-an index of bending strength-in the neck where fractures occur, but SM is not different in the shaft where fragility fractures are rare. These results suggest greater hip BMD and bone strength among blacks in both S. Africa and the U.S.

Observed ethnic and geographic differences in BMD and in bone architecture probably contribute to population differences in osteoporosis and fractures. Variation in lifestyles must be considered when evaluating BMD differences and varying rates of osteoporotic fracture.

### Analysis of basicranial variation in modern humans.

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Composed of endochondral bone and deriving early in ontogeny, the cranial base has been argued to be evolutionarily conservative. If the basicranium is relatively insensitive to epigenetic growth factors, one would expect to find little intraspecific variation, and consequently basicranial characters would carry a strong phylogenetic signal. Alternatively, if the basicranium shows a high degree of variability, then basicranial characters need not take precedence over other types of characters.

A sample of 120 adult humans of known age, sex, and biological affinity are examined for 35 basicranial characters in an attempt to understand cranial base variation in hominid evolution. This sample indicates significant variation in a few aspects of basicranial morphology. For example, the height of the anterior aspect of the occipital condyle as well as its mediolateral orientation shows a wide range of variation. The results of this study suggest no necessary relationship between all basicranial characters and evolutionary conservatism.

### Paleoindian skeletal remains from Santana do Riacho I, Minas Gerais, Brazil: archaeological background, chronological context and comparative cranial morphology.



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In the last decade, a few authors started to change the way we used to understand the first human occupation of the New World. Ever since, this phenomenon has turned into a hotly debated subject among physical anthropologists and archaeologists. Surprisingly, artifacts and sites in the Americas are older than the presumed pioneer people, the Clovis. More startling is the fact that the Paleoindians of South America hold an unexpected cranial morphology, showing no resemblance whatsoever with recent Asians and later Native Americans.

In the present work we announce and characterize the richest Paleoindian cemetery scientifically excavated to date in the Americas. The Santana do Riacho I (SRI) burial site has yielded at least 40 individuals dated between 8,1 Kyr and 11,0Kyr; of which 2 males and four females were suitable for metric analysis and for multivariate statistical comparisons. The results obtained from the Principal Component Analyses of SRI hominids confirm our long held opinion that the first Americans were not Mongoloids. They show, as do the now world famous Hominid 1 from Lapa Vermelha ("Luzia"), strong morphological affinities with modern African and Australian aboriginal populations. The explanation for the presence of this human cranial morphology in the Americas does not have necessarily to implicate any transoceanic migration. The traditional Bering Strait is still the most plausible option for the entry of these non-Mongoloids into the New World, if we consider that they were also present in East Asia by the end of the Pleistocene.

In summary, our results suggest that the first anatomical moderns, who departed from Africa and soon arrived in Australia, also took a northern path in mainland Asia and eventually arrived in the Americas, still in unknown times.

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#### Variation and scaling within a wild vervet population with comparison to closely related cercopithecin taxa.

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The past two decades have seen a substantial amount of focus on issues of varia-

tion within modern primate species and the influence of scaling on shape and proportion variation among closely related species. We address both of these important topics by providing a description of variation of limb bone proportions, dental size and proportions, and body mass for a population of wild vervets (*Cercopithecus aethiops*). This sample includes complete or nearly complete skeletal material, and body mass for 36 adults (16 females, 20 males).

We compared the variation in limb bone proportions with published data for talapoin (*Cercopithecus talapoin*) and mustached monkeys (*C. cephus*). Vervets are significantly larger in body mass than the talapoin and are quite similar to the mustached monkey. Thus, if variation among these Old World monkeys in limb bone proportions is largely a scaling phenomenon, vervets should differ from talapoin in the same fashion as do mustached monkeys. In radius/humerus and tibia/femur ratios vervets do resemble mustached monkeys and differ significantly from talapoin. This variation can be attributed in large part to body size. In contrast, vervets differ significantly from mustached monkeys and more closely resemble talapoin in humerus/femur and radius/tibia ratios. This might be explained by differences in the habitat or positional behaviors utilized by these species. In addition, we found that the males and females within the study sample more closely resemble each other than they do either of the other species.

We also analyzed a small subset of dental traits and body mass in regards to sexual dimorphism in the vervet sample. Canine area varies more for males than females in both absolute terms and in relation to body mass. In contrast, M2 area varies in a consistent fashion for males and females both in absolute terms and in regards to body mass.

#### Neandertal, Upper Paleolithic, and recent human hands: What are the differences?

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This analysis quantifies between-sample contrasts in Late Pleistocene and recent human hand functional anatomy. The materials are: the distal carpals (excluding the trapezoid), the first through fifth metacarpals, and the first through fifth proximal phalanges. The samples are: European and Near Eastern Neandertals (N=13), Early (N=12) and Late Upper Paleolithic (N=9) humans, and North American and European recent Holocene humans (N=37).

Univariate analyses indicate few significant between-sample differences exist for metacarpal cross-sectional properties

calculated from biplanar x-rays, or for proximal phalangeal base articular surface areas derived from digitized photographs. The univariate analysis of hand joint mechanical advantages indicates Neandertals maintained significant mechanical advantages relative to all other samples. A 3-D morphometric analysis of the carpometacarpal (CMC) 1 through 5 joints demonstrates the Early Upper Paleolithic and Neandertal samples have similar metacarpal 1 base shapes, while the Early and Late Upper Paleolithic samples have intermediate metacarpal 2 and 3 base morphologies relative to both Neandertal and recent human samples.

Neandertal hands, being adapted primarily for power rather than precision, are distinct from recent human hands. However, the Neandertal sample is less distinct from the Early Upper Paleolithic sample when CMC joint morphologies are considered. The pattern of functional contrasts, which is partly related to the more frequent use of hafted tools during the Early Upper Paleolithic, points to subtle, not dramatic, frequency shifts in manipulatory behaviors at the Middle-to-Upper Paleolithic transition. Further elucidation of the behavioral transition requires both skeletal analyses and functional analyses of Early Upper Paleolithic tools.

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#### Methods for assessing nutrient intake in wild primates: temporal- vs. weight-based estimates.

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Most primate feeding studies that aim to measure the nutritional intake of primates substitute time spent feeding for actual intake. Parameters for assessing ingestion rates (i.e. minutes feeding on specific resources) are not as difficult to achieve as weight-based studies (i.e. counting the number of items ingested / unit time and determining dry weight (DM) of samples); therefore, most studies on wild primates are based on timed samples. While the temporal method has been criticized for overlooking the significance of variable handling times and thus presenting a biased view of nutrient intake, few studies have compared the methods using the same sample. Here we describe the findings of a short study comparing temporal- and weight-based intake estimates of a well-habituated, wild, female white-faced saki monkey (*Pithecia pithecia*) inhabiting Round Island in Guri, Venezuela.

The adult female (c. 1,500 g body weight) spent an average of 191.5 minutes per day feeding (n = 5). We estimated that she ingested 19.5 g (DM) or 98.4 g (wet wt.)

per day (6.6% of her body weight). Fruit and insect samples were analyzed for macronutrients, fiber fractions, and tannins. We found no significant differences comparing ingestion time with DM intake for any nutrient or feeding deterrent, despite the fact that this sample included mechanically protected fruit. The direction of the differences that were found were not predicted by either method. For example, the average daily lipid intake by time was estimated to be 33.4%; by DM intake was 29.6%. The average daily crude protein intake by time was 7.9%; by DM intake was 8.3%. Daily average NDF intake by time was 41.4%; by DM intake was 45.2%. On the basis of these data, there is no reason to broadly reject timed samples as inaccurate. Research was supported by NSF 98-07516.

#### **Evaluation of mortality bias in deciduous tooth emergence, and implications for paleodemographic age estimation.**

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Deciduous tooth emergence and other dental traits are frequently used as age indicators in paleodemographic samples. The selective mortality hypothesis suggests, however, that the mortality sample may not accurately represent parameters of the living population. This research assesses the selective mortality bias for deciduous tooth emergence.

Data were collected from longitudinal studies of deciduous tooth emergence in Javanese, Guatemalan, and Bangladeshi children. For each child, clinical emergence was assessed over periodic intervals. Samples were divided into a *living sample* for those who survived through the study and a *dead sample* for those who died during the study. We estimated parameters and standard errors for the distributions of times to tooth emergence (left dentition only) assuming an underlying lognormal distribution shifted back to one month after conception. Significance was assessed by a likelihood ratio test for the hypothesis that dying in the study has no effect on emergence. A  $X^2 = 3.84$  indicates a significant difference.

For all three samples, there were no significant differences between the living and dead sub-samples in the distribution of tooth emergence, although the near-significance of the Bangladeshi  $m_1$  ( $X^2=3.26$ ),  $i_2$  ( $X^2=2.40$ ), and  $m_1$  ( $X^2=2.36$ ) may reflect the small sample of dead individuals. These results tentatively suggest that there is no bias resulting from mortality selection in the timing of deciduous tooth emergence. This indicates that the mortal-

ity sample (e.g. a skeletal series) can be considered representative of the living population when using deciduous emergence as an age indicator.

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#### **The sex trade: Llama caravans as a vehicle for gene flow in the South Central Andes.**

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For populations represented in cemeteries or archaeological sites, measures of biological distance can reflect the extent to which ancient groups are related "genetically". These measures can then be compared to patterns of affinity assessed from cultural material preserved in the archaeological record. To understand how prehistoric South Central Andean groups were associated, the following research questions are asked: do "cultures" formulated from material remains by archaeologists correspond to the classifications constructed by biological anthropologists from osteological sources? How does cranial variation correspond to space and time; and how do trends in cranial morphology reflect models of inter-regional exchange shown in the archaeological record? This project will contribute to the disciplines of biological anthropology and archaeology by providing information on an exciting and understudied area of prehistoric South America.

To address these questions, morphological variation within a collection of 237 human crania from prehistoric Bolivian Central Valley populations is investigated. Crania are subjected to multivariate statistical analysis, applying the Mahalanobis, generalized distance statistic ( $D^2$ ) to the metric data and the Mean Measure of Divergence statistic to the nonmetric traits. The resulting biological groupings are compared to archaeological classifications based on material culture. To broaden the cultural area two highland altiplano sites, Tiwanaku and Iwawi, are also included in the analysis.

Three archaeological models of culture contact are considered: vertical ecological complementarity, trade caravans, or migration/colonization. The results show an association in regional cranial morphology and patterns of cultural interaction between South Central Andean Valley and Altiplano groups consistent with the trade caravan model.

#### **The consent process and aDNA research: Contrasting approaches in North America.**

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The development of molecular techniques that permit direct investigation of prehistoric genetic variation has been coincident with an increase in the complexity of the consent process required to gain access to research specimens. These changes have led to a diversity of strategies for securing access to aDNA samples.

Our experience in four aDNA research projects in North America over the past twelve years illustrates both the changes that have occurred in the consent process and the diversity of consultative styles and concerns that today characterize the process. We review the consultative process involved in aDNA research on prehistoric Fremont (Utah), Anasazi (US Southwest), Aleut (Alaska), and Inuit (Nunavut) samples. Consultation included museum curators, museum research boards, institutional IRBs, native corporation leaders and boards, and local corporation/tribal authorities. Consultative styles ranged from repeated personal interactions and detailed discussions of the proposed research, to brief written correspondence. The time from initial request for research access to granting of permission ranged from over two years to less than six months. Subsequent contact with permission granting entities ranged from essentially no contact, to regular written or verbal reports during and after the research project.

The consent and research reporting process is likely to continue to evolve. Clear and consistent communication between researchers and those who have authority to provide research access to collections is paramount to the future success of human aDNA analyses. Although our experiences have been generally positive and rewarding, not all requests for research access are granted, and several scientifically important skeletal samples remain inaccessible to qualified researchers. Investigators should be cognizant that in this changing scientific and political climate, aDNA research results may be used to support repatriation claims that will remove additional samples from the research arena.

This research has been supported by grants from the National Science Foundation and Wenner-Gren Foundation for Anthropological Research.

#### **Diaphyseal cross-sectional shape in the Amud 7 Neandertal and modern human babies and infants.**

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The humeri, femora, and tibiae of adult Neandertals are frequently robust, suggesting biomechanical strength of the upper and lower limb. Diaphyseal morphology appears to be an expression of primarily activity-related, rather than genetic, influence (Trinkaus et al., 1994). Ruff and

colleagues have shown that femoral diaphyseal robusticity appears in Neandertals as early as the age of 3-5 years (La Ferrassie 6 (Ruff et al, 1994)). However, the nature of diaphyseal shape in the youngest (babies and infants) modern and fossil humans has hitherto not been explored in great detail.

This paper examines diaphyseal cross-sectional shape in the 9.5 month old Neandertal baby Amud 7, which preserves a nearly complete humerus and proximal tibial diaphysis. Humeral and tibial cross-sectional data were collected from four modern human baby/infant samples (African, Arctic, European, and Native American) and Amud 7. Total periosteal (TA) and total and percentage cortical (CA) and endosteal (MA) areas were compared between Amud 7 and the modern humans. The comparisons indicate that Amud 7 does not differ significantly from modern human babies of similar dental-age or similar humerus and tibia length (used as a proxy for body size) in any of these measures of cross-sectional shape.

Given the developmental age of Amud 7, these findings are consistent with the general notion that diaphyseal robusticity appears after the developmental onset of significant mechanical loading of the skeleton. Therefore, it is likely that humeral and tibial robusticity would be expressed in Neandertals somewhere between the end of the first year (Amud 7) and beginning of the third year (La Ferrassie 6) of life.

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### The shape of a long bone's shaft: bending stress or growth plate form?

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The femoral midshafts of chimpanzees and gorillas are mediolaterally very broad. Cross-sectional geometric properties calculated directly from computed tomography images show that their maximum second area moments are tightly concentrated along the mediolateral plane, and are large relative to minimum second area moments which must be orthogonal and thereby anteroposterior. The traditional interpretation of these results, based on 'Wolff's Law', would be that African ape femora are adapted to habitually large mediolateral bending stresses that greatly exceed those in the anteroposterior plane.

Bending of the femoral shaft is determined by a combination of body mass, locomotor dynamics, muscular contraction, and geometric properties of the shaft. In-

spection of the probable effects of these factors in the ape thigh shows that anteroposterior loads are very likely to greatly exceed mediolateral ones. In particular, the largest cross sectional area of those muscle groups that can induce femoral bending moments are those of the hamstrings and the quadriceps.

This 'natural experiment' demonstrates that bone probably does not respond to the magnitude of stress, as is often assumed, but is instead a more complex reflection of multiple determinants including restrictions imposed by developmental factors, in particular the shape of the physes. Both proximal and distal femoral epiphyses are broad in African apes, and it is the developmental history of their physes that is most likely responsible for final diaphyseal form. The implication is that, 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.

### Three-dimensional analysis of the lateral tibial condyle in gracile australopithecines.

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Condyle shape varies among fossil tibias attributed to *Australopithecus*. It has been suggested that this variation reflects functional differences. Convex anteroposterior curvature of lateral tibial condyles in *A. africanus* is interpreted to indicate a more chimpanzee-like locomotor repertoire than the flatter lateral tibial condyles of *A. afarensis* (Berger and Tobias 1996). Alternatively, Latimer et al. (1987) have suggested that in response to increased transarticular loads accompanied by larger body mass, joints should become flatter as size increases.

To test this hypothesis, three-dimensional surface areas of the lateral tibial condyle were computed to assess joint contours, and compared to two-dimensional arc and cord length measurements of the anteroposterior and mediolateral axes. Tibial condylar impressions were taken of wild-shot *Pan troglodytes*, *Gorilla gorilla*, as well as *Homo sapiens* at the Cleveland Museum of Natural History. Casts were prepared and scanned at a resolution of 12.7  $\mu\text{m}$  using a Surveyor 500 (Laser Design, Inc) laser digitizer with RPS 150 laser. Images were analyzed using DataSculpt 4.62A. Measurements were then compared to those of *A. anamensis* (KNM-KP 29285), *A. afarensis* (AL 129 1B, AL 288-1AQ, AL 333x-26), and *A. africanus* (Stw 514).

Results of this study suggest an isometric relationship between body size and anteroposterior condylar profile, with ape condyles more convex than those of humans. *A. anamensis* and *A. afarensis* fall

below the human regression line, indicating flattened lateral condyles. *A. africanus* falls between the ape and human lines, but within the distribution of chimpanzees. All hominids in this study, however, exhibit significant flattening in the mediolateral axis, unlike apes. Our results reveal that two-dimensional analyses do not accurately characterize tibial condylar geometry, and underscore the need to consider this morphology in three dimensions when interpreting knee joint form and function.

### Achondroplasia in the Middle Woodland Period, Elizabeth Site, IL.

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Achondroplasia, the most common form of dwarfism, has a modern rate of occurrence of one in 10,000 births. In the prehistoric record achondroplasia is rare. Of the four established North American prehistoric examples, the Elizabeth dwarf is the oldest, dating to the middle woodland period (50 BC - AD 250).

Achondroplasia is characterized by disproportionate short stature, comparatively long trunk, and rhizomelic shortening of the limbs. To determine the degree of shortening of the long bones, a morphometric study was conducted in 1989 comparing measurements from the Elizabeth Dwarf to the mean of a reference population comprised of middle and late woodland females over the age of 16. This sample ranges in size from 20 to 40 individuals and varies by measurement. In this study, two-tailed student's t tests were calculated. A second metric analysis was conducted in 2000 using Z-scores to determine how many standard deviations the dwarf measurements are above or below the mean of the reference population. These studies demonstrate the degree of rhizomelic limb shortening and also the difference in limb proportion (proximal to distal) of the long bones. The study of Z-scores also showed that the indices indicating robusticity were significantly higher in the dwarf than that of the reference population mean.

### Assessing tribal identity in the Plains using nontraditional craniometrics (interlandmark distances).

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Establishing the cultural affiliation (i.e. ancestry) of human remains is an essential part of NAGPRA and the NMAI act. Most often, the decision whether or not to repatriate and to whom has been based on archival records, taphonomy, and morpho-

logical (traditional craniometric) analysis. Rather than merely assessing Indian vs. non-Indian, the migratory habits of Plains groups necessitate a tribal affiliation whenever possible. Discriminant functions using interlandmark distances (ILDs) collected using a three-dimensional digitizer are a valuable tool to use for tribal affiliation. ILDs are especially useful when sorting out trophy remains, ambiguous archival information, and multicomponent sites.

Trophy skulls, remains from another tribe that are often found in non-cemetery locations, present another challenge. At the Sully site (39SL4), one set of remains consists of a cranium with the base missing and a partial mandible. On the zygomatic arch, a hole was made using a primitive drill, and the cranium was likely hung upside down. In an analysis using ILDs it has an atypical Sully morphology and is more reminiscent of the Sioux.

When using archival records, script legibility and ambiguous wording can cause problems in interpretation. One set of remains at the Smithsonian was recorded at the Army Medical Museum with a "Kiowa Indian" affiliation over 100 years ago, but the remains did not show evidence of typical Kiowa funerary practices. Further examination of original records revealed that the remains were documented as being from a "known Indian", thus requiring a reassessment of cultural affiliation. After carefully rereading another set of documentation, one set of possible Arikara remains supposedly found on a scaffold were actually found buried near another set of remains that were on a scaffold.

Multicomponent sites present their own challenges. The remains from the Black Widow Ridge Site (39ST203) had been considered to be Post-Contact Coalescent (1650-1750). Reevaluation of the context and biology suggest that the remains are associated with an earlier Extended Middle Missouri (1300-1400) component at the site.

### **Social and ecological influences on female dominance in day-active prosimian primates.**

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Primatologists agree that female dominance among prosimians is a complex issue and needs further attention. Here, we examine how ecological and social variables relate to female dominance in day-active prosimians and present some preliminary results that suggest several promising avenues of further study.

Nearly half (45%) of the day-active lemur species exhibit female dominance (FD). The remaining cases are not classified as female dominant (NFD) because no dominance hierarchy can be identified or

dominance relations within species are inconsistent. Social variables such as group size and composition, affiliative patterns, tolerance of other females, and female dispersal patterns do not predict the occurrence of FD species. FD species live in small to large groups which contain adult pairs or multiple adult males and females; females disperse in some but not all species. While all FD species (with the exception of *L. catta*) tend to form pairs within social groups and are intolerant of other females, this is true of NFD species as well.

The only ecological variable that was fairly consistent among FD species was activity; the majority (but not all) of FD species are strictly diurnal. FD species are found in a variety of habitats (seasonal dry forest, topical rainforest), have a wide range of diets (fruits, leaves, seeds), and some are territorial while others are not. As data on food availability patterns in Madagascar become available, it is clear that all prosimians experience extreme seasonality in food availability that can be unpredictable, particularly during reproductive seasons. This may place additional "ecological stress" on reproductive females. Given the variable social and ecological profiles of FD and NFD species, the suggestion by Pereira et al. that female dominance is but one strategy available to prosimians to mediate energetic costs related to ecological stress is compelling.

Some alternative strategies that we have identified to date based on a preliminary study of *P. d. edwardsi* and *E. f. rufus* are: female leadership of groups to food sources and female feeding priority in the absence of female dominance. As part of along-term comparative study on four species of prosimians in the Ranomafana National Park, we are exploring the possibility that female dominance may be expressed only seasonally or vary depending on group composition.

### **The tyranny of size.**

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Investigators have long worried about non-normal distributions and spurious correlations of ratios. Criticisms related to these have been highly influential, prompting leading textbooks to caution against using ratio data. As a result, most recent multivariate analyses employ measurements. Yet, also often, little is evident in the data other than size. In contrast are the experiences of practical usage where many studies employing ratios have yielded biologically meaningful insights confirmable by independent methods.

Constraint to measurements alone is a particularly serious problem for areas of biology where relationships within sys-

tems are the objects of inquiry. For example, the ratio of two bony lever arms are more important in biomechanical investigations than the absolute size of one lever arm. Ratios of inputs and outputs of brain parts in neurobiology are more useful in understanding brain function than the absolute size of any particular brain part. Ratios involving different organisms may be far more insightful than absolute values for one organism. Even ratios between organisms and environments are more useful, for some questions, than absolute values alone.

The absolute size of the hand, or of the branch that it grasps, seems largely irrelevant in studies of locomotion. The ratio of the size of hand to the size of the branch seems more useful. A small hand on a large branch implies, perhaps, scurrying, a large hand on a small branch implies, perhaps, acrobatic climbing.

This study suggests, both by simple theoretical analysis and practical examples examining limbs, dentitions, brains, behaviours and environments, that ratios represent genuine intrinsic properties of some systems. It demonstrates the paucity of analyses of measurements alone, wherein much information is lost, compared with the richness of results obtained from analyses of ratios. It concludes that ratios in anthropology are useful and should be evaluated in terms of measurement techniques, choice of variables, and questions being studied.

### **Lessons from the study of microwear variation within and between populations of middle Miocene primate species at Maboko Island.**

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Occlusal dental microwear analysis (DMA) was conducted on second molars of five sympatric primates (*Kenyapithecus africanus* N=16, *Victoriapithecus macinnesi* N=34, *Mabokopithecus clarki* N=4, *Mabokopithecus pickfordi* N=16, and *Simiolus leakeyorum* N=15) from 15 mya deposits on Maboko Island, Kenya. Microwear differences between species and between "populations" from two temporally distinct stratigraphic units were assessed (Palmer, 2000). In addition, a study of microwear variation within species and within "populations" from Beds 3 and 5 were used to infer whether seasonal or temporal shifts in diet may have occurred for species found in both beds (*K. africanus*, *V. macinnesi*, and *S. leakeyorum*). The study examines how well DMA assesses the overall dietary preferences of extinct primates, as opposed to possibly representing their "last supper" (Grine, 1986).

In this study, intraspecific DMA analy-

sis of the species found in both beds indicated that no statistically significant differences in microwear or broad dietary categories occurred and thus categorical dietary differences between species were consistent over time. Additionally, whatever seasonal dietary variation might have occurred within each bed and for the combined sample, was easily encompassed within the range of features found in the overall microwear pattern, i.e. no *Simiolus* individuals were found to be frugivores, and no *Kenyapithecus* to be folivores. Thus, for the Maboko primates microwear was not highly variable, but appears to accurately reflect the broad dietary preferences of each species.

DMA did prove useful for detecting slight differences in some categories of microwear data (i.e. pit width) between populations of *Simiolus* in Beds 3 and 5, albeit at low levels of significance ( $p=.05$ ). These differences may reflect changes in the environment (harder fruits in Bed 5), or a response to increased competition with *Mabokopithecus*, which is abundant in Bed 5 but not in Bed 3.

#### Food processing technique differences across three capuchin (*Cebus capucinus*) populations in Costa Rica.

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Researchers have identified several foraging traditions (i.e., intraspecific behavioral differences across populations not due to obvious genetic or ecological variation) in chimpanzees, orangutans, and macaques. What is not currently known is whether this high level of interpopulation variation in behavior is unique to Old World primates. In this study we use long-term data from three Costa Rican field sites that are geographically close and similar ecologically (Lomas Barbudal, Palo Verde, and Santa Rosa) to identify potential foraging traditions in white-faced capuchins (*Cebus capucinus*).

The processing technique(s) used for food species that were eaten by monkeys at two or more of the three main study sites were compared. All differences found were classified as present, habitual, or customary. Social network data were also analyzed, when available.

Our results demonstrate that hominoids and macaques are NOT unique among the primates in regard to their degree of interpopulation variation in foraging behavior. Of the 61 foods compared, 20 of them are processed differently by capuchins across the three sites. The differences involve pound, rub, tap, fulcrum, "leaf-wrapping", and "army anting". For most of the differences there is a strong correlation between proximity scores and the individuals within a population who share the "different" processing techniques.

#### Strikingly high acute-phase protein values in stunted Nepali children reporting low morbidity.

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Associations between severity of stunting, plasma protein concentrations, and morbidity reports, are examined for 104 Nepali 10-to-14 year old boys living in contrasting environments. Villagers are compared with three urban groups: poor squatters, homeless street children, and middle class children. All but the middle class group are stunted, particularly village boys whose height-for-age z-score (mean -2.97, SD 0.82) indicates severe growth retardation. Stunting is significantly associated with increased levels of the acute-phase protein  $\mu_1$ -antichymotrypsin (ACT), itself inversely related to levels of albumin. The ACT levels of village boys (mean 1.52 g/l, SD 0.43) are three to four times higher than those of squatters and homeless children, and five times higher than those of middle class boys.

Despite being the most severely stunted and having the most abnormal plasma protein values, village children reported the lowest burden of disease, a contradiction which may reflect exposure to sub-clinical infections or habituation to illness and low expectation of treatment. The study draws attention to the strikingly high levels of ACT and of stunting in the rural sample. It also cautions on the use of morbidity reports *uncorroborated by biochemical evidence* across different epidemiological and socio-ecological environments. Possible mechanisms to explain the impact of illness and inflammation on growth faltering are discussed.

#### Health and subsistence of a Neolithic population: a case study from Alepotrypa Cave, Greece.

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The cultural transformations of the Neolithic, namely the adoption of domesticated species and sedentism, had a great impact on human health, diet, and lifestyle. This study focuses on a Late Neolithic site, Alepotrypa Cave, Greece, which was occupied from 5000 to 3200 BC, and analyzes the human osteological remains from the entire population of this site, one of the largest and best preserved series of this period.

The Alepotrypa population consists of a minimum number of 161 individuals of equal proportions of males, females, adults, and subadults, and falls within the range of other eastern Mediterranean Neolithic sites in terms of age profiles, mortality and stature with a mean adult age 28.8 years, life expectancy at birth of 17.87, and high incidence of child mortality between birth and ten years. The series exhibits a high incidence of cribra orbitalia (60%) and porotic hyperostosis (50%), anemic conditions most probably of nutritional origin, resulting from an iron poor diet focused on terrestrial resources, with the synergy of chronic pathogen loads. An iron-poor diet based upon terrestrial resources, mainly C3 domesticated cereals, has been documented by the carbon and nitrogen stable isotope analysis of human bone collagen and carbonate apatite.

Other pathological conditions include relatively high incidence (13%) of healed depressed cranial fractures, evidence of violent, non-lethal confrontations, probably due to competition for critical resources, a similarly high incidence of spinal joint osteoarthritic conditions (12.2%) and musculoskeletal stress markers indicative of elevated mobility, physical activity and habitual movements, and high frequency of calculus (18.6%) and antemortem tooth loss (18.4%), as well as severe cupped tooth wear (37.1%), characteristic of an agricultural diet and food preparation techniques. The population, however, presents a relatively low frequency of enamel defects (8.3%), caries (3.2%), and skeletal infection.

This research was supported by a J.L. Angel Fellowship from the Wiener Laboratory of the American School of Classical Studies at Athens.

#### A possible case of Down's Syndrome in a 19<sup>th</sup> century Canadian cemetery: a multidisciplinary approach.

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In 1982 the remains of 29 individuals were unearthed at the site of the Stirrup Court Cemetery in London, Ontario. These individuals resided in what is suggested to be a 19<sup>th</sup> century peri-urban community

adjacent to the historic township of London. One particular individual (Burial 21) of this small skeletal sample reveals the presence of morphologic abnormalities that indicate the existence of a genetic disorder which predominantly affected the neuromuscular system. In addition, several non-genetic pathological conditions are present. This poster presents the descriptions of these skeletal abnormalities at the macroscopic level. They suggest that this individual suffered from Down's Syndrome. Historic records also point to this suggestion. A combination of burial groupings, a burial plaque and census records all converge to strongly support the suspected identity of this individual as well as his parents. Finally, aDNA research is used to confirm or refute the presence of this chromosomal aberration and possibly provide information as to the origins (*i.e.*, maternal or paternal) of this disorder. By using different forms of evidence (macroscopic descriptions, historic records and aDNA research) a more complete analysis of this particular individual is performed.

#### **The Armstrong Mound: a case of difficult DNA.**

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Purveyors of ancient human DNA analyses strive constantly to coax genetic history from ancient archives of bone, teeth or soft tissue. Often these samples are recalcitrant to DNA recovery techniques which have worked well on other ancient sample sets. Human remains recovered from the Armstrong Mound, in Northwestern Ontario, Canada, were such samples. Procedures and protocols developed for other ancient remains, which were difficult to salvage ancient nucleic acids from in their own right, were applied to the Armstrong Mound material with little success. Finally, a combination of techniques from several extraction procedures enabled DNA recovery, and subsequent analyses, from these remains.

#### **Growth data collected from French-born girls of Malian descent: How do they compare to their Malian-born counterparts?**

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Anthropometric data collected in Mali has indicated poor growth and development among adolescent girls. Malian girls are shorter and lighter than their U.S. female counterparts. Many studies suggest that this evidence of poor growth and development is due to a combination of poor nutritional intake, high-energy expenditure, and poor access to healthcare. Thus in order to examine the effects that an overall improved environment have on the

growth of Malian adolescent girls, growth data were collected from Malian girls born and raised in metropolitan France.

In the summer of 2000, anthropometric data were collected from a total of 61 girls ages 10 to 17 years living in metropolitan France. Criteria for participating in the study were that the girls be born in France and have parents who were born in Mali. These data were then compared with growth data collected in Mali.

French-born Malian girls are considerably taller and heavier than their Malian-born counterparts. Further the French-born Malian girls are at similar heights and weights as their U.S. counterparts. When compared to the U.S. NCHS percentiles, the French-born Malian girls are close to 50<sup>th</sup> percentile for both height and weight at most ages and the Malian-born girls are near the 30<sup>th</sup> percentile for height and the 25<sup>th</sup> percentile for weight at most ages. While these data may suggest a similar genetic potential of growth regarding height and weight among Malian girls when compared to U.S. girls, only with a larger sample size can this issue be more closely examined.

#### **Dimensions and moment arms of the hind- and forelimb musculature of the hominoids.**

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This paper supplies quantitative data on the hind- and forelimb musculature of the Hominoids. We find that when scaled to a standard 80 kg body mass, human hindlimbs have by far the greatest mean physiological cross-sectional areas, representing force production capacity. Conversely, the (non human) ape hindlimb with longer fascicles and smaller PCSA's indicates an emphasis on mobility at the expense of tension production.

While, due to flexed hip and knee postures, chimpanzees need to exert higher moments at their hindlimbs to sustain bipedalism than do humans, they actually produce far smaller moments for the same muscle stresses. Orangs are unique in having almost equal distribution of muscle mass between the hind- and forelimb, with longer fascicles for all muscles. Of the apes, the orang has much larger hamstring PCSAs and corresponding moment arms making it better adapted than the African apes to exerting extensor moments at the hip arid knee. Muscular geometry thus mirrors our kinetic and kinematic experiments which show that untrained orangs are, in several respects, more mechanically effective in bipedalism than other great apes.

Extended postures of the hip and knee, which reduce the magnitude of moments required to sustain bipedal posture, are characteristic of the orthograde scrambling

and hand-assisted bipedalism occurring in most great apes. Thus, we suggest these behaviours are likely to have been pre-adaptive for the acquisition of orthograde bipedality by a generalized, arboreal, common African ape ancestor.

#### **The reliability of estimates of hominin body mass derived from bi-iliac breadth and stature.**

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Recent papers by Trinkaus, Ruff, and colleagues have used a new method to estimate hominin body mass. The estimates are derived from a multiple regression of group means for body mass on stature and bi-iliac breadth in 31 male & 25 female recent human samples. The procedure produces body mass estimates very similar to those derived from femoral head diameter. With fossils, the procedure often requires the estimation of stature and bi-iliac breadth. The breadth of only one Skhul pelvis and one (perhaps two) Neandertal pelvis can be measured. Trinkaus and Ruff therefore estimated the bi-iliac breadths for the rest of the individuals in these groups by multiplying estimated stature by the ratio of bi-iliac breadth to stature of the measurable specimen. This should be reliable if within-group variability in the ratio is low; otherwise it may produce a substantial systematic error.

We evaluated the procedure by measuring the bi-iliac breadth and femoral length of 35 male African Americans and 33 Inuit skeletons. The range of ratios of known bi-iliac breadth to estimated stature in each sample exceeded the range of Ruff's population means, and the standard deviation (SD) of the ratio within each sample was equal to or exceeded that of Ruff's population means. For single-specimen-based estimates of a mean, a ratio  $\pm 1$  SD from the group's observed mean creates a systematic bias of 6.4% - 8.0% in mass from that predicted by the measured femoral lengths and bi-iliac breadths. More importantly, individual values for the ratio in African American and Inuit data each encompass most of Ruff's population means. A sample of one will frequently produce erroneous impressions of a group's average body proportions. Paleobiological inferences should take ranges of variation and confidence limits into account whenever possible.

#### **Admixture mapping: The effects of continuous gene flow and assortative mating on population structure.**

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Admixture between genetically distinct populations can create non-random allelic associations (linkage disequilibrium -LD) that can be used to map genes. However, the power and applicability of admixture mapping depend on the way in which admixture occurs. In particular, if admixture occurs quickly and is followed by isolation of the hybrid population (Hybrid Isolation model), simulation results suggest that a panel of ancestry-informative makers have approximately 80% power to detect LD between markers separated by 10 cm and a relatively low (~5%) chance of detecting disequilibrium between unlinked loci. If admixture continues through many generations (Continuous Gene Flow model) simulation results show that LD between loosely linked (recombination fraction >0.10) loci can be detected. However, the CGF model also demonstrates a significant amount of LD between unlinked loci. Additionally, assortative mating based on phenotype can increase the amount of LD observed in a population. Here we demonstrate that the pattern of LD observed in two southeastern African American populations resembles a CGF model of admixture, and cannot be explained by either a simple HI model, or a HI model with assortative mating. Specifically, both population samples demonstrate significant LD between two markers separated by 22 cm (FY and AT3), as well as significant amounts of LD between unlinked loci which are characteristics of CGF populations, but not HI populations. In order to determine whether this pattern of LD could be generated by assortative mating, we simulated HI and CGF populations in which individuals assorted by phenotype. The simulation results show that, while the HI assortative mating model generates significant LD between loosely linked loci, there is little disequilibrium between unlinked loci. The CGF assortative mating model demonstrated much more LD than is observed in the African American population samples.

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#### **Craniometric relationships of Pacific, East Asian, and Southeast Asian peoples: A multivariate analysis.**

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An impressive corpus of biological, historical linguistic, and archaeological evidence suggests that the primary source of the immediate ancestors of Polynesians was most likely somewhere in eastern Asia

and that their expansion into remote Oceania was a relatively rapid event. While recent molecular genetic evidence (e.g., mtDNA, Y-chromosome markers, etc.) strongly supports an Asiatic origin for the ancestors of Austronesian-speaking peoples and Polynesians, there is less consensus among researchers using molecular data on the exact location in eastern Asia of this ancestral homeland. An alternative model, based primarily on archaeological data, stresses that diffusion and complex interactions of people and cultures resulted in a more indigenous development of Polynesian ancestors (& Lapita culture) in western Melanesia. In this paper, craniometric data are used to test these alternative hypotheses based on the results of recent genetic data as well as evidence from other sources.

Stepwise discriminant function analysis and Mahalanobis' generalized distance are applied to 29 measurements recorded in prehistoric and more recent crania representing the indigenous inhabitants of remote and near Oceania, Australia, East Asia and Southeast Asia for examining the biological relationships of Pacific and circum-Pacific groups. Sixty-five cranial series representing 2,889 male crania are included in the present study.

The results of this new multivariate craniometric study support interpretations of recent molecular genetic data that the ancestors of Polynesians are primarily of eastern Asiatic derivation and reject interpretations that they are primarily of an indigenous Melanesian origin. Additionally, the overall cohesiveness of Polynesian cranial shape supports a relatively rapid expansion of the initial founding group. Finally, the biological relationships based on these craniometric results point to an island Southeast Asian homeland for the ancestors of Polynesians.

#### **Differentiating species, subspecies and populations of chimpanzees using dental characters: Implications for fossil species recognition.**

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Due to the predominance of teeth in the fossil record, dental characters are commonly used in diagnosing fossil species. In this study, dental characters are used in differentiating the known species, subspecies and populations of extant chimpanzees. By using dental characters to sort chimpanzees into their known taxonomic groups, the aim is to provide a test case for examining the utility of dental characters in differentiating extant species, with implications for the diagnosis and differentiation of fossil species.

A total of 342 specimens of *Pan* including *Pan paniscus* (n=45), *Pan troglodytes*

*verus* (n=73), *Pan troglodytes troglodytes* (n=135) and *Pan troglodytes schweinfurthii* (n=89) were studied from museums in the USA and Europe. Based on biogeographic data and previous studies on geographic variation, these species and subspecies were further divided into nineteen populations. Characters on the occlusal surface of teeth, particularly the kind used in fossil species differentiation, were studied by taking measurements either directly on the specimen or on digital images of the occlusal surface. About two hundred dental metric characters were studied on each specimen. After applying size adjustments to these data using the Geometric Mean, univariate statistical tests such as one-way Anova and the F-ratio, and multivariate statistical tests such as discriminant analysis and principal components analysis were performed on both the size-adjusted and non-size-adjusted data.

The results of these analyses indicate that the two species of *Pan*, *Pan troglodytes* and *Pan paniscus* are classified with accuracy of about 90%. The accuracy is higher with non-size-adjusted data. The three commonly recognized subspecies of *Pan troglodytes*, *P. t. verus*, *P. t. troglodytes* and *P. t. schweinfurthii* are classified with accuracy of at least 60%. Classification accuracy for the populations drops significantly, with accuracy being higher for certain tooth types.

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#### **Patterns of craniofacial variation, dimorphism, and species recognition in primates.**

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The relative magnitude of variation of traits is commonly used to infer the presence of multiple species in samples of extinct primates. It is often assumed that molar tooth dimensions are among the best characters for this purpose, because they universally show low within-sex variation and little sexual dimorphism, meaning that inflated variability in unknown samples should suggest the presence of more than one species. While several analyses demonstrate this by comparing variation in tooth dimensions of controlled single-species and mixed-species samples, similar studies have not been carried out on craniofacial dimensions. This study evaluates the utility of such dimensions for recognizing mixed-species assemblages on the basis of relative variation.

Bootstrap analysis of variation in 40 craniofacial dimensions from large, geo-

graphically limited samples of 75 anthropoid species were carried out. Coefficients of variation and ratio estimates of sexual dimorphism were calculated for single-species and mixed-species assemblages of congeneric species. For each combination of species, 1000 iterations were carried out for each of a variety of sample sizes, sex ratios, and proportional combinations of species.

Congeneric species show remarkable stability in the pattern of variation across craniofacial dimensions. Some mixtures of species show virtually no inflation of CVs across characters. Where species differ substantially in size, there is a substantial increase of CVs across all characters. Most interestingly, similarly sized species often show a disproportionate increase in CVs in the face, palate, and jaws, as compared to dimensions of the orbits, neurocranium, and basicranium. This pattern of unequal inflation in character variance across traits suggests that multiple species assemblages can be recognized using a straightforward combination of dimorphic and non-dimorphic characters.

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#### **Directional bilateral asymmetry in the sacral morphology of males from the Hamann-Todd and Terry Collections.**

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Directional bilateral asymmetry (DA) is frequently used as an indicator of biomechanical stress on the human skeleton. Previous investigations have shown that right upper limb bones tend to be more robust in certain dimensions than left upper limb bones. Conversely, left lower limb bones are generally more robust than right lower limb bones. This asymmetry has been explained as the result of differential mechanical loadings largely due to handedness and activity pattern.

The sacrum is the pivoting zone for the transition of weight and energy from the upper to the lower body. Research by DeVita et al. (1991) suggests that loads carried by the right upper body are transmitted primarily through the left lower body. The present analysis will attempt to confirm the findings of DeVita et al. by identifying DA in the sacrum.

The sample in this analysis was comprised of 73 white male sacra from the Hamann-Todd and Terry skeletal collections. Three measurements detailing the sacroiliac surface and ala were recorded for each side of the sacrum. Asymmetry was calculated by subtracting the left side from the right then dividing by the sum of the left and right sides ( $[(\text{left} - \text{right}) / (\text{left} + \text{right})]$ ).

The results revealed significant DA in one of the measurements, lateral breadth of the ala. The remaining two measurements were not significantly asymmetrical. The DA in lateral ala breadth is further discussed in relation to the physiology and mechanical uses of the sacrum.

#### **Current research on Oldowan hominid activities at Kanjera South, Kenya.**

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The appearance of Oldowan archeological sites c. 2.5 million years ago (Ma) may reflect one of the most important adaptive shifts in human evolution. However, basic issues about Oldowan hominid habitat preferences and their use of vertebrate tissue remain to be resolved. Detailed reconstructions of paleohabitats based on paleontological and geological evidence are necessary to better understand the interplay between environmental change and hominid biological and behavioral evolution. Site formation processes in a variety of depositional contexts need to be assessed to more accurately determine the degree of variation in Oldowan hominid foraging ecology and in the transport and utilization of lithic raw materials.

Since 1996, carefully controlled excavations in c. 2.2 Ma sediments at Kanjera South have recovered rich concentrations of fossils and artifacts. Preliminary lab analysis has identified hominid marrow processing and carnivore damage to bone, as well as several artifact refits. Stable isotopic chemistry of paleosol carbonates and high equid frequencies indicate Oldowan hominid activities in a more open habitat (wooded grassland to open grassland) than have been identified elsewhere. A relatively high proportion of small (size 1 and 2), immature mammals is suggestive of small mammal hunting, while larger mammal remains (including a potentially butchered hippopotamus) may have been scavenged. Hominid transport of artifacts and raw material selectivity is suggested by lithic analysis. Results provide a refined understanding of the paleoenvironmental setting at Kanjera South and in combination with research elsewhere will assist in the interpretation of Oldowan hominid behavioral ecology.

#### **A comparison of population distances calculated from genetic loci and dental morphological trait frequency data.**

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Genetic markers and dental morphological traits were used to investigate relationships between human populations. This study examined the conformity of the population distances calculated from genetic and dental discrete data. A statistical analysis of these distance matrices allowed for theorization of population histories on a global scale.

Frequencies of genetic polymorphisms and dental discrete traits were gathered from a worldwide sampling of populations. Several populations were drawn from the published literature for each of the following regions: Africa, Asia, Australasia, Europe, and the Americas. The frequencies were entered into PAUP (genetic data) and NTSYS (dental data) to generate appropriate distance measures. These measurements were based on mtDNA haplogroups, Y-chromosome STRs (n=3), classic genetic markers (n=5), and dental morphological traits (n=9). We then created dendrograms from these matrices and compared each genetic distance matrix to the dental matrix using 10,000 permutations of the Mantel test.

Preliminary results generally indicated agreement between the population distances based on genetic loci and dental discrete traits. Sub-Saharan African groups, as well as Native American and Asian populations, clustered closely in all trials. These relationships conformed to previous research and were most likely a reflection of common origins and admixture; divergence between groups was presumably the result of genetic drift and/or selective pressures. In addition, some deviations were the result of sampling error for the traits examined.

#### **The millennial trend in bone mineral density in the femoral neck of a Danish population**

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The excavation of a Medieval cemetery gave us the opportunity to investigate 49 Danish skeletons comprising 29 males aged 29-80 years (mean 49.6 years) and 20 females aged 26-72 years (mean 41.0 years) dating from AD 1000 to 1250 in comparison with contemporary Danes and assess the millennial trend in bone mineral density (BMD) in populations considered genetically closely related. BMD of the femoral neck was measured by Dual-Energy X-ray Absorptiometry (DEXA) and



compared with data from contemporary healthy Danish women (n=184) and men (n=114) aged 19-79 years. BMD was transformed into z-scores on the basis of BMD of the contemporary controls.

BMD (z-score) was significantly reduced in Medieval women ( $-0.54 \pm 0.25$ ;  $p=0.04$ ) while BMD (z-score) in Medieval men was significantly elevated ( $0.55 \pm 0.22$ ;  $p=0.02$ ). In Medieval women, BMD (z-score) tended to increase with age ( $r=0.42$ ;  $p=0.07$ ) while no change was seen in men ( $r=0.19$ ; n.s.).

In conclusion, our data brings focus on different aspects of the development of osteoporosis. We observe that Medieval women had lower BMD in comparison with contemporary women but that this relationship was reversed in women who survived to older ages. In contrast, Medieval men had significantly higher BMD as compared to contemporary men at all ages, and the age-related bone loss was almost identical. A higher degree of physical activity in the Medieval time period is supposed to account for the higher BMD observed among the men. The observed lower BMD in Medieval women as compared to contemporary women can be explained by the well-known selective mortality among the younger women. A high birth rate and prolonged periods of lactation are the main reasons for the observed increased mortality and therefore very likely also for the associated low BMD.

#### Comparison between KNM-ER 1805 and other specimens of early *Homo*: a reevaluation of its taxonomic allocation?

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Since the discovery and the description of the Kenyan specimen KNM-ER 1805 by Leakey in 1974, the taxonomic assignment and the interpretation of its features are quite enigmatic and under discussion. The aim of this paper is to reevaluate the taxonomic attribution of this specimen after comparison with a sample of Plio-Pleistocene hominids.

This specimen appears to exhibit many traits not seen in the specimens attributed to early *Homo* and expressed in specimen of *A. boisei*. Our preliminary results suggest that KNM-ER 1805 could not be used as an average male of *H. habilis*. The metopic suture and the large size of the skull have been considered as a possibility of some growth abnormality. A comparative study of 207 specimens of *Homo sapiens*, *Pan troglodytes*, *Pan paniscus*, *Pongo pygmaeus*, and *Gorilla gorilla* do not confirm this point of view. Another interpretation should be advanced to explain this particular feature.

#### A heritability study of the non-metric trait fronto-temporal articulation in the Dakhleh Oasis, Egypt using mitochondrial DNA analysis

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Molecular genetic data provides an additional means to address the heritability of morphogenetic traits. Research is being performed on ancient skeletal remains in order to assess the heritability of fronto-temporal articulation, a cranial non-metric trait. This articulation is defined as the direct contact between the frontal and temporal bones of the skull, normally separated by the sphenoid and parietal. Mitochondrial DNA (mtDNA) analysis is being performed on 7 ancient skeletons from the Dakhleh Oasis, Egypt which possess this cranial trait. Five adults clearly show this front-temporal articulation while 2 juvenile skulls suggest early development of the trait. Analysis of ancient mitochondrial DNA includes sequencing of the hypervariable region as well as analysis of selected restriction site markers to assess maternal kinship. The evaluation of the heritability of non-metric traits can aid in both bioarchaeological research and forensic identification. Our results demonstrate the utility of using ancient mtDNA to test heritability of non-metric traits of the skeleton.

#### Status of the savanna chimpanzees (*Pan troglodytes verus*) at Mont Assirik in Parc National du Niokolo Koba and in adjacent areas in southeastern Sénégal.

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A survey of the western subspecies of chimpanzee (*Pan troglodytes verus*) was conducted from 1 February through 9 April 2000 in southeastern Senegal, West Africa. Areas within the Parc National du Niokolo Koba (PNNK), including the Mt. Assirik region, and outside of the park were censused. Night nests made by chimpanzees were used to estimate chimpanzee densities, and surveys included line transect samples and more opportunistic samples of high use areas. A total of 112 kilometers were surveyed for chimpanzee nests, and a total of 1730 nests were recorded (736 nests within PNNK 994 outside PNNK). Based on fresh nest observations, at least 14-17 chimpanzees used the 'Lion Valley' area, a riverine gallery forest habitat with flowing water, near Mt. Assirik in PNNK during the dry season. Other evergreen valleys in the Assirik area

were used less frequently. During the Stirling African Primate Project's (SAPP) 4-year study in the late 1970's, McGrew et al. (1981) identified 24 different individuals in the Assirik community. A minimum of 7-9 different chimpanzees were observed during this brief study, based on age and sex. Five of these individuals were immatures. Chimpanzees outside the PNNK seemed less alarmed by human presence than chimpanzees within PNNK and coexisted with humans in a habitat that was significantly more disturbed than that of PNNK chimpanzees. Surprisingly, however, chimpanzee density in some areas outside PNNK (Bandafassi, Cobo, Segou) was similar to that of the Assirik community (7-15 and 5-12 nest-building chimpanzees per km<sup>2</sup> in high-use areas, respectively). Overall chimpanzee density was estimated at 0.25 nest-building chimpanzees per km<sup>2</sup>. The Assirik population, as well as chimpanzees in unprotected areas in southeastern Senegal, was estimated to live at higher densities than those reported by SAPP over 20 years ago (i.e., 0.1/km<sup>2</sup>).

#### Growth velocity of bone variables and indices in the squirrel monkey (*Saimiri sciureus boliviensis*). A longitudinal experiment.

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In a previous study, the growth in distance of different skeletal components in 12-36 month-old squirrel monkeys was adjusted by four four-function linear equations. The aim was to test the null hypothesis: "the growth of major functional skeletal components may be described by a single equation, independently of sex and/or environmental influences". In the present study, the same hypothesis was employed for testing velocity growth.

Five males and five females (controls) were fed *ad libitum* on a 20% protein diet. A second group of five males and five females (undernourished) were fed *ad libitum* on a 10% protein diet. Between the 12<sup>th</sup> and the 36<sup>th</sup> month from birth, the animals were radiographed monthly, from lateral and superior views. Food consumption per animal/day, the length of the femur; and the length (L), width (W), and height (H) of the neurocranium, face and pelvis, were measured. A volumetric index (VI) for each component was calculated:  $VI=100*(L*W*H)^{1/3}$ .

The null hypothesis could not be rejected since growth velocity for all components -femur length and food consumption

included - was acceptably adjusted by the polynomial equation:  $Y=a+bx+cx^2+dx^3$ , with mean values of adjusted  $r^2=0.99$ , fitted  $SE=1.5E-07$ , and model  $F=6.3E+12$ . Differences, however, were shown in the magnitude of the parameter values and in two trajectory models: (a)parabolic (pelvic index in the females from the two treatments) and (b)sinusoidal (the remaining indices plus femur length and food consumption). The former model may be connected with pregnancy and parturition. The latter explains in a better way the sinusoidal growth in distance previously reported for the skeletal components of these animals.

#### **Ancestral loss of the maxillary sinus in Old World monkeys and independent acquisition in *Macaca*.**

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Cercopithecoid monkeys are unusual in that most of the members of the superfamily lack a maxillary sinus, an atypical condition both for primates and eutherian mammals generally. Although this uncommon distribution of cranial pneumatization has been noted previously, few studies have investigated the ramifications. Recent CT and phylogenetic analyses of extant Old World monkeys by the present authors, however, suggest that the loss of the sinus may have occurred at the origin of the group, an inference that, if confirmed, would have far reaching consequences.

To test the hypothesis of early maxillary sinus loss in Cercopithecoidea, CT examination of KNM MB 29100, a complete cranium of the stem cercopithecoid *Victoriapithecus macinnesi* from ca. 15Ma deposits of Maboko Island, Kenya, was undertaken. This taxon is crucial for evaluating hypotheses of sinus evolution in Old World monkeys, due to its unique phylogenetic position, having diverged before the cercopithecine/colobine split. Coronal CT scans were made with the Siemens Somatom AR.SP of the MITC Diagnostic Centre, Nairobi, at 130 kV, 249 mAs, with slice thickness and increment of 1 mm, and a pixel size of 0.17 mm. The resulting character state distribution was optimized on phylogenies using the software Hennig86.

CT examination clearly shows that *Victoriapithecus* does not possess a maxillary sinus. All scans reveal only cancellous bone lateral of the nasal cavity, a condition that strongly supports the ancestral loss of the sinus in cercopithecoids. This, in turn, suggests that the maxillary sinus found in the genus *Macaca* is not homologous with that of other eutherians, which

may provide insights into the origin and function (if any) of paranasal pneumatizations.

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#### **The Baldwin Effect: the genetic assimilation of acquired characteristics.**

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At the end of the 19<sup>th</sup> century Baldwin, Oswald, and Morgan proposed that innate specialization for the acquisition of complex behavior might be the result of selection pressure for acquired characteristics and their genetic assimilation over generations rather than during the lifetime of the individual. The "Baldwin Effect," a genetically facilitated postnatal design-fixing process, is currently considered to underlie the genetic foundation of language (Dennett 1991). Proto-language was presumably acquired by means of a "less efficient, general-purpose learning-mechanisms. Only after early language became essential for social functioning could selection for more its rapid acquisition and for the reduction of errors in its production and comprehension lead to canalization of language acquisition (Kirby & Hurford 1997). Recent computer simulations of language learning in agents with a variety of innate endowments demonstrated the disappearance of genetic assimilation with high levels of developmental plasticity; thus, the Baldwin effect was unlikely to be a factor in the emergence of complex adaptive behaviors such as language (French & Messinger 1994). Kirby (2000) has argued that universal language parameters are the result of a transmission "bottleneck" during language acquisition in children. I would add that all perceptual learning appears to be a function of pattern generalization. Thus over historical time, a shared semantic representation and syntactic structure are likely to emerge in all dynamic, negotiated, serial exchanges of information within a community.

#### **The effect of restricted arm swing on human walking.**

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During human walking, each upper limb swings in synchrony with the contralateral lower limb. Early research on this motion has shown that human arms are made to swing with muscular control and do not swing merely as passive pendula. Active swinging of the upper limbs indicates that the arms may serve an adaptive function during human walking. Further, the different limb proportions found in early hominids suggest evolution-

ary implications for the study of arm swing.

Researchers have neglected the function of arm swing in most studies of the kinematics and kinetics of human walking. Preliminary studies have shown that the arms may serve two functions, though neither has been fully tested. The first is to counter torso rotation caused by pelvic rotation. The second is to modulate the position, velocity, and acceleration of the whole body center of mass.

Ground reaction force data can give an important representation of center of mass motion, since forces are a result of center of mass accelerations ( $F=ma$ ). In this pilot study, kinetic data were collected on subjects walking with freely swinging arms and with arms bound to their torso. Kinetic variables were compared between the different experimental conditions.

Differences between conditions were found in both the vertical and the mediolateral ground reaction force patterns. These differences indicate that loss of arm swing causes a definite change in the acceleration of the whole body center of mass through either compensation by whole body kinematics or by actual modulation of center of mass motion.

This project was supported by the Liberal Arts Graduate Research Fellowship from UT Austin.

#### **Brucellosis in Early Bronze Age Jordan and Bahrain: an analysis of possible cases of *Brucella Spondylitis*.**

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The authors describe spinal lesions observed in skeletons from the Early Bronze Age site of Bab edh-Dhra', Jordan (ca. 3200-3000 B.C.E.) and from burial mounds on the Island of Bahrain (ca. 2000-1800 B.C.E.). A lytic focus on the anterior-superior margin of the vertebral body, osteophyte formation - often in the form of a parrot's beak osteophyte, periosteal reactive bone formation on the anterior vertebral body, and a wide sclerotic region in the cancellous bone adjacent to the lytic foci characterize the pathological features. These lesions are consistent with and characteristic of changes observed clinically with brucella spondylitis as seen radiographically and through CT scans. The sclerotic reactions associated with the observed lesions, confirmed by the authors through radiographs and CT images, provides plausible evidence for brucella spondylitis at least 5000 years BP. Possible differential diagnoses considered include degenerative disk disease, osteoarthritis, tuberculosis, staphylococcal spondylitis and various types of hematogenous osteomyelitis. After an analysis of the possible causes of the observed lesions the authors

favor a diagnosis of brucellosis.

As the vectors for this disease include sheep, goat, cattle and pig, we expect that brucellosis was an important cause of illness in the ancient world, as it is today in endemic regions such as the Middle East and Mediterranean. Goats are the primary vector for the type of brucellosis (*Brucella melitensis*) that would most likely affect the skeleton. Since goats were domesticated about 10,000 BP this variety of brucellosis is the most probable cause of the lesions we describe. Despite the difficulties of making a diagnosis of brucellosis, brucella spondylitis-with its relatively distinct spinal lesions-should be identifiable in archaeological populations from regions where the vectors for the disease were important.

Reference: CAPASSO L.(1999) Brucellosis at Herculaneum. *International Journal of Osteoarcheology* 9:277-288.

### **It's not all in your head: Analyses of population affinity based on postcranial discriminant functions.**

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It is commonly thought that cranial measurements provide much better information for estimating "racial" affinity than postcranial dimensions. Historically, anthropologists have neglected the postcranial skeleton in multivariate discriminant analyses designed to assess biological affinity (e.g., Howells, 1973).

Here, we show that postcranial skeletal measurements can be used to develop multivariate discriminant functions that distinguish populations as successfully as discriminant functions based on crania. Post-cranial measurements of recent males and females of Europeans, Asians and Native Americans, and Africans were analyzed. Groups from these populations each consisted of roughly 25 males and 25 females. The group sizes by sex ranged from 7-41 individuals, but most groups had roughly equal numbers of males and females. A total of 122 measurements were collected on each complete skeleton. The measurements concentrated upon the appendicular skeleton and the limb girdles, capturing the lengths, midshaft diameters, and articular dimensions of the major long bones (excluding the fibula) and similar dimensions of a number of hand and foot bones. Using reduced data sets of 30 variables, preliminary results show that canonical variates analyses (CVAs) of the post-cranial data using SAS produce 80-100 percent correct classification. Initial cross-validation was conducted by splitting the most numerous samples in half, omitting one half from the calculations to produce the discriminant axes, then interpolating the omitted samples back into the resulting discriminant space. The cross-

validation results produced a reduction to between 80-60 percent of individuals who were correctly classified. However, these errors tended to misclassify individuals as members of morphologically similar groups.

Discriminant classification on the basis of postcranial dimensions therefore appears to be comparable in precision to classifications based on cranial data and should prove to be very useful in a variety of areas including forensic contexts.

### **Dental morphology of the aborigines (Orang Asli) of West Malaysia**

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The Orang Asli of the Malay Peninsula are traditionally defined by their language and cultural practices and have been divided into three major recognised divisions: the hunter-gatherer Semang; horticulturalist Senoi; and Aboriginal Malays who live mostly in peasant populations.

In 1999 dental casts were taken of 211 male and female individuals in five different Orang Asli villages (57 Semang, 64 Senoi, 89 Aboriginal Malay). From these casts 15 dental morphological crown traits were scored using the Arizona State University dental anthropology system.

Multivariate logistic discrimination was performed on the frequency data to determine whether the Orang Asli divisions could be distinguished. Only 59% of samples could be correctly classified to one of the three divisions implying greater intra-population than inter-population variation.

Comparisons of trait frequencies were made with similar data from 21 other samples from around the world and Mean Measures of Divergence were calculated. The distance matrix was graphically represented using average-linkage cluster dendrograms and two-dimensional ordination plots. Although all Orang Asli samples were similar to each other the Semang also show relatively close affinities with samples from New Guinea, North Africa and Europe. The other two Orang Asli groups clustered with South East Asian and Pacific (Micronesia, Polynesia, and Island Melanesia) samples. It may be tentatively hypothesized that the Semang have dental morphological frequencies similar to those of the earliest *Homo sapiens sapiens* outside of Africa.

### **Cerebral asymmetries on the endocasts of *Hylobates syndactylus*.**

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The endocasts of many nonhuman primate species are known to exhibit cerebral asymmetries, where pongids show a

greater degree of asymmetry compared to Old World and New World monkeys. However, little has been done to examine cerebral asymmetries of hylobatid endocasts. Thus, the purpose of this study was to investigate cerebral asymmetries on the endocasts of the hylobatid species, *H. syndactylus*.

Endocasts prepared from skulls of adult male and female *H. syndactylus* were collected from the American Museum of Natural History, NY (n=15); Smithsonian Institution, Washington D.C. (n=14), and the Museum of Comparative Zoology at Harvard University, MA (n=2) and examined for asymmetries. Data were collected and analyzed for the occurrence of (1) frontal, occipital and cerebellar petalia; (2) length differences in the hemispheres of the frontal and occipital lobes; and (3) the sizes and positions of the right and left transverse sinuses.

From the endocasts that were collected, 29 (16 male and 13 female) were used to analyze cerebral asymmetries. The most common petalia observed was a left occipital petalia that occurred on 57% of all specimens, while a right frontal petalia occurred on 34.5%. On specimens that possessed cerebellar petalia a left was more common occurring on 61 % of the endocasts.

Paired t-tests on hemispheric arc lengths revealed that frontal arc lengths were larger on the right than left hemispheres. The greatest difference was found between the occipital hemispheric arc lengths, with a difference of 1.60 mm indicating a significantly larger left than right occipital hemispheric arc.

The transverse sinus was significantly larger on the right side, appearing larger in 64% of the endocasts examined. Likewise, the transverse sinus was higher on the right in 64% of all endocasts.

All measures were also analyzed separately by sex.

### **Identifying patterns of migration and endemism in African mammal localities.**

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Biogeographic analyses of African mammal communities have been used previously to identify possible hominid migration patterns in the past. One way of measuring similarity among localities is through taxonomic means, i.e. examining degrees of differences between taxa among sites. These differences are likely explained by geographic distances among these sites, as well as ecological barriers to migration. In this study, we determine the relationship between taxonomic differences and geographic distances and ultimately use the results to identify possible migration routes and areas of endemism.

We use the Mantel test to analyze correlations among three separate sets of distance metrics: geographic distance, taxonomic dissimilarity, and ecological Euclidean distances based on a matrix of ecological variables. Cluster analyses and multi-dimensional scaling are used to show the relationships among sites based on these three types of data.

As expected, geographic distances are strongly correlated with taxonomic distances among sites. Ecological distances are also correlated with taxonomic distances as the distributions of various habitat types are often related to geography. However, there are exceptions to the general correlation between taxonomy and geography that are dictated by certain ecological constraints. For example, northernmost sub-Saharan zones of scrub woodland share more taxa with habitats in central and eastern Africa than with the forests of western Africa to which they are in closer proximity.

Thus, the results support the idea that distributions of taxa and exchange of fauna are largely determined by geography. However, while most taxonomic distributions are determined by geography, some are limited by ecological parameters. Both types of data can be quantified when attempting to identify probable migration routes. These data are also important to the discovery of Plio-Pleistocene centers of endemism and, once fossil sites are incorporated, the migration patterns of early hominids.

#### **A population-specific model for determining enamel growth rate and defect timing in medieval Danes.**

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Although the degree of variability in the rate of enamel growth between human populations is largely unknown, many studies have assumed that published schedules of enamel growth are applicable to all populations. This study presents a population-specific model for enamel growth in skeletal individuals from medieval Danish friary cemeteries (ca. A.D. 1250 - 1537) and compares the model to previously published enamelization schedules. The rate of enamel development in the Danish model was determined from counts of striae of Retzius in permanent unworn mandibular canines. Perikymata on the surface of the teeth were also counted to determine the average amount of hidden enamel in the cuspal end of the canine. The Danish model was used to calculate the timing of enamel defects in 450 canines from the samples. Additionally, the defect data were examined using a published schedule (Massler et al., 1941) to uncover any differences in timing resulting from the type of model chosen.

The results suggest that: (1) there is variability in enamelization schedules between populations and (2) using standard published schedules can result in mistakes in calculating the timing of enamel hypoplasia occurrence.

This research was supported by the Anthropological Database at Odense University (ADBOU), the Fulbright Foundation, and the American Association of University Women.

#### **Forty years gone: Pima dental eruption after Dahlberg and Menegaz-Bock.**

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In 1958, Albert Dahlberg and Renee Menegaz-Bock published dental eruption times for Pima Indian children living in the Gila River Indian Community south of Phoenix, AZ (*Journal of Dental Research* 37:1123). Their data came from dental casts made by Albert and Thelma Dahlberg from 1946 through 1957, during annual treks to southern Arizona. After a brief hiatus, the Dahlbergs continued to make dental casts of Pima children from 1963 to 1971. The AA Dahlberg Collection of Pima Indian dental casts is now curated at the Department of Anthropology, Arizona State University, Tempe.

Data for the present study come from the Pima subadult casts made from 1963 to 1971. The goal of the study was to determine if there are any differences in eruption times and patterns between the earlier and later casted groups. Individuals who were also casted in 1957 and before were excluded from this analysis, so that there was no overlap of individuals between this study and the previous one. Individuals were randomly selected for observation, except that efforts were made to ensure that sample sizes in all age groups were equal to or greater than sample sizes used by Dahlberg and Menegaz-Bock. Eruption times were determined using probit analysis on presence/absence data grouped by half-year age groups, following Dahlberg and Menegaz-Bock (1958).

Preliminary results indicate that individuals in the later-casted group have earlier eruption times compared to those studied by Dahlberg and Menegaz-Bock, with boys showing a greater divergence than girls. Eruption order remained the same in all quadrants of the mouth, but there were differences in the right-left patterning of eruption. Reasons for the earlier eruption times in the later group include dietary and nutritional shifts, and possible methodological differences in recording age-at-casting between the two studies.

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#### **Who is crooked, and who is not: A comparative study of anatomical versus functional asymmetry in the airway.**

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Questions on why and how certain features of mammalian anatomy achieve symmetry or asymmetry have long been asked. While many areas-from embryonic development of unpaired organs to brain asymmetry-have been addressed, the existence or extent of asymmetry of the mammalian upper respiratory tract (URT) has not been extensively examined. As the URT is the crossroads of many essential physiological activities, it is imperative to understand both anatomical and functional asymmetries. To this end, we examined the pharyngeal, laryngeal, oral and nasal regions (including sinuses) in a large range of mammals (50 genera) via imaging (e.g., CT, MRI, cineradiography) and/or dissection to assess whether significant functional or anatomical asymmetries exist. Results indicate that in many mammals, including primates, the URT exhibits remarkable anatomical symmetry. Humans are typical of mammals and show clear URT soft and hard tissue symmetry. The only feature that regularly exhibits any observable asymmetry is the paired frontal sinuses. In contrast to primates, toothed whales are one group of mammals that show marked URT asymmetry, manifest by both positional and shape differences. The blowhole opening (nasal aperture), paired bony nares, hyoid apparatus, and larynx are all off-centered to the left side. This URT positional asymmetry is probably related to coordination between respiratory and digestive function, enabling toothed whales to use the right side for swallowing and the left side for air flow to support sound production. Their nasal tract is surrounded by asymmetrically sized air sacs, with the sacs on the right side being consistently larger than those on the left. While humans and non-human primates have not evolved consistent anatomical URT asymmetry, they appear to have functional asymmetry, e.g., as occurs during the nasal cycle. This functional asymmetry may allow the retention of anatomical symmetry, thus enabling important redundancy of essential functions. Understanding the trajectories that led some groups to marked URT asymmetry and others not may shed light on the evolution of URT behaviors.

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### Dental microwear in *Mesopithecus pentelici* from the late Miocene of Pikermi, Greece.

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Dental microwear analysis has been used to reconstruct diet in a number of fossil and extant cercopithecoids. To date, published comparative studies of microwear in fossil forms have generally been restricted to the victoriapithecids and Plio-Pleistocene cercopithecines from Africa. In contrast, inferences as to the diet of early colobines have come primarily from studies of functional dental morphology. Yet, the dietary habits of the Late Miocene colobines bear directly on hypotheses concerning the adaptive influences on the origin of the subfamily Colobinae and the Cercopithecoidea in general.

In this study, dental microwear analysis is used to examine the dietary preferences of one of the earliest fossil colobines, *Mesopithecus pentelici* from the late Miocene of Pikermi, Greece. Analyses of shear crest and other functional data indicate that *M. pentelici* consumed more fruit than leaves, and that it included either hard fruits or seeds in its diet. Dental microwear analysis provides an independent means of testing whether this reconstructed paleodiet is correct.

High resolution epoxy resin casts were made of *M. pentelici* specimens housed in the collections of the National Museum of Natural History in Paris by one of the authors (BRB). Scanning electron microscope analysis of these casts (by JJR) demonstrated that they preserve microwear features very well. Microwear, analysis of wear facets on upper and lower second molars of *M. pentelici* was conducted. Of those specimens for which microwear features have been quantified thus far, enamel grinding (Phase II) facets exhibit more pits (51%) than striations. This wear pattern indicates that the early colobine from Pikermi relied more on fruits than leaves, supporting inferences made from shear quotient data. Further analysis of variation in wear in the moderately large sample is discussed in relation to the degree of terrestriality exhibited by *M. pentelici*, its potential seasonal changes in diet, and differences in wear between age classes. Broader implications for the evolution of cercopithecoid bilophodonty are also considered.

### Regional affinities of Neandertal DNA.

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Ancient mitochondrial DNA has been extracted successfully from two

Neandertal specimens (Feldhofer and Mezmaiskaya). While the mtDNA sequences are clearly different from living humans, controversy still exists regarding evolutionary significance. Some have argued that these data support the view of Neandertals as a separate species, although comparison with variation among chimpanzee subspecies suggests subspecific status for Neandertals might be appropriate.

A number of papers have suggested that analysis of Neandertal mtDNA supports the African replacement model and rejects multiregional models that propose some Neandertal ancestry in living people. This conclusion is based in part on the lack of European regional affinity when comparing Neandertal mtDNA sequences with those from living humans in different geographic regions. The implication is that under multiregional evolution, with isolation by distance and regional endogamy, samples within geographic regions should be more similar to each other than to samples from other regions. However, this prediction of regional affinity is true only over short intervals of time; migration matrix models show that the actual level of accumulated ancestry over many hundreds or thousands of generations produces different expectations. In particular, any matrix of interregional gene flow will ultimately lead to the same level of accumulated ancestry deriving from any specific region. This finding means that if multiregional evolution did occur, then living humans in all geographic regions will have the same level of Neandertal ancestry, and no region will be more similar to Neandertals than any other. Consequently, the lack of regional affinity of Neandertal mtDNA cannot be used to reject a multiregional model and confirm a model of speciation and replacement—the observed data are compatible with both models.

### Ontogenetic data suggest the presence of HOXD targets that act as growth scalars in the hominoid forearm and hand.

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We have previously presented evidence that covariance in adult digit and distal forearm proportions suggest their modulation by growth promoting targets downstream of shared posterior HOXD genes

(Lovejoy *et al.*, in press, *Evol. & Dev.*). However, some researchers have argued that growth pattern analysis requires ontogenetic data, even though distinguishing condensational versus post-anlagen developmental events cannot be resolved using such data. Nevertheless, we measured the diaphyseal lengths of the five metacarpals, the proximal phalanx of the first ray, and the diaphyseal lengths of the proximal and distal radius (as defined by the nutrient foramen) in an ontogenetic series of *Homo*, *Pan*, *Gorilla* and *Pongo* (N = 95). Analysis of covariance demonstrates positive allometry between distal and proximal radial lengths, indicating that a majority of growth occurs at the distal growth plate. ANCOVA is not an appropriate method for testing the modular hypothesis, however, because covariance in general somatic size obscures any less ubiquitous effects of other growth correlates. We therefore performed a PCA using the osteometrics defined above. As expected, all elements loaded heavily on the first component. However, the second component, which accounted for a surprising 8% of the variance, links the distal radius and four posterior metacarpals (which share *Hoxd11* expression) and excludes the elements of the first ray. The same PCA of our adult sample yielded identical results. Additional research is still necessary to directly link HOX genes to growth regulating mechanisms of the physis (e.g. the GH/IGF-1 and PTHrP/Ihh systems) and to identify specific target alleles (BMPs; FGFs; CTGFs, etc).

### Preliminary analyses of ancient Maya kinship within the Copán Valley using dental metric traits.

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Skeletal remains are extremely friable in the Copán Valley, making the use of dental traits a viable alternative to traditional skeletal analyses or DNA sampling. Numerous researchers have shown through monozygotic and dizygotic twin and family studies that dental metrics are inherited. Using dental metrics, this paper investigates biological relationships within the Copán Pocket during the Classic Period (ca. A.D. 250-800). Twenty barrios found within a 24 km<sup>2</sup> area of the Copán Pocket will contribute to an investigation of an isolation by distance model through geographic and social means. The Copán Pocket has been extensively excavated since the 1800's, providing cultural and biological material from not only elite, but non-elite households as well. Additionally, the polity of Copán is located on the southeastern frontier of the ancient Maya realm and it is an ideal location to investigate the interactions between Maya and non-Maya groups. Genetic relationships

are analyzed for three biological dynamics within the Copán Pocket: barrio to barrio, elites and non-elites, and Maya and non-Maya.

Out of the 808 skeletons presently excavated in the valley, 493 have been sampled thus far; of which preliminary conclusions are based on the sample of 358 individuals (234 adults, 94 subadults, and 30 undetermined age) whose teeth were observable. Of those 358, thirty are males, 42 are females, and 286 are undetermined sex. The following five measurements were taken on appropriate adult teeth: mesiodistal (MD), buccolingual (BL), crown height, cervical MD and cervical BL. Measurements that were obviously affected by wear (i.e., MD measurements affected by interstitial wear) were not taken and are not in the analyses.

Statistical analyses determine possible trait correlations. Genetic distance measures, including Mahalanobis' Distance, provide distance measures between the barrios, elites and non-elites, and Maya and non-Maya within the Copán Pocket.

#### Knuckle-walking and the midcarpal joint.

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Despite nearly a century of debate, there is no consensus regarding the mode of locomotion that preceded bipedalism. The knuckle-walking hypothesis has been difficult to test due to the small number of features recognized as knuckle-walking adaptations, and the inconstant expression of many of these features among extant knuckle-walkers. Several researchers have drawn attention to the limited degree of wrist extension in African apes as an adaptation for knuckle-walking, and have described related carpal morphology. The present study quantitatively examines the anthropoid midcarpal joint in order to test the hypothesis that morphology believed to limit extension is distinct in knuckle-walkers.

Sixteen measurements of the capitae and hamate were collected to quantify the size of each bone (length, AP depth, ML breadth), the distal extent and angulation of scaphoid/os centrale, lunate, and triquetral articular margins on the dorsal aspect of each bone, and the degree of concavity of the scaphoid and triquetral facets. Taxa examined include *Homo sapiens*, *Pan troglodytes*, *Gorilla gorilla*, *Pongo pygmaeus*, *Hylobates sp.*, *Papio sp.*, and *Alouatta palliata*. Raw and size-adjusted variables were examined using multivariate statistical methods, including principal components and canonical variates analyses.

Results show that African ape hamates

exhibit proximally-oriented triquetral articular margins, and the capitae are characterized by their markedly concave scaphoid facets, and proximally-oriented scaphoid articular margins. Along with other structures, these features function in limiting distal movement of the triquetrum and os centrale portion of the scaphoid relative to the distal carpals during wrist extension, and in distributing stresses involved in quadrupedal weight support. Therefore, these traits are likely to be knuckle-walking adaptations. The extension-limiting role of the os centrale portion of the scaphoid lends support to the hypothesis that fusion of the os centrale with the scaphoid early in development is a knuckle-walking adaptation retained in humans.

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#### A quantitative morphometric comparative analysis of the primate temporal lobe.

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Given its importance in language comprehension, the human temporal lobe might be expected to be larger than allometric predictions for a non-human anthropoid brain of human size. A recent comparative study presented evidence that the human temporal lobes are larger than predicted for an ape brain of human size, but concluded that the difference was not statistically significant (Semendeferi and Damasio, 2000). We revisit this issue with an expanded primate sample and additional temporal lobe measures. Measurements were obtained from whole brain, T1-weighted MRI scans from 44 living anthropoid primates spanning eleven species. "Easyvision" software (Philips Medical Systems, The Netherlands) was used to measure the volumes of the entire brain, the temporal lobes, the superior temporal gyri, and the temporal lobe white matter. In addition, a measure of cortical gyrification was obtained.

Allometric regressions revealed that temporal lobe volume scaled with negative allometry on the volume of the rest of the brain among non-human primates (log slope = 0.74 +/- 0.03). Consequently, the ratio of temporal lobe to brain volume decreased with increasing brain size. However, the human brain violated this trend; human temporal lobes averaged 44% larger than predicted by the non-human primate regression line and this difference was statistically significant (paired t-test on observed and predicted volumes = 6.07, 5 df, p=0.002). Similar analyses revealed that temporal lobe surface area, superior temporal gyrus volume, and temporal lobe white matter volume were also all significantly larger in humans than predicted by

non-human primate regressions on brain volume. In these same regressions, old world monkeys had significantly larger residuals than new world monkeys or gibbons, with the discrepancy being most pronounced for superior temporal gyrus volume. In contrast to these other measures, the degree of gyrification in the human temporal lobe was predictable based on brain size. The observed departures from allometry might reflect neurobiological adaptations for species specific communication in both humans and old world monkeys. Supported by the Leakey Foundation, the Markey Foundation and NIH RR-00165.

#### Heritability of CSF dopamine, serotonin and norepinephrine among baboons.

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The CNS neurotransmitters dopamine, serotonin and norepinephrine play important roles in the control and expression of behavior. Dopamine is associated with arousal and reward seeking, and norepinephrine with anxiety. Serotonin acts to inhibit behavior, including impulsive aggression. We measured metabolites of these neurotransmitters in the cerebrospinal fluid of 186 pedigreed baboons (*Papio hamadryas*) drawn from the multigeneration colony maintained at the Southwest Foundation. Quantitative genetic analyses were performed using univariate models, with age, sex, body weight and subspecies as covariates. Individual variation is significantly influenced by genetic variation. The estimated heritability ( $h^2$ ) of HVA (metabolite of dopamine) is 0.34 ( $p < 0.03$ ),  $h^2$  of MHPG metabolite of norepinephrine is 0.32 ( $p < 0.03$ ) and  $h^2$  of 5HIAA (metabolite of serotonin) is 0.42 ( $p < 0.014$ ). The ratio of 5HIAA/HVA, which may be a better indicator of behavioral tendencies than either HVA or 5HIAA alone, has estimated  $h^2$  of 0.46 ( $p < 0.005$ ). Data from humans and other mammals implicates these neurotransmitters in the control of various behaviors. Field studies show that CSF levels of these neurotransmitters vary across subspecies of baboons that differ in fundamental aspects of social behavior. Our data indicate *Papio* can be used as a model for genetic studies of individual variation in neurochemistry and behavior. Partial support was provided by a Southwest Foundation Forum grant to A.G.C. and NIH grant P51-RR13986 to J.R.

### The issue of multiple human species in the mid-to-late Pleistocene: a view from below the neck.

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Taxonomic distinctions in human evolution have most often been based on the morphology of cranial and dental remains which are best represented in the fossil record. However, characters of postcranial morphology and/or behavioral inferences derived from that morphology have also been used to support these taxonomic arguments and to test hypotheses about modern human origins.

This paper examines claims of postcranial evidence for multiple human species in the mid-to-late Pleistocene. Three alternative categories of explanation may account for the evidence that has been used as a basis for taxonomy. First, a consideration of the fossil sample suggests that some taxonomic interpretations are based on shared, primitive characteristics and are not appropriate for drawing taxonomic distinctions. Second, the effect of geographic differences (due directly to climatic selection or indirectly to body size variation) within modern humans suggests that features such as body shape and limb proportions cannot be used to support species-level distinctions. Finally, differences in skeletal morphology associated with variation in activity patterns and levels are widespread among modern humans. For example, the presence of two patterns of postcranial morphology in a group of fossils, such as those of the late Pleistocene Levant, may reflect behavioral differences but are not necessarily indicative of species-level distinctions. Although the pattern of postcranial variation does not rule out multiple hominid taxa in the mid-to-late Pleistocene, it can be accommodated by these sources of variation within a single, evolving, polytypic species.

### The sacrum of A.L. 288-1 and its relevance to the question of locomotion in *Australopithecus afarensis*.

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While many observers maintain that *A. afarensis* was fully adapted to habitual bipedality and did not engage in significant arboreality, others still argue that it actively climbed and that its bipedality differed kinematically from the gait of modern humans in significant ways (Stern, JT 2000. *Evol. Anth.* 9:113-133). The sacrum of A.L. 288-1 is asserted to exhibit anatomical traits that support the latter view. Specifically, its flatness and lack of prominent upper lateral angles are claimed to distin-

guish it from modern human sacra and thereby to signal (to these authors) a less efficient mechanism for truncal stabilization during bipedal progression. Here we analyze these arguments in light of a more thorough examination of sacral variation.

Contrary to previous claims, the most definitive feature of the A.L. 288-1 sacrum is its great relative breadth. While A.L. 288-1 has one of the smallest body masses for our sample of *Gorilla*, *Pan*, and *Homo* (N= 60), her alar breadth still lies within the human range, and is well above that of the African apes. The extreme width of A.L. 288-1's alae alters its coronal/sagittal proportions, giving the visual impression of anteroposteriorly short alae that lack dorsal angles. Moreover, the form of human alae is highly variable, and many human sacra exhibit a nearly identical alar phenotype to A.L. 288-1 in both curvature and alar form. Thus, in those features claimed to distinguish its sacrum from that of *H. sapiens*, ranges of variation in the two species overlap; conversely, such arguments simultaneously ignore the demonstrable sacral reorganization evinced by A.L. 288-1 and its implications with respect to developmental biology and locomotion. These show that a radical shift in pattern formation antecedent to human morphology had occurred in the entire lower axial and pelvic region by the late Pliocene, which promoted habitual bipedality and precluded substantial arboreal behaviors.

### Biological effects of European contact: Craniofacial variation in the Americas.

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After the Spanish conquest of Central and South America, the ethnic composition of the region was drastically changed. The mestizaje (admixture) of indigenous, imported Africans and European populations increased the biological variability of the population. Craniofacial variation is investigated in Latin America as well as the biological effects of European contact.

The samples included in this study are: two historic and one prehistoric sample from Ecuador; two prehistoric samples from Mexico; a prehistoric sample from Cuba; a modern Cuban sample; a prehistoric sample from Peru; a modern admixed Mexican sample; Terry whites and Blacks. Biological distance is investigated using traditional craniometrics by computing size and shape variables according to Mosimann and colleagues using raw measurements. An ANOVA procedure was performed on the size variable to test for size differences among the groups. A canonical discriminant analysis was then performed on the new shape variables to investigate

craniofacial variation among the populations. The degree of differentiation among the groups was measured using Mahalanobis D<sup>2</sup>.

The ANOVA procedure yielded significant (Pr>F 0.0001) size related shape differences among the groups. Four significant canonical axes were extracted. Maximum cranial length and maximum cranial breadth accounts for approximately 44% of the variation on CAN1, nasal breadth and orbit breadth accounts for 28% of the variation on CAN2, approximately 14% of the variation is accounted by basion-bregma height and orbit breadth on CAN3, and 8% is accounted for by maximum breadth and basion-bregma height on CAN4. The D<sup>2</sup> matrix shows that prehistoric Ecuadorians and prehistoric Mexicans do not differ significantly, while both are distinct from prehistoric Peruvians. The historic Ecuadorian-European component and the historic Ecuadorian-mixed (South American and European) component are the most closely related, suggesting that the historic Ecuadorian-mixed sample is largely of European ancestry.

### Can ecology and life-history data be used to predict mortality patterns in wild primate populations?

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Mortality rates play a central part in many models of life history evolution and the evolution of mortality patterns has been linked to the evolution of social systems and parental care strategies. A good estimation of mortality rates is therefore important for a full understanding of the evolution of a species' behaviour and socioecology. The estimation of mortality rates in poorly studied or extinct species is generally based on estimates of their body mass, ecology and life history parameters. This paper investigates whether such parameters can be used to predict mortality rates in extant wild primate populations, and thus, by extrapolation, whether we can estimate mortality rates in extinct species. I collected data on infant, juvenile and adult mortality rates 25 species (32 populations) of wild haplorhine primate species. These data were used to investigate whether a knowledge of a population's ecology, body mass or life history can be used to predict mortality rates in wild primate species. Analyses were carried out using two comparative methods, the first treating each population as statistically independent and the second using phylogenetic information to control for potential phylogenetic bias. The analyses do not suggest that ecology or adult female body mass are good predictors of mortality rates in extant haplorhine primates. However, female age at first reproduction and birth rate do appear to be correlated

with mortality rates as predicted by some life-history models. It is concluded that estimation of the mortality pattern of extinct primate species cannot be made with any certainty using estimations of either their ecology or body mass.

***In vivo* intraorbital bone strain from the lateral orbital wall of *Macaca* and the functioning of the craniofacial haft.**

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Various models have been proposed to explain how the mammalian skull absorbs/resists feeding forces. Many of these models posit that specific components of the craniofacial haft resist stresses associated with feeding. The interorbital region experiences low strains compared with the anterior root of the zygoma and the mandibular corpus. This suggests that although the interorbital "pillar" does resist feeding forces, this function is unlikely to be an important determinant of interorbital form. In order to determine the pattern of deformation of the lateral orbital wall and the possible role of the lateral orbital wall in resisting feeding forces, bone strain data were collected from the intraorbital surface of the postorbital septum and the anterior surface of the postorbital bar in experiments with five *Macaca mulatta*.

Maximum principal strain orientations are generally rostrocaudally directed on the medial surface of the working side septum and downward and laterally on the anterior surface of the working side bar. Bone strain magnitudes in the postorbital bar are low in comparison with those recorded in the corpus and the zygomatic arch. Bone strain magnitudes along the postorbital septum are very low in comparison with those recorded simultaneously from the postorbital bar.

These data suggest that the lateral orbital wall is dorsoventrally compressed and bent on the working side. However, although the lateral orbital wall does resist feeding forces, it resembles the interorbital region in experiencing lower strains than the mandibular corpus and zygoma. Therefore the morphology of the lateral orbital wall in macaques, like that of owl monkeys, may not reflect the loading regime to which it is subjected. Although the primate craniofacial haft does resist feeding forces, its morphology does not seem to be adapted to perform this function.

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**Bone infection and porotic hyperostosis in 2000 ybp Ciboneyes of Cuba.**

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Relative osseous health of Dominican Republic Taino stimulated evaluation of neighboring Cuban Ciboneyes, similarly dated to 2000 years before present.

Infectious diseases and presence of hemolytic anemia were assessed on the basis of periosteal reaction, osteomyelitis and porotic hyperostosis in 151 skeletons from Cueva del Perico, Guayabo Blanco Matanzas, Matanzas, Cueva del Esqueletos I, Cueva de las Santa, Pinar del Rio and Cueva del Infierno.

Periosteal reaction was limited to a single bone in 7 individuals (1 ulnae, 2 proximal phalanges, 1 femur, 1 tibia, & 2 parietals). Osteomyelitis was seen in 1 tibia, 2 ulnae and 1 phalanx. Ballooning was present in 7 ulnae (1 each with periosteal reaction and osteomyelitis) & 1 phalanx. Phalangeal lesions also suggested possible tuberculosis or histoplasmosis. Porotic hyperostosis is present in 7 skulls. Additional skull pathology include probable meningitis, subdural hematoma, and one case of Histiocytosis X. Serpentine ilium, humerus and parietal lytic areas base crenulation appear specific for the latter, apparently occurrence of histiocytosis.

Presence of porotic hyperostosis in 5% suggests a low population frequency of hemolytic anemia, whether congenital or parasite-induced. The variant pattern of periosteal reaction and absence of sabre shin reaction precludes diagnosis of treponemal disease and suggest possibility of unknown infectious derivation. It is clear that the Ciboneyes of Cuba were highly stressed by infectious disease.

**Locomotion, long bone structure and body mass estimation in Old World anthropoids.**

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Reconstruction of body size and locomotor mode from skeletal remains are important goals of many paleontological studies. The two goals are interrelated, in that the in-vivo function of a skeletal element affects its relative size and proportions. In this study, I examine the effects of locomotion on long bone articular surface area and cross-sectional diaphyseal strength in 179 individuals distributed among 13 species of hominoids and Old World monkeys. A technique for allocating fossils to locomotor/taxonomic categories based on articular and diaphyseal proportions is dem-

onstrated. Body mass prediction equations are developed using the same structural properties.

The size of articulations relative to diaphyseal strength, within the same bones, is generally larger in more suspensory animals than in less suspensory taxa. This is true for both broader comparisons between hominoids and cercopithecoids, and in narrower comparisons within hominoids (i.e., orangutans versus African apes). In comparisons between limbs, more "forelimb dominant" taxa have relatively larger and stronger forelimbs, and more "hindlimb dominant" taxa (i.e., more frequent leapers) have relatively larger and stronger hindlimbs. Again, this is true both between cercopithecoids and hominoids, and within each of these groups. Success in assignment of individual specimens to general locomotor category varies depending upon the particular structural features available, but is reasonably good for many comparisons.

The accuracy with which individual body masses can be estimated using these structural properties is again dependent on the specific features employed and how definitive the locomotor/taxonomic classification is. %SEE's of body mass for the better prediction equations range between 5 and 15%. Both articular and cross-sectional diaphyseal properties provide better estimates than bone lengths, even within narrow locomotor/ taxonomic groups. Sample applications of these methods to several fossil anthropoid specimens are given.

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**Description of a feral *Alouatta palliata* population observed during three decades.**

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A feral population of *Alouatta palliata* that has been studied since 1972 in Costa Rica is described. Data exist for over 700 individuals, including body masses and linear and circumferential measurements. This sample size is very large for a study of noncaptive self-sustaining nonhuman primates.

Information was collected from over 500 females and 200 males. Almost 200 individuals are clearly juveniles and another 70 are either subadults or young adults. Males and females occur in roughly equal numbers as young infants. After the first year, however, there are less than half as many males as there are females.

For many monkeys, data were collected multiple times. This subset includes data from consecutive years for juveniles, en-



abling the construction of mixed longitudinal growth curves.

Patterns of growth are also assessed using the total juvenile/subadult subsamples through application of pseudovelocity curves. These curves are compared to published data from other studies.

Male-male and female-female competition and juvenile emigration are considered as possible factors influencing growth patterns such as typical age at physical maturity and growth spurts. In addition, mosaic rates of growth for different properties are explored.

Adult data are also very important. The groups within the sample inhabit two types of environments—river and dry forest. Differences in resource availability are considered as a possible explanation for lower average body masses in some groups than others.

#### Dental microstructure and life history in subfossil lemurs.

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Palaeopropithecidae and Archaeolemuridae are two families of large-bodied "subfossil" lemurs known from Quaternary deposits in Madagascar. The closely related indrids possess unique features including a highly accelerated dental eruption schedule and a low dp4/M 1 occlusal area ratio. These features are correlated with dental precocity at weaning and a diminished role of the deciduous teeth. To date, no work has related the dental microstructure of subfossil lemurs to life history strategies. Our aim is to examine the dental histology of *Archaeolemur* and *Palaeopropithecus* to determine if these subfossil lemurs share with modern indrids this accelerated pattern of dental growth and precocity.

We report here the dental microstructure of specimens attributed to *Palaeopropithecus ingens* and *Archaeolemur edwardsi*, and compare the patterns of tooth formation to those of living indrids, lemurids and anthropoid primates of similar body mass. Histological sections of *Palaeopropithecus* teeth show accelerated formation of the molar teeth: M1 is complete and M2 is nearly fully formed by birth. Daily rates of enamel secretion range from 2.9 μm in the inner enamel to 6.21 μm in outer enamel, and crown formation times range from 1.21–1.80 yrs, far faster than any other similarly-sized primate and well outside the

range of any extant prosimian. *Archaeolemur* molars also exhibit fast secretion rates and possess the thickest enamel of any non-hominin primate. Despite body mass more similar to extant apes, periodicities for both subfossil species range from 2–3, indicating that certain aspects of tooth formation do not vary as closely with body size as previously thought. These results support the notion that like modern indrids, certain subfossil lemurs were dentally precocious at birth. This has implications for reconstructing other paleobiological aspects of this bizarre radiation of extinct Malagasy lemurs such as diet, ecological competence at weaning and maternal investment

#### Pre-Columbian diet, health, and ecological adaptation at the Tutu Site, St. Thomas, U. S. Virgin Islands.

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The Tutu site, located on St. Thomas, in the United States Virgin Islands, represents a large prehistoric village that was occupied from approximately AD 65 until around AD 1500, overlapping the Saladoid and Ostionoid periods. We review major temporal changes in disease and diet, focusing on those that may reflect the unique challenges of island ecosystems, including the risk of environmental degradation.

Neutron activation analyses of human bone provided evidence of dietary change over time. Diagenetic studies including soluble ions in soil and mapping of trace elements in bone microstructure (SEM) indicated that Sr and Ba concentrations were not appreciably altered by diagenesis. Changes in the Ba/Sr ratios suggest shifts from lesser consumption of marine animals during the Saladoid to a more equal consumption of marine and terrestrial species in the Ostionoid. These results are consistent with the faunal analyses (Wing et al. 1995). Concomitantly, alterations in disease patterns over time are indicated by studies of skeletal pathology. Among the types of skeletal pathology considered here are lesions that are consistent with those seen in treponemal infections. Such lesions became more severe and widespread during the Ostionoid.

changes in diet and possibly island ecology were accompanied by alterations in mortuary practices and in the spatial patterning and distribution of burials and structures. The extent to which such changes were sparked or associated with alterations in island ecology, and related to shifts in sociopolitical structure, are ongoing concerns.

#### Archaeological evidence for early maritime adaptations in western South America, 11,000+ to 5000 14-C yrs BP.

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Until the 1980s, the archaeological record for the Central Andean coast in western South America showed significant use of marine resources only after 5000 14-C yrs BP. In the last 20 years, excavations at a series of sites in southern Ecuador, Peru, and northern Chile have extended the evidence for prehistoric maritime adaptations through the Mid and Early Holocene to the Terminal Pleistocene. This paper explains why early studies failed to uncover the first 6000+ years of marine resource utilization and reviews our current knowledge of maritime adaptations for that period. The discussion uses Peruvian sites excavated by the author to illustrate the relationship between resources, climate, subsistence, and settlement systems throughout this time span (Quebrada Jaguay: Terminal Pleistocene–Early Holocene; Ring Site: Terminal Pleistocene–Early Holocene; Siches: Mid Holocene; Ostra: Mid-Holocene).

#### The temporal articular surface and mandibular fossa in anthropoids: Interspecific variation and relationships to diet and mastication.

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The topography and area of the temporal articular surface and the mandibular fossa of the temporomandibular joint was measured in 53 extant and 9 fossil anthropoid genera for interspecific variability in morphology. Statistical analysis revealed significant differences between dietary groupings in the temporal articular surface area.

Cluster analysis revealed that the *Australopithecinae* grouped with the African apes, while the archaic *Homo* specimens grouped within the extant taxa. Overall the area of the temporal articular surface and the degree of definition of the mandibular fossa were significantly related to masticatory activity. This implies that the *Australopithecinae* diets and masticatory activity were similar to that of the extant apes.

These results indicate that adaptations to specific functional demands should be taken into account when attempting interpretation of morphology in the paleontological context, and caution exercised in drawing phylogenetic inferences.

### Anatomy of a serial killer: differential diagnosis based on rib lesions from the Coimbra Identified Skeletal Collection.

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Analysis of the Hamann-Todd (Kelley and Micozzi 1984 *Amer J Phys Anthropol* 65: 381-386) and Terry (Roberts *et al.* 1994 *Amer J Phys Anthropol* 95: 169-182) Collections, and a radiological study on living patients (Eyler *et al.* 1996 *Amer J Roentol* 167: 921-926) suggests that new bone formation on the visceral surface of ribs may be the result of chronic pulmonary infection, most likely tuberculosis. The aim of this study was to reconsider the diagnostic criteria for tuberculosis and examine differential diagnoses, particularly the effect of non-tuberculous pulmonary diseases on ribs from individuals curated in the Coimbra Identified Skeletal Collection, Museum of Anthropology, University of Coimbra. Ribs from 323 individuals (66 juveniles and 257 adults) were observed macroscopically without prior knowledge of cause of death. Eighty-five individuals were excluded due to postmortem damage. The remaining 238 consisted of 75 (31.5%) pulmonary tuberculous, 25 (10.5%) extrapulmonary tuberculous, 33 (13.9%) pulmonary non-tuberculous, and 105 (44.1%) individuals with non-pulmonary and non-tuberculous causes of death. Medical and documentary data from the beginning of the 20th century were also analysed. Results showed that for this population, who died before antibiotic development, ribs lesions were significantly more common in people who had died from TB, were most often on left sided, on the 4th-6th ribs, and on their vertebral ends. Differential diagnosis for the lesions and the current diagnostic criteria for TB are discussed.

### An examination of the relationship between post-conflict interaction method and theory

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Within the area of conflict and post-conflict research, data collection methods are intertwined with theoretical interpretations. Indeed, our notions of primate post-conflict behavior may be dictated by prevailing methodology. The most widely employed technique of examining post-conflict interaction is the post-conflict and matched control sessions (PC/MC) method. While this method generates conciliatory tendency values comparable between

groups and species, it may not provide accurate depictions of primate behavior. In this investigation, we addressed these methodological and theoretical concerns with a juxtaposition of two data collection methods: the PC/MC method and an activity budget method.

The subjects were 11 lion-tailed macaques (*Macaca silenus*) residing at the St. Louis Zoological Park. For the PC/MC method, we employed data collection protocols described by de Waal and Yoshihara (1983). For the activity budget method, we used ten-minute focal animal samples and group scan data. Activity budget data collectors continuously recorded feeding, resting, traveling, and social behaviors of focal animals. During group scans, the number of group members engaging in each activity was recorded.

The behavioral profile generated by each of these methods is compared. Although the PC/MC data confirm prevailing post-conflict theory, the activity budget method yielded information within a broader context of focal and group activity. The activity budget method indicated that this group used several strategies to cope with conflict events. This complex repertoire of lion-tailed macaque behavior was not conveyed in the PC/MC analysis. The results of this comparison emphasize the importance of a more holistic approach to post-conflict behavior.

### Molecular clocks.

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Washburn, typically, came closer than anyone else had, when, in 1963, he suggested, on anatomical grounds, that the hominid line might be no older than the Pleistocene. Just how close was then documented molecularly by Sarich and Wilson in 1967. Our solution has held up pretty well over the last 34 years, and needs no further comment here. But that early success has not led to very many others, and the general picture is one of failure. Why? In part it derives from a tendency on the part of some workers to ignore what is known from the fossil and/or archaeological records in producing spurious calibrations for their molecular clocks, and the same has happened with linguistic clocks. Three such cases will be discussed briefly.

But by far the larger part would appear to derive from the difficulty of the problems chosen—the origin of anatomically modern humans and of variation within the species, and, by extension, the place of the Neandertals. There it appears that the actual organismal scenario may well be outside the range of the possibilities originally envisioned, and that there were problems with calibration for the molecular clocks used. This combination made it difficult to engage in the usual successive ap-

proximation approach, as it was difficult to impossible to sufficiently suspend disbelief in both the organismal and molecular realms at the same time. What made it possible—actually, imperative—for me, and what the results were, will then be the subjects of the rest of the presentation.

### A biometric analysis of sexual dimorphism in wild ringtailed lemurs (*Lemur catta*).

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Sexual dimorphism in anthropoids is much more common and pronounced than in prosimians. Most studies on sexual dimorphism in prosimians have looked at one measure such as body weight or canine size, and compared the measure across species. *Lemur catta* the ringtailed lemur, is reported to be sexually monomorphic, which is unexpected given that the species is polygynous and exhibits marked intrasexual male competition. However, recent evidence of significant dimorphism with males having greater maxillary canine height indicates that there may be some selective pressure for dimorphism in this species. As the patterns of prosimian dimorphism are unusual among primates, a variety of measurements are required in order to explore the possibility that sexual dimorphism is being expressed in ways other than overall body weight. However, analysis of sexual dimorphism in the postcranial morphology of this species has never been done. Here we present the results of such an analysis. The data presented in this study were collected from wild ringtailed lemurs in the Beza-Mahafaly Reserve in southwestern Madagascar. As part of a long-term study of the health, demography and ecology of this population, adult and subadult members were captured, collared and tagged and physical measurements were taken in 1987 and again in 1995. Weight, linear and circumference measurements were collected from 89 individuals during the two field seasons. Two categories of comparisons were utilized: 1) static comparisons of males and females of corresponding age groups (subadult, young-adult, prime-adult) (Student's unpaired *t*-tests used); and 2) ontogenetic comparisons of males and females, in which significant changes in successive age groups of males and females are compared for similarities or differences in the developmental patterns of each sex. SPSS 8.0 was used to perform all statistical tests. No significant weight differences between males and females were found in any age group. However, prime-adult males had larger upper arm circumferences and longer feet than prime-adult females. Males also differ from fe-

males developmentally, emphasizing growth of the lower arm, lower leg and foot, while females emphasize weight. These differences are discussed relative to sexual selection and life history factors.

#### Frontal cranial profiles of archaic and modern subadult and adult humans.

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In a comparison of interior as well as exterior frontal bone profiles from archaic and modern humans, we found substantial differences between archaic and modern samples in the external tables, differences that are mainly confined to the region around the browridge. However, in the median-sagittal profile of the inner table, the shape remained remarkably constant over all specimens (Bookstein *et al.*, 1999 *The Anatomical Record (New Anatomist)*, 257, 217-224). This implies that no significant alteration in this region has taken place over a period of a half-million years or more of evolution, even as considerable external change occurred within the hominid clade spanning several species.

Consequently, a fascinating question suggests itself: how does this relate to the shape of the frontal cranial profile of subadult *Homo*? Or, more precisely, do modern as well as archaic children and juveniles exhibit the same shape, or if not, in what way do they compare with results found for the adults? Does the inner table curvature stay invariant during the ontogeny of Neanderthal and modern individuals? What happens to the outer table during this time?

We used median-sagittal sections of CT-scanned crania with adequately complete frontal regions of adult *H. heidelbergensis* specimens, and adult as well as subadult Neanderthals and *H. sapiens*.

We found that Neanderthal as well as *H. sapiens* subadults fit into the pattern we had found in adults of genus *Homo*, namely, that the inner frontal tables are all indistinguishable in shape. This means that the internal table morphology not only remained constant over at least the last 600,000 years but also that only size changes-not shape-at least in Neanderthal and *H. sapiens* ontogeny. Externally, the situation is very different. The general reduction of the glabellar region with time is a phenomenon observed in hominid evolution towards modern humans and a general expansion of this region in the ontogeny of *Homo sapiens*, and *Homo neanderthalensis*.

#### Malarial selection on the GM Locus in Taiwan Aborigines: Effects on measuring genetic affinity to other populations.

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The aborigines of Taiwan represent the indigenous inhabitants of the island at the time of the arrival of the Chinese from the mainland. Three tribes occupied lowland areas while six tribes occupied highland areas. Previous studies indicate malarial selection on the lowland populations. Linguistically the aboriginal Taiwanese are related to the Malayo-Polynesian speaking inhabitants of Indonesia and the Philippines. Though the GM haplotypes are demonstrated to be very useful in the measure of population affinities, the possibility of malarial selection on this locus could affect studies of population affinity. This is a case study to see whether a subdivided insular population under a possible selective load will provide divergent clustering analysis depending on the population sampled.

Immunoglobulin allotype (GM and KM) profiles were generated on 167 lowland and 468 highland Taiwan Aborigines from the nine tribes. A highly significant difference was detected between lowland and highland populations adjusted  $G^2 = 39.417$ , 3 df,  $p < 0.001$ . There were no significant differences in KM\*1 frequency by altitude.

The Taiwan aboriginal GM frequencies were compared to data from Indonesians, I, Vietnamese, Thai, Malay, Chinese from Taiwan and Okinawan's using principal component analysis (PCA). The Lowland populations plot among the Thai (N, NC) and Malay. In contrast the Highland and Total Taiwan aborigine samples plot with the Indonesian and Vietnamese samples. Thus, depending on the populations of Taiwan Aborigines used, different conclusions would be reached. The Highland population supports the published linguistic ties, however, the lowland population do not support the linguistic relationship with Indonesian populations but are more closely related to Thai and Malays or reflect a similar selection history.

#### Degradation of DNA in bone material recovered from soil in relation to soil environment and incubation time

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Decomposition of bone material and degradation of bone macromolecules like DNA has been the subject of a number of investigations, applying different experimental designs and studying different aspects.

According to the study of the process of DNA degradation, experiments carried out so far have been investigating the context of DNA preservation in dependence of single parameters like temperature (Waite 1996, Waite *et al.* 1997), or a limited complex combination of factors like pH-value and temperature (Lindahl, 1993), or temperature and moisture (Waite *et al.* 1997) respectively.

Besides this laboratory experiment, the analysis of experimentally soil stored bone material enables a simulation of the "natural" environmental conditions corresponding to that of skeletal material analysed within the anthropological and some times also the forensic context. In reverse, data coming from such a study may enable prognoses according to the state of DNA preservation within material from a similar soil environment.

The aim of the study presented here was to get data concerning the process of DNA degradation within bone material recovered from different soil environments after different burial times, and the resulting changes in the typability of the DNA recovered applying STR loci.

#### Dental evidence for a maize-supplemented diet during the Late Woodland in Indiana.

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A recent paleobotanical study has determined that maize was exploited in Indiana as early as the Albee Phase of the Late Woodland period (AD 600 - AD 1200). The current study seeks to determine if there is odontological evidence in Albee Phase skeletal assemblages to support this idea of maize subsistence.

A study of dental macrowear, caries, and microwear was conducted on Early/Middle Woodland (n = 55), Late Woodland (n = 90), and Mississippian (n = 79) adults predominantly from Indiana (a single Mississippian site from Kentucky was also included). The methods used for this analysis followed standard guidelines for odontology. Macrowear scores were assigned to the molars using Scott (1979) and to the anterior teeth using Smith (1984). Dental caries were recorded for all teeth and were classified as either occlusal or non-occlusal. Microwear was quantified using Microwear 2.2 software (Ungar, 1995).

Parametric and non-parametric tests suggest that the expression of Late Woodland Macrowear and Microwear is not significantly different from what is seen in the Early/Middle Woodland. However, the

Late Woodland caries frequency differs significantly from the Early/ Middle Woodland and the Mississippian.

It is concluded that the dental evidence is not inconsistent with the paleobotanical evidence. It is possible that the Late Woodland diet included a cariogenic resource, like maize, but that this resource was not exploited to the same extent that it was during the Mississippian. In terms of wear, the Late Woodland diet remained similar to that seen during the Early/ Middle Woodland.

It should be added that the current study may assist future stable isotopic studies on these Late Woodland individuals. It is possible that the isotopic values may come out as intermediate, and, on the surface, not overwhelmingly in favor of a maize-based diet. However, the results presented here suggest that intermediate isotopic values are what one might expect to encounter.

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#### **Dynamic modeling of facial expression**

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Facial movements function as social signals. Yet, although the facial muscles are well-described, the dynamic course of facial expressions (signals) is relatively unknown. Using computer vision approaches to measurement of facial movement, we measured and described the dynamic course of expression. A dynamic model for facial expression was developed from these data, allowing for testing hypotheses of homology in human and non-human primate facial expression.

Observer-based methods (Facial Action Coding System) were used to identify spontaneous facial expressions, including smiles, in 38 individuals, videotaped while viewing funny and disgusting films. Once identified, expression sequences were analyzed using automated facial feature tracking. This method yields detailed motion information, including the direction and magnitude of pixel-wise changes in facial feature positions. Onset time, intensity, and total duration of expressions were calculated from these data.

Increasing lip width (mouth widening) during smiles was compared and expressions clustered in two groups, based on onset, total intensity and duration. Average time of smile onset was 0.61 seconds (SD 0.30 sec), and smiles lasted for an average of 2.29 seconds (SD 0.97 sec). The width of the mouth increased 12.9% on average during smiles (SD .06). Changing lip width during smiles was best fit by a cubic function.

Lip corner movement during smiles was also analyzed, allowing for measure-

ment of asymmetry in expression. In contrast to earlier studies, 74% of smiles analyzed were asymmetric, and 76% of asymmetric smiles were right-sided.

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#### **Distribution of protein patterns in different groups of subadult age in prehistoric and historic populations.**

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Normal longitudinal bone growth is achieved by the coordinated recruitment, proliferation, differentiation and eventual death of the cells of growth plate and bone. The essential cellular activity is carefully regulated by endocrine factors which act directly or indirectly. These factors are locally produced and stored within the tissue of the bone and the cartilage. Thus, the microenvironment of bone matrix plays a critical role in intercellular communication.

The protein pattern in the bone matrix of prehistoric and historic specimens was examined. The small samples were taken from individuals grouped in different classes of subadult age. The proteins were extracted from bone matrix and after solubilization and precipitation separated electrophoretically, using SDS PAGE (Poly-Acrylamide-Gel-Electrophoresis). The first step in identifying proteins in ancient bones is to control microscopically the preservation of organic and inorganic bone structures by viewing thin ground sections in plane and polarized light. Thus, contamination and destruction caused by decomposition and diagenesis can be estimated reliably. For this study, only bone samples were used characterized by an excellent preservation state. It is striking that there are different protein patterns in these subadult groups which are probably related to the different stages of growth.

#### **Reconstruction of late prehistoric and historic diet in Baja California Sur, Mexico: Isotopic considerations.**

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The Cape Region of Baja California Sur, Mexico attracted anthropological attention in the late nineteenth century due to the unique mortuary customs of the local population. Secondary cave burials painted with red ochre, and wrapped in animal hides and palm fronds are relatively abundant and provide much of the skeletal and archaeological evidence of the prehistoric inhabitants of this region. These remains, now known as the Las Palmas Culture, are believed to be the ancestors of groups liv-

ing in the Cape Region in historic times.

Available information on the diet and health status of the late prehistoric and early historic populations in the Cape Region is somewhat contradictory. Ethnohistoric documents describe historic populations as nomadic marine-oriented foragers. The limited archaeological record and dental pathology evidence from the antecedent Law Palmas Culture suggest a substantial terrestrial contribution, based on limited maritime technology (Massey 1955) and high caries frequencies (Molto 1996). The present study explores stable isotope ratios of human bone collagen and apatite carbonate as another line of evidence to investigate Las Palmas diet and possible impacts associated with Spanish contact.

A sample of 81 individuals from 12 cave burial sites in the Cape Region is analyzed for stable isotopic composition. This geographically concentrated sample is compared temporally and geographically to an additional sample of 29 individuals from predominantly coastal site contexts from Southern California to the northern and central portions of the Baja Peninsula, as well as published data from this region. In general, the results from the Cape Region demonstrate extremely enriched nitrogen and carbon isotope ratios. Superficially, these data suggest a level of marine exploitation difficult to sustain physiologically and are inconsistent with paleopathological studies. A thorough analysis of the isotopic ecology of the region is incorporated into this study in order to model the influence of an arid coastal environment on human bone isotope values, permitting more accurate dietary reconstruction.

The variability in diet represented by individuals within single cave sites is also discussed in reference to the duration of mortuary site use, dietary diversity in foraging populations, and between age-sex groups.

#### **Differential diagnoses of *intra vitam* and postmortem bone loss on the micro-level.**

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Sometimes, it is difficult to differentiate between *intra vitam* and postmortem bone loss in dry bones. Therefore, in prehistoric and historic anthropology, in paleopathology as well as in forensic anthropology and legal medicine, microscopic research is necessary to establish a reliable diagnosis. The causes of *intra vitam* changes are well known (e.g. osteoporosis due to inactivity or old age; osteoclastic processes such as malignant tumors, tuberculosis and other inflammatory processes; insufficient blood supply or hemorrhages). However, the postmortem factors of decomposition and diagenesis are,

as a rule, still not very well understood. The most important factors of diagenesis causing bone loss in dry bones are soil and water, plant roots, fungi, algae and bacteria, arthropods, and secondarily mineralized crystals.

This contribution presents the differential diagnoses of intra vitam and post-mortem bone loss and recommends the microscopic examination of thin ground sections of samples taken from dry bones as the method of choice.

#### **Intrapopulation craniometric variation in the European Upper Paleolithic and Southeastern Florida.**

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The level of morphological variation within a population is the result of certain genetic processes. Gene flow, genetic drift and selection are processes that can cause intrapopulation variation to decrease. These three factors are influenced by population size, system of mate exchange, frequency and/or geographic extent of population mobility and the level of interpopulation contact and interaction.

Two populations were examined in order to determine levels of intrapopulation variation using coefficients of variation based on the means and standard deviations of fifteen craniometric variables. Cranial material from the European Upper Paleolithic (45-10kyr; n=45) and Fort Center, a South Florida ceremonial site (AD200-600; n= 28), was analyzed.

A comparison of the coefficients of variation indicated that there are no significant differences in the level of intrapopulation variation for these two groups. Different explanations for the low degree of variation for each population are explored. In the Upper Paleolithic, continuous gene flow is the primary factor that contributes to the low levels of intrapopulation variation. Small breeding groups over large territories require exogamous mate exchange. High population mobility is further necessitated by the limited availability of local floral resources and faunal migration patterns.

At Fort Center, the stability of marine resources and stored maize results in lower levels of population mobility. Additionally, this site and other sites in the area are isolated due to the geographic constraints of peninsular South Florida. Despite small estimated population sizes, these two factors result in a system of endogamous mate exchange. Thus, low levels of intrapopulation variation are a result of group isolation and decreased population mobility. Therefore, it is selection and genetic drift that serve to reduce the level of morphological variation observed within this population. While both the European Up-

per Paleolithic and the Formative Period in South Florida exhibit low levels of intrapopulation variation, this is the result of different genetic processes, differences in population structure and differing levels of population mobility and interaction.

#### **A mitochondrial DNA perspective on Asian and Native American population relationships.**

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For decades, researchers have analyzed biological data to try and understand the genetic relationships between Asian and Native American populations, in particular, to model the initial peopling of the New World. These studies have suggested that between one to several migrations from Asia are responsible for the biological, cultural and linguistic diversity observed in past and present Native American populations, depending on the data set employed in the study. They have also revealed a general division between northern and southern Asian populations that suggests that Asia and Siberia were colonized through multiple population expansions. The abundance of new mitochondrial DNA (mtDNA) data from both Asian and Native American populations allowed us to reexamine questions about their origins and affinities through the statistical and phylogenetic analyses of these mtDNA data. Our results suggest certain regions of northern Asia as being more probably source areas for ancestral Native Americans, show regional patterns of genetic diversity in Siberia, and generally imply that both Asia and the Americas have undergone a complex settlement process.

#### **Signatures of stable strontium isotopes in human hard tissues - Applications to forensic identification?**

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The isotopic ratio of <sup>87</sup>Sr and <sup>86</sup>Sr in human hard tissues mainly results from the intake of dietary Sr. As no fractionation of Sr isotopes occurs in the course of the food chain, the local geogenic background, the food, and the tissue, in which the ele-

ment is finally stored, are expected to show identical isotopic signatures. In cell-free tissues, such as dental enamel, where no metabolism takes place after the formation phase, this leads to the preservation of the signature of a certain ontogenetic stage. In case of subsequent residential mobility, the enamel signature will still refer to the initial isotopic ratio and thus inform about geographical provenance, whereas the signature of the bone tissue will gradually alter and align to the isotopic ratio of a new environment.

This preliminary study will explore, how these conditions can be utilised as an application to forensic identification. A multi-regional sample is presented showing variation and difference of regional and local Sr isotope ratios. By comparing bone and tooth signatures, a mismatch with local isotopic ratios of the site can demonstrate a change of domicile by way of exclusion and thus help revealing information as to individual provenance.

#### **The ontogeny of positional behavior in captive chimpanzees: A mixed cross-sectional/longitudinal study.**

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In primates, considerable change takes place in the size, shape, and morphology of the skeleton during ontogeny. Reliable interpretation of the biological significance of these changes requires knowledge of accompanying changes in function and behavior throughout ontogeny. This study investigates age differences in the positional behavior (locomotion and posture) of chimpanzees housed at the Primate Foundation of Arizona (PFA) through a combined cross-sectional/longitudinal approach.

Forty-two subjects representing a cross-section of ages were observed, with the majority of subjects being observed across a three-year period. Instantaneous focal animal sampling was used to record both locomotor and postural behaviors as part of the overall positional behavior repertoire. Subjects were divided into eight age categories for analysis: infants (young, middle, and older), juveniles, adolescents, and adults (young, middle, and older). Analysis of variance (ANOVA) was used to test for age differences in each behavior. Probability values were evaluated for significance using a sequential Bonferroni approach.

Significant differences between age categories were found for quadrupedal locomotion, climbing, suspensory locomotion, brachiation and leaping, sitting, lying, quadrupedal and bipedal standing, and suspensory posture. For all subjects up to 13 years of age, each of these behaviors were plotted against age using LOWESS

(locally-weighted scatterplot smoothing), in order to discern ontogenetic trends in behavior. General trends with increasing age include an increase in quadrupedal locomotion, sitting, lying, and quadrupedal standing. Climbing, suspensory posture, and bipedal standing tend to decrease with age. Suspensory locomotion, brachiation and leaping exhibit more complex inverted U-shaped trends. These results are discussed in the context of previous analyses of growth and development in PFA chimpanzees conducted by Marzke and colleagues.

#### **Histological analysis of dental development in *Gorilla*.**

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The pattern and rate of dental development are important for understanding life history in primates. Much recent research has focused on sorting out the details of dental development in chimpanzees and several other hominoids. Surprisingly little is known about dental development in *Gorilla*, and to date, dental chronologies for this genus are based on a sample of one. Thus, information about variations in the time and timing of crown initiation and completion are lacking.

Fourteen teeth (maxillary and mandibular I1-M2) from the permanent dentition of a captive, juvenile, female western lowland gorilla (*Gorilla gorilla gorilla*) with a known-age of death (3.2 yrs.) were analyzed and a total of 34 thin sections prepared according to well-established histological techniques. Crown initiation (CI) and crown formation times (CFT) were assessed using short- and long-period incremental lines in both enamel and dentine.

CIs and CFTs are advanced for all teeth compared to the previously published chronology. CIs for I1s and I2s are 0.5-0.8 years earlier than 'normal' and complete 1.13 years ahead of schedule. CFTs for M<sup>1</sup> and M<sub>1</sub> are advanced by 0.5 and 0.8-1.1 years, respectively. Values for sequential molar overlap between M1 and M2 are 0.99 years for maxillary molars and 0.94 years for mandibular molars, nearly three times that known previously for this genus. Major accentuated stress lines visible in all teeth are tightly associated with exact dates of surgical procedures and follow-up hospital visits as recorded on zoo medical records.

The differences in dental chronology between our gorilla specimen and the pre-

viously described gorilla specimen may reflect differences in growth rates between wild-shot and captive populations. This has important implications for interpreting previous work on chimpanzee dental development (both histological and radiographic) from both types of populations.

#### **The morphometric picture of prehistoric and recent Japan in comparison with Northeast and Southeast Asia.**

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Recent and prehistoric human craniofacial morphometric samples in Japan were compared with Northeast and Southeast Asian populations. In order to see more broad geographic perspectives, this project included European Upper Paleolithic and Crimean Kurgan samples for comparison.

The statistical treatment included discriminant function analyses, calculation of biological distances (i.e., Mahalanobis distance) and cluster analyses using the Neighbor-Joining method and bootstrapping (Saitou and Nei, 1987). We performed analyses by females only, males only and by both sexes. We also utilized IVEware developed by the Survey Methodology Program at the University of Michigan's Survey Research Center (2000) to treat missing data. IVEware uses a multivariate sequential regression approach to imputing item missing values. Impute can create multiple imputed data sets. Therefore, we can test the consistency of several imputed data sets.

As well as the past studies, this analysis of craniofacial form clearly shows that there is continuity in Japan from the beginning of the Jomon leading to the recent Hokkaido Ainu, but not to the living Japanese (Brace and Nagai, 1982; Brace et al., 1989; Seguchi and Brace, 2000). Living Japanese craniofacial form clearly clusters with Yayoi (300 B.C.-300 A.D.), Korean, Neolithic, Bronze age and living Chinese facial form (Brace and Tracer, 1992; Seguchi and Brace, 2000).

In addition, preliminary results of this study have shown that there are morphological similarities in form among the prehistoric Jomon, recent Ainu, and European Upper Paleolithic. This would explain why observers keep seeing something that is reminiscent of European form in the Hokkaido Ainu of Japan. It may suggest that Jomon and Ainu represent the descendants of the Upper Paleolithic era's inhabitants of northeast Asia.

#### **Anatomical subdivisions of the frontal lobe in the great apes.**

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Major components of the frontal lobe like the dorsal, mesial and orbital sectors are associated with distinct cognitive attributes. It is here hypothesized that some species-specific adaptations in the behavior of the great apes may be reflected in the relative size of these sectors including the relative size of their gray and white matter.

MR scans of the living brain of three bonobos, six chimpanzees, two gorillas and four orangutans were used to estimate the absolute and relative volumes of a) the frontal cortex (FC) and its immediately underlying white matter (WM), and b) the dorsal, mesial and orbital cortices of FC and the white matter underlying each of these cortical regions.

Across species the dorsal sector has the lowest ratio of cortex to white matter, followed by the mesial and orbital sectors. The dorsal cortex occupies the largest part of FC (55% to 60%) and the mesial cortex makes up 26%-30% across the great ape species. The orbital cortex forms 15% to 17% of FC in the African apes, but only 10% of FC in the orangutans. Orangutan individual relative values of the orbital cortex do not overlap with individual values of the rest of the apes.

The mean ratio of FC to WM is larger in gorillas and orangutans. Individual values overlap across the hominoid species, but most bonobos and chimpanzees have a lower FC to WM ratio than other individual apes.

The orbital sector of the frontal lobe is involved in emotional responses to social stimuli and the present results confirm our earlier observations regarding the small size of this part of the brain in orangutans. The present findings also suggest that bonobos and chimpanzees may have increased interconnectivity between closely related areas in the frontal lobe.

#### **A new late Miocene hominid from Turkey.**

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During the 2000 excavating season at the late Miocene locality of Çorakyerler (Çankiri Basin, Central Anatolia) a new hominoid palate was recovered. The specimen includes most of the palatine and alveolar processes from a large adult male. The canines to M<sup>2</sup> from both sides are preserved. A portion of the palate anterior to the canines indicates an elongated premaxilla as in most late Miocene hominids (*Sivapithecus*, *Ouranopithecus*,

*Dryopithecus*, *Ankarapithecus*). The canines are morphologically male but have small cervical areas relative to the molars. Both premolars are rectangular, molarized, and strongly bicuspid, with protocones as large as the metacones. The molar surfaces are wrinkled, lack cingula and have well developed accessory cusps. The pattern of wear and crown fracture surfaces indicate hyper-thick occlusal enamel. All postcanine teeth are bunodont and flared, with board cusps defined by deep fissures. This combination of characters is unknown in any other hominoid. Certain aspects of dental morphology suggest affinities with both *Ouranopithecus* and "australopithecines". Çorakyerler is a rich locality with a fauna dominated by open country grazing ungulates (*Gazella*, "Palaeoreas"). Preliminary analysis suggests that it may be younger and more open ecologically than most Eurasian Miocene hominid localities. With a morphology and possible age and paleoecology intermediate between most Eurasian late Miocene hominids and the earliest African Mio-Pliocene hominids, the Çorakyerler discovery has important implications for understanding the paleobiogeography and evolution of late Miocene hominids in the eastern Mediterranean and East Africa. This work is supported by grants from NSERC and the Alexander von Humboldt Stiftung.

#### Late Pleistocene human anterior femoral curvature.

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It has been observed that Pleistocene hominids, especially Neandertals, exhibit a high degree of anteroposterior curvature of the femoral shaft. There is no clear advantage of this curvature. However, it may present a structural hazard considering the primary role that the femur plays in supporting body mass during locomotion, as well as the high activity patterns that these hominids exhibited. There has been no consideration regarding the function of this curvature in Pleistocene hominid populations, although long bone curvature has been studied in modern humans and other mammals. In modern humans, anterior curvature is a consistent characteristic of the femur, but it has been shown to be developmentally plastic and variable among different populations and individuals.

An analysis was performed to explore femoral curvature in Middle and Late Pleistocene fossil remains using a comparative sample of two recent human groups (one of twentieth-century Euroamericans and one of late prehistoric and early historic Puebloans). Regression analysis was used to determine the rela-

tionship between femoral curvature and length. Additionally, regression analyses were performed to investigate whether variation in curvature was correlated with several functionally significant characteristics related to the femur including body mass, features related to loading of the knee complex, and anatomical structures of the hip. No correlation was found between femoral length and curvature. For this and biomechanical reasons, an index that incorporates length is inappropriate for between group comparisons, as it confounds the issue of curvature with femoral length. Absolute subtense, the biomechanically relevant variable, is similar across recent human samples. However, Late Pleistocene archaic and early modern humans consistently exhibit elevated anterior curvature. Additionally, no correlation was found between absolute curvature and any of the discrete functional complexes.

#### Ranging and habitat use of sympatric agile and grey-cheeked mangabeys (*Cercocebus agilis* and *Lophocebus albigena*) in the Dzanga-Ndoki National Park, Central African Republic.

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Recent studies have found that the two mangabey lineages, *Cercocebus* and *Lophocebus*, are a diphyletic group whose phylogenetic affinities are very different than was previously thought. The semi-terrestrial mangabey species (*Cercocebus*) are most closely related to drills and mandrills (*Mandrillus*), while the arboreal mangabey lineage (*Lophocebus*) is more closely related to baboons (*Papio*) and geladas (*Theropithecus*). These surprising results were originally generated through biomolecular studies, and have since been confirmed by detailed morphological analyses. However, prior to the project presented here, no long-term field study of sympatric members of the two mangabey lineages had been conducted, thus it was not clear how the genetic and morphological differences between the two lineages might correlate with their behavior and ecology.

This paper reports on over 2,200 hours of data on agile and grey-cheeked mangabeys collected during a 32-month study (Feb. 97 - Oct. 99) at the Mondika Research Station, in southwestern Central African Republic. Data on feeding, ranging, habitat use and social interactions were collected on one habituated group of each mangabey species. Focal groups of the two mangabey species had overlapping home ranges in *terra firma* forest. The agile mangabey group never used swamp or inundated forest, which is reported in the literature as typical habitat for this species. Both species used mixed-species for-

est more than riverine *Gilbertiodendron*-monodominant forest. Grey-cheeked mangabeys used *Gilbertiodendron* forest primarily in foraging for insects, while agile mangabeys used this habitat type for finding mushrooms on the ground. The home range of the focal grey-cheeked mangabey group (c. 12 individuals) was approximately 250 hectares, while the agile mangabey group (c. 21 individuals) used over 400 hectares. Seasonal patterns of habitat and home range use are explored, and related to diet and food availability.

#### Ontogeny of gait in *Papio cynocephalus*.

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Primates differ from almost all other mammals in their predominant use of a diagonal rather than lateral sequence quadrupedal walking gait. Neurological and biomechanical mechanisms have been proposed for the evolution of diagonal sequence gait, but there remains no consensus on why primates prefer this unique quadrupedal gait.

A key to understanding primate gait lies in locomotor ontogeny. Hildebrand and others have documented that infant primates walk in lateral sequence gait early in their development before switching to adult-like diagonal sequence. Human infants are also known to use lateral sequence gaits or trots during crawling. The identification of the biomechanical and/or neurological factors driving gait choice throughout development can provide insight on the evolution of diagonal gait in primates, but research in this area has been limited in scope.

This study presents preliminary data for a larger project that aims to test the hypothesis that biomechanical factors (e.g., limb proportions, body mass distribution) influence footfall sequence during development in primate quadrupeds. Gait frequencies during walking were calculated for two infant baboons (4 and 15 weeks old, n=52 strides) and two human infants (n=10). Unlike adults, both infant baboons use appreciable frequencies of lateral sequence gait, diagonal sequence gait, and a walking trot. Our preliminary data on human infants confirms other studies documenting the use of lateral sequence gaits or walking trots. Comparison to similar data on nonhuman primates collected by others is problematic, but suggestive of interspecific differences in the timing of ontogenetic gait transitions. Future research will examine additional gait transitions and their relationship to changes in body mass and shape.

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### Mechanobiology in the evolution and development of the human bicondylar angle.

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The presence of a femoral bicondylar angle in the earliest known human ancestors, *Australopithecus*, has been used as a marker for bipedality. The bicondylar angle is a particularly interesting morphologic structure because its development can be examined in both phylogeny and ontogeny. In this study we demonstrate how the mechanics associated with bipedal activities influences the formation of the bicondylar angle.

Long bones grow in length by endochondral ossification. Previous studies have shown that this process is influenced by mechanical stresses and strains in the developing bone. In particular, hydrostatic stress inhibits the growth process and maintains cartilage while octahedral shear stress accelerates growth and promotes ossification. We implemented these principles into a finite element computer model to simulate growth of the distal femur in a growing child from birth until approximately age three. When a child first walks, the center of gravity of the body is medial to the knee joint in the frontal plane. Therefore, more load is placed on the medial condyle than on the lateral condyle. The finite element analyses demonstrate that this loading results in asymmetrical stresses in the femoral growth plate and predicts asymmetric growth of the distal femur. The medial side of the femur grows faster than the lateral side, progressively increasing the bicondylar angle and bringing the knee joint in line with the body center of gravity.

These results explain the development of the bicondylar angle in growing children. They further strengthen the suggestion of Pauwels and Tardieu that the appearance of the bicondylar angle in hominids can be interpreted as a reflection of the locomotor activity of an individual during ontogeny, and as a consequence, an epigenetic functional feature. Understanding the relationship between endochondral ossification and mechanical loading may provide powerful insights to other morphological features that are observed in the fossil record.

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### Adolescent male chimpanzee grooming behavior at Ngogo, Kibale National Park, Uganda.

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Chimpanzees live in male bonded, fission-fusion communities in which males are xenophobic. Past research has demonstrated that adult males use grooming to establish and maintain affiliative relationships with other intracommunity males. However, few studies have focused on the grooming behavior of adolescent males and the development of male behavior. I present preliminary data on the grooming behavior of adolescent males at Ngogo, Kibale National Park, Uganda.

The Ngogo chimpanzee community is the largest on record (>130 members) and has the most adolescent males (15) of any known community. Over 420 hours of observation were completed from May - August, 2000. All occurrence grooming data were collected for each of the adolescent males within the community.

Adolescent males directed more grooming toward adult males than any other group of conspecifics. They also groomed adult males more frequently and for greater periods overall than the reverse. Finally, adolescent males were selective in their choices of grooming partners. These preliminary results indicate that adolescent males are strategic in their allocation of grooming effort and that they use grooming to establish affiliative relationships with higher ranking, primarily adult, males. I will conduct further research on this and other aspects of chimpanzee male behavioral development at Ngogo, Kibale National Park. Supported by a grant from the L.S.B. Leakey Foundation.

### Frequency of the occipital marginal drainage pattern in African great ape endocasts.

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Enlargement of the occipital marginal (O/M) venous sinus system has been used as a phylogenetic character to argue for the affinities of *Australopithecus afarensis* and the "robust" australopithecines. However, since reports in the literature differ with regard to the frequency of O/M sinuses in great apes, the phylogenetic significance of this character is unclear. The present study was undertaken to determine the range of variability of O/M sinus morphology in the extant African great apes.

Endocasts of *Pan troglodytes* (M=10; F=6), *Pan paniscus* (M=16; F=15) and *Gorilla gorilla* (M=22; F=13) from Holloway's collection were included in the sample. Each endocast was examined for the pres-

ence or absence of a visible O/M sinus. In addition, if judged to be present, the size of the O/M sinus system was compared to that of the transverse-sigmoid system.

Among African great apes (n=82), a detectable O/M (or occipital) sinus occurred in 50% of cases (*P. troglodytes* = 50%; *P. paniscus* = 35%; *G. gorilla* = 63%). However, in not a single case did the O/M sinus system appear to be "enlarged", i.e., equal or dominant to the transverse-sigmoid system. These results extend prior reports of O/M sinuses in the African great apes based on different methods (e.g., Kimbel, 1984; Falk, 1986). Our results support Kimbel's (1984) conclusion, based on observations of the endocranium through the foramen magnum, that enlarged O/M sinuses are highly uncommon among *Pan* and *Gorilla*. The use of different criteria for assessment of O/M sinus size may be responsible for the present disagreement. These issues will be discussed.

### Relative placement of the mandibular fossa.

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In describing the Chemeron temporal, Hill et al. (1992) identified a medially positioned mandibular fossa in KNM-BC 1. Tobias (1993) challenged this assessment claiming an absence of substantiating metrics. Since that time, several researchers have investigated, or commented on, relative fossa placement in hominins, with variable conclusions. The bulk of this work was based on placement of the fossa relative to the ectocranial margin of the cranium.

A confounding factor in this work is the influence of temporal bone pneumatization. Extant apes (as well as some fossil hominins) are characterized by a fully pneumatized temporal bone. This results in a concomitant thickening of the squamous that may ultimately affect the perceived placement of the fossa. To investigate this, a sample of adult human (n=12), chimpanzee (n=12), gorilla (n=14) and orang (n=5) from the Cleveland Museum of Natural History, University of Wisconsin Zoology Museum, and University of Wisconsin Anthropology collections, were CT scanned. ImageJ (NIH) was used to display and measure coronal scans on a personal computer. To identify fossa placement, fossa breadth was measured as the minimum chord distance in the coronal plane between the tip of the entoglenoid to lateral margin of the articular surface. A second distance, from the tip of the entoglenoid to a sagittal plane, tangent to the lateralmost margin of the endocranial surface was taken to indicate the extent of medial placement of the fossa.



By eliminating the influence of pneumatization, these data unambiguously confirm the medial placement of the human fossa and show all apes as having a laterally placed fossa. Similar measurements on KNM-BC 1 and OH 5 demonstrate that, while both specimens demonstrate a broad fossa, the former is characterized by medial placement while the latter displays lateral placement.

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#### **Ontogeny of the nasopalatine duct in prenatal mouse lemurs.**

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Ecological explanations have been suggested for the precocious or delayed functionality of the vomernasal organ (VNO) during prenatal ontogeny in certain species of mammals. Perinatal function may be related, in part, to the patency *versus* fusion of the vomernasal duct or nasopalatine duct (NPD), the stimulus access point. However, no studies have attempted to examine a prenatal series of primates, mammals that generally have a prolonged period of dependence during infancy. In this study we examined 23 histologically sectioned embryos and fetuses from two species of mouse lemurs (*Microcebus murinus*, n=6; *M. myoxinus*, n=17), housed in the Bluntschli collection, Dept. Mammalogy, American Museum of Natural History. In order to determine if the nasopalatine duct (NPD) was completely or partially patent or fused, the duct was examined in its entirety. *M. murinus*, encompassing CRL of 11 to 16 mm possessed NPDs that exhibited complete fusion, whereas for 28.5 to 37 mm, the ducts remained completely or partially patent. However, *M. myoxinus* of all stages examined (7.5 to 32 CRL) demonstrated partial patency or fusion, but no ducts were found to be completely patent in any of the fetuses. These contrasting observations may relate to the differences in perinatal VNO function. It is unclear why some mammals (eg. mice, pigs) have a prolonged prenatal fusion of the ducts, whereas other mammals (eg. rats, cats) have an earlier patency of the vomernasal duct or NPD. The differences noted in our study suggest that *M. murinus* and *M. myoxinus* may differ in perinatal VNO functionality and perhaps in related behavior.

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#### **Micronutrient intake of working and non-working impoverished women in Cali, Colombia.**

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Although it is generally assumed that micronutrient intake is low in impoverished populations in developing nations, there is very little actual data on the micronutrient intake of poor urban dwellers. As part of a larger study of the energy nutrition of urban poor women in Cali, Colombia, we collected dietary data to assess both macronutrient and micronutrient intake. Among these women, we expected that micronutrient intake would be higher in working women than in non-working women.

The subjects were 64 non-pregnant, non-lactating women, 19 to 43 years in age. Of these women, 30 were non-working and 34 were employed in activities such as domestic work and street vending. Dietary intake was collected by trained observers for two days in a one week period, at 0, 3, and 6 months for a total of 6 days of dietary intake data per participant. Macronutrient and micronutrient data were obtained from published food composition tables. The 1989 Recommended Dietary Allowances (RDA) and the 1997-98 Dietary Reference Intakes (DRI) for the U.S. were used to assess the adequacy of intake for seven micronutrients: iron, thiamin, niacin, vitamin C, vitamin A, calcium, and folic acid.

Preliminary results indicate that there is no significant difference in micronutrient intake between groups. Intakes of iron, thiamin, niacin and vitamin C appear to be adequate in both groups. Intakes of vitamin A and calcium, however, were less than 55% of the recommended intake, and intakes of folic acid were only 9% of the recommended.

We conclude that although the women were impoverished, their intakes of some micronutrients appear adequate, and that being employed does not translate to a significantly higher micronutrient intake among these women.

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#### **Variability and adaptability in macaque social structure.**

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We have come a long way from the days in which any monkey would do for medical experiments, behavioral research and other investigations using primates. Sherry Washburn was THE major player in bringing about the change, showing the scientific world that there is great variability in the behavior and adaptation of the primates. It makes a real difference when

one chooses to use a sperm competing bonnet macaque instead of a precopulatory excluder rhesus macaque. In the spirit of Sherry Washburn's insight, we look at the variability within the genus *Macaca* and what it means for their adaptation.

Adaptations involving reproductive strategies should correlate with environmental pressures (predation, disease, availability of resources). Reproductive strategies influence male/female and adult/infant relationships, copulatory patterns, sexual dimorphism in size, rate of reproduction, and a number of related traits. In fact, it can be argued that reproductive strategies influence virtually every aspect of behavior.

The following elements are investigated: rate of reproduction, sex ratio, sexual dimorphism, copulatory patterns, male competition for access to estrus females, male/infant interactions, and related traits.

The total configuration of anatomical, behavioral and physiological elements for each species is evaluated in relation to outside factors in the environment: predator pressure, disease vectors, character of the space (degree of forestation, etc.) and resource availability.

#### **Molar flare in Miocene hominoids-function or phylogeny?**

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Early and Middle Miocene hominoids are characterized by flaring mandibular molars. Molar flare has been linked to frugivory in fossil and extant Old World monkeys (Benefit 2000), and it has been suggested that flare may also be a functional correlate of diet in Miocene hominoids. Based on a cladistic analysis of fossil and extant apes, Singleton (2000) hypothesized that this feature is primitive for Miocene hominoids and so may be uninformative concerning early hominoid diets. To test these hypotheses, the relationship between molar flare and diet in Miocene hominoids is tested and the phylogenetic distribution of this trait is examined.

The study sample comprises minimally worn second mandibular molars of 18 extant and fossil catarrhine genera. Taxa are classified as folivorous, frugivorous, or frugivorous/hard object-feeding based on shearing quotients, microwear, and ethological studies (extant taxa). Molar flare indices-computed as the log-ratio of mesial intercusp distance to maximum mesial breadth-are calculated using data from Singleton (1998). One-way ANOVA and Kruskal-Wallis tests are performed across genera by diet class. Molar flare is coded as a discrete variable using homogeneous subsets (Simon 1983) and tested for independence against diet.

Both parametric and non-parametric tests show that  $M_2$  molar flare values do not differ significantly among dietary categories ( $F = 3.35$ ,  $p = 0.063$ ,  $X^2 = 3.55$ ,  $p = 0.17$ ), and molar flare is not significantly associated with diet ( $G_{adj} = 7.07$ ,  $p > 0.10$ ). When molar flare categories are mapped onto the cladogram of Begun *et al.* (1997), relatively flaring molars are observed in the outgroup (*Aegyptopithecus*) and early Miocene stem hominoids, while Middle and Late Miocene and extant apes exhibit reduced molar flare. Thus molar flare is not a functional correlate of diet, but appears to be a primitive trait for Miocene hominoids. Functional and phylogenetic implications of molar flare reduction are discussed.

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#### The role of cross-sectional cortical morphologies in interpreting habitual bending across the anthropoid hip: A comparative analysis.

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Cross-sectional morphologies of anthropoid femoral necks are considered sensitive characteristics for interpreting changes in habitual loading during the evolution of bipedality. However, recent data challenge the reliability of these characteristics. The present inquiry focused on the use of cortical cross-sectional shape and robusticity in interpreting differences in habitual loading across hip regions of hominids versus great apes - where hominid femoral necks reputedly have relatively distinct loading, characterized by habitual bending. This question was examined in a comparative context by performing geometric analyses on proximal femora of adult modern humans ( $n=23$ ) and chimpanzees ( $n=23$ ), and calcanei of sheep ( $n=15$ ), deer ( $n=21$ ), and horses ( $n=15$ ). The calcanei are well-established "tension/compression" bones, documented by *in vivo* or finite element analyses. To facilitate comparisons, all bones were modeled as beam-like structures with "end" loading, and each was transversely sectioned in the respective functionally analogous locations: at 20%, 50% and 70% of "beam" length in calcanei, and mid-neck, basal neck, and subtrochanteric in primates. The computer program SLICE was used to digitize tracings and calculate: 1) "Robusticity" = cortical area to total (subperiosteal) area ratio (CA/TA), and 2) "Circularity" = cortical cross-sectional shape, or the ratio of maximum to minimum second moments of inertia ( $I_{max}/I_{min}$ ). Radiographs were visually evaluated for

arched trabecular patterns, which, if present, may reflect adaptation for tension/compression stress trajectories. Results demonstrate that the human mid-neck and the calcaneal distal (20%) sections have similar circularity and robusticity. In contrast, the chimpanzee mid-neck was significantly more circular and robust ( $p < 0.05$ ). The chimpanzee femur was the only bone that did not clearly demonstrate arched trabecular patterns. These results demonstrate that the human femoral neck sections have cross-sectional morphologies similar to the free ends of the tension/compression bones-the chimpanzee femur clearly deviates from this pattern. Although the calcanei and human femoral neck share these areal characteristics, it is still premature to suggest a causal relationship with a habitual tension/compression loading regime. Additional investigations are warranted using other characteristics, such as predominant collagen fiber orientation, that are more sensitive and specific to these strain modes.

#### A comparative cross-sectional study tracking maxillary sinus (MS) growth in *Pan* and modern humans: How similar are they?

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Among catarrhines, only the African great apes and humans exhibit all four paranasal sinuses (PNS) (Márquez *et al.*, 1999, 2000; Koppe *et al.*, 2000). Of these, the PNS morphology of the common chimpanzee appears to parallel the human configuration more closely than the gorilla (Márquez, 1999). However, the mode and tempo of chimpanzee PNS development has yet to be fully examined. For this present study, we track the growth and development of the largest sinus within the PNS system-the MS-in an ontogenetic series of humans and chimpanzees. Quantification of MS volumes based on computer tomography (CT) was undertaken to assess the degree of developmental similarity and evaluate the ontogeny of MS expression between these intimately related genera.

A cross sectional series of dry crania representing a mixed sex sample of both *Pan* ( $n=24$ ) and *Homo* ( $n=44$ ) were selected from the American, Cleveland, and National Museums of Natural History. A CT data base of human patients ( $n=67$ ) with non-respiratory disorders were also included from UT Medical Center and Mount Sinai School of Medicine. Developmental stages were determined by dental eruption

patterns. Volumetric determinations were performed from multiplanar reformatting and 3D reconstruction of CT digital data. Results show of the two major growth spurts (GS) in *Homo*, the largest occurs between M1 and M2 eruption. The pattern was maintained in *Pan*, but an additional GS was observed after M2 eruption and prior to canine emergence.

Although the added GS in chimpanzees may reflect a developmental retention from a common ancestor, the parallel ontogeny of MS expression in humans and chimpanzees supports the cytologic and molecular sequence evidence that these genera are closely related.

#### Mid-sagittal cranial variation in geographically distant modern human populations.

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Mid-sagittal differences in the shape of crania from geographically distant modern human populations were studied using geometric morphometric methods. Samples included Austrian Europeans ( $n=85$ ), Khoi-San Africans ( $n=34$ ), Australians ( $n=14$ ), and New Guineans ( $n=5$ ) with 2-dimensional coordinates for landmarks prosthion, nasion, bregma, lambda, inion, opisthion, and basion.

After Generalized Procrustes Analysis with unit centroid-size scaling, pairwise randomization tests of overall shape identified significant, Bonferroni-corrected differences between the Austrian-Europeans and all other groups ( $P=0.001$ ) and between the Khoi-San Africans and the Australians ( $P=0.003$ ). A suggestive, but non-significant, difference was found between the Australians and New Guineans ( $P=0.055$ ), but very little separation exists between the Khoi-San Africans and New Guineans ( $P=0.787$ ).

Examination of thin-plate spline grids between population means suggests that in the mid-sagittal plane the Austrian Europeans and Australians have rounder heads and the Khoi-San African and New Guineans have more elongate heads. A pronounced rotation of the foramen magnum is evident in the Europeans, and pronounced prognathism local to the face is seen in the Australians and New Guineans. Differences between the facial shape of the Khoi-San Africans and that of the Austrian Europeans is detectable, but the difference appears attributable to the relative elongation of the African crania and greater mid-sagittal roundness of the European skulls.

### The identification of secular trends, in health in skeletal samples.

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The analysis of potential sources of bias in archaeological skeletal samples has received an increasing amount of attention over the last several decades. In addition to the continuing discussions of differential preservation, curation biases, and problems with age and sex estimation, new questions have recently arisen regarding the very nature of skeletal samples as reflections of the populations from which they are derived. Some of the most interesting of these discussions have been instigated by the now famous "Osteological Paradox" article (Wood et al. 1992).

Although this article raises fascinating questions about our ability to reconstruct populations from the remains of their dead, one large potential confounder was apparently overlooked: the effects of temporally specific environmental stressors on a population. Because most cemeteries are aggregate samples, with an accumulation of several generations which are indistinguishable from each other, such effects are usually not measurable. In this study, we take advantage of a unique skeletal collection to begin to address the question of how much lesion frequency can be attributed to secular trends and unique environmental circumstances.

In this study, a sample of 64 individuals with relatively complete anterior dentitions from the site of Herculaneum was assessed for enamel hypoplastic defects. The individuals from Herculaneum were all killed simultaneously, on August 24th, 79 A.D. in the documented eruption of Mt. Vesuvius. This unique situation allowed us to determine the approximate year in which each hypoplastic defect was formed, and draw conclusions based on our estimates of the age at death of each individual. The data indicate that there is indeed a secular trend apparent, with younger individuals displaying a much lower frequency of hypoplasias than older ones. Because this is precisely the reverse of the effect usually observed in cemeteries, where individuals with multiple hypoplasias have a lower age at death on average, the results are striking.

The implications for the future study of more conventional cemetery samples is clear. A new potentially pervasive source of bias has been identified, and the impact of secular trends and singular historical environmental circumstances must now be more fully addressed in the study of archaeological skeletons.

### Intergroup violence: a comparison between Dallas phase and Mouse Creek phase frequencies and patterns.

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Based on the widespread presence of palisaded villages, warfare iconography and a handful of single site osteo-archaeological descriptions of particularly frequent violent trauma (i.e., cranial fractures, inflicted projectile points, scalping and dismemberment trophy taking), the Late Mississippian Period has been characterized as having endemic intergroup violence. Although the perception is credible based on the extensive literature detailing intergroup violence among precontact Plains Indian skeletal samples, it is perhaps premature to generalize about a large and diverse cultural area as the American southeast based on the few single site surveys. To remedy this paucity of baseline data, a comprehensive reservoir by reservoir survey of the Late Mississippian Period Tennessee River Valley skeletal samples has been undertaken.

One such reservoir, the Chickamauga of southeastern Tennessee, was home to two relatively contemporaneous culture phases: Mouse Creek and Dallas. All Dallas (n=4, 288 individuals) and Mouse Creek (n=4, 273 individuals) sites were examined for evidence of violent trauma. The results indicate that violent trauma in the reservoir as a whole was one half to one third as frequent as the referent published data and contrary to Mississippian iconography, no trophy taking other than scalping occurred. The frequency of violent trauma in the collective Mouse Creek sample (8.4%) was significantly different from Dallas (3.8%). There are archaeological indications that these frequency differences are sociopolitical. Mouse Creek males are significantly more likely to be victims of violent trauma. The pattern of non lethal head trauma in the reservoir suggests that some of the violent trauma was interpersonal rather than intergroup. Therefore more interregional complexity appears to be emerging.

### Midsagittal facial tissue thicknesses of Montreal children and adolescents.

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Data on facial tissue depths from various populations are useful for forensic reconstructions. While data from several groups have been collected, less is known about the changes in tissue thicknesses during growth and development. This study examines changes in 6 soft tissue thicknesses of girls and boys from 6 to 16 years. Two hard tissue relationships (sella-nasion and nasion-menton) are utilized for comparison.

The subjects derive from a mixed-longitudinal sample studied at the Montreal

Human Growth Research Center in the 1960s and 1970s. Thicknesses were computed from landmark distances digitized on lateral cephalographs and are corrected for radiographic enlargement. Total sample size is 278 (129 males, 149 females), with Ns varying by age and measurement. Soft tissue measures include glabella (GL), nasion (NA), anterior nasal spine - subnasale (ANS), mid-philtrum (PHIL; subspinale - superior labial sulcus), labial superior (LAS; supradentale - labrale superius), and labial inferior (LAI; infradentale - labrale inferius). Data were analyzed using SPSS and a multilevel modeling program (MLwiN).

For hard tissue growth, boys show adolescent spurts, while girls display no spurt (sella-nasion) or an extended, low rise in velocity (nasion-menton). Boys have a mid-growth spurt for nasion-menton as well. For both girls and boys for GL and NA, tissue thicknesses change little (GL, girls: range 4.7-5.6 mm; GL, boys: 4.8-5.7 mm; NA, girls: 7.0-7.4 mm; NA, boys: 7.5-8.3 mm) and show no clear growth spurts. For ANS, boys, but not girls, have an adolescent spurt (girls: 8.0-11.2 mm; boys: 8.5-13.1 mm). Both boys and girls show mid-growth and adolescent spurts for PHIL (girls: 11.2-15.4 mm; boys: 11.5-17.6 mm). Boys, but not girls, have adolescent spurts for lip thicknesses (LAS, girls: 12.4-14.0 mm; LAS, boys: 13.5-16.6 mm; LAI, girls: 13.9-15.8 mm; LAI, boys: 13.8-17.3 mm); a mid-growth spurt occurs for LAI at least in girls.

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### Reconsideration of the vomeronasal complex in Old World primates.

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Among primates, humans have been shown to have atypical prenatal development and adult structure of the vomeronasal organ (VNO). A recent study (Smith et al., in press, *J. Anat.*) has described similar VNOs in the postnatal chimpanzee, demonstrating the need for further investigation of the vomeronasal complex (VNO and associated tissues) in Old World primates. We histologically examined nasal septal tissues from 33 perinatal or postnatal primates, including *Macaca fascicularis* (2), *M. nemestrina* (2), *Colobus guereza* (1), *Pan troglodytes* (3), *Homo sapiens* (20), *Microcebus murinus* (2), *Otolemur garnettii* (2), and *O. crassicaudatus* (1). Each septum was coronally sectioned and stained using vari-

ous procedures. Prosimian species had well-developed VNOs with a prominent chemosensory epithelium and vomeronasal cartilages that nearly surrounded the VNO. In contrast, *Pan* and *Homo* had bilateral epithelial tubes that were above the superior margin of the paraseptal cartilages (vomeronasal cartilage homolog). Histologically, these tubes differed from the VNOs of prosimian species in having a homogeneous, ciliated epithelium and a different type of mucin production as demonstrated by alcian blue-periodic acid-Schiff staining. *Macaca spp.* and *Colobus* had multiple epithelial ducts in the presumptive region of the VNO, but these were structurally and histochemically different from the distinct, bilateral, ciliated, mucous-producing VNOs seen in *Pan* and *Homo*. This study and others suggest that Cercopithecoids may exhibit a synapomorphic loss of the VNO, but too few species have been carefully examined to draw this conclusion yet. These findings also show that *Pan* and *Homo* are similar in possessing a relatively superiorly positioned VNO, which lacks the clear sensory epithelium seen in prosimians. Such a VNO may be exhibited by other Old World species (e.g., apes) yet to be studied.

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#### Dental development in *Graecopithecus freybergi* (*Ouranopithecus macedoniensis*).

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*G. freybergi* (*O. macedoniensis*) is a late Miocene hominoid from Greece (9.5-9.0 m.y.a.) that has been interpreted either as the sister group to great apes and humans (Andrews *et al.*, 1996) or to australopithecines (de Bonis *et al.*, 1998). Andrews and Martin (1991) reported that *G. freybergi* shows thicker enamel than other Miocene hominoids, comparable to that of *Paranthropus* sp. This study examined enamel microstructure and development in this fossil ape. Recent research on *Afropithecus*, *Proconsul*, *Griphopithecus* and other Miocene hominoids allows for comparisons with taxa that show variable degrees of enamel thickness and patterns of development.

One  $M_3$  was examined using scanning electron microscopy and polarized light microscopy. Cross-striation repeat intervals were measured throughout the crown, and the periodicity of Retzius lines was determined. Retzius lines in the imbricational enamel were counted and used together with an estimate of cuspal enamel formation time to reconstruct total crown formation time.

The results of this study show that

cuspal enamel makes up a large portion of the crown area, and that only a small number of Retzius lines reaches the surface as perikymata. The angle of Retzius lines at the EDJ increases dramatically from the dentine horn to the cervix, which suggests that increased enamel thickness is the result of a large number of cells working at the same time. This is very similar to the pattern reported for molar teeth of *Paranthropus robustus* (Dean *et al.*, 1993) and the hominids from Omo (Ramirez Rozzi, 1998). Cross-striation spacing is at the high end of the range reported for hominoids, and most similar to *Proconsul nyanzae* (Beynon *et al.*, 1998). Crown formation time is similar to published values for other hominoids.

This study supports the view that thick enamel is the ancestral condition for the great ape and human clade, and reveals intriguing similarities between *G. freybergi* (*O. macedoniensis*) and *Paranthropus*.

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#### Variation in field metabolic rates among primates and other mammals: Implications for human evolutionary biology.

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Biological anthropologists are increasingly recognizing the importance of energetics for understanding the ecology of primates and early hominids. Over the last two decades the doubly labeled water (DLW) method has become the most widely applied technique for measuring daily energy expenditure in wild mammalian species. More recently, the DLW technique has been extensively used in human nutrition research to explore aspects of energy dynamics. To date, however, no studies have combined the available human and mammalian data to examine the energy expenditure of humans and other primates from a comparative perspective. The purpose of this research is to explore the scaling relationship between FMR and body mass among a diverse sample of mammals, and evaluate how humans and non-human primates compare to other mammals.

Data on field metabolic rates (FMR; kJ/day) and body mass (kg) were compiled for 75 mammalian species, including 2 non-human primates and 10 human samples. The allometric relationship between FMR and body mass for the entire sample is:  $FMR = 708M^{0.705}$  ( $R^2 = 0.963$ ;  $P < 0.001$ ) with the scaling coefficient approximately that of the Kleiber relationship (0.75). Analysis of standardized residuals from the FMR-mass regression suggest that primates have similar FMRs to those of other mammalian species. Primates, on average, deviate from the mammalian re-

gression by  $+0.13 \pm 0.77$  SD units, compared to  $-0.02 \pm 1.03$  among non-primate mammals (n.s.). The ecological correlates of variation in FMRs for primates and other mammals are discussed along with the implications for modeling early hominid energy demands.

#### Why do female primates engage in non-procreative mating with multiple males?

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Female primates often engage in costly, non-procreative mating with multiple males. Consequently, the search for compensating benefits has captured the attention of many biologists. Four common explanations for multiple, non-procreative mating by female primates are 1) sperm depletion, in which females deplete sperm supplies of rival females, 2) male recruitment, in which females lure males to their group for group-defense, 3) parental investment, in which females gain parental investment from more than one male, and 4) infanticide avoidance, in which females reduce infant harassment or infanticide. Here I use both theoretical analysis and empirical evidence to evaluate each of these explanations. 1) The sperm depletion hypothesis is weak because theoretical models show that such 'spiteful' behavior is difficult to evolve, and empirical evidence is lacking. 2) The male recruitment hypothesis is theoretically plausible provided females live in kin-groups, but convincing empirical evidence is lacking. 3) Theoretical analysis shows that the parental investment hypothesis may explain modest levels of female polyandry, and empirical evidence from the family *Callitrichidae* provides strong support. In such groups, females mate polyandrously, males invest in offspring of their former mate, and care from additional males improves offspring fitness. 4) The infanticide avoidance hypothesis receives strong theoretical support, but supporting empirical data are limited. In Japanese macaques (*Macaca fuscata*), however, infants are 8 times less likely to be physically attacked by males who previously mated with their mothers, compared to males who had not mated with their mothers. In general, the parental investment hypothesis may explain mating with a few males. The infanticide avoidance hypothesis, on the other hand, may best explain mating with most for all group males, as well as non-group males.

#### Quantifying cranial deformation in the Plains through geometric morphometry.

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Cranial deformation in the Great Plains culture area has been left largely unstudied in the past, and studies that have dealt with it have focused on the qualitative nature of assigning categories based on observer-perceived methods. Through the use of geometric morphometry, however it is possible to in fact quantify cranial deformation within a population.

Geometric morphometry allows the analysis of shape-based data by obtaining a generalized least squares fit of the data, effectively removing any size differences that might exist through sexual dimorphism or other natural effects. Two samples from the Great Plains are analyzed through the method of geometric morphometry. Data were from ninety-five cranial landmarks from the face and vault on the two samples from both the Northern Plains, and Southern Plains. Both samples display similar patterns of fronto-occipital deformation, but are analyzed separately as this analysis is not focusing on the possible inter-site genetic differences.

Two analyses are presented per site to quantify undeformed versus deformed crania. The first relies on the compute inter-landmark distances produced by the coordinate data and uses a canonical discriminant function to address which of the distances contribute to the deformation. Secondly, an analysis based on the residuals from a greatest least squares fit of the crania is performed in order to understand how the landmarks effected by the deformation process change in relation to one another in 3-dimensional shape space in situations of fronto-occipital modification.

#### **Biomechanics of sexual dimorphism in the anthropoid masticatory system.**

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Despite a growing literature on the subject of primate cranial sexual dimorphism, little is known about how males and females compare in the mechanics of masticatory force production. Shape differences exist between the sexes, but it is rarely argued that they reflect sex-specific feeding behaviors, perhaps because potential dietary differences between the sexes are largely unknown. However, when such shape differences exist interspecifically they frequently form the basis of adaptive interpretations. There is a logical difficulty in concluding that variation is an indication of adaptation when observed between species, but that it is unimportant when observed within a species. The goal of this study is to explore whether intraspecific sexual differences influence the function of the masticatory apparatus in anthropoid primates.

Biomechanically relevant dimensions

of the facial skeleton were measured in 624 cranial specimens (male and female) representing 23 anthropoid taxa. Data were collected using digital calipers and from three-dimensional coordinate data recorded using a computer-based image analysis system. Measurements include dental size and position, skull size, and skeletal indicators of muscle position, orientation and 'size'. Unscaled and scaled values were compared statistically between sexes in all taxa.

Many aspects of the observed patterns of sexual dimorphism differ among taxa, as reported by previous authors. However, there are several commonalities across the examined groups. Typically, taxa that show no significant size dimorphism also lack shape dimorphism in masticatory form. For most taxa, however, males have larger faces than females and show consistent shape differences that must influence masticatory function. These differences include more anteriorly positioned teeth and masticatory muscles, and larger masticatory muscles. In contrast, the mechanical leverage of the masticatory system is surprisingly similar between the sexes in most taxa. Coupled with evidence for larger chewing muscles, this suggests that males of dimorphic species can produce higher peak magnitude bite forces than females, but not because they are more mechanically efficient at force production. While this may mean that males can process a wider range of foods than females, it is unlikely that it reflects differential selection acting on males and females due to consistent dietary differences. It may instead be a byproduct of selection favoring larger body size in males.

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#### **Great ape semicircular canal size: shared adaptation or phylogeny? The evidence from *Theropithecus oswaldi*.**

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The semicircular canals of the inner ear scale with body mass, with different vertebrate taxa showing similar allometric exponents. Taking this scaling effect into account, the canals of extant great apes are smaller-arc'd than those of non-hominid primates. Given that canal arc size appears to correlate with aspects of a species' locomotor repertoire, the question arises whether the smaller canal size of the great apes reflects shared behaviour, perhaps related to their large body size, or simply represents shared phylogeny. It is interesting in this context to examine whether non-hominid primates of great ape size show the smaller canal size as well. One of the very few species for which

this can be assessed is *Theropithecus oswaldi*. During the Plio-Pleistocene this cercopithecoid doubled in body mass leading to later representatives of female gorilla size.

The bony labyrinths of six *T. oswaldi* specimens (Upper Burgi & Okote Members, Koobi Fora Formation, Upper Bed II & Bed IV, Olduvai Gorge) were imaged using CT, and their semicircular canal sizes were measured. The results suggest that with the dramatic temporal increase in body mass the canals actually became smaller-arc'd. Early baboon-sized *T. oswaldi* has baboon-sized canals, whereas later female gorilla-sized specimens have great ape-sized canals. This intraspecific shift in canal size from the non-hominid to the great ape regression suggests that the smaller canal size of great apes may not just reflect shared phylogeny but also some, probably size-related, aspects of locomotor behaviour, that perhaps characterized late *T. oswaldi* as well.

#### **Patterning of joint margin lipping in relation to the location of surface osteoarthritis within appendicular joints.**

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In studies that analyze osteoarthritis (OA) patterns in relation to habitual activities in prehistoric populations, joint margin changes are often excluded. Rather, researchers commonly associate the presence and patterns of joint surface changes such as eburnation and porosity with repetitive stresses produced by habitual activities. Age correlates with the prevalence of both surface OA (SOA) and marginal OA (MOA); however, it has been found to be a strong confounding factor in the prevalence of MOA in many appendicular joints, suggesting to some researchers that the presence of MOA does not reflect occupational stress. Rather than emphasizing prevalence, this study examines the placement of MOA within joints and assesses its position relative to the location of SOA within joints.

A skeletal sample from the Engelbert site in the Upper Susquehanna River Valley of New York was analyzed. The site was occupied from the Late Woodland Period (1280+/-160 AD) until the protohistoric early 1600's. Appendicular joints of 99 individuals were scored for OA using a mapping method developed by Nagy (1993). The location of MOA in subdivided joint regions with SOA was compared to that of regions lacking SOA in all major appendicular joints (shoulder, elbow, wrist, hip, knee, ankle, hands, and feet) and the temporomandibular joint (TMJ). Additionally, the presence of both SOA and MOA was compared with age to assess its confound on the association between SOA and MOA patterns.

Results indicate that the relationship between SOA and MOA varies both between and within joints. While ball and socket joints did not demonstrate distinct patterns of MOA based on the patterns of SOA, an association was found in the superior patella, the lateral TMJ, the central articular region of the distal humerus, and the superior margin of the proximal ulna. These results suggest that the presence of MOA is influenced by various factors, including joint type, joint mechanics, and repetitive stress.

### The origins of the prehistoric Easter Islanders (Rapanui).

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The origin, migration and evolution of Polynesian populations, in particular the Rapanui (Easter Islanders), have been the center of controversy for many years. Archaeological, linguistic and genetic/serological data have played instrumental roles towards resolving these disputes thus far. Recently, physical anthropological investigations have been contributing to the understanding of Polynesian prehistory and the origin of the Rapanui. Several settlement models have been developed which have addressed the origins of the prehistoric population that colonized Rapa Nui (Easter Island). This study's examination of prehistoric Rapanui crania (349), along with prehistoric crania of other east Polynesian islands: Gambier Islands (14); Hawai'i - O'ahu (100); Marquesas Islands (210); Society Islands - Mo'orea (24), Tahiti (66), and Huahine (1); Tuamotu Archipelago (44); and coastal Peru (47), have shed light on the physical anthropology of east Polynesia.

All data were corrected for sex and shape variation, tested for intra- and inter-observer error, and assessed for European admixture. Multivariate analyses of the craniometric data (30 variables) indicate that the prehistoric Rapanui had the strongest affinities with the Gambier Islands population (unbiased  $D^2$  value - 0.03629), followed closely by the Tuamotu Archipelago population (unbiased  $D^2$  value - 0.08953). There is no evidence of a South American origin for the prehistoric Rapanui (unbiased  $D^2$  value - 0.33318). The Rapanui and east Polynesian data exhibited patterns of biological variation indicative of the microevolutionary processes of genetic drift and gene flow. Though the colonizing population of Rapa Nui remained relatively isolated, very slight levels of migration with neighboring islands was indicated.

This study identifies a probable place of origin of the prehistoric Rapanui (Gambier Islands) and the evolutionary forces that produced their uniqueness. This study incorporated model-bound population ge-

netic approaches. The results of these methods should encourage the implementation of model-bound methods of analysis for future investigations of biological affinity when using skeletal samples to represent prehistoric populations.

### Effects of branch compliance on quadrupedal walking in *Loris tardigradus*.

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One of the most dramatic challenges for arboreal animals is that tree branches are often compliant, and move under the weight of an animal (Grand 1979). Branch compliance has been mentioned in the context of the role it may play in reducing energetic costs of locomotion (Alexander 1990), and in how it may reflect differences in foraging tactics (Nieschalk and Denies 1992). Yet virtually no data have been reported to date that address the extent to which primates make postural adjustments while walking on compliant supports.

Lorisids have some of the longest relative limb lengths of all primates (Jungers 1985). This potentially places their center of mass farthest from a support, and may require some of the most dramatic postural adjustments in order to cope with branch movements. Thus, the slender loris serves as an interesting taxon for examining effects of branch compliance and movement.

Limb posture was recorded during locomotion on fixed, compliant and moving supports. Joint angles were measured at touchdown, midstance, and toe-off, and angular excursions were calculated. In addition, stride lengths and gait patterns were examined.

Among the adjustments to substrate compliance were higher forelimb and hindlimb stride durations and duty factors than those observed on fixed supports. This indicates that lorises move more cautiously and maintain contact longer on unstable supports.

On supports that were actually moving, these differences were even more pronounced, and were accompanied by dramatic alterations in limb joint angles. Particularly at midstance, lower shoulder, elbow, hip and knee joint angles were observed, indicating a more flexed forelimb posture and a more protracted and flexed hindlimb.

These results suggest that, at least for lorisids, pronounced postural accommodations are necessary to move about on compliant and moving branches. Further work is underway to examine accommodations to substrate compliance in primates of differing body sizes, proportions, and locomotor preferences.

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### Bone loss, fracture histories, and body composition characteristics of older males.

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There has long been a tendency to view bone density loss as a problem for women. However, as information concerning bone density status of men accumulates, it has become increasingly clear that osteoporosis in males is a problem of significant concern.

During the course of a 16-year mixed-longitudinal study of bone density change in an Arizona population, the rate of bone loss of males and females has been monitored on an annual basis, along with measurement of stature, weight, and questionnaire responses on food intakes, exercise patterns, and health status. Included in the latter category was an annual update of bone fracture histories. When male and female statistics on bone fracture rates for 2947 women and 815 men were compared, it was found that the rate of fracture occurrence beyond age 50 was slightly higher (0.41) for men than for women (0.37) after correction for such traumatic causes of injury as automobile accidents. This result was surprising in view of the fact that the percent cortical area (PCA) of the radius at the distal one-third site in men averaged 55.3 as compared with a value of 50.2 for women. Preliminary data also indicate that the consequences of bone fracture in the ages beyond 75 are more serious for men than for women in terms of long-term morbidity and mortality.

Several investigators have observed that the risk of osteoporosis in men is more closely associated with estrogen than with testosterone levels, and that the process of bone remodeling in men differs from that in women. In the Arizona population, it has been observed that loss of lean body mass (LBM) is more rapid in men than in women after age 80.

As an increasing number of men survive into their 80's and 90's, the problem of age-associated bone loss among men may emerge as a public health concern as serious as that already recognized in women although the mechanisms underlying the process are different.

### Ethical issues in human biology behavioral research and in research with children.

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Research in human biology generally includes both a biomedical and behavioral component. While it is usually straightforward to identify the risks of biomedical

procedures, identifying risks of behavioral research is frequently much more difficult. This is especially true when the research takes place in a cultural context other than the researcher's own, where it may not be easy to determine what types of research are going to result in embarrassment, psychological stress, or stigmatization. The unpredictable nature of field research can exacerbate these problems.

As a "vulnerable population," children are provided special protections under U.S. regulations. One provision is that children should not be asked to participate in research involving more than "minimal risk," except under special circumstances. This is not generally a problem in human biology research because most research with children does not involve risky procedures. But it should be kept in mind that the definition of "minimal risk" can be difficult to apply. An additional consideration in research involving children is the U.S. regulatory necessity of obtaining both the permission of parents and the assent of the child. This regulation can be problematic in situations where parents and/or children do not have a good understanding of research and where ideas about the rights of children are different from those in the U.S.

#### **The middens of Aitape: the taphonomy of mortuary ritual on the Sepik Coast, Papua New Guinea.**

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The processing, decoration, consumption, and curation of the remains of ancestors, enemies, and loved ones are all documented in the history of mortuary ritual in Melanesia. The bioarchaeological and taphonomic analysis of fragmentary human remains from archaeological sites tested by the New Guinea Research Program indicate that complex mortuary ritual has a time depth of ca. 1,300 years in this region.

The largest site, a hilltop shell midden, yielded 3366 bone fragments, 1159 of which are identifiable as human. These represent a minimum of 7 individuals (3 children and 4 adults). Mean size of the human bone fragments is 2.25 cm; the largest is 16.5 cm. Perimortem fractures are present on 70% (98 of 140) of the long bone fragments, and peeling is evident on 9% of the human bone fragments. Fewer than 2% of the human remains exhibit cut marks, but those present are on cervical vertebrae and cranial fragments suggesting both decapitation and the enlargement of the foramen magnum. Cranial vault and arm bones are markedly underrepresented. Eleven pigs are also represented in the faunal assemblage. The pig remains are almost exclusively (96% of 1011) teeth and

cranial fragments.

We examine the range of possible explanations for the content and condition of the human and pig bone from this site, and interpret the archaeological data in light of the remarkable parallels we observed in our taphonomic study of the Field Museum's collection of historic crania from the same locality.

#### ***Pan troglodytes* and *Pan paniscus* diversity: results from the Y chromosome.**

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To investigate demographic history and current population structure of *Pan troglodytes* and *Pan paniscus*, we present the results of Y chromosome analyses of over one hundred chimpanzee, four bonobos and forty-two humans.

Polymorphisms in different regions of the Y chromosome were identified using Denaturing high performance liquid chromatography (DHPLC). DHPLC uses liquid chromatography to detect sequence mismatches in DNA heteroduplexes. The Y chromosome markers examined were all identified on the human Y chromosome. To verify that these markers are Y specific in *Pan* as well as humans, PCR was used to test each in a male and a female of each species. Currently, we have investigated over 4 kb of Y chromosome sequence in each individual.

Y chromosome diversity was significantly higher in both bonobos and chimpanzees than in humans. In chimpanzees, Y chromosome haplotypes were not shared between the three currently recognized subspecies. Our analyses indicate that *P. t. troglodytes* Y chromosomes are the most diverse while *P. t. verus* Y chromosomes are least diverse. These results agree with the nuclear data generated to date rather than mtDNA data. Our results also show that the Y chromosome haplotype found in one chimpanzee with the Nigerian mtDNA type is identical with that found in *P. t. verus* and, thus, do not support the designation of Nigerian chimpanzees as a fourth subspecies. However, as this sample included only one wild born Nigerian chimpanzee, further samples are needed to confirm this result.

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#### **JC virus genotypes in the Western Pacific.**

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Human polyomavirus JC (JCV) is a ubiquitous DNA virus that is principally transmitted within families, probably by contact with infected urine from adults. It establishes a persistent kidney infection in children. Rarely, JCV causes a fatal CNS disease in immunocompromised individuals, called progressive multifocal leukoencephalopathy (PML). Approximately 20-80% of adults are episodic or chronic excretors. JCV has evolved very slowly, and has likely coevolved with humans. Seven major genotypes with additional subtypes serve as plausible markers for following early and more recent human migrations in all parts of the world. We have begun to analyze the genetic diversity and molecular phylogeny of JCV in the Pacific. The Tolai (Austronesian speaking, Oceanic Branch) and the Baining (non-Austronesian) of New Britain, and people of the Eastern Highlands Province in Papua New Guinea (PNG) were studied. Variants in the typing region of the major capsid protein VP1 were found and five complete genomes were resequenced (~5,100 bp). Phylogenetic reconstruction with 28 other complete genomes including one from Guam showed a new genotype in the Highlands and in New Britain that we have designated Type 8. In one of the Tolai samples a different type (Type 2E) was found which matched a major type in the Chamorro of Guam. The other major genotype in the Chamorro was shared with people in South China and Taiwan (Type 7). We posit that the early migrants into "Near Oceania" brought JCV Type 8, while more recent Austronesian-speaking settlers, arriving about 3,500 years ago, carried predominantly Type 2E. In Guam, and possibly other islands within Western Micronesia, which were settled more directly from the west, and where the languages are in the Western Malayo-Polynesian branch of the Austronesian language family, additional South China (Type 7) strains are found. If this interpretation is correct, the phylogenetics of a virus may contribute to deciphering the mosaic of genes, cultures, and languages in this vast region stretching from Madagascar to Easter Island.

#### **Anatomy and function of the hylobatid thumb and index finger region.**

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Investigations of the hylobatid hand have led to the identification of unusual morphological features of the thumb and index finger region. Some research has suggested that hylobatids, unlike any other mammal, have a flexor pollicis lon-

gus muscle (FPL) comparable to the human FPL. Other studies have focused on the index finger's unusual *musculus accessorius interosseus* (MAI). The present research examines both morphology and behavior in order to address the question of similarity between the hylobatid and human FPL, and to assess the relationship between the anatomy of this region and hylobatid grip behavior.

The morphological component of the study involved the assessment, via dissection, of the origins, insertions, and actions of the FPL, the tendinous shunt that runs between the FPL and the flexor digitorum profundus muscle (index finger portion), and the MAI. These observations were used to help interpret the grips that were seen in the behavioral portion of the study.

The behavioral section entailed observation of the grips used by captive gibbons (*Hylobates lar*) and siamangs (*syndactylus*) in locomotor, postural, and manipulative activities. Data from this aspect of the study were used to test earlier researchers' hypotheses of anatomical function, and to generate new hypotheses regarding ways the anatomical features might work together as a functional complex.

Results demonstrate that the hylobatid and human FPLs are very similar in form, and both contribute to a powerful, mobile thumb. However, there are some differences in morphology, such as the tethering of the hylobatid FPL tendon at the distal interphalangeal joint. These differences result in important functional differences between the hylobatid and human FPL. The data also suggest that the FPL, its shunt, and the MAI are able to work individually or as part of a functional complex. Examples include the recruitment of the FPL and the shunt in the creation of a secure brachiation grip; and the importance of the MAI for maintaining a secure grip of thin vertical supports.

#### Finite element analysis of a partial macaque skull.

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Many facial features in primates and fossil hominids are thought to be designed to resist the stresses imposed by chewing hard foods. However, attempts to test hypotheses of facial function are confounded by the fact that the geometry of the facial skeleton is extremely complex. This paper introduces a long-term research program in which these hypotheses will be tested using an engineering method, finite ele-

ment analysis (FEA). The functional relationships of a simple character, palate thickness, are examined so as to demonstrate how FEA can be applied to diverse evolutionary questions.

A three-dimensional finite element model of part of a macaque skull was constructed by digitizing 25 CT-scans using reverse-engineering software. The digitized images were linked using a smoothing function to produce a realistic model preserving both internal and external geometry between the postorbital region and M<sup>1</sup>. The model was then meshed, and forces were applied to the zygomatic arch (representing the masseter muscle) and the M<sup>2</sup> (representing the bite force). Bone strain data obtained from published *in vivo* studies were employed in model validation.

The functional relationships of palate thickness were examined by comparing the palatal strain patterns in the macaque model to those obtained in a modified model in which the palate was artificially thickened. Insofar as strains were reduced in the palate as a result of thickening, one cannot reject the hypothesis that a thick palate is an adaptation designed to resist masticatory stress. However, palate thickening led to increased strains in neighboring regions of the cranium. FEA offers a unique opportunity to examine the biomechanical significance of purported masticatory traits in isolation or unique combination, such as those that occur in early hominids and other fossil primates.

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#### Development of sexual dimorphism in the facial skeleton of anatomically modern *Homo sapiens*.

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The development of sexual dimorphism in the facial skeleton has been extensively studied in non-human primates. Little work, however, has been carried out on the comparative development of sexual dimorphism in the facial skeleton of modern humans.

The present study compares facial sexual dimorphism in five populations of modern humans, to establish whether the degree and nature of those dimorphisms are identical across modern human populations, and whether all four populations achieve their facial sexual dimorphisms through the same growth processes. In order to do so 26 unilateral landmarks are taken from a total of 204 individuals at all stages of post-natal development. The landmarks are then analysed using geometric morphometric techniques, which allows the partitioning of size from shape.

All the modern human populations studied show a significant degree of sexual dimorphism in facial size, and all but one a significant degree of sexual dimorphism in facial shape. The degree and nature of facial sexual dimorphism is found to differ significantly between populations. It is likely that these differences arise through a combination of: various degrees of difference in facial *shape* already established at birth and carried through by identical growth vectors; various degrees of extension of the facial *shape and size* growth vector through time or rate hypermorphosis; and/or a growth independent difference between the parallel male and female *shape and size* facial growth vectors, so that the male facial form is different from the female facial form at all stages of maturation.

The study shows that the development of sexual dimorphism in modern humans is a highly complex process. It is not universal in mechanism across populations, and involves processes not previously described in other primates. To understand it properly it is necessary to separate size and shape dimorphisms and, where possible, analyse them independently. The results of this study indicate that workers should be cautious of making inter-specific and even intra-specific generalisations about the development of sexual dimorphism in the facial skeleton.

#### Theopetra cave: a regional analysis of the paleopathological patterns of the early Holocene populations in Greek peninsula: a case study

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The cave of Theopetra, located in NW Thessaly, is developed between the edge of the Thessalian plain and the eastern foothills of the Pindus mountain, at an elevation of 300 m asl. Lethaios, a tributary of Peneios River, flows in front of the cave, the only one with archeological deposits in the broader area.

The aim of this contribution, part of a multi-disciplinary research project, is to outline the identity and process of the epidemiological burstouts prevailing in the populations from Late Pleistocene and early-middle Holocene contexts, periods of major sociocultural changes in this part of the Balkan peninsula, a crossroad for population movements in prehistory.

Within this conceptual framework, the research design is focused on testing the hypothesis which supports that the Mesolithic and Neolithic people in Greece experience severe epidemiological phenomena attributed to the overall changes in their lifeways.

The first level of analysis indicates that the Mesolithic and Neolithic people of Theopetra provide "unorthodox data" as to



the severity and the distribution patterns of the bone lesions compared with samples in other Greek and European sites. Few cases of slight porotic hyperostosis, minor arthritic phenomena and growth arrest lines are evidenced in both samples in a remarkable low frequency. It is worth reporting the low child mortality rate and the overall good dental health, not often observed in prehistoric societies.

The contextual analysis of the data from Theopetra cave suggests that the major shifts in the lifeways of the early-middle Holocene population in Greek peninsula, yet an open issue, do not have a critical impact on the health profile of the societies at the same degree. Actually, the model that predicts the burstout with the intensification of agriculture, high population density and dietary shifts does not hold on a broad scale but it is justified only on a regional level. It is remarkable that in those early-middle Holocene societies where the curve is high under analogous conditions it falls down, independently of any cultural or/and environmental parameters. The suggested model is to be solidified by new data and a thorough analysis in a holistic perspective.

#### Change in bone mass in subadults.

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The histomorphology of sub-adult cortical bone reflects the processes of growth, modeling, and remodeling. This study presents the results of a preliminary histomorphometric study of 36 subadult ribs collected at autopsy (age range 5-22 years, mean age 15.4 years). In contrast to adult cortical bone, Volkman's canals, primary vascular canals, and resorptive bays predominate in a background of woven and primary lamellar bone. Haversian systems, evidence of secondary intracortical remodeling, are present in small numbers, but usually take the form of drifting osteons. As a result, many of the parameters used to characterize the mature cortex, i.e., OPD and mean osteon area, are not useful indicators of age or remodeling activity. Variables such as percent cortical area, total subperiosteal area, medullary area, and cortical area, which have been reported to be reliable indicators of bone growth do exhibit a linear association between age and area measurements, e.g., total subperiosteal area ( $R^2=0.49$ ). This paper describes the histomorphometry of a sample of sub-adult ribs and discusses its implications for future study of age-associated bone remodeling, age prediction, and growth.

#### Populational thinking in primatology: Re-evaluating patterns of behavioral variation and implications for conservation.

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Contemporary approaches to understanding primate behavioral variation emphasize comparisons among species using appropriately sensitive phylogenetic controls. Typically, species-specific values for variables such as group size or male numbers are derived by averaging data across different study groups or over years when long-term data on the same study groups are available. Data on intraspecific variation are lost in this process, despite the fact that many behavioral variables of comparative interest are known to fluctuate in response to local ecological and demographic conditions. Behavioral variation can also be greater among populations of the same species than between different species. Thus, while comparative models are providing important new insights into patterns of primate behavioral variation across taxonomic groups, our knowledge of intraspecific, or inter-population variation remains limited.

Understanding such population variation is critical not only for interpreting comparative analyses, but also for developing informed policies to protect endangered species. In contrast to the species-level focus of many behavioral comparisons, the trend in primate conservation is to recognize isolated populations as distinct taxonomic entities. As increasing habitat fragmentation disrupts primate distributions, the disparity in how primatologists and conservationists treat population variation is likely to grow. Greater attention to population patterns of behavioral variation would benefit both fields of study.

#### Genetic evidence of east Asian contribution to the second wave of migration to the New World.

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Whether East Asians were involved in the earliest migrations to the New World remains unclear. In this study, more than 3,000 Y chromosomes from East Asia, Siberia and America were analyzed using Y chromosome specific biallelic and

microsatellite markers. Our results showed that the RPS4Y711T, an Asian specific allele, has a wide distribution in East Asia, and reaches to the highest frequency in the Northern Asian populations. The gene diversity of the RPS4Y711Ts in East Asians, based on microsatellites, is four times higher than those in Siberians and American Indians suggesting a northward migration starting in East Asia. This northward migration is marked by a founder event in North Asian populations which are associated with the prevalence (88.8%) of a unique microsatellite allele, DYS391-9 in most of the North Asian RPS4Y711T Y chromosomes, which were originally derived from DYS391-10 alleles in East Asian populations. The founder effect was further reflected by restricted distribution of an A to G mutation at a Y chromosome locus M48 in Siberian populations. Hence, we propose that a prehistoric migration associated with the RPS4Y polymorphism started from the southern part of East Asia, crossing mainland China, reaching Siberia about 15,000 years ago and eventually contributed to the second migration wave to the New World.

#### Quantifying fission-fusion behavior and social dynamics in free-ranging spider monkeys (*Ateles belzebuth belzebuth*).

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Increasing numbers of studies demonstrate fission-fusion or flexible social grouping patterns in primate species. Fission-fusion social organization is described as an adaptation to foraging problems encountered by fruit specialists, particularly for *Ateles ssp.* and *Pan ssp.* When environmental fruit abundance is low, animals are able to avoid direct competition from conspecifics by splitting away from other group members and traveling and foraging in smaller groups. A more precise understanding of the relationship between feeding ecology, aggression, and flexibility in social structure requires a detailed examination of the factors that influence fission-fusion events in the wild, and requires quantification of group changes for more accurate comparisons between taxa.

This project investigates the dynamics of fission and fusion events in free-ranging longhaired spider monkeys at the Yasuni National Park in eastern Ecuador. Data were collected during ten two-week follows of focal subjects from March 1999 to May 2000. During follows, all vocalizations, feeding bouts, aggressive interactions, and changes in subgroup composition were recorded, and fission-fusion events were described in detail.

During 1279 hours of focal contact, 265 subgroup changes were detected, 236 of

which were clearly observed and described. Subgroups changed composition 0.23 times per hour, varying from 0.01 to 0.46 per hour during follows. Only 4% of all fissions occurred within one hour of aggressive interactions. Over 50% of fusions occurred at feeding trees or sleeping spots. An additional 36% were the result of long-calling, and 13% occurred during travel. While a significant association was found between aggressions and fissions at the scale of an hour ( $P=0.0003$ ), rates of aggression per follow were weakly related to subgroup change rate ( $P=0.09$ ,  $n=10$ ). Association matrices are analyzed to assess patterns of interaction for study animals.

These data provide a foundation for comparative study of the influence of ecological and behavioral factors on social flexibility and fission-fusion social structure.

#### **Child mortality among the Karimojong agropastoralists of north-eastern Uganda.**

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From August, 1998, through March, 1999, reproductive histories were collected from over 300 Karimojong women from four settlement clusters in Bokora and Matheniko territorial sections, in Moroto District, northeastern Uganda. The Karimojong are semi-nomadic agropastoralists who have strong genetic, linguistic, and cultural affinities with nomadic Turkana pastoralists of Kenya. This analysis is part of a comparative study of child survival and child mortality of East African pastoralists.

Women provided information concerning the outcomes of every pregnancy, live birth, and miscarriage. They were asked to provide as much information as possible regarding child death, including child development stage (at the time of death), cause of death, death year, and whether the child received medical treatment of any kind. Women also were asked to provide information on the deaths of their husbands, parents, and siblings, where applicable, to allow us to examine familial effects on mortality.

Our preliminary analysis suggests that the major causes of death in children under five include, but are not limited to, measles, malaria, gastrointestinal and respiratory infections. High child mortality among the Karimojong is most probably linked to a high disease load, recurring drought and famine, and socio-economic instability, as a result of widespread armed violence. Unlike nomadic Turkana, the Karimojong have experienced dramatic cultural, economic, and environmental changes in the last 30 years. These changes have altered both biological and

behavioral determinants of child survival and child mortality.

This research was funded by the Wenner-Gren Foundation Grant 6276, National Geographic Society Grant 6048-97, and by the General Research Fund of the University of Kansas.

#### **Gradient phenomena in primates and the intermembral index.**

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A fundamental principle of Huxley's (1932) work on relative growth is that changes in the size and proportions of animals' body parts take place within gradient field systems. Gradients may steepen or flatten, and may interact in different planes of space. This implies that correlations of body segment dimensions with measures of body size (even with functional adaptive studies) are not sufficient to explain the total effect of body size on body segments. Body segment dimensions should also be analyzed in relation to gradients.

The intermembral index is a candidate for additional analysis. Besides being an indicator of body size and locomotor function (Jungers, 1984, 1985; Fleagle 1988), it is apparently also a measure of antero-posterior gradient steepening. Correlations of the index and a relative trunk breadth measure would test the hypothesis that gradients interact and that the index correlates at least as well with breadth as with body size.

Over 500 adult primate skeletons, from virtually all extant genera, made up samples tested for significant correlations between the intermembral index and biclavicular width/vertebral column length. Over 30 significant correlations were produced, with high to moderate  $r$  values for All Primates, Platyrrhines, Callitrichids, Cebids, Catarrhines, and Hominoids, among others. Indriids, hylobatids and *Pongo*, which are outliers in correlations of the intermembral index and body size, are not outliers in correlations with breadth. *Contra* predictions based on body size alone, the intermembral index is relatively high in broadened dwarf forms, in hylobatids, and, arguably, in *Daubentonia*. However, there are deviations from expectations based on breadth correlations, as well. *Homo* is an outlier in some samples, as are *Erythrocebus*, potos, and some leapers.

#### **Dispersal and philopatry in Hamadryas baboons: A re-evaluation based on behavioral and genetic evidence.**

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Sex-biased patterns of dispersal and philopatry are an important determinant of the genetic structure of populations. In contrast to the pattern of male dispersal and female philopatry found in most baboons, hamadryas baboons have traditionally been described as having the opposite pattern of female dispersal and male philopatry. Neither male philopatry nor female dispersal, however, may be a valid description of the hamadryas social system. Patterns of dispersal in hamadryas are more complex than those of other baboons because transfer can potentially occur between one-male units, between clans, between bands, or between troops. As the band appears to be the ecological unit for hamadryas and the social unit analogous to the group or troop of other papionin monkeys, it is dispersal between bands that is likely to most influence the genetic structure of hamadryas populations. Both behavioral observations and genetic data from this and other studies suggest that both male and female hamadryas disperse between bands to a limited degree and that the composition of hamadryas bands is, in fact, quite stable over time. Female hamadryas do not disperse voluntarily nor to the same degree as in other female-dispersing taxa. Male hamadryas do disperse occasionally, though they do appear to be more philopatric than hamadryas females. Overall, both male and female hamadryas show very high levels of relatedness and inbreeding within bands. It appears that, during hamadryas evolution, the ancestral "savanna baboon" pattern of female philopatry and male dispersal evolved into a system in which neither males nor females willingly or regularly transfer between groups, but rather females are transferred on occasion by males and males migrate on occasion to find females. This research was supported by the National Science Foundation (SBR-9629658), the Wenner-Gren Foundation for Anthropological Research, the L.S.B. Leakey Foundation, the National Geographic Society, the Herman and Margaret Sokol Foundation, and the New York Consortium in Evolutionary Primatology (NYCEP).

#### **Surface area proportions, articular surface curvature, and the locomotor repertoire of AL 288-1.**

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Surface area and articular curvature represent the major factors influencing joint surface architecture. These features reflect the mobility, stability, and loading requirements of an articulation and should then reveal the habitual locomotor repertoire of the organism. Numerous investigations focused on the nature of australopithecine locomotion and the evolution of

bipedality have sought clues in the postcranial material of these species. This investigation attempts to aid in resolution of this question with analyses of joint surface area proportions and articular curvature of four australopithecine joint surfaces.

Pectoral and pelvic girdle joint surface area proportions and articular curvatures of AL 288-1 are compared to those of modern humans, African apes, and orangutans. Surface areas for femur and humeral heads and for the acetabulum are established by modeling these surfaces as partial spheres. The surface area for the glenoid fossa is calculated as the product of maximal superior/inferior and anterior/posterior dimensions. Articular curvature is determined as a ratio of joint surface radius as compared to joint depth.

Analyses reveal AL 288-1 to have forelimb to hindlimb joint surface area proportions intermediate between humans and great apes, with a slight tendency toward the human condition. Analyses of articular curvature, however, reveal AL 288-1 to have retained an ape-like morphology. Together these analyses indicate a hominid that relied heavily on its hindlimbs for weight bearing, but that still availed itself of an arboreal environment.

#### **Variability and structural reduction: Second metapodials in lorises.**

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A tenet of evolutionary theory is that, within a species, phenotypic variability is inversely related to the intensity of stabilizing selection. A corollary is that a vestigial or miniature structure should be highly variable, unless structural reduction is the target of selection. I have previously demonstrated that the first metacarpal is highly variable in primates with vestigial or miniature thumbs. The present study evaluates the variability of the second metapodials in the vestigial or miniature index fingers and second toes in *Perodicticus potto* and *Nycticebus coucang*. This study tests whether the second metapodials in these species are highly variable relative to, and have low correlations with, the other metapodials. The relationship between relative length and relative variability of the second metapodial is also evaluated in a sample of 17 species of primates. The results show that the second metapodials of *P. potto* and *N. coucang* are neither significantly nor relatively more variable than the other metapodials. Furthermore, the mean correlation coefficients in *P. potto* and *N. coucang* between the second metapodials and metapodials three through five are not the lowest in the sample of 17 species. Finally, the correlation coefficient among the 17 species between relative length and

relative variability of the second metapodials is low and nonsignificant. The results support an interpretation that there was direct selection for reduction in length of the second digits in lorises. Moreover, high variability of a structurally reduced second metapodial would be disadvantageous developmentally as it would result in a corresponding high variability of the nonreduced first metapodial.

#### **Studies of bone organization in three dimensions.**

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Demineralized bone retains its size and shape if it remains wet. After washing and block staining, serial sections permit tracing microscopic features in three dimensions. Femurs of adult African monkeys have a much larger area of circumferential lamellae relative to the deeper region of osteons than femurs of humans. In the monkeys primary vascular canals penetrate diagonally from the periosteal surface and gradually pass deeper. Split-lines produced at the surface show no relationship to the penetration of these canals, evidence that split orientation is not determined by the vascular supply of bone, but more likely by collagen fiber orientation.

A silver nitrate procedure colors decalcified osteons differentially in humans, other primates and dogs, suggesting an equivalence to radio-micrographs of undecalcified thin sections, where less mineralized osteons are more transparent to the X-rays and thus are darker than fully developed osteons. The idea was tested in long bones of young baboons by making radiomicrographs of ground sections and comparing them with photomicrographs of the same sections after decalcification and staining. The close similarities indicate a strong interaction of bone mineral with the organic matrix as mineralization proceeds. These comparisons also demonstrate that the silver nitrate distinguishes osteoid in decalcified bone, a significant advance in research on developing osteons, which are very similar in humans, baboons and dogs. Sample serial photomicrographs show some of the features of forming osteons.

Further research using serial sections should help to resolve questions concerning the significance of osteons and why they predominate in long bones of many mammals.

#### **Variation in the lumbar neural canal.**

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The National Center for Health Statistics reported that generalized back complaints (excluding specific disc problems)

were among the top complaints in non-institutionalized patients in 1995. Neither clinical researchers nor anthropologists have completely explained the causation for lower back problems. One 'catch-all' diagnosis is lumbar spinal stenosis. Spinal stenosis is a small or restrictive bony neural canal.

Clinical research on lumbar spinal stenosis largely concentrates on diagnosis and treatment, with a smaller subset of research focusing on possible causes of stenosis. Cut-points for a minimum or stenotic canal size have been determined from a small body of clinical work (eg Verbiest, 1954; Epstein, 1962). Any variation in the neural canal size with respect to sex, ancestry or age has not been widely examined. The goal of this research is to understand the variation in the lumbar neural canal so that more accurate diagnoses of spinal stenosis can be made. This project compares a sample of lumbar neural canal sizes taken from 321 individuals in the Hamann-Todd and Terry skeletal collections with data collected from skeletal samples from England, prehistoric North America, South Africa, and Asia. In addition, some data from clinical settings is included.

Statistical analyses of the anterior-posterior and transverse diameters of the lumbar neural canal show significant variation with respect to sex, ancestry and age. Generally, males demonstrate a larger canal size than females. In this study, contrary to others (eg. Clark, 1985), older individuals possess small lumbar neural canal sizes. Finally, the canal sizes in this study are consistent with those from England, however, significant differences are noted between the current sample and the South African and Asian samples. This study establishes a better understanding of lumbar neural canal variation, though further work is necessary.

#### **Adaptation and population thinking.**

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Populational thinking, as energetically advocated by Ernst Mayr, in particular, has had a profound impact on systematic practice in paleoanthropology over the past half-century. Especially in replacing typological notions of species, populational concepts have had a salutary influence on interpretations of the human fossil record. The prewar plethora of nonbiological hominid species, for example, gave way to a much simplified schema of human evolution-although the remarkable augmentations of the record since the 1960s have subsequently, and inevitably, acted to re-establish a large part of the hominid diversity that was denied by Mayr and other architects of the Evolutionary Synthesis, notably Theodosius Dobzhansky.

In this context it is important to remember that all good ideas are potentially subject to caricature, and it is critical to keep the notion of population thinking in perspective. This significant concept should not be used as a device to deny the existence of taxic diversity in the human fossil record, as has on occasion been done. Yes, species *are* variable, and always have been; but they are not infinitely variable; and not all morphological variations among individual fossils can be ascribed to mere interindividual variety. A significant portion of the substantial variation we see among the fossils that document the past of our family carries the signal of taxic diversity; and we need to make every effort to recognize this signal for what it is, rather than to brush it under the rug of intraspecific variation in the name of population thinking.

#### **An Archaic burial exhibiting a rare odontoid type III fracture of the C2.**

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The Ernest Witte site (41AU36) is a large prehistoric cemetery located in Austin County, Texas. Excavations in 1974-75 yielded four discrete burial groups which ranged in date from the Middle Archaic to the Late Prehistoric (4500-500 BP). While examining the Middle Archaic burials, we discovered an adult male with a partially healed odontoid type III fracture of the C2. The fact that fracture was in the process of healing suggests that he survived his injury for several weeks, perhaps months before his death. During the Middle Archaic period (4500-3000 B.P.) this must have been an extremely rare injury. Surviving it for any length of time would have been very difficult.

Odontoid fractures result in either sudden hyperflexion or hyperextension of the neck. Hyperflexion leads to an anterior displacement of the dens fragment with the atlas. Hyperextension leads to a posterior displacement of the dens (Anderson & D'Alonzo, 1974).

To explore how this traumatic injury might have occurred in an Archaic setting, we examined the medical literature to determine the possible means for how this fracture occurs in a modern setting. Health officials typically encounter this form of fracture as a result of 1) motor vehicle accidents, which accounts for the highest number of C2 fractures, 2) falls from great heights, and 3) severe blows to the back of the head which accounts for a very small percent of these injuries (Anderson & D'Alonzo, 1974). Traumatic events 1 & 2 usually occur with multiple injuries (i.e. additional broken bones). Only event 3, a blow to the back of the head, can occur with minimal body damage. Given the lack of additional broken bones for this burial, we

suggest that a severe blow to the back of the head is the best explanation for this specific fracture. We also offer cultural implications of how this individual might have survived his injury.

#### **Cannibals in the Cooks? Dental microwear from a special-use site (MAN-84) Mangaia, Cook Islands.**

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Prehistoric human colonization of Oceania initiated major changes in island ecosystems. The most dramatic of these were landscape modification related to agriculture, introduction of non-native species, and extinction of native birds via overhunting, habitat loss, and predation by non-native mammals including humans. Archaeological evidence suggests that early human diets consisted largely of marine fish and birds that were quickly extirpated as agriculture increased. In late prehistory all resources decline dramatically with more marginal resources such as rat being relatively common. As a result, increased resource stress probably led to intertribal warfare and sometimes to cannibalism.

To understand diet during resource stress, we report the first dental microwear data from Mangaia, Cook Islands. We evaluate 30 teeth from a late prehistoric rockshelter site (MAN-84) that yielded abundant fragmentary human remains (MNI = 41) in and around traditional earth ovens. The faunal/human remains and material culture of MAN-84 differ from other rockshelter habitation sites on Mangaia and from mortuary practices recognized in burial caves on the island. These data suggest that MAN-84 is a special-use site that may have included ritual or nutritive cannibalism similar to that predicted for periods of resource stress. We compare molar microwear between stratigraphic layers at MAN-84 and with microwear patterns of Native American populations from the southeastern U.S. Dental casts were prepared using standard techniques (e.g., "President Jet" impression material, "Araldite" epoxy), and SEM micrographs were analyzed using "Microware 3.0". Analyses of variance indicate significant differences in molar microwear between archaeological units within the site, and significant differences between MAN-84 and the sites from the U.S. Supported by NSF grants EAR-9714819 & SBR-9601766 and U. Fla. Div. Sponsored Research (U001).

#### **Degenerative joint diseases in the early Neolithic population from Aiterhofen, Bavaria (Germany).**

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In the late 1970s and early 1980s, a prehistoric cemetery was excavated at Aiterhofen, Bavaria. The skeletons represent a population of the earliest Neolithic period in Central Europe which date to the 6<sup>th</sup> or 5<sup>th</sup> millennium B.C. From 153 burials, the skeletons of 100 inhumations were suitable for this investigation. The shoulder, elbow, hip and knee joints were studied by macroscopic and radiological techniques. The pathological changes were scored according to Schultz (1988).

The intensity and the frequency of the osteoarthritic lesions in the males and females according to the age groups adultus (21-39y), matusus (40-59y) and senilis (>60y) were examined and calculated. It is striking that the intensity of degenerative joint disease is relatively mild. However, many individuals in all three adult age groups suffered from osteoarthritis. In comparison with medieval populations from Central Europe and Pre-Columbian Amerindians, the frequency is, however, low. Therefore, this Neolithic population representing early agriculturists was exposed to relatively slight physical stress.

#### **Application of the C2000 software using computed tomography to some fossil hominids, African apes and extant humans.**

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The understanding of biological variation within and between the currently recognized African apes extant species (*Pan paniscus*, *Pan troglodytes* and *Gorilla gorilla*) is a prerequisite for the testing of hypotheses regarding early hominid evolution. The C2000 software provides a computational model describing and analysing facial evolutionary and developmental changes. It was used to generate both three-dimensional imagery and model of osteodental maxillo-facial structures in extant chimpanzees, gorillas and some fossil hominids.

An invariant maxillo-facial model of reference was observed in immature and adult extant humans from genetically distinct populations. Clear cut differences were found between the African ape species whereas the geometric model ap-

peared stable during development within each taxon. Importantly, the differences between the two chimpanzee species identified so far, appeared to be as profound than the differences between, on the one hand, these chimpanzee species considered separately, and, on the other hand, gorillas. It was possible to apply this method to some fossil hominids even if some of them were incompletely preserved.

#### **A test of the applicability of modern, US obstetric standards to skeletal populations.**

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In their analysis of the obstetric dimensions of the Nubian pelvis, Sibley, Armelagos, and Van Gerven (1992) conclude that modern obstetric standards may be problematic when used to evaluate populations living under different biocultural conditions. Although modern American obstetric studies suggest that women of greater socioeconomic means generally have roomier pelvis and better reproductive histories than those less fortunate, it cannot be assumed that the same holds true for other populations. Despite this problem, skeletal biologists wishing to examine the obstetric dimensions of past populations are often forced to compare their samples with a modern, American obstetric standard to determine obstetric adequacy. The skeletal remains from Christ Church, Spitalfields provide a unique test of the applicability of such standards because of the wealth of historic and reproductive data available about individuals in this sample.

The excavation of 138 adult female skeletons associated with coffin plates stating name, age, and date of death and subsequent historical documentation by Cox (1992) allowed the reproductive histories of 94 women to be described. Variables such as number of children, birth spacing, and age at first and last birth are known for the majority of these women. Standard obstetric measures were taken on a subset of 45 of these women and compared to American obstetric standards (Williams Obstetrics 1997) for the same dimensions. This comparison demonstrates an interesting pattern of difference between the Spitalfields pelvis and the American standard, with the Spitalfields pelvis having substantially smaller pelvic inlets. The known reproductive histories for this sample allowed individual measures of obstetric adequacy to then be compared to known reproductive outcomes, allowing for a test of the applicability of American standards. Finally, the Spitalfields pelvic measurements were compared to other published populations (Tague 1992; Sibley 1992). These comparisons highlight the importance of biocultural factors in both the functional

analysis of the true pelvis and also in the comparison of such analysis with a modern, Western sample.

#### **Relative postcranial and cranial growth in Neandertals and modern humans.**

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Our recent work has concentrated on the comparison of dental and postcranial maturation rates in fossil hominids in an effort to reconstruct the population specific patterns of growth and development that led to population specific adult morphs. The earliest hominids appear to have had a pattern of rapid linear growth taking place early in the dental eruption sequence. This contrasts with the modern human pattern of generally slow linear growth that is punctuated by a growth spurt shortly after the eruption of the 2<sup>nd</sup> molar. The European Neandertals do not demonstrate a pattern that is intermediate between early and modern hominids; rather they appear to concentrate linear growth in the very end of the dental eruption sequence.

In this paper we extend this analysis to consider cranial growth as assessed by linear and volumetric measurements of the cranial vault, relative to dental development. The majority of cranial growth takes place within the first 8 years of a modern human child's life, finishing between the time of eruption of the 1<sup>st</sup> and 2<sup>nd</sup> molars. This is also the period when the apparent delay in European Neandertal linear growth becomes apparent.

Our results indicate that relative to the timing of dental development, European Neandertal cranial growth does not demonstrate the same pattern of developmental delay as does the postcranium. Indeed, in absolute terms the Neandertal juveniles appear to be advanced relative to modern humans in cranial growth. However, when the difference in achieved adult size is taken into account, the growth trajectories are quite similar. Thus, it would appear that European Neandertals and modern humans share similar ontogenetic programs for cranial vault growth and dental development. This conclusion makes the delayed linear growth of the postcranial skeleton demonstrated by the European Neandertals even more distinctive.

#### **Head shaping and dental decoration: Two biocultural attributes of cultural integration and social distinction among the ancient Maya.**

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The presence, forms and techniques used in artificial cranial deformation and dental decoration were studied in 1,745 skeletons found in 102 mostly pre-Hispanic archaeological Mayan sites (from Mexico, Guatemala and Honduras) dating from Preclassic, Classic, Postclassic and colonial times. Biographical and associated archeological information was evaluated, based on a theoretical model of biocultural interaction patterns and regional mortuary practices.

The osteological and contextual information was analyzed in terms of biographic data (age and gender). Regional and local distribution patterns were evaluated as potential signs of social distinction during the Classic Period. For statistical data processing we employed Chi-square, Lambda, Tau, Goodman, Phi coefficient and multivariate analysis.

According to the results, in the Classic Period, both practices evidence great regional and local cultural diversity which diminishes afterwards. Regional, local and family particularities of the dental handwork and cranial modification manifest everyday uses that reflected prehispanic beliefs and customs. The internal site distribution of head shaping and dental decoration evidence aspects of the customs' social role in residential and family ambits. There is a tendency provided by some visual dental patterns associated to high position within social organization, although never manifest in terms of exclusiveness.

#### **Y chromosome variation on the Isle of Man: Evidence of Celtic and Scandinavian admixture.**

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Situated in the Irish Sea, the Isle of Man was colonized first during the Mesolithic, and shares both cultural and linguistic history with Ireland and parts of Britain. From 800-1200 A.D., the Isle of Man was forcibly settled and occupied primarily by Vikings whose political allegiance was initially to Norway, and whose influence was felt all over Britain. Research was undertaken to determine the genetic impact of Viking settlers on the originally Celtic Manx population.

Variation on the Y chromosome was used to detect differential Celtic and Viking paternal contributions to a sample

from the population of Manx Y chromosomes. Analyses are based on 227 samples from Norway, Sweden, Denmark, Iceland, Shetland, Scotland, Ireland and the Isle of Man. Haplotypes were constructed from both biallelic polymorphisms and microsatellites. Preliminary analyses based on three microsatellite loci offer support for substantial Scandinavian admixture, primarily from Norway (which shares haplotypes with 17/18 of Manx haplotypes). There is also a numerically smaller but unambiguous, Celtic signal, with one haplotype uniquely shared between Ireland and the Isle of Man.

The preliminary analyses reveal that the original, presumably dominant, Celtic Y chromosome pool was inundated and mostly replaced by Y chromosomes of Scandinavian origin.

#### Functional analysis of the hip and thigh of *Paracolobus* and other large-bodied fossil cercopithecids.

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The Plio-Pleistocene colobines *Paracolobus chemeroni* and *Paracolobus mutiwa* were larger than any extant monkey, overlapping with chimpanzees in body size. These species are now known from partial skeletons (KNM-BC3 and KNM-WT16827) providing the first opportunity to assess and compare their locomotor behavior. To date, none of *P. mutiwa* and only the forelimb of *P. chemeroni* have been examined. We conducted a functional analysis of the hip and thigh of these specimens to assess patterns of hindlimb use.

The hipbones and femora of the *Paracolobus* skeletons are compared to those of over 150 extant colobines and cercopithecines, as well as those of the large-bodied fossil colobine *Cercopithecoides williamsi* and cercopithecine *Theropithecus oswaldi*. Model II (reduced major axis) regression is used to examine pelvic and femoral dimensions in an allometric context, using femoral head size as an estimator of body mass.

The two *Paracolobus* species exhibit morphologies suggesting differing levels of emphasis on terrestrial and arboreal behaviors. Although it is a colobine, *P. mutiwa*, like *C. williamsi* and *T. oswaldi*, possesses cercopithecine-like features, including a tall greater trochanter, low femoral neck-shaft angle, and long lower iliac height, indicating an emphasis on a terrestrial locomotor habit. *P. chemeroni*, on the other hand, more closely resembles the extant colobines in these morphologies. However, analysis of ischial length reveals that *P. chemeroni* deviates from the colobines and clusters with the cercopithecines.

Our results suggest that, although they are congeneric, *P. chemeroni* and *P. mutiwa* not only differed in their locomotor special-

izations, but both of their locomotor repertoires were unlike that of any extant monkey.

#### In or out of the womb? The analysis and interpretation of fifteen fetal skeletons from Roman period Egypt.

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The discovery of complete or partial human fetal skeletons during an archaeological excavation raises many interesting questions. The first, of course, refer to the age of the fetus with the concomitant queries about its viability or pre-maturity. These are accompanied by questions surrounding the burial itself, such as how and where the fetus was buried in relation to others of the population, including estimating their biological affinities. Answers to these questions can offer significant insights into the religious ideology and mortuary patterns of past populations, in addition to their corporate value for paleodemographic, paleogenetic, and paleoepidemiological research.

This study presents the results of skeletal analyses of 15 fetuses recovered from Kellis 2, a Roman period cemetery in the Dakhleh Oasis, Egypt (circa A.D.200-400). In this population, the majority of fetal remains were individually wrapped in linen and buried in an east-west orientation with the head facing to the west. The fetal remains were not segregated, but buried alongside other juveniles and adults. In this study, particular emphasis is placed on establishing the age at death of each fetus based on standard osteological criteria. Age estimates of the fetal remains were found to range from 22 to 40 weeks gestation. Since current fetal growth standards are based solely on modern reference samples the possibility of differences in the pattern and rate of fetal development is discussed. Finally, considering the way in which fetal remains were treated during this time period, the burial customs of this Roman period Egyptian population are briefly explored in relation to contemporary religious and political ideology.

#### Love potions in primate brains?

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When centrally secreted, the hormone vasopressin (AVP) is involved in the modulation of some behavioral functions including memory and species-specific social behaviors. These findings are based primarily on numerous studies of the effects and

characteristics of the central AVP system in nonprimate species. The distribution patterns of binding sites for these hormones often differ between species, sometimes between closely related species, and even between sexes within some species. This report confirms the existence of AVP receptors in the primate brain and compares the central binding sites for an AVP analogue in several cortical and subcortical regions of two primate species.

Using receptor autoradiography, binding sites for analogues to AVP were mapped in rhesus monkey (*Macaca mulatta*) and common marmoset (*Callithrix jacchus*) brains. In the rhesus, in situ hybridization, PCR techniques, and autoradiography characterization studies confirmed these sites as AVP V1a-type receptors. Although AVP receptor binding was found in the amygdala, stria terminalis, and suprachiasmatic nucleus of both species, the intensity of binding differed. Overall, the binding pattern differed between the species. In particular, the rhesus showed a much greater intensity of binding in several cortical areas. The V1a-type receptors found in several subcortical regions of the rhesus may be relevant to previous reports of AVP effects on memory in humans.

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#### The utility of dental data in reconstructing omomyoid phylogeny: An analysis using outgroup swapping.

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Omomyoidea represents a diverse primate radiation from the Eocene through Oligocene of North America, Europe, Asia, and Africa. As a group, or in part, the omomyoids have undergone a history of comparison and proposed relationships with plesiadapiforms, tarsiers, strepsirrhines, and anthropoids. Much of the uncertainty about the phylogenetic placement of the Omomyoidea stems from the paucity of cranial and postcranial materials, which forces students of omomyoid systematics to base hypotheses of omomyoid evolution solely on dental remains.

This analysis compares phylogenetic hypotheses of forty-eight omomyoid, adapoid, and haplorrhine taxa through the use of outgroup swapping to investigate the utility of dental characters in delineating relationships within the Omomyoidea. Outgroup swapping involves moving taxa back and forth between the ingroup and outgroup over a series of phylogenetic analyses to investigate not only the effect of outgroup choice on phylogenetic hypotheses but the strengths of certain linkages over a series of analyses. One-hundred-thirty-six dental characters from Williams (1994) are evaluated using PAUP 4.0 to assess the phylogenetic relationships of all

forty-eight taxa through eight independent parsimony analyses. Outgroup swapping (using anthropoids, adapoids, and omomyoids) is performed prior to each analysis, and heuristic search methods incorporating randomized, stepwise addition (1000 repetitions) and branch swapping by tree bisection-reconnection are employed to identify the most parsimonious tree(s).

Each analysis (regardless of outgroup) results in the retention of three equally parsimonious trees (length= 1158, CI=0.43). Comparison of character state change and branch lengths between the eight consensus trees indicates that despite the high numbers of homoplasy associated with dental characters, dental data prove effective in consistently delineating certain lower level omomyoid clades. However, these data offer little evidence in support of higher level taxonomic relationships between omomyoid clades, as evidenced by the equally parsimonious placements of taxa between the ingroup and outgroup.

#### **Treil's three-dimensional cephalometry using computed tomography: Prospects in physical anthropology.**

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Many geometric techniques have been developed for the analysis of cranial variation. However, the landmark data should have a clearly identified physiological meaning and should not be confined to two-dimensional models for the study of biological variation within and between extant species as well as in incompletely preserved fossil hominids.

We present a computational model by applying the "C2000cépha" and "Cépha3Dt" softwares to a large sample of immature and adult extant humans. These softwares mathematically transform data related to anatomical landmarks and teeth (all located on the trigeminal axes described by Moss) and selected on a complete series of high-resolution, 1-mm-thick, transaxial computed tomography scans of the head. A three-dimensional imagery of osteodental maxillo-facial structures is generated and a accurate maxillo-facial model is constructed. This invariant model of reference includes three orthogonal principal axes of inertia (calculated using the principal moments of inertia) for each selected tooth, groups of teeth and the maxillo-facial frame. These axes of inertia lead to the mathematical definition of each anatomical element of the model (each tooth, arches and the maxillo-facial frame)

but also to the calculation of the relative spatial orientation of each selected anatomical elements. Biologically meaningful components of the growth tensors are calculated with respect to invariant models of reference, describing facial developmental changes. They would be particularly well suited to the study of evolutionary changes in fossil hominids.

#### **Evolutionary medicine and population-based thinking in cultural context: The best of three worlds?**

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Biomedicine, public health and evolutionary medicine differ in their primary units of analysis: biomedicine places emphasis on the individual, public health research stresses the population, and evolutionary medicine takes as its first focus the whole species. A critical aspect of the research methodology associated with evolutionary medicine is the analytic weight given to the ways local cultural conditions, either through ideologically based scientific theories or related practices, enhance or diminish human health. One important goal of evolutionary medicine is to analyze health issues through a broader, more inclusive lens while simultaneously identifying socio-cultural contexts and physical settings that cause health variations or deviations. Although evolutionary-based conceptualizations and research must be considered only the beginning and not end points for analysis, they are, nonetheless critical. Such beginning points have produced unanticipated new paradigms, many of which have emerged only in the past decade. Here we illustrate that population-based thinking, alongside sensitivity to social context, is alive and well and central to new understandings of, for example, how to manipulate pathogen microbes to human advantage, interpret degenerative age-related diseases, and understand why babies exhibit so many sleep disorders and why human females seek out and need emotional support during birth. Combining the population perspective of public health and the time depth, species-wide perspective of evolutionary medicine may lead to new, if not revolutionary, strategies and approaches to the control and prevention of disease both at the local and international levels.

#### **The prevalence of enamel hypoplasias in the bonobo, *Pan paniscus*.**

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Enamel hypoplasia (EH) is a dental enamel defect that is often used as an indicator of non-specific systemic stress dur-

ing the early stages of development. There are few reports of this enamel defect in non-human primates and little is known about the prevalence of this defect in the bonobo, *Pan paniscus*.

The frequency and distribution of EH within the bonobo are investigated using skeletal specimens from the Royal Museum for Central Africa in Tervuren, Belgium. All permanent teeth were examined with a 5-20X pocket hand lens in oblique incandescent and natural light. Linear defects were scored as mild, moderate, or severe and defect distances from the cemento-enamel junction were measured with digital calipers. Pit-type hypoplasias were counted and recorded as present or absent.

At the level of the individual (N=82), the vast majority of bonobos in this skeletal sample (98.8%) are affected to some degree with linear enamel hypoplasia (LEH) and there is no significant difference in the expression of LEH between the sexes. Pitting is observed in 13.4% of these individuals with no significant difference between the sexes. The anterior teeth are more affected with hypoplasias than the posterior teeth although maxillary and mandibular differences are noted. The incisors express the greatest frequency of enamel hypoplasias, closely followed by the canines. In contrast to previous studies, the mandibular canine does not demonstrate a marked difference in the expression of LEH when compared with the maxillary canine.

Comparisons with the common chimpanzee are made and it appears that the bonobo is more developmentally stressed. Etiological factors such as locality and seasonal stress are examined. This macroscopic inventory of EH provides the necessary insight into the prevalence of this defect within the bonobo and serves as a foundation for the current micro-incremental analysis of EH within this endangered species.

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#### **Ancient population of Mongolia: Craniofacial morphological perspective.**

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The Penrose's shape distance analysis (Knussmann, 1992) was applied to 16 measurements recorded in human skulls representing Neolithic and Bronze Age populations from Mongolia in comparison with prehistoric populations from Siberia and Southeast Asia for assessing the historical-biological relationships of these populations. Based on the results of the Penrose's shape distance matrix were constructed neighbor-joining tree.

The studies of prehistoric samples of

Mongolia reveal great heterogeneity of morphological traits among the Neolithic (12-6 kya), Bronze and Iron ages populations (Tumen, 1985, 1992, Alexeev et. al., 1987). Medieval and contemporary Mongolians have been shown to be more closely related to the prehistoric population of the Neolithic, Bronze and Iron Age from East Mongolia (Tumen, 1986, 1992)

The Asian Neolithic populations divided into three major clusters: one cluster includes East China and Primor'e groups, second cluster contains Neolithic populations from Amur basin and Yakutia, and others belong to the third cluster which in turn divides into three subclusters: the Jomon and the Neolithic population from Altai, Minusinsk and West Mongolia belong to one subcluster, Neolithic populations from Central and East China, and North and South Korea belong to another subcluster, and the third subcluster includes the populations from Cis-Baikalia, Transbaikalia, Northwest China, and East Mongolia.

The three major divisions of the dendrogram are observed among compared the Asian Bronze age populations. The first cluster includes South Siberians and West Mongolians, the second subcluster includes East Mongolian and Transbaikalian groups, and the third one includes bronze age populations from Manchuria, Inner Mongolia, Northeast and Central China, Yayoi, Central Mongolia, and South and North Korea. However, Central Mongolian and North Korean bronze age's groups show another separation within the third cluster.

#### **Ethical concerns in biological anthropology: Introduction to the symposium.**

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Statements regarding principles of bioethics began to emerge in the aftermath of World War II with the drafting of the Nuremberg Code in 1947. Various professional organizations, including the American Anthropological Association, followed suit. The AAA recognized that their primary responsibility was to those they study. The ethical statement of the Association makes the protection of the welfare, dignity and privacy of the individuals they study paramount. In 1974 the United States Congress created the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. They were charged with developing guidelines for research involving human subjects. These guidelines define three ethical principles that form the basis of current human protection and bioethics. These principles are: respect for persons, beneficence, and justice. Biological anthropologists working with living hu-

man populations face questions raised by these principles in terms of informed consent, community consultation and group consent and disclosure of identity. However, the breadth of the discipline means that biological anthropologists confront other complex ethical concerns. Even with the diversity of concerns, subjects, and species in the discipline biological anthropologists all address the three major ethics principles.

#### **Knuckle-walking with Sherry.**

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In 1967, a confluence of new information from studies of serum proteins, albumins, chromosomes, and Gombe chimpanzees and from my dissertation research on the functional morphology of great ape and human hands inspired, stimulated and provoked Sherry Washburn to interpolate a knuckle-walking troglodytian stage in early hominid phylogeny. By 1974, based on no quantified data set or statistical procedure, he placed odds of 4-to-1 or 5-to-1 that we had evolved from knuckle-walkers. In 1968, Corruccini proffered support for the knuckle-walking model, and Zihlman has championed it regularly throughout her career. I expect that the recent paleobiological observations of Richmond and Strait and perhaps the support of Begun and others would have encouraged Sherry Washburn to venture even higher odds that knuckle-walking preceded obligate terrestrial bipedalism.

To me, knuckle-walking is a culmination, not a beginning. Like Louis Leakey and later, Sherry Washburn, I believed that savanna had been overemphasized as the habitat in which our lineage had been launched, and I expected that there had been more direct selection via arboreal bipedalism and vertical climbing, which led to terrestrial bipedalism instead of there having been a halfway-house of terrestrial quadrupedism on the way to obligate terrestrial bipedalism. Accordingly, I proposed a hylobatian model as an alternative to the knuckle-walking troglodytian model. Today, unlike Keith, who in 1940 abandoned his brachiationist model in the twilight of his career, I am not quite ready to leave my hylobatian model out on a limb without issue.

Since one of the main goals of Sherry Washburn's new physical anthropology was to remove futile debate from the field, I will forgo the temptation to rehash my arguments for the hylobatian model. Instead, I will suggest studies that might further illuminate knuckle-walking and will point out a few puzzles that we might ponder in greater detail, particularly in light of the publications of Richmond and Strait.

#### **Skeletal biology of the Voegtly Cemetery sample, Pittsburgh, Pennsylvania.**

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Stimulated by planned highway construction, archeological survey located the cemetery associated with Voegtly Church and Parsonage, dated between 1833 and 1861. Excavation located 724 features thought to represent burials of this Swiss-German community. Analysis revealed skeletal remains of 544 individuals with highly variable preservation. Most burials showed extreme weathering, especially those of subadults.

Procedures for data collection followed those outlined in the *Standards for Data Collection from Human Skeletal Remains* (Buikstra and Ubelaker, 1994).

Dental health was generally quite poor. Thirty-one percent (31%) of deciduous teeth showed at least one carious lesion and 29% of permanent teeth were carious; most lesions were located in interproximal spaces. Seventeen percent (17%) of permanent teeth had been lost antemortem and the frequency of active alveolar abscesses was 5%. Eighteen percent (18%) of teeth showed evidence of enamel hypoplasia. Frequencies of carious teeth, abscessing, and antemortem loss were higher in females than males; males showed higher frequencies of hypoplasia.

Despite high frequencies of dental disease, only two individuals showed evidence of dental restorations. A young female (17-22 years) had three gold foil fillings; a middle-aged female had a filling made of tin. However, their teeth showed numerous other untreated lesions, suggesting that dental care was not frequently sought. The graves of both of these women contained burial goods (jewelry and a tortoiseshell comb) indicating that they were probably relatively wealthy or high-status individuals.

Nine males displayed dental alterations consistent with pipewear facets, suggesting that they habitually smoked tobacco from an abrasive pipe.

Pathological conditions included trauma (12 individuals with healed fractures), infection, extreme arthritis, and tuberculosis.

Measurements of the femora suggest that living stature averaged about 5 feet 3 inches for females and 5 feet 6 inches for males.

#### **"Let us go to the house of the Lord": Biocultural re-construction of pilgrimage.**

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The textual record indicates that in the early Byzantine period, the population of Jerusalem expanded considerably due to the influx of large numbers of pilgrims. Travelers arrived from Europe, Africa, and Western Asia. Many purportedly took up residence in the "Holy Land" and numerous churches and monasteries were constructed during this time to house the growing number of those choosing a religious vocation. A recent debate has surfaced however, questioning whether pilgrims indeed comprised a majority of those taking up the monastic life, or if the written record reflects the accounts of an elite minority. Were the monks of the Byzantine period travelers from afar or residents of the surrounding region? The purpose of this study was therefore to determine the relative heterogeneity or homogeneity of the members of a large urban monastic community using dental non-metric traits.

The basilica of St. Stephen's was constructed in 438 AD and remained in use until the early 7<sup>th</sup> century. Its location on a major thoroughfare of pilgrimage, known association with the first Christian martyr, and significant imperial patronage made it the largest monastic complex in the region for almost 100 years. The mingled remains of the site's Byzantine inhabitants, represented by 15,000 bones and over 2,000 teeth thus make this an excellent collection for addressing the question of community composition.

For this investigation, all teeth were scored for the presence of 30 non-metric traits using the ASU Dental Anthropology System. Preliminary results indicate that the monks of St. Stephen's are similar to populations from the surrounding area. In particular, the group does not share as many traits with Western Europeans as it does with groups from the Middle East. The collection is also not as heterogeneous as was expected. For example, the incidence of Carabelli's trait was low (10%), as was the frequency of hypocone reduction on the upper second molars (10%). These results show the importance of examining skeletal indicators in order to evaluate possible biases in textual evidence.

This work was made possible through the generous support of the NEH and the Institute for Scholarship in the Liberal Arts at the University of Notre Dame.

#### **A preliminary study of molar microwear of early *Homo* from East and South Africa.**

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Dietary reconstruction is crucial to understand the paleobiology of our ancestors.

Traditional analyses of tooth shape have been limited in their ability to identify dietary differences within genera. This study presents a preliminary analysis of microscopic use-wear on molars of early *Homo* specimens from South Africa, Kenya and Tanzania.

High-resolution replicas of molar teeth of all available individuals of *Homo habilis* and *H. ergaster* were prepared using conventional techniques. Replicas were examined by scanning electron microscopy at 500x magnification. Many specimens showed taphonomic erosion or other artifacts and did not preserve antemortem microwear. Molars that preserved microwear on "Phase II" crushing and grinding facets were imaged and analyzed using Microware 3.0. Two micrographs for each surface were taken and resulting data were averaged when possible. Specimens used include OH 4, OH 15, OH 41, SE 1508, SE 1579 (identified tentatively as *H. habilis*) and KNM-ER 807, KNM-WT 15000, SK 15, and SK 27 (identified tentatively as *H. ergaster*).

Results show moderate to high ratios of pits to striations on microwear surfaces. The average pit percentage value for early *Homo* specimens is 37.6%. Specimens identified as *H. ergaster* have higher pit percentages (mean = 49.1 %) than seen on *H. habilis* surfaces (mean = 28.4 %). There is no overlap between the ranges of the two taxa.

*Homo ergaster* pit percentage values are similar to those of *Cebus apella*, whereas *H. habilis* values are similar to those of *Pan troglodytes*. This pattern is consistent for both South African and East African specimens. This suggests that *H. ergaster* may have eaten more hard or brittle foods than did *H. habilis*. This further suggests that neither taxon specialized on soft, tough foods (including raw meat) that would tend to leave microwear patterns dominated by striations. Still, small sample sizes make analysis using other techniques necessary to confirm these interpretations.

This project was funded by SBR 9804882.

#### **Paleodemography: A comparison of a Danish medieval cemetery with a modern Amish cemetery.**

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Most cemetery samples used for paleodemographic research produce age-at-death distributions that are unlike those of any living populations. Differences include too few infants, large numbers of deaths in young children and young adults, and large differences in the age-at-death

patterns for male and female adults. Some researchers have claimed that the discrepancy reflects a fundamental difference in past demographic processes. However, under the uniformitarian principle, human populations in the past had the same demographic constraints as modern populations. This project tests if the unusual age-at-death distributions in paleodemographic samples are a result of cemetery structure and formation processes or if they reflect other demographic events (errors in age and sex estimation can also produce unlikely age-at-death distributions).

This study compares a cemetery in Mifflin County, Pennsylvania, to a paleodemographic sample from the medieval village cemetery of Tirup. The Pennsylvania cemetery has been used by local Amish and Mennonite families for almost two hundred years, and contains headstones for 1200 individuals. The authors recorded demographic data from headstones, and used these data to construct an age-at-death distribution for the cemetery. Excavations at Tirup cemetery revealed just over 600 graves, with 460 skeletons that were well enough preserved for age and sex estimation. These data were also used to create an age-at-death distribution. The mortality patterns from these different sources are compared. Some of the paleodemographic patterns are also seen in the modern cemetery, including a dearth of infant graves. However, the excess young adult deaths and significant differences in male and female mortality are not seen in the Amish cemetery.

This research was supported by a Fulbright Fellowship and a Pennsylvania State University Hill Grant (to BMU).

#### **Evolutionary depth of primate brain language areas: Interhemispheric symmetry of sylvian fissure, with marked hypertrophy of right middle temporal gyrus, in *Erythrocebus patas*.**

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In most humans with left hemisphere predominance of receptive brain language areas, the left sylvian fissure (SF) extends more posteriorly than the right. This pattern has been identified in hominin fossil endocasts and living great apes but reports in living Old World & New World monkeys have varied.

This study determined whether SF was asymmetric in patas monkeys by study of 48 (27?, 21?) perfusion-fixed brains. 3-D L&R SF length measures were taken using 2-0 silk suture superimposed on SF from its anterior to posterior (sylvian

point) endpoints, straightened then measured with a micrometer. However, in many cases, the sylvian point was obscured by the middle temporal gyrus. Here, measurements were also taken using the operculated point as the posterior border since endocasts would denote this "false sylvian point" (f-SP) as being the true SP (t-SP).

An operculated SF was present in 9 (18.75%) left and 18 (37.5%) right sides ( $R=2xL$ ). Only 7 (14.58%) showed bilateral operculation. Using paired sample t-tests, no significant difference was found between L versus R t-SP / f-SP operculation magnitude ( $p = 0.135$ ) although there was a trend toward a larger % difference on the R side. T-tests revealed that there was no significant difference between the length of the L & R SF using t-SP ( $p=0.47$ ). However, when data were analyzed based on measurements of the f-SP, to emulate the endocast condition, the left SF was significantly longer than the right ( $p=0.0038$ ).

The SF-L>R asymmetry present in hominids is not exhibited in patas monkeys. However, if analyses were based directly on surface measurements from a *false sylvian point*, which predominates on the right hemisphere, significant L>R SF would be indicated. As such, endocast studies should take this variable into account to determine SF asymmetries, at least in OW monkeys, particularly since a similar phenomenon, present in *Macaca mulatta*, was reported recently (Gannon, et al. AAPA 2000).

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#### **Energetics and postpartum fecundity: Changes in C-peptide levels in breastfeeding Toba women.**

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Among the physiological mechanisms that link female fecundity and energetic state is the sensitivity of ovarian function to hormones that regulate energy metabolism, such as insulin and cortisol. The association between insulin metabolism and the maturation of the HPO axis during puberty has been well described. However, the postpartum changes in insulin levels that can be associated with the return to fecundity remained grossly unexplored. This study looks at the relationship between postpartum levels of c-peptide, a metabolite of insulin, and the resumption of fecundity in breastfeeding women.

This longitudinal study was conducted in a Toba village, an indigenous population in northern Argentina. Monthly anthropometric measures from 126 breastfeeding women were taken from childbirth until their third postpartum menses. Seventy of those women provided weekly urine samples for hormonal assess-

ment of reproductive status (E1C and PdG levels) and energetic status (C-peptide levels). Information on breastfeeding patterns, calorie intake, and energy expenditure was recorded during biweekly home visits.

Toba mothers breastfed their infants intensively. Subjects were well nourished (mean BMI = 25.5) and they did not lose weight during lactation. Urinary C-peptide levels increased with time during the first year postpartum ( $r = 0.93$ ). Women with long periods of lactational amenorrhea seemed to show a peak of C-peptide levels before their first postpartum menses. Average duration of lactational amenorrhea was 9.8 months ( $\pm 4.1$ , range = 3 - 30 mo.)

These results provide a finer-grained view of the role of energetics in the regulation of reproduction and allow us to better understand the factors determining the return to postpartum fecundity.

#### **Evidence of ancient viruses and their role in hominid evolution.**

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Infectious diseases may have been important agents of selection in human evolution even before the Neolithic, but their effects have been difficult to detect. Many ancient disease agents vanished with the populations they infected. Few infections leave any traces in the skeleton. Sequence analysis of both humans and their pathogens can now provide clues to some of these ancient diseases. Viruses, with their smaller genomes, have been particularly well studied. This paper reviews some of the genetic evidence for ancient viral infections and their effects on human evolution.

Endogenous retroviruses, remnants of ancient germ cell infections, make up about 1% of the human genome. These viral sequences, which integrated into host DNA 5-50 mya and then multiplied via retrotransposition, have served as a source of genetic variation during human evolution. Expression of some of these sequences results in pathological conditions, but others may be involved in normal placental formation and fetal development.

Molecular phylogenies of a number of human viruses such as papilloma, herpes, and adenoviruses indicate host-linked evolution with primates, which implies a long history of infection with these agents. This has allowed diversification into subtypes with different tissue tropisms and varying degrees of virulence. Herpes simplex types 1 and 2, for example, appear to have diverged with the adoption of habitual bipedalism and consequent separation of oral and genital niches. Other herpesviruses hint at missing strains once carried by extinct hominid lineages and recombination between hominid viruses.

As transmission to new hosts often leads to increased virulence, these viruses may have been involved in parasite-mediated competition. Conditions required for such competition to have a major effect (e.g., extinction) suggest that zoonotic agents such as rabies or arboviruses may also have been involved.

#### **Life history and cognitive evolution show correlated evolution in mammals.**

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Comparative analyses that control for the effects of body size and phylogenetic non-independence show that life history is a good predictor of relative brain size among primates and other Eutherian mammals, although exceptions are found. The effects of life history on relative brain size can be due to several constraining and adaptive relationships: (i) life history constrains brain evolution in that faster life history is incompatible with increased brain size; (ii) the cognitive adaptations made possible by large brain size reduce mortality and thus select for slower life history; and (iii) slower life history leads to increased potential for intersexual conflict, which may impact cognitive evolution. While life history (linked to arboreal life style) explains why primates are large-brained, and while it predicts cognitive evolution in mammals rather well, specific hypotheses as to the nature of the cognitive adaptations are still needed. A life history perspective suggests that numerous cognitive benefits exist and that it is premature to accept social strategizing ("Machiavellian intelligence") as the sole driving force in primate cognitive evolution.

#### **The dentition of Saint-Césaire I, a partial skeleton from the Châtelperronian levels of La Roche à Pierrot (Charente-Maritime).**

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In 1976, the site of La Roche à Pierrot in the village of Saint-Césaire was accidentally discovered during construction activities. In 1979, much of a human skeleton, Saint-Césaire 1, and isolated teeth from several other individuals (Saint-Césaire 2 and 3) were discovered associated with a Châtelperronian archaeological context, the most complete fossil human yet discovered with this industry. Saint-Césaire 1 is an adult but it is not possible to identify its sex with any certainty. Similarly, it is unclear if the skeleton represents a deliberate burial.

29 teeth have been preserved from the

Saint-Césaire 1 skeleton. The right side maxillary and mandibular dental arcade are complete and *in situ*; most of the left side teeth are isolated and three right mandibular teeth are missing.

Except for the loss of occlusal detail from attrition, the preserved teeth are in excellent condition. All the anterior teeth exhibit reasonably heavy wear, in marked contrast to the posterior teeth which possess much less wear. This is similar to the pattern observed in many Middle and Upper Paleolithic fossils, as well as some modern human gatherer/hunter populations. There is no evidence of serious pathology or caries; there are, however, indications of periodontal resorption and a number of linear hypoplasias are present on the anterior teeth.

There are few distinctive morphological features in the dentition that can provide definitive indications of the taxonomic status of Saint-Césaire 1. Enlarged pulp chambers, taurodontism, often used to identify the teeth of Neandertals, are not present in any of the molars. There are several metric patterns, however, which link this dentition to those of the Neandertals. One such pattern, the relationship of the bucco-lingual sizes of the anterior to the posterior teeth are similar in Saint-Césaire 1 to those of European Neandertals. A more specific, but related metric pattern, the breadth dimension of the incisor teeth, places the Saint-Césaire 1 fossil within the range of variation of European Neandertals and outside that of a modern human sample.

#### **Physical growth and body proportions of Portuguese Cape Verdean children from the slums and Portuguese children living in regular dwellings: the role of SES.**

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The existing research finds that children living in urban slums often show both short stature and disproportionate stunting of the legs compared with the growth of the trunk and head of the body. Slums concentrate a social, economic, and political environment of poverty and violence. Children with long exposure to these negative stressors often become adults handicapped by poor health, impaired intellectual capacity and limiting earning potential (Bogin, 1999).

Since 1993 we have been studying Portuguese, Cape Verdeans living in Lisbon, Portugal and in the Cape Verde Islands. We verified, in a sample of 1118 individuals (mean age=12.01±1.36), that in 1993 the Cape Verdean children of the Cape Verde Islands were significantly shorter than the Portuguese and the Portuguese Cape Verdean subjects and the tallest were

the latter group living in the slums. When we analysed the sample of 1999, the mean height of both Portuguese and Portuguese-Cape Verdean subjects (male and female) had declined to equal the shortest group of Cape Verdeans of 1993. We also measured sitting height ratio [(sitting height/height)/100] and we verified that the Portuguese Cape-Verdean subjects have longer legs than the Portuguese. We cannot "blame" the "extremely bad environment of the slums" for the decline in stature, because the Portuguese subjects do not live in the slums and they also showed a decline in the expected mean height. Prior studies (Varela Silva, 1996) showed that even inside the slums there are differences in SES among dwellers. These differences, as well as the adverse components of the local environment are our main purpose of study. We intend to document the possible reasons for this "short-term negative secular trend" in height, and for the differences in the mean values of the sitting height ratio among Portuguese and Cape Verdean subjects.

Bogin, B. (1999). *Patterns of Human Growth* 2<sup>nd</sup> edition. Cambridge: Cambridge University Press.

Varela-Silva, MI (1996). *Influência de variáveis bioculturais na motivação para a participação desportiva*. Lisbon: FMH, Masters thesis (non-published).

#### **Daytime resting-site selection in mantled howling monkeys (*Alouatta palliata*): Relative influences of feeding and comfort.**

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Sleeping and resting makes up most of the circadian activity budget of primates, yet the literature on these subjects is fragmentary. Many factors are hypothesized to influence sleeping site selection in primates including predation risk, comfort, and food availability. Resting-site selection and use of diurnal resting-sites in mantled howling monkeys (*Alouatta palliata*) was studied at the Ometepe Biological Field Station, Nicaragua.

The Ometepe monkeys range in a highly disturbed, dry-deciduous forest. Nearly all of the trees used for resting were species known to provide food for the monkeys. Several of these species were rare in the troop's home range. Resting trees were also significantly larger in dbh than other trees within the home range. This choice may be based more on feeding than on resting needs. The Ometepe howlers feed in small 'clumps' of feeding trees, avoiding some areas of the forest altogether. The distribution of resting sites observed also supports a patchy habitat usage.

The howlers rested in tree species they were observed to feed in significantly more often than non-feeding trees. When feeding bouts were directly observed either be-

fore or after resting, the distance moved between resting and feeding sites was most often less than 1 m. Both adult and immature howlers preferred to rest in branch forks, as opposed to single branches. Adult howlers preferred to rest on medium sized branches, while immatures preferred small- and medium-sized. These results suggest that howlers choose resting locations based on both food and comfort.

#### **Effects of vitamin D on bone and the consequent evolution of skin color.**

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Since vitamin D nutrition reflects only environment and culture, not food supply, accurate estimates of prehistoric vitamin D nutrition are possible, and their implications can be extrapolated from what we know of certain modern humans. Serum 25(OH)D reflects vitamin D nutritional status; a concentration <40 will contribute to osteoporosis. Modern people in sun-rich environments who regularly expose most of their skin surface to the sun are a paradigm for Paleolithic human vitamin D status. Lifeguards, and farmers in the Caribbean consistently exhibit 25(OH)D concentrations exceeding 100 nmol/L. Since the yield of vitamin D within UV-exposed skin attains a self-limiting chemical equilibrium, skin color does not play a role in protecting against vitamin D toxicity. Very black skin requires six times longer than white skin to attain the equilibrium. At least four studies show that full-body exposure to sunlight causes the equivalent of 250 µg vitamin D (10 000 IU) to enter the body. The current adult RDA is 5 µg (200 IU). Beyond 40° latitude, the angle of the sun is so low that wintertime UV intensity is insufficient for vitamin D production, and it is much diminished in spring and fall. Dark skin is the natural, default color for humans, because it protects both the skin and circulating nutrients from photodegradation (Jablonski NG, Chaplin G. *J Hum. Evol.* 2000;39:57-106). The evolution of lighter skin, and the consequent correlation between human skin color and latitude was the result of natural selection for enough vitamin D synthesis to permit human reproduction. In its most severe form, selection pressure was due to rickets. Less severe vitamin D deficiency caused osteomalacia, which progressed, with each pregnancy, causing deformation of the pelvis and miscarriages. The most moderate form of vitamin D insufficiency is now recognized as a cause of senile osteoporosis, which occurs beyond age 60 y. Since senile osteoporosis could not have contributed to natural selection and adaptation, I conclude that osteoporosis in ancient populations was a conse-

quence of environment and culture, and not simply inadequate calcium nutrition.

**Reproductive strategies of West African chimpanzees (*P. t. verus*) of the Tai National Park: a reduced role for extra-group paternity.**

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Until recently, the social and reproductive unit in chimpanzees was assumed to be the same, with males employing a variety of strategies to secure mating opportunities. In 1997 Gagneux *et al.* suggested, based upon paternity analysis of 13 infants of the North community of Tai, that females frequently mate outside their social group and that half of the infants in the community are fathered by extra-group males. We have both extended and reproduced parts of the original study by genotyping, using microsatellite loci, some 90 individuals comprising the North, Middle and South communities. Potential fathers were tested for 45 offspring using a set of 9 highly variable loci with a combined exclusion power of 0.999. This study employed several approaches aimed specifically to detect extra-group paternity, such as sampling of neighboring communities and of unhabituated males outside the communities. Accuracy of results obtained using DNA from non-invasively collected feces and hair samples was checked both by extensive repetition and through use of a real-time quantitative PCR assay to measure the amount of amplifiable DNA in an extract. Assessment of the DNA content allows one to discriminate between reliable samples and those likely to provide spurious results, and represents a significant advance in the effective and accurate use of non-invasive samples. Preliminary results suggest that extra-group paternity plays an insignificant role as a reproductive strategy of the chimpanzees within the social groups studied.

**Randomization methods to analyze variation in non-metric characters, and the single-species hypothesis for *Homo erectus*.**

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Both metric and non-metric characters have traditionally been used in alpha taxonomy, but frequently only metric characters are used to compare ranges of variation in known and putative species. One of the applications of metric characters has been in resampling, in which the statistical result is the probability that a fossil sample with a given level of variation could have been derived from a single-species comparative sample. However, to date,

resampling strategies have not employed non-metric characters in the same manner. In the present study, a suite of non-metric characters is employed to investigate the range of variation in a fossil sample, for the purpose of testing the single-species hypothesis.

Several workers have offered a list of non-metric characters which may differentiate between African and Asian specimens of *Homo erectus* sufficiently to warrant their designation as separate species. However, it is important to address the possible effects of intraspecific variation in a statistical manner. Therefore, to examine whether the amount of differentiation observed in these characters exceeded what might be expected in a geographically widespread species, I examined the variation in ten characters in a collection of 221 modern humans from Africa and Asia. Following Lahr (1994), and using her standards on two of the characters, a grading scale was created which encompassed the total morphological variation found in the fossil and modern human samples. The Manhattan distance between the Asian and African fossil samples was calculated and compared to a distribution of distances calculated for 1000 randomly selected and bootstrapped samples of African and Asian moderns.

The difference between the total Manhattan distance for the fossil sample and those calculated from the resampled moderns approached statistical significance (at  $\mu = .05$ ), essentially falsifying the single-species null hypothesis. For any single character, however, the fossil sample's distance varied from the 1<sup>st</sup> percentile to the 100<sup>th</sup> of the comparative sample, suggesting that not all of the characters were equally effective at discriminating between the Asian and African fossil samples.

**Deep masseter recruitment patterns during chewing in callitrichids.**

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Electromyographic (EMG) studies of chewing in many anthropoid primates show that peak activity in the balancing-side (BS) deep masseter occurs relatively late in the power stroke of mastication when most other chewing muscles are declining from peak activity. Further, the BS deep masseter appears to be nearly as active as the working-side (WS) deep masseter during chewing of hard or tough foods. The late firing of the BS deep masseter coupled with its transversely-directed force component help create the lateral transverse bending, or wishboning, of the anthropoid mandible at the end of the power stroke. Wishboning, in turn is hy-

pothesized to have been a major factor driving fusion of the mandibular symphysis in living anthropoids. Thus, this BS deep masseter recruitment pattern during chewing likely has considerable functional and evolutionary significance for anthropoids.

Over the past 30 years, primatologists have argued that callitrichids are morphologically-primitive anthropoids, phyletic dwarfs, or an adaptive radiation of exudate feeders. If so, perhaps callitrichids differ in the activity patterns of their chewing muscles as compared to other anthropoids. Thus, callitrichids are a compelling group to explore the breadth of this BS deep masseter recruitment pattern during chewing among anthropoids.

We collected EMG data on the recruitment patterns of the deep masseters during chewing in two common marmosets (*Callithrix jacchus*). Our preliminary findings indicate that the WS to BS ratio of the scaled peak values for the deep masseters average 1.2 in common marmosets. Additionally, the BS deep masseter exhibits peak activity on average 32 milliseconds after the WS deep masseter. Common marmosets fall within the respective ranges of other anthropoids for these values (Hylander *et al.* 2000; *AJPA* 112:469-492). We are currently collecting deep masseter EMG data in two saddle-back tamarins (*Saguinus fuscicollis*).

Our results show that small callitrichids share a similar recruitment pattern for the BS deep masseter during chewing with relatively larger non-hominoid anthropoids. These data uphold the argument that the BS deep masseter recruitment pattern is a distinguishing characteristic of most living anthropoids. These findings also support the hypothesis that symphyseal fusion in anthropoids is functionally linked to strengthening the symphysis against transversely-directed forces from the BS jaw muscles during chewing.

This study was supported by a grant from NSF (SBR-9420764) and a NIH Merit Award (DE04531) to WLH.

**Variance dimorphism in the postcrania of hominoids and several monkeys.**

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Several researchers link sexual dimorphism and variability in a species. Leutenegger and Cheverud developed a model of sexual dimorphism evolution using a quantitative genetic approach (1982, *IJP* 3:387-402). Their model relates sexual dimorphism evolution to phenotypic variation by suggesting that character dimorphism can arise through sex-related differences in a structure's variance in addition to sex-specific differences in selection and/or heritability. While sexual dimor-

phism in primates has received considerable attention, this variance dimorphism remains largely unexamined. Their model predicts that in sexually dimorphic taxa the larger sex will show greater phenotypic variation than the smaller sex (*i.e.*, the species exhibits variance dimorphism). For this study of anthropoid primates, it is predicted that the males of a species will have greater variation than the conspecific females in their postcranial dimensions.

To address the association between sexual dimorphism and postcranial variation, males (m) and females (f) of *Cebus apella* (m=55, f=24), *Macaca fascicularis* (m=36, f=24), *Colobus badius* (m=16, f=30), *Hylobates I. lar* (m=53, f=50), *Pongo pygmaeus* (m=27, f=28), *Pan t. troglodytes* (m=39, f=73), *Gorilla g. gorilla* (m=74, f=64) and *Homo sapiens* (m=53, f=50) were studied. Variation was quantified by the standard deviation (STDEV) and the coefficient of variation (CV) for 97 dimensions taken on the humerus, radius, ulna, femur and tibia. Mann-Whitney U-tests ( $\alpha=0.05$ ) were performed by sex on the STDEVs and CVs for these postcranial dimensions to assess whether males are more variable than females for each species.

Results uphold the prediction that males are more variable than females in most of these species. For both the CVs and STDEVs of all measurements, males are significantly more variable than females in *C. apella*, *C. badius*, *G. gorilla*, *P. pygmaeus* and *H. sapiens*. Only STDEVs are significantly larger in male *M. fascicularis*. For the remaining two species, males are more variable than females, but not significantly so. Similar analyses will be done on subsets of these dimensions to examine variation in regional and functional categories.

These results suggest that postcranial variance dimorphism is common in sexually dimorphic anthropoids. Thus, variance dimorphism may be a significant factor contributing to character and sexual dimorphism evolution.

This research was supported by grants from the L.S.B. Leakey Foundation, Sigma Xi and the AMNH.

#### **Is the trabecular patterning at the proximal femur body-mass dependent in primates? A test on cercopithecines.**

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Previous investigation (e.g., Kummer, 1959) has shown that only minor architectural differences can be found in the trabecular patterning at the proximal femur among mammals which have similar locomotor patterns, but exhibit substantial variation in body size (e.g., *Panthera* vs. *Vulpes*). In order to ascertain a similar model in primates, cercopithecines have been preliminarily considered, because

while their locomotor repertoire is quite similar (mostly terrestrial and arboreal quadrupedalism), body size ranges from about 3 kg (small *Cercopithecus sp.*) to over 30 kg (*Papio* males). The skeletal sample under investigation includes a whole of 45 adult individuals of both sexes from small (*Cercopithecus*, *Macaca fascicularis*), medium (*M. fuscata* and *nemestrina*), and large body-sized (*Papio*, *Mandrillus*) taxa.

Proximal femurs have been radiographed under standard conditions, and the structural arrangement of the cancellous network was site-specifically enhanced and compared by means of advanced digital image processing techniques (Macchiarelli *et al.*, 1999). The possible existence of architectural (not densitometric) differences among the taxa has been quantitatively evaluated by the Line Fraction Deviation index (Geraets, 1998).

Preliminary results indicate that only slight size-dependent structural differences exist in trabecular patterning among the taxa. A structured vertical bundle is always present, even in the smallest specimens. On the other hand, the arcuate bundle and the trochanteric cancellous system are more variable, and seem to be more structured in large body-sized individuals.

#### **Quantifying relationships among Pleistocene hominids.**

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This research quantifies morphological similarities among temporally and geographically defined samples of Pleistocene hominids with the aim of exploring the feasibility of replacement (single origin) and continuity models of modern human origins. The sample includes members of the genus *Homo* from north Asia, Australasia, Africa, Europe and the Levant dating from approximately 8 kybp to 1 mybp. Metric and discrete traits were measured and recorded for a sample of 106 crania. Means were calculated for 15 temporally and spatially defined OTUs. Means were then standardized and average taxonomic distances were calculated among all pairs of OTUs. A distance matrix was constructed and corrected for bias due to small sample size. Both uncorrected and corrected distance values were used to interpret relationships among the groups.

Among the shortest distances between all OTU pairs were those between modern human groups (between 8 and 32 kybp) regardless of region. The closest affinities of Australasians were to other moderns; their closest affinities to groups from earlier time periods were to late Middle Pleistocene Africans and the Skhul/Qafzeh sample. Dali and Mapa showed greater similarity to contemporary Africans and the Skhul/Qafzeh sample than to modern

Asians, a result that is contrary to the expectations of regional continuity. The Middle Pleistocene African group, composed of Laetoli 18, Jebel Irhoud 1 & 2, Border Cave and Florisbad show close affinities to Skhul/Qafzeh, Dali and Mapa and modern Australians, but no strong similarity to other modern groups; such similarity would be expected under a replacement model.

Matrix correlations were performed contrasting regional continuity and single origin models depicted as design matrices. Correlations between models of modern human origins and a distance matrix derived from discrete traits, exclusively, gave stronger support to replacement models. However, matrix correlations between these same models and distance data calculated from both metric and discrete traits, (with and without Konigsberg's correction), produced equivocal results.

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#### **Testosterone and cortisol response to competition within and between male coalitions.**

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We investigate salivary testosterone (T) and cortisol (C) response to competition among adult males in a rural Caribbean village. While testosterone (response?) is clearly associated with competitive outcomes, no study to date has examined the role of male coalitions on hormonal response. Male coalitions are integral to determining status positions and likely form a fundamental human adaptation. T and C responses to competitive events are therefore predicted to be influenced by the social context, *i.e.*, the presence of allies and enemies.

Testosterone and cortisol profiles were assessed from immunoassay of saliva samples. Individual social position (social network coalitions and relative status) were determined from peer assessments. Bilateral anthropometric measures were used to estimate fluctuating asymmetry (FA), a measure of developmental stability (phenotypic fitness?). Domino matches were used as competitive events (stressors?).

Analyses of data indicate that male status is associated with T, C, and FA. T and C response is different when males compete with their friends against outsiders as compared to when they compete amongst themselves. These results suggest

that coalitions are a significant environmental factor affecting male physiological response to competitive events in this population. Supported by NSF BNS 8920569, NSF SBR 9205373, and the MU Research Board and Research Council.

**A survey of remodeling in the vertebrate skeleton, part III. Variation in percentage haversian bone.**

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Modeling and remodeling are responsible for both skeletal form and its continuous repair during adulthood. Local mechanical loading clearly plays a key role, but considerable debate continues over the nature of the transduction signal(s). Previous work in this series has demonstrated general bilateral symmetry in density of haversian structures (complete and fragmentary osteons) from side to side in cats (Walker, AJPA Supplement 26: 224-225 (1998)), chickens, and in the human forelimb (Walker and Lovejoy, AJPA Supplement 28: 272 (1999)). Haversian remodeling represents the response of bone tissue to imposed mechanical forces, and is a reflection of the forces to which the bone is subjected during life. Continuing this research, we examine percentages of cross-sections of bones which exhibit haversian remodeling. Percentages of haversian bone in sections at 10 percent intervals along the lengths of bones (femur, tibia, humerus, radius and ulna) were examined in a series of vertebrate species (*Gallus*, *Felis*, *Homo*). Across species, no asymmetry was noted in percentage haversian bone from side to side. Within some individuals, however, there are bilateral asymmetries, particularly in the forelimb, and particularly in *Felis*. Interestingly, in *Homo*, where asymmetric usage of the forelimb is well documented, there is no difference in percentage haversian bone in the left and right ulnae, yet the percentage area of cross sections composed of haversian bone in the feline forelimb differs significantly between left and right sides. Results from *Homo* and *Gallus* suggest this is idiosyncratic for this particular specimen. As expected, there is no difference between sides in either fore- or hindlimb in *Gallus*. The general symmetry between sides in haversian area suggests more genetic control and less idiosyncratic remodeling behavior: the same pattern indicated by densities of complete and fragmentary osteons. This research is supported in part by the NYCC Research Department.

**A Western Hemisphere perspective on the etiology of cribra orbitalia and porotic hyperostosis.**

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Data collected on a large skeletal sample (n= 5844) as part of the History of Health and Nutrition in the Western Hemisphere Project provide a unique opportunity to resolve some of the uncertainties that exist concerning the etiology of cribra orbitalia and porotic hyperostosis. The Western Hemisphere database contains information on people of Native American, European American, and African American ancestry who lived during both the prehistoric and historic periods. The proportions of men and women with cribra orbitalia (males=12.6%, females 12.6%) and porotic hyperostosis (males= 14.6%, females= 15.7%) in this sample are very similar and do not differ significantly (p>0.3). However, there is a significant sex difference in the age distribution of cribra orbitalia. For adult females, the frequency of this condition is highest in women who died during their early twenties, and declines with increasing age. For males, the frequency of cribra orbitalia increases until the age of 40, and then decreases. An analysis conducted using site-specific ecological information reveals statistically significant correlations between the presence of both cribra orbitalia and porotic hyperostosis and ecological variables such as altitude, the Normalized Differential Vegetation Index (a measure of primary productivity), and topographical relief (maximum slope) in the vicinity of the site. Our analysis of the demographic and environmental correlates of cribra orbitalia and porotic hyperostosis suggests that these conditions are the result of interactions between a complex set of local cultural and environmental variables.

**Evolution of behavioral and ecological variables in the Pitheciinae.**

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It is now universal wisdom that the three pitheciine genera, *Pithecia*, *Chiropotes*, and *Cacajao*, form a tight clade within the Platyrrhini, with *Chiropotes* and *Cacajao* most closely related to one another. However, variability within the pitheciines is marked in features such as habitat choice, forest use and diet, and positional behavior, as well as in associated morphologies. Here we explore the distribution of a variety of ecological and behavioral traits as well as associated anatomical features in an evolutionary framework.

Each pitheciine species or species group for which there are data were coded on a series of features, with *Callicebus* and *Aotus* used as outgroups. Features included aspects of distribution, habitat use, and dietary and positional adaptations. Polarity of features were based both on the out-group criterion and on an assumption that more specialized ecological and behavioral choices are likely to be more derived. PAUP 4.0 and MacClade were used examine evolutionary models.

The phylogenetic analysis unsurprisingly confirms past work pointing to the tight link among the pitheciines, especially between *Cacajao* and *Chiropotes*. Of far more interest and importance are the resulting trajectories of change suggested for many features. This study confirms Hershkovitz' (1979) suggestion that the *Pithecia monachus* group may be more generalized and primitive than *P. pithecia* in most features but not all. In some ways, *P. pithecia* is one of the most specialized members of the clade, matched by *Cacajao* but in distinctly different ways. *P. pithecia* represents a form specialized in movement and forest use, while the larger *Cacajao* (and to a lesser extent *Chiropotes*) is specialized in diet and substrate choice. These findings, in conjunction with the current distribution and sympatry/allopatry patterns of the taxa, allow a new model for the biogeographic history of this group.

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**Cranial morphology predicts relatively low forces and relatively large gapes during gouging in primate gummivores.**

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Tree exudates are an important part of the diet of many extant, small-bodied primates. A number of primate gummivores gouge holes in trees with their anterior teeth to initiate exudate flow. Most workers have assumed that gouging holes in trees requires that high forces (relative to those during chewing and biting) be generated at the anterior dentition and resisted by the mandible and skull. Our preliminary observations of the kinematics of gouging in *Callithrix jacchus* indicate the frequent use of very large gapes during gouging as compared to gapes during chewing. Here we report the results of a morphometric study to identify skeletal features predicted to be associated with the generation of relatively high forces and

large gapes during tree gouging in three gougers (*Phaner furcifer*, *Eutoticus elegantulus*, and *C. jacchus*) as compared to groups of their close relatives that do not gouge.

Darroch and Mosimann shape ratios derived from 23 external cranial dimensions for 256 individuals in 6 cheirogaleid species, 7 galagid species, and 3 callitrichid species were analyzed for all possible pairwise comparisons of gougers to non-gougers within a phylogenetic group. We tested 12 predictions related to the presence of relatively high forces and/or large gapes in the gougers.

We find that gougers infrequently and inconsistently possess the features, *e.g.*, a deep mandibular corpus, predicted to be linked to relatively high forces during gouging. The gougers consistently possess features, particularly in the TMJ, predicted to be linked to relatively large gapes during gouging. Only one feature, a low condyle relative to the occlusal plane, characterizes all of the gougers compared to all of the non-gougers within a phylogenetic group. This feature is linked to large gapes. A low condyle minimizes the negative effect of adductor muscle stretch on force production at large gapes and helps keep the upper and lower anterior teeth in vertical alignment during gouging. Our results predict relatively low forces and large gapes during gouging. These predictions can only be tested with *in vivo* data on gouging behavior.

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#### mtDNA diversity in Southeast Asian populations.

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In a previous study of Southeast Asian genetic variation, we characterized mtDNAs from six populations through high resolution RFLP analysis. Our analysis revealed that these Southeast Asian populations shared most genetic variation, suggesting they had a common origin. However, other patterns of population associations also emerged. Haplotypes from one major founding haplogroup in Papua New Guinea was present in Malaysia, the Vietnamese and Malaysian aborigines (Orang Asli) had high frequencies of haplogroup F, which was also seen in most other Southeast Asian populations, and haplogroup B, defined by the Region V 9-bp deletion, was present throughout the region. In addition, the Malaysian and Bornean aborigine populations exhibited a number of unique haplogroups not observed in most other populations. However,

most other studies of Southeast Asian mtDNAs have not employed RFLP analysis, making it impossible to link these data with other published data. Therefore, it was necessary to better characterize the evolution of Southeast Asian mtDNAs, hence, to more fully elucidate the genetic relationships among the populations bearing them. To accomplish this goal, we sequenced the control region (CR) of mtDNAs of these populations and compared the resulting data with published information from Southeast Asian and Oceanian populations. Our findings revealed a great diversity of CR sequences among these populations, and, in most ways, confirmed the trends determined through RFLP analysis alone. They further showed links between the RFLP haplotype and CR sequence data for these groups, which has allowed the association of similar published data with these results.

#### Degenerative joint disease in two pre-Columbian skeletal samples: Bay West (8CR200) and Windover (8BR246).

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The study of pathological changes to articular joints provides insight into activity patterns and workloads of prehistoric peoples. Among Archaic hunter-gatherers, the frequency, severity, and early age (<40 years) of the onset of degenerative joint disease (DJD) has been linked to heightened activity levels and harsh lifeways (Smith 1996). Within this context, however, few gender differences in the severity, pattern of expression, and age of onset have been observed among Archaic hunter-gatherers.

This present investigation evaluates the severity, pattern of expression, and age of onset of DJD within two pre-Columbian skeletal samples. Specifically, I examine 168 nearly complete skeletons from the Windover collection (5,866 joint surfaces) and 42 fragmentary skeletons from the Bay West collection (874 joint surfaces) in order to shed light on the presumed harsh lifeways and activity patterns among Archaic hunter-gatherers and to determine whether significant differences in the expression of DJD occur between males and females.

I scored the articular surfaces of the TMJ, hip, knee, ankle, shoulder, elbow, wrist, and intervertebral joints for severity and comparative degree of DJD. I calculated frequency patterns by joint surface and tested each skeletal sample for differences using Mann-Whitney U and Chi-square analysis of variance.

Within the Bay West and Windover skeletal samples, marked degeneration was present in the elbows, knees, hips, ankles and spinal column with the Bay West sample exhibiting the most degen-

eration. This result is consistent with the expectation that hunter-gatherers exhibit more degeneration due to their more mobile lifeways and heavier workloads.

In the Windover sample, males had more degeneration in their cervical spine, knees, and wrists while females exhibited marked degeneration in their lumbar spine. These results suggest a division of labor may have existed among Florida's Archaic hunter-gatherers.

#### How human intelligence evolved.

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Brain size and intelligence are strongly associated with social complexity among mammals. Increases in neocortex size in particular are interpreted as a consequence of the brain functioning as a tool for social competition.

Alexander (1989, 1990) proposed that competition among human coalitions created a biological arms race selecting for relative increases in brain size. This unique situation occurred because at some point in our history, hominids became ecologically dominant to the extent that within-species competition became the 'principal hostile force of nature' guiding the evolution of human intelligence.

Alexander's model integrates the evolution of intelligence and its specific aspects such as consciousness, cognition, language, emotions and personality with complex sociality, extended childhood dependency, male parental care, concealed ovulation, reduced sexual dimorphism, and other unusual human characteristics. We argue that this model explains the increase in brain size, body size, decreased sexual dimorphism and a rapid geographic expansion that characterized the early evolution of *Homo*, and subsequent changes within our genus.

We suggest that the comprehensive and robust nature of Alexander's model provides a critical theoretical framework for understanding the human paleontological and archeological record.

#### Linear sparing of long bone growth in the pathological fetus.

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Spontaneously aborted fetuses provide a unique opportunity to study the effect of pathology on linear growth and to evaluate aborted fetuses as a valid sample for understanding normal growth and development.

This study analyzes the relative linear growth and proportionality of the long

bones for a sample of 245 fetuses based on radiographic measurements of diaphyseal length and recorded crown-heel length (CHL). The data are derived from full-body radiographs of stillborn and spontaneously or therapeutically aborted fetuses delivered near sea level in the southeastern United States. Additional data on soft tissue pathology, recorded in associated autopsy records, permit the examination of subsets of the sample categorized by the type and severity of pathology. No pathology is noted in many cases; other cases exhibit an acute insult during the birthing process (i.e. abruptio placenta, placenta previa, or acute chorioamnionitis), or acute "pathology" associated with premature delivery of a normally developing fetus (i.e. hyaline membrane disease, persistent fetal circulation, or simply non-viable immaturity). These cases are compared with those in which a significant pathological condition, possibly affecting normal growth, was noted during the postmortem examination.

The sample is arbitrarily divided into 10 groups of CHL measurements, roughly corresponding to gestational ages from 4.5 lunar months to term. A non-parametric bootstrap is used to compute marginal confidence intervals for the differences between the first-eigenvector coefficients. Measurement-specific differences in scaling are indicated by confidence intervals that exclude zero.

Linear growth is not significantly affected by most prenatal pathology in this study. The proportional relationship between long bone length and CHL is both stable and predictable. Likewise, Brenner et al. (1976) found that data derived from spontaneous abortions in the late second and third trimesters were valid for interpreting normal fetal growth, even when underlying pathology was noted in the fetus. The lack of effect of pathology on long bone length is consistent with other studies that find girth but not length to be affected by congenital conditions (Richards and Antón, 1991). This phenomenon might be called "linear sparing" since this basic aspect of body form might possess priority over other aspects of musculoskeletal development.

#### Allometry of manual proportions.

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Since Mollison (1911), researchers have employed osteometric indices to investigate interspecific differences in primate body proportions, and relate those differences to locomotor abilities. There are four standard osteometric indices: intermembral, brachial, crural and humerofemoral. Researchers investigating substrate use of non-primate mammals have used manual indices. These manual

proportions have proved valuable predictors of substrate use. However, Martin (1990) suggests that many of those using such osteometric indices do not fully account for allometric influences. Chi-square ( $X^2$ ) was used to determine whether general substrate use is independent of body mass (BM). The Null Hypothesis ( $H_0$ ) of a significant association between BM and general substrate use was accepted for the primates ( $X^2 = 28.39$ ,  $p < 0.01$ ,  $df = 5$ ), and for the carnivores ( $X^2 = 40.15$ ,  $p < 0.01$ ,  $df = 5$ ) in this study.

Primate body size ranges are more skewed toward the small end of the scale, so this bias may have undue influence. However, comparing the relationship of two different manual attributes to BM may alleviate this bias, and shed light into the differential effects of allometry. For the combined primate taxa, there is a high correlation between BM and hand length ( $r = 0.940$ ,  $p < 0.05$ ). However, primates possess a metacarpal/proximal phalange III (M:PP3) ratio that is only moderately correlated with BM ( $r = 0.678$ ,  $p < 0.05$ ). The correlations for BM/hand length and BM/M:PP3 ratio do not agree (e.g. for platyrrhines,  $r = 0.962$  for BM/hand length; while  $r = 0.149$  for BM/M:PP3 ratio).

The degree allometry influences M:PP3 ratios may be gleaned from gender differences. Even though hominoids generally display extreme sexual dimorphism, the correlation between BM and M:PP3 ratios is lower for males ( $r = 0.364$ , ns) than for females ( $r = 0.537$ , ns). *T*-tests confirm that there is not a significant difference between male and female M:PP3 ratios. Generally female hominoids actually possess marginally higher M:PP3 ratios than do males, which if body size is a critical factor, it would be assumed to be reversed. These large body size differences between the hominoid sexes further demonstrate a lack of a compelling association between the M:PP3 ratio and body size. Results are very comparable for Lemelin's (1999) modified Phalangeal Index.

#### Dental microwear in two species of fossil papions: *Parapapio ado* from East Africa and *Parapapio jonesi* from South Africa.

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Dental microwear analysis is a valuable quantitative method for discerning diet and tooth function of fossil mammals. Examination of the relative abundance and size of pits and scratches allows inferences regarding the amount of folivory and frugivory to be assessed.

The present study focuses on two distinct *Parapapio* populations: *P. ado* from Laetoli, eastern Africa and *P. jonesi* from Swartkrans, southern Africa. Although some may have closer affinities to

*Cercocebus* and others to *Papio*, species attributed to *Parapapio* lie near the ancestry of all papions. Like modern mangabeys and unlike other species of *Papio* and *Parapapio*, both *P. ado* and *P. jonesi* exhibit a high degree of molar flare that would indicate each was a committed frugivore. However, analysis of shear crest and occlusal cusp relief suggest that both species included significant portions of leaves in their diet, with *P. ado* annually consuming twice as many fruits (57%) as leaves (29%), and *P. jonesi* (SK) 67% fruit and 15% leaves.

In order to test these dietary predictions based on functional morphology, analysis of dental microwear on upper and lower second molars of *P. ado* and *P. jonesi* was undertaken. Initial quantification of SEM micrographs for samples of each species indicates the combination of pits and scratches on their molar enamel support the dietary inferences based on shear crest analysis. Pit frequency for both species shows a range from 22% to 35%. This information, and additional data about contemporaneous cercopithecoid and hominid species inhabiting the same environment, is used to provide insights into niche partitioning and competition within their respective primate communities. The information is also useful for forming more accurate paleobiogeographical models about the relationships and extinction of *Parapapio* during the Pleistocene.

#### Male chimpanzee boundary patrolling and social bonds.

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Chimpanzees and humans are among the few mammals that engage in lethal between-group aggression by coalitions of males. Boundary patrolling, mostly by males, plays an important role in chimpanzee intergroup hostilities. Patrolling is cooperative behavior with associated risks and with time, energy, and opportunity costs. Their possible benefits (e.g., improved protection, improved female foraging efficiency and reproductive success) are shareable to varying extents, and patrolling may present males with collective action problems. Despite its relevance to human behavioral evolution, few quantitative data on boundary patrolling exist.

We present detailed data on boundary patrolling by males in an extremely large chimpanzee community at Ngogo, Kibale National Park, Uganda, in which patrols occur at much higher rates than in smaller communities and often lead to intergroup aggression (including four known infanticides). The large number of males at Ngogo allow us to address questions about variation in male participation and the relationship of joint patrol participation to other



aspects of male-male social relationships. Variation in male participation is correlated with variation in mating success, as expected if patrolling represents a collective action problem with asymmetric benefits. Participation is also positively correlated with participation in, and success at, hunts of red colobus monkeys, another activity that requires risk taking. The frequency with which individual males patrolled together correlated positively with frequencies of dyadic grooming and agonistic support. These results show that males inclined to take risks in other contexts are also most inclined to join patrols, and that males patrol most with others who show in other contexts that they are reliable risk takers and reliable cooperative partners.

### Climate induced variation in recent human hip morphology.

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Many researchers have demonstrated climate's role in producing geographical patterning in recent human pelvic width and leg to trunk proportions, but the influence of these changes on other hip features has not been fully investigated. This study is stimulated by the following two observations: 1) regional differences in body shape are inherited and present early in life, and 2) the juvenile skeleton is responsive to forces produced by bipedal locomotion during development. Slight changes in mechanical forces due to differences in body proportions would be predicted to indirectly affect many aspects of hip morphology. This hypothesis is explored through a morphometric analysis of recent human hip variation.

Using a Microscribe digitizer, the 3-D coordinate locations of 54 landmarks were collected on matched sets of innominates, sacra, and femora from a recent human adult sample ( $n = 243$ ) divided into seven globally distributed regional groups. The raw coordinate data for each individual were mathematically transformed to articulate the skeletal elements and orient the hip joint in standard anatomical position. Then, residuals from the mean locations of each of the landmarks were calculated and analyzed with Principal Component Analysis (PCA). To further confirm these results, the shape changes in the unarticulated skeletal elements were also examined using Generalized Procrustes Analysis (GPA). In all cases, interactive computer imaging was used to visualize change along each of the principal component axes.

Some of the most significant results of these analyses are that "cold-adapted" people, relative to "warm-adapted" individuals, tend to have: 1) larger M-L birth canal dimensions, increased distances be-

tween their acetabulae, wider sacra, and longer pubic lengths; 2) dorsal iliac blades that are more posteriorly rotated and positioned relatively further from their sacra; and 3) lower femoral neck-shaft and torsion angles. Additionally, variation in A-P depth of the pelvis and in A-P birth canal measurements appears to be constrained, showing less geographic patterning than do the M-L dimensions. These and further results, as well as their implications for the interpretation of fossil hominid morphology, will be discussed in the context of the biomechanics of skeletal growth and development.

### Coordinate-based, measurable 3-D endocasts.

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3-D imaging techniques have been used in pedagogical contexts in physical anthropology (e.g. Kappleman, 1998), but tools for quantification and morphological comparison have been slow to develop, due to high costs, technical complexity, and software limitations.

We present a series of dynamic, fully interactive, high-resolution, coordinate-based 3-D models of Pleistocene hominid endocasts, generated by a Minolta non-contact laser digitizer and processed with InnovMetric's industrial modeling software, Polyworks. The images permit both volumetric and linear measurements.

Volumes of these "digitized endocasts" are highly correlated with published values ( $r^2=0.997$ ;  $n=13$ ). Digital volumes (DV) are consistently slightly lower than published volumes (PV):  $DV = 24.4 + 0.998 PV$ ; but the average coefficient of variation is quite small ( $V = 0.024 \pm 0.0005$ ).

Digitized 3-D images of paleontological materials provide a replicable, electronic format that is ready for curation and widespread dissemination through an Internet-accessible database. This database allows a large number of researchers access (with permission) to fragile, rare materials in an environment suitable for nondestructive manipulation, marking, "virtual dissection," and comparison.

Thanks to the LSB Leakey Foundation (Grant #3-15171); Wenner-Gren Foundation (Grant # 6528); and to Prof Jeffrey T. Clark for creative problem-solving and access to facilities at NDSU.

### Age-related bone loss in nonhuman primates: results and models.

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Nonhuman primates are becoming established as models for age-related bone loss in humans. We will show that the great physiological similarity of other anthropoid primates to humans extends to bone, bone cells, and bone related chemistry. This paper will review and critique patterns and processes of age-related bone loss in a number of nonhuman primate models, including chimpanzees, macaques, and baboons.

There is no strong support for physical activity related negative effects on bone in nonhuman primate models, in fact bone responses to reduced activity in nonhuman primates seem very different than in humans. We will review this issue and propose explanations for the different responses to physical inactivity in nonhuman primates and humans.

Menopause, as opposed to reproductive cessation, is rare (or nonexistent) in nonhuman primates although experimental manipulation of estrogen levels has yielded expected results in bone and other organ systems in nonhuman primates. After briefly reviewing the literature on menopause in nonhuman primates, we will show that age-related bone loss in nonhuman primates is not due to the loss or withdrawal of estrogen, or to physical inactivity, and so must be almost entirely age-related. Therefore, nonhuman primates may provide a more direct and uncomplicated model of age-related bone loss than occurs in human.

Finally, we will show that nonhuman primates, and macaques in particular, are excellent models for age-related bone loss in humans and that those models will prove very useful for evaluating potential preventatives and treatments of age-related bone loss.

### Human hands are adapted for bipedalism, not tool use.

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Two extreme positions on the origins and development of tool use in hominids can be identified. The "morphocentric" view, typified by Susman (Science, 9/9/94), holds that details of hand morphology distinguish between those hominids which can make stone tools and those that cannot. The "neurocentric" view, typified by Paillard (1993), states that tool use is the result of a sophisticated intellect and, hence, is correlated with brain size and structure. According to this theory, tool manufacture and use are seen as largely psychological acts, rather than anatomical ones.

In attempting to explain the occurrence of tool use in hominids, we have developed

and tested a hypothesis which stems from a "neurocentric" viewpoint: the anatomy of modern human hands and those of earlier *Homo* is partly the result of selection for foot anatomy that is adapted to terrestrial bipedalism. Hence, the length of the fingers (other than the thumb) is due to the pleiotropic affects of genes which cause shortening of the toes (especially the lateral toes).

In addition to other pieces of evidence, genetic data from the OMIM (Online Mendelian Inheritance in Man) database were used to test the hypothesis. A total of 713 genes was evaluated on the basis of their effects on the cheiridia. Of those genes known to affect the form of the toes, 91% also affect the fingers. Of those genes known to affect the length of the toes, 96% also affect the fingers. Of those genes known to affect either form or length of the toes, 92% also affect the fingers. These results, along with fossil data, suggest that selection for foot morphology was 91-96% likely to affect the hands, too, supporting the "neurocentric" theory.

However, there is also evidence, from this study and from the fossil record, that the "neurocentric" theory cannot fully explain modern human hand morphology or the occurrence of tool use in hominids. Hence, the role of polarized viewpoints in scientific research is also discussed.

#### **New discovery of *Australopithecus* in the Somali region of Ethiopia.**

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We conducted a preliminary field survey, covering two areas in the Somali Region of Ethiopia: Satkawhini (SKW) and Galila (GLL). The PEER (Palaeontological Ethiopian-European Research) - Team is led by the Inst. for Anthrop., Univ. of Vienna, and contributed by the Inst. of Geol. and Petr., Univ. of Vienna, the Natl. Prehist. Ethnogr. Mus. in Rome, the Dept. of Geol. and Palaeont., State Mus. of Hessa, Darmstadt, and the Dept. of Anthrop., SUNY Albany. The areas investigated are situated in the upper parts of the Stratoid Basalts of the Afar Group. The formations predominantly comprise sedimentary deposits and to a minor extent volcanic layers of basaltic and acidic chemistry. The sediments were settled in a lacustrine environment, interfingering by several fluvial facies. We discovered vertebrate remains (cranial and postcranial) of large mammals (Equidae, Rhino-

ceratidae, Dinotheriidae, Elephantidae, Bovidae, Suidae, Hippopotamidae, Giraffidae, Cercopithecidae, and Homi- nidae), reptiles (Crocodylia and Chelonia) and fishes. A fossil hominid remain was collected at Galila. The specimen (GLL 33) consists of a lower right M3 preserving a virtually complete crown. Most of the mesial root is lacking. The specimen was re-deposited but its generally good preservation conditions suggest no far transportation. The original sedimentary beds are assumed in the upper section of a close profile towards SW. The specimen is attributed to the genus *Australopithecus*, based on general crown size/shape, enamel thickness, and occlusal wear pattern. In the SKW fossiliferous region, a number of stone tools representing different lithic technologies/traditions (Oldowan, Acheulean, and abundant Levallois-like silex tools) were discovered.

#### **Paleopathology and biomechanical indicators of stress at the MacDuffee Site.**

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The MacDuffee Site of Craighead County, Arkansas, was excavated in the 1960's by amateur archaeologist Frank Soday and other avocationalists. The excavation of the site, a Late Woodland/Middle Mississippian mound, provided a large collection of ceramics, lithics, and faunal remains in addition to burials. The collections were transferred to the Gilcrease Museum in Tulsa, Oklahoma, and were inventoried in 1995 as per NAGPRA regulations. Ethnohistorical research undertaken by the Gilcrease suggests that the population could be of Quapaw affiliation. Permission to study the remains was obtained from the Quapaw Tribe. The current skeletal analysis is part of a comprehensive study of all materials associated with the site.

This Late Woodland/Middle Mississippian (based on ceramic and lithic analyses) population consists of 49 subadults (age 15 years and under) and approximately 112 adults. Bone preservation at the site is variable, and only 43 of the adult skeletons could be assessed for sex and age at death. Of these, twenty-seven are male/probable male, and 16 are female/probable female. Mean age at death among the males is 30.8 years compared to 29.6 years among females. Preliminary results suggest high incidences of osteoarthritis and muscular hypertrophy. Periosteal reaction, both remodeled and unremodeled, is present in 67 percent of the adults studied. Evidence of remodeled porotic hyperostosis is present in 38 percent of the adults studied. The results of paleopathological and biomechanical evaluations will be presented here.

#### **Ancient Irish dental variation: Research on issues of migration and population continuity.**

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There are many tales in Irish mythology of waves of invading populations and the destruction or displacement of indigenous peoples. Irish archaeologists have long debated the veracity of invasionist or continuist models in Ireland's past, but the spatial distribution and origins of diagnostic artifacts and architecture provide no definitive conclusions. Genetic diversity has been examined in modern and recent Irish populations (Hill, Jobling and Bradley, 1999; Relethford, 1995). However, with the exception of one brief biodistancing study (Brothwell, 1985), there has been no research on the genetic variation of ancient Irish populations to provide information on this important issue.

This study adds information about genetically-controlled traits by examining human dental morphology and metrics from 353 individuals of Neolithic (c. 4000-1800 BC), Iron Age (c. 700 BC-A.D. 100) and Early Christian Ireland (c. A.D. 400-700). Morphological variation was assessed using the Arizona State University Dental Anthropology System (Turner, Nichol and Scott, 1991) and mesio-distal and bucco-lingual diameters were recorded.

Multi-dimensional scaling of these genetic markers shows significant differences between the three time periods and between geographical regions. Significant differences were found between eastern and western populations, similar to that discovered by Relethford (1995) in recent and modern Irish populations and also suggested by Hill *et al.* (1999).

This research was supported by a Hill Grant and a RGSO Grant from Pennsylvania State University.

#### **Body proportions, climatic adaptation, and secular trends in *Macaca mulatta* skeletons from Asia and Cayo Santiago, Puerto Rico.**

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Although body size and proportions tend to vary in widely dispersed species that inhabit different climates, the rate at which the skeleton responds to new climatic conditions is unclear. Primate colonies transplanted to new environments suggest that morphological change may be a short-term response to new climates. Alternatively, some researchers argue that variations in body proportions between two closely related populations represent long-term adaptations to local climatic condi-

tions. *Macaca mulatta* is ideal for testing the rate at which body proportions respond to new climatic conditions because of this species' great geographic range in the wild and the long established transplanted colony in Cayo Santiago, Puerto Rico.

I compare maximum lengths of the humerus, radius, femur, and tibia, femoral and humeral head diameters, fore- and hindlimb proportions, and vertebral column length in adult skeletons of *M. mulatta* from tropical and temperate habitats in Asia (n=35) with their conspecifics from Cayo Santiago (n=80). I also test whether there is a species-wide pattern in the scaling of limb lengths and proportions through least squares and reduced major axis regression models that compare each limb variable with overall size.

Cayo Santiago skeletons have longer limb and trunk lengths and greater sexual dimorphism in overall size compared with their Asian conspecifics. Longer limbs and greater sexual dimorphism may be related to increased nutritional quality in the Cayo Santiago colony, a pattern similar to morphological change in human populations exposed to higher quality nutritional environments. However, limb proportions and scaling patterns, and femoral and humeral head diameters do not differ between Cayo Santiago and Asian skeletons. These results suggest that while changes in limb lengths and overall size represent secular trends related to nutritional quality, changes in body proportions are long-term adaptations to local climatic conditions.

#### **Mitochondrial DNA diversity among Native Americans from the southeastern United States.**

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Prior to their relocation to Oklahoma during the nineteenth century, the Creek, Choctaw, and Chickasaw tribes comprised the largest Native American presence in the southeastern states of Georgia, Alabama, and Mississippi. Although archaeological and ethnographic evidence suggests that these historic groups formed relatively recently (between 1500 and 1700 AD), these populations all speak languages belonging to the Muskogean language family, which first began to subdivide 3000-3500 years ago. Archaeological evidence and shared cultural traits also indicate a long history of contact and interaction among these tribal groups.

Most Native Americans belong to one of five founding mitochondrial DNA (mtDNA) haplogroups, each of which is characterized by the gain or loss of restriction sites or by the presence of a nine base-pair deletion, as well as by one or more mutations in the mitochondrial control region (CR). In this study, samples from

68 Choctaw, Chickasaw, and Creek individuals were haplogrouped, and CR sequence was obtained for a subset of these individuals.

Surprisingly, haplogroup frequency distributions differed significantly between these tribal populations, an unexpected result given their close linguistic, geographic, and cultural proximity. The haplogroup and haplotype frequency distributions for these groups were also compared with those from other Native American populations originating in eastern North America.

#### **Kennewick Man's behavior: a CT-scan analysis.**

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Kennewick Man is one of the very few early Holocene (circa 9000 yrs BP) skeletons found in North America. His antiquity, alleged Caucasoid facial features, and arrowhead lodged in his hip catapulted him to celebrity status. Using computer tomography to obtain femoral cross-sections this project examines the skeletal remains of Kennewick Man.

Two types of ratios are calculated on three femoral locations: (1) cortical area to total cross-sectional area (CA/TA) to determine robusticity, and (2) anteroposterior orientation to the mediolateral orientation (*Iap/Iml*) to determine directional bending strength. The CT-scans of Kennewick Man are compared to those of other populations of known subsistence patterns, time periods, and origins to examine to which population Kennewick Man is most similar.

Comparisons revealed that Kennewick Man's CA/TA ratios are similar to other preagricultural groups and are in between Pleistocene and Holocene groups. Concerning the *Iap/Iml* ratios, Kennewick Man's cross-sections are the most anteroposteriorly oriented, indicating high mobility.

Kennewick Man appears to have behaved like other Holocene hunter-gatherers - hunting small animals and gathering wild vegetables. My analyses also indicate that Kennewick Man may have engaged in some big game hunting behavior like his Pleistocene ancestors and he still retained some Pleistocene adaptations.

However, these conclusions have to be viewed cautiously because of his injury and the asymmetry of his sciatic notches that indicate pathology.

I would like to thank Professor Jerome Rose for providing me with access to Kennewick Man's CT-scans.

#### **Male sexual strategies in a semi-free ranging group of long-tailed macaques (*Macaca fascicularis*).**

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This study presents data collected during May-July, 2000, on a group of semi-free ranging long-tailed macaques, *Macaca fascicularis*, at Padangtegal, Ubud, Bali, Indonesia. The goal of this project was to test two currently debated hypotheses regarding male mating strategies: that affiliative male-infant interactions may act to improve male mating success, and that male aggression directed toward females improves male mating success via a sexual coercion.

Ten adult male macaques were focally followed and all social behavior, proximity data, and substrate use were continuously recorded in 30-minute samples, for a total of 204 hours of data.

Frequencies and durations of each behavior were tabulated and tested for correlational relationships using the SPSS statistical package.

Results show that overall durations of affiliative male-infant interactions are not correlated with copulation. However, the correlation between the duration of male grooming by infants and male-female copulation is highly significant.

A high level of aggression toward females is also significantly correlated with copulation, suggesting that the sexual coercion may be a viable strategy.

Both affiliative male-infant interactions and aggression toward females appear to be related to sexual access, so males could be employing either one or both strategies simultaneously.

Interestingly, male-infant interactions were largely contained within one of the three groups of macaques at this site. This study suggests the possibility of a variable role for male-infant interactions in *Macaca fascicularis*.

#### **Analysis of Arikara humeral and femoral cross-sectional morphology.**

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Diaphyseal cross-sectional shape analyses, especially involving the investigation of bilateral asymmetry, are extremely useful for the reconstruction and interpretation of activity patterns in archaeological skeletal populations. However, its use has been extremely limited in studies of skeletons from the Great Plains. This study investigates age, sex, and temporal trend in bilateral asymmetry of humeral and femoral structural properties among the Arikara in order to examine changes in activity patterns and sexual

division of labor from the mid-16<sup>th</sup> century to the early 19<sup>th</sup> century.

Computed tomography (CT) images were collected for paired humeri and femora from 11 cemetery samples representing three protohistoric and historic variants of the Coalescent Tradition attributed to the Arikara. The humeri were scanned at 35% from the distal end and femora were scanned at midshaft and subtrochanteric. The CT images were computer digitized and used to obtain estimates of cortical area, minimum and maximum bending strength, and torsional strength for each bone.

In general the Arikara are homogeneous and typical of a horticulture group. There are significant differences in asymmetry between males and females, and asymmetry differs slightly by age group and temporal period.

### Postural adaptations and sexual dimorphism in the primate pelvis.

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In defining the positional relationship of the trunk to gravity, the concepts of orthogrady and pronogrady underscore the varied biomechanical challenges different axial orientations impose. Vertebral differences between orthograde and pronograde primates have been well documented, but the influence of posture on the pelvis has been less well studied. This study investigates pelvic morphology in primates characterized by different habitual postures: *Homo*, *Hylobates*, *Pan*, *Propithecus*, *Galago* and *Lemur*. Fifteen biomechanically relevant variables of the false pelvis were measured for each species, and adjusted for differences in body size through geometric mean standardization. Variates were analyzed by principal component analysis and the nonparametric Wilcoxon test.

*Homo* is clearly isolated in multivariate space from all other taxa with 42% of the variation on the first axis. Discrimination is driven by relatively large acetabular diameters, expansion of the minimum iliac breadth, and large ventrodorsal diameter of the superior pubic ramus in *Homo*, in contrast to relatively reduced pubic symphyseal height, and shortened anterior iliac spine height. These traits are largely consistent with human bipedal locomotion. Axis two represents 20% of the multivariate space, separating orthograde and pronograde taxa, driven predominantly by a relatively broad iliac maximum diameter and broad sacral breadth in orthograde primates.

Pelvic sexual dimorphism was also examined in order to assess the potential interaction between habitual posture and reproductive biomechanics. Interspecific tests show statistically significant levels of sex-related differences in *Homo* and

*Hylobates* only, suggesting the pelves of orthograde females may be subject to different biomechanical demands than do those of pronograde females. Based on preliminary findings, and initial small samples sizes for *Propithecus* and *Galago*, further research is planned to examine comparative degrees of pelvic sexual dimorphism in orthograde and pronograde primates.

Supported by the American Museum of Natural History.

### An analysis of the prosimian knee.

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This study examines knee morphology in prosimian primates. Anatomical comparisons were made using specimens (n=200) divided into five locomotor classifications: active quadrupedalism with leaping (AQLP), active quadrupedalism with climbing (AQCL), grasp clinging and creeping (GCCR), and two patterns of vertical clinging and leaping (VCL1 and VCL2). In addition, Tupaiidae was used for an outgroup morphological comparison.

In general, the prosimian distal femur is characterized by: (1) a deep epiphysis, (2) a higher lateral condyle, and (3) a wide medial condyle. Deviations to these patterns are demonstrated by prosimians classified as GCCR and VCL1. The generalized prosimian proximal tibia is mediolaterally broad (relative to anteroposterior dimension) and demonstrates a long, wide, and convex lateral facet. This study highlights several functional and phylogenetic interpretations on the basis of differences between the 'singular' intercondylar eminence morphology of strepsirhine primates (living lemurs and lorises) and the 'notched' condition exhibited by haplorhines (tarsiers, monkeys, and apes). Comparisons with fossil primates (*Hemiacodon*, *Notharctus*, *Adapis*, and *Smilodectes*) adds significant information to our current interpretations of the euprimate morphological condition, and to strepsirhine and haplorhine locomotor and phylogenetic reconstructions. (Research supported by a Sigma Xi grant).

### Child growth among Karimojong agropastoralists of northeastern Uganda.

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Between August, 1998 and March, 1999, anthropometric examinations of 440 children, aged from birth to their late teens, were conducted in Moroto district, northeastern Uganda. The exams were part of a comparative study of child growth and development among pastoralists of

East Africa. The children in the sample are all from the Karimojong population, a group of semi-nomadic agro-pastoralists who have linguistic, genetic, and cultural affinities with neighboring Turkana pastoralists in Kenya.

Anthropometric measurements include height, sitting height, weight, infant recumbent and crown-rump lengths, 8 circumferences, and 7 skinfolds. We also collected information on development (dental, motor and cognitive development, onset of pubertal development, pubertal stage, etc). Additionally, we collected immunization histories, information on morbidity, and incidence of scabies, eye infection, respiratory tract infection, diarrhea and malaria. Children's ages were estimated using a local event calendar in conjunction with immunization records provided to mothers by mobile health clinics.

The pattern of growth among East African pastoralists has been characterized as slow with a brief adolescent growth spurt, but prolonged growth into the early 20's; as adults, East African pastoralists are tall and lean by comparison with European populations. This growth pattern is hypothesized to be an adaptive response to chronic low energy intake in an unpredictably harsh environment. In Turkana, tall adult stature is attributed to high protein intake. We are testing the hypothesis that this is similar among the Karimojong given their affinities with the Turkana. In comparison with nomadic Turkana, Karimojong children appear to be both stunted and wasted in their early childhood years, while as adults they are fatter and heavier. We attribute poor child growth to the affects of psychosocial and environmental stressors that are linked to culture change, economic development, prolonged political instability, and armed violence.

This research was funded by the Wenner-Gren Foundation Grant 6276, National Geographic Society Grant 6048-97, and by the General Research Fund of the University of Kansas.

### Involvement of HLA loci in host resistance/susceptibility to tuberculosis in the Ache, a Native American population from Paraguay.

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Tuberculosis is a significant health problem for the majority of the world's populations. A growing body of evidence indicates that host genetics play an important role in determining susceptibility and resistance to tuberculosis. Research in various areas of the world has shown that multiple loci are usually involved in susceptibility, and that these loci differ by population.

In this project we use molecular biological techniques to examine the human leukocyte antigen (HLA) loci for potential association with tuberculosis susceptibility in an indigenous population from Paraguay, the Ache. Preliminary data from PPD skin tests and PCR of IS6110 from cheek swab specimens correlate strongly, and indicate that Ache suffer high levels of tuberculosis. The Ache are a highly endogamous population, and provide a unique opportunity to examine the effects of genetic differences among related individuals on susceptibility/resistance to tuberculosis.

#### The Levantine hominids as a fuzzy taxon.

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The debate over modern human origins concerns the identification of how, when, and where anatomically modern humans evolved, including the ability to identify modern humans (versus archaic humans) in the fossil record. I address this problem by applying a fuzzy statistical analysis to the Levant in Western Asia. Two groups of humans existed there in the Late Pleistocene, Neandertals (*e.g.*, Amud, Kebara) and non-Neandertals (*e.g.*, Skhul, Qafzeh). Each group has distinctive anatomy, and yet they have important morphological features in common. Do these groups represent two species or one?

It is difficult to determine how to recognize and model speciation events and processes based on the fossil record. Tattersall (1986) argues that Neandertals are a separate species (*H. neanderthalensis*) from modern humans (*H. Sapiens*); since the phylogenetic species concept is based on shared morphology, the distinct Neandertal morphology separates them from modern humans. Wolpoff (1996) disagrees, arguing that since Neandertals and modern humans share the same lineage without a clear morphological break, they must belong to the same species, albeit one with much geographic and temporal variation.

I am utilizing a new method for analyzing these two Levantine groups. The statistical tool of fuzzy analysis allows partial group membership and reflects the ambiguous nature of the fossil record. The fuzzy tool allows researchers to sort the specimens into distinct groups, while accommodating the shared features as important data. Fuzzy statistics has been previously reported (*e.g.*, Willermet and Quam 1998, reporting on Tabun C2). By applying this tool to the entire Levantine hominid sample, I evaluate to what degree each of these specimens are Neandertal-like and non-Neandertal-like. A determination of how different these groups are adds important insight useful in determining

whether the non-Neandertals in the Levant were a distinct taxon from which all modern humans descended, or whether these groups were two different subspecies of humans that each may have contributed to today's populations.

#### Diagnosing heterochronic perturbations in the craniofacial evolution of *Homo* (Neandertals and modern humans) and *Pan* (*P. troglodytes* and *P. paniscus*).

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Heterochrony is seen as a critical mechanism of evolutionary change. As long as the shape path is maintained from ancestor to descendant, altering ontogenetic trajectories can produce paedomorphosis (shape of the ancestral juvenile), peramorphosis (shape development beyond the ancestral adult) or isomorphosis (ancestral adult shape). To test the efficacy of heterochrony in explaining the evolutionary change in *Homo* and *Pan*, growth curves derived from piecewise regression of raw craniofacial linear measurements from Neandertals ( $n = 42$ ), modern humans ( $n = 294$ ), *P. troglodytes* ( $n = 156$ ) and *P. paniscus* ( $n = 151$ ) were input into the program Hetpad (Heterochronic Process: A Diagnostic), and competing hypotheses of modular and global heterochrony were compared. Trait modularity was obtained from Hetpad's exhaustive search, and from partial correlation analysis. Heterochronic change accounts for approximately 70% of the ontogenetic differences between Neandertals and modern humans, and almost 90% of the differences between *P. troglodytes* and *P. paniscus*. With respect to Neandertals, the outer dimensions of modern human calottes may be characterized as peramorphic, whereas modern human mandibles are largely paedomorphic. *P. paniscus* is modeled by Hetpad as slightly paedomorphic with respect to *P. troglodytes*. Neoteny, *sensu* Gould's (1977) *Ontogeny and Phylogeny*, fails to provide a convincing argument to explain the adult craniofacial differences exhibited by Neandertals and modern humans on the one hand, and the two species of *Pan* on the other.

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#### The bioarchaeology of Sa'ad, a late Roman/Byzantine site, Jordan.

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The late Roman/Byzantine site of Sa'ad is located approximately 30 km from the former Decapolis city of Jerash, in modern day north Jordan. Three seasons of excavation, led by the University of Arkansas and Yarmouk University, Jordan, have yielded the commingled and fragmented skeletal and dental remains of the inhabitants of Sa'ad. Interred in 88 excavated tombs, the analysis of these remains provides a valuable insight into the life and health of this sample of a rural population during this little known period of human history in the Levant. The question 'who was buried in the stone cut tombs at Sa'ad?' is analyzed by examining the skeletal, dental, and archaeological remains including artifacts and tomb architecture. Central to this analysis has been the development of effective methods to collect and analyze data from highly commingled and fragmented skeletal remains and dentition. Results include an MNI, caries rates, hypoplasia data, trauma rates, and data suggesting possible occupational stress. One exceptional insight into occupational stress experienced by the people of Sa'ad is illustrated in Tomb 4. This large stone-cut tomb, unique at this site because of its size and complexity, contains the largest number of remains in Grave 3. The high percentage of fractures to the distal radius and ulna, arthritic changes to the shoulder joint and hip, and exaggerated muscle attachments specifically of the knee and forearm, demonstrates the physical stresses placed upon the individuals.

Funding for excavation and analysis were provided by the King Fahd Middle East Studies Program, University of Arkansas, Fayetteville and Yarmouk University, Deanship of Graduate Studies and Institute of Archaeology and Anthropology.

#### Genetics, history and public perception: the Sally Hemmings-Thomas Jefferson story.

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On November 5, 1998, an article entitled "Jefferson fathered slave's last child" by Foster and coworkers appeared in the journal, *Nature*. The article, and the subsequent media coverage, provoked a storm of controversy and discussion, particularly among the descendants of Sally Hemmings.

Interviews with study participants and other Hemmings family members are used to address several ethical issues related to genetic research. The first issue concerns whether group consent as well as individual consent can and should be required when a study affects a large number of individuals. A second issue involves the kinds

of information and the level of detail needed in discussions held between the scientists and study participant prior to an individual's agreement to participate in the study. This information might include what the possible outcomes will be and the degree of confidence with which the study's conclusions can be accepted. The final issue involves the effect of media coverage on genetic research and the need to include discussions concerning how and where study results will be published and the possible affects of subsequent media coverage on the lives of the participants. Many of these concerns are now routinely addressed when genetic research involves medical applications and interventions, but studies like the Hemmings-Jefferson case expand the discussion to include research where the potential benefits to the participants and to others may be somewhat more ambiguous.

#### **Intradental variation in stable carbon isotope ratios in human tooth enamel.**

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The analysis of stable carbon isotope ratios in tooth enamel is an established technique for quantifying diet in individuals up to millions of years old. While analyses of the mean characteristics of large, homogenized samples of tooth enamel have proven useful in contrasting adult and juvenile diets, and even in the identification of weaning ages through the comparison of isotope ratios in teeth which form at different ages, our research on the microsampling of individual teeth shows significant intratooth variation in carbon isotope ratios.

Previously, microsampling variation from a single sample has been demonstrated in bovids (Wiedemann 1999). Because of differences in sampling position on a tooth, we demonstrate that a single sample may differ isotopically from another sample from a second tooth or different individual simply because of seasonal or other short-term variation in diet, rather than any general difference in overall dietary adaptation. Multiple microsamples from single teeth therefore might be used to identify seasonal or short-term dietary variation in individuals and populations. We present as an example results from the microsampling of teeth exhibiting enamel hypoplasia in which we attempt to correlate the pathological markers of dietary stress with short-term dietary changes as recorded in carbon isotope ratios. The implications of tooth enamel formation processes and sampling techniques are also discussed.

Eight teeth from eight individuals were chosen for the analysis. Up to 10 samples were drilled from each tooth and results for 40 samples are discussed. Enamel hypoplasia is evident in at least 4 of the teeth. While the carbon isotope ratios for all samples are within the range of C<sub>3</sub> consumers (-1.7 to -6.4‰), the ratios for samples from single teeth have a range of up to 4‰, representing a difference of up to 35% in the C<sub>4</sub> contribution to the diet. We suggest seasonal or short-term over-reliance on maize as the possible cause of the nutritional deficiencies indicated by the enamel hypoplasia.

#### **Intergroup differences, troop immigration, and genetic variation in mantled howling monkeys in Nicaragua.**

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Previous studies (Pope, 1995; Winkler et al., 1998) indicate a high degree of homozygosity in Central American howling monkey populations. However, questions remain as to whether this homozygosity is regionally specific (is there interregional variability?) or geographically uniform. The present study continues our work on genetic variation in the mantled howling monkey (*Alouatta palliata*) in a tropical dry forest environment on the Isla de Ometepe, Nicaragua. Blood samples were taken from 4 monkeys that were new immigrants into our 1998 study group and from 14 monkeys in two new groups in a new area as part of a capture, mark, and release project in June 2000. DNA was extracted and PCR techniques utilized to amplify 11 microsatellite loci that we had examined in our 1998 howling monkey study group.

As reported in previous studies, our results indicate considerable homozygosity at these loci. Several of the loci are monomorphic. When variation is present, the number of alleles ranges from 2 to 4. However, there is greater variation in the new sample. New alleles have been identified in the new groups or in immigrants to the 1998 group. These results accentuate the importance of intergroup immigration in maintaining intragroup heterozygosity. In addition, one of the new alleles is only found in one of the new groups in the new study area several km from the 1998 group (and separated from the 1998 group by human disturbance and environmental fragmentation). This may represent localized geographic variability. Geographic variability has been proposed to be important in maintaining species heterozygosity in the howling monkey.

This project was supported by research funds from the University of Pittsburgh and by the Fundacion Ometepe.

#### **Primatologists: duties, rights and obligations.**

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Early in the history of field primatology conducting research was relatively uncomplicated. Before leaving for the field, the primatologist obtained the necessary funds and permits to enter the area inhabited by the troop to be studied. Upon arrival at the study site, she had every expectation to be allowed to carry out her research and publish her results unharmed and without interference. More recently, however, as rain forests and other areas inhabited by primates have shrunk in size it has become increasingly difficult to find sites to study primates that are not fraught with complexity. Field primatologists (and ethnographers) are now frequently faced with problems caused by nonhuman and human primates forced to live in smaller and smaller habitats and governmental authorities/park rangers whose responsibility it is to manage natural parks and reserves. In other words, field primatologists often find themselves caught between a desire to protect dwindling primate populations, compassion for native populations, and a sense of obligation to cooperate with local authorities. In this paper I will argue that the role of the field primatologist is collecting and providing scientific information on the primates they study, assisting those in authority in protecting both people and primates from possible danger, and overseeing the humanitarian treatment of the primates.

#### **How did we get here?**

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This paper introduces the symposium "Read Our Lips, No New taxa." In it I will evaluate recent history of human taxonomy, beginning with the multiple species created for racial and fossil human variation in the 19<sup>th</sup> century, and extending to the many species of *Homo* some recognize today. Certain of the current statements supporting these multiple species have been rewriting history, describing their work as an overturning of the once widely believed Single Species Hypothesis, or even as a triumph of modern evolutionary theory over the New Synthesis. These characterizations are not correct. I am pained to admit that my Single Species Hypothesis was never believed by the majority of paleoanthropologists. Even the most dramatic lumping of the 1960's and 1970's was at the generic level and did not effect the numbers of species - for instance Robinson's reduction of australopithecine genera to *Australopithecus* and

*Paranthropus*, Simons and Pilbeam's reduction of Miocene ape genera to *Dryopithecus*.

In contrast to the genera, through the 20<sup>th</sup> century there has been a steady progression in the number of named human species. This is a more interesting issue because it reflects a phylogenetic multiplication involving branching and lineages, rather than a taxonomic issue such as whether a *Homo erectus* → *Homo sapiens* lineage should be called one species or two. The plague of taxonomizing within *Homo* might be a consequence of discovery. But new specimens do not necessarily create more gaps, they may bridge them. I would argue the state of paleoanthropology is a reflection of the *failure* of the New Synthesis to penetrate throughout, not its defeat. It reflects an *inattention* to modern evolutionary theory, not its triumph. Microevolution and other populational phenomena are ignored, isolation by distance and other aspects of population genetics remain disregarded, and homoplasy has become a commonly accepted explanation for the pattern of human evolution.

Yet many paleoanthropologists cannot be characterized this way. In this symposium, a group of them ask not whether there is but one Pleistocene lineage, and therefore species of *Homo*, but rather why there are far too many.

#### **Parasite load, growth, fluctuating asymmetry, and stress hormone profiles among children in a rural Caribbean village.**

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We investigate intestinal parasitic infection, growth, fluctuating asymmetry, and salivary cortisol profiles among 116 children in a rural village on the east coast of Dominica.

Intestinal parasite loads were determined from stool samples preserved in PVA and 10% formalin, prepared using Trichrome slides and formalin/iodine sedimentations. Observed parasites include *Entamoeba coli*, *E. histolytica*, *E. hartmanni*, *Iodamoeba butschlii*, *Blastocystis hominis*, *Giardia lamblia*, and Hookworm. Growth measures included height for age, weight for age, and body mass index. Bilateral anthropometric measures were used to estimate developmental stability. Cortisol profiles were assessed from immunoassay of saliva samples.

Analyses of data indicate that parasite loads are associated with weight for age, fluctuating asymmetry, and cortisol profiles. Virulent protozoa (*E. histolytica* and *G. lamblia*) are associated with more se-

vere growth disruptions. These results suggest that parasite loads have important consequences for child growth and development in this population.

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#### **Fruit tissue toughness as a determinant of masticatory "robusticity" and food utilization: A study of primates in central Guyana.**

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From November, 1999 through August, 2000, I collected data on the toughness of fruits processed by primates within and adjacent to a northern portion of the Iwokrama Reserve, Guyana.

Data were collected on fruits that were observed firsthand to be used, and on fruits reported to be used by primates in the Guiana Shield. The data presented here focus on the fruits processed by *Alouatta seniculus*, *Ateles paniscus*, *Cebus olivaceus* and *Cebus apella*. Data were collected on tissue toughness using a portable tester (Darvell, 1996).

It was found that the fruit parts breached, ingested, discarded or swallowed by all 4 primates are of statistically similar toughness. However, the primates with the least "robust" jaws (*A. paniscus* and *C. olivaceus*) ingested and breached the toughest tissues. This finding suggests that fruits may not pose as great a processing challenge as other utilized items, such as leaves for *A. seniculus* and insect extraction from wood for *C. apella*.

It was also found that a number of easily masticated fruit parts were either discarded or swallowed whole by the primates. This finding suggests that the limiting factor in the selection of these tissues was chemical as opposed to physical. These findings permit the presentation of a range of hypothesis to be tested in the future.

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#### **A comparison of the locomotor behavior and habitat use of *Cebus olivaceus* and *Cebus apella* in Guyana.**

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Wild populations of *Cebus olivaceus* and *Cebus apella* were observed from November 1999 through August 2000 in and adjacent to the Iwokrama Forest Reserve in central Guyana. Data were collected on positional behavior and habitat use. The home range of each species was sampled for structural characteristics and substrate availability.

The results of this study corroborate

the findings of Youlatos (1998), regarding general patterns of positional behavior in *C. apella* and *C. olivaceus* in French Guiana. However, a more detailed examination of their locomotor behavior has yielded interesting differences with respect to quadrupedalism in these two capuchin monkeys. While both species exhibit primarily quadrupedal behaviors, *C. olivaceus* quadrupedal runs and bounds more frequently during both travel and foraging than *C. apella*. *C. apella* quadrupedal walks most often, while bounding and running infrequently. *C. apella* also exhibits more suspensory and bridging behaviors than *C. olivaceus*.

It was also found that while the two species inhabit generally dissimilar forest types, both used structurally similar parts of these forests. Both capuchins forage low in the canopy or understory, and often utilized dense vine tangles.

These findings emphasize the need for more detailed analyses of quadrupedal behavior in closely related primates and greater consideration of forest structure in studies of primate positional behavior. Funding for this study was provided by The National Science Foundation #980238 and the National Geographic Society #083-0370A-6025525.

#### **Estimating sex by discriminant function analysis of long bone measurements from the Protohistoric Maya site of Tipu, Belize.**

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Determination of sex in prehistoric Maya skeletal series has long been problematic because of poor bone preservation in the region. One notable exception to this is the protohistoric (AD 1542-1668) cemetery of Tipu, Belize. Although postcontact, the population shows no signs of European admixture and appears to have maintained a large degree of cultural independence. Some 81 individuals with well-preserved cranial and pelvic indicators to allow reliable estimates of sex were chosen from the Tipu collection in order to generate a set of discriminant functions that could be used to determine sex in skeletal samples exhibiting a more fragmentary condition.

Seventeen long bone robusticity and length measurements of the humerus, tibia, and femur were taken on 38 males and 43 females. T-tests showed that the sexes were significantly different for each measurement. Twelve discriminant functions were then generated using combinations of two and three variables. Each equation correctly classified between 93 and 99% of the Tipu individuals. Two small

prehistoric samples from the sites of Seibal and Barton Ramie were used to test the reliability of the functions for earlier Maya populations. Though the sample sizes of reliably sexed individuals from the two prehistoric sites were fairly small, the preliminary results of this analysis show that the discriminant functions generated on the protohistoric sample work extremely well in prehistoric contexts.

These discriminant function equations should prove useful in Mesoamerican archaeological research where poor bone preservation severely limits the analysis and interpretation of data relating to demography and gender.

### Contrasting views of the "Race" concept in the Russian and American Physical Anthropology.

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During the past forty years, Russian and American physical anthropologists have diverged significantly in their willingness to recognize the "race" concept as scientifically useful. The position currently held by many American physical anthropologists is that the race concept has little biological meaning because of the lack of co-variation among clinally distributed heritable traits. Many people also believe that, because of historical abuses of the race concept by people who conflate cultural and biological characteristics of human populations for political purpose continued use of the term has considerable potential to do harm.

Russian physical anthropologists approach the study of human biological variation from a somewhat different perspective. From a genetic point of view, we can all agree in the fundamental biological unity of humankind. Although we are members of a polymorphic species, this morphological and biochemical variability has not destroyed the fact that we share a common gene pool. On the contrary, the polymorphism of our species is an extremely important biological precondition for the adaptability that is the hallmark of *Homo sapiens*. From the Russian perspective, the success of humankind as a cosmopolitan species has a biological as well as a cultural basis; the genetic differences that exist between modern human populations are seen as adaptations to specific ancient environmental conditions in different parts of the world.

Among Russian physical anthropologists, the major morphological variants of our species (geographical races) are united by a common genetic origin and long histories of adaptation to environmental conditions of specific geographical areas. We also recognize that different traits (cranial form, dental morphology, dermatoglyphics, blood groups, and so on) result in differ-

ent systems of racial classification. Recognition of this lack of covariation among morphological traits provides strong support for the Russian position that the "human race" cannot be divided into any biologically meaningful taxons. Acceptance of this lack of covariation among adaptively significant traits allows us to feel quite comfortable in developing different systems of classification based on the different dimensions of human biological variation.

Another key aspect of the Russian perspective on human variation concerns the relationship between cultural and biological variation: ethnic groups can encompass many different racial groups and visa versa. Just as in America, Russian physical anthropologists recognize that confusing racial and cultural differences is the basis for racist ideologies and can cause great harm. However, in contrast to many Americans, we believe the study of racial variation is important because of its ability to expose fallacious beliefs such as the idea of "higher" and "lower" races. Perhaps the term "race" has so many unfortunate connotations that another term such as "groups of populations" should be substituted for it. Never the less, from the Russian perspective, ignoring of the racial differences that do exist in our species is dangerous because it disarms us in our struggle to fight racism and racial intolerance.

### New estimates of Neanderthal speech capabilities.

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Neanderthals and *Homo sapiens* probably had similar language capabilities, but the phonetic range of Neanderthals is unknown, partly because of problems with reconstructing their supralaryngeal vocal tracts (SVTs). An adult modern human SVT has a unique two-tube shape in which the vertical and horizontal portions of the SVT (SVTv, SVTh) are equally long, allowing the production of quantal vowels—the most distinct sounds in speech. Of all vowels, the quantal vowel [i] requires the most extreme modification of the SVT by the tongue such that the mean cross-sectional area of the SVTv is 10 times that of the SVTh. Differences in skull shape and the lack of fossilized vocal tracts have made it difficult to estimate if Neanderthals could produce quantal vowels such as [i].

Previous studies of the pharynx, hyoid, and skull in humans and chimpanzees allow us to estimate the range of SVT shapes in Neanderthals. Relative to the mandible, chimpanzees have a high hyoid and larynx whereas humans have a low hyoid and larynx. We estimated maximum SVTv length in adult Neanderthals using a human regression, and minimum SVTv

length using a chimpanzee regression. Cross-sectional area functions for the vowel [i] were estimated for the maximum-length Neanderthal SVTs by proportionally expanding the interval lengths of a human area function for [i], and for the minimum-length Neanderthal SVTs by decreasing the SVTv portion of the maximum length SVT. A formant-synthesizing program returned formant frequencies using these area functions. The first two formant frequencies are the acoustic determinants of vowel type, and the second two formant frequencies indicate whether the vowel falls within quantal range for [i].

The estimated formants indicate that adult Neanderthals with a maximum-length SVT (long SVTv) can produce a quantal [i], but outside the range of [i]s produced by living humans. In contrast, the estimated formants for Neanderthals with a minimum-length SVT (short SVTv) yield [i]s that are not quantal and are outside the range of [i]s produced by living humans. Formants for intermediately-shaped SVTs were also estimated. The results show that the vowels that an adult Neanderthal could produce may have been quantal, but would have differed in some ways from those of modern humans.

### An observer error test of the transition analysis aging technique.

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The accurate determination of age at death is among the more crucial pieces of information required for any forensic and bioarchaeological investigation. In recent years a number of aging techniques have been devised and employed by physical anthropologists. Recently, Boldsen, Milner and Wood devised a new age determination technique that utilizes a number of commonly used skeletal areas in the assessment of age. This new method is called the "Transition Analysis" aging technique. It utilizes a number of features of three different skeletal regions: the pubis, auricular surface and cranial sutures. This paper examines the effects of inter- and intra-observer error on age estimates using this method. One hundred individuals from St. Mikkel's churchyard cemetery in Viborg, Denmark were scored using the technique to evaluate the repeatability of the technique between two observers (the authors). A further sub-sample of 50 individuals was then re-scored by the first author to test the technique's replicability by a single observer. Because the aging technique uses multiple variables (the pubis, auricular surface and cranial sutures) testing was done not only on the overall ages obtained between observers,



but also the ages obtained by each bone separately and in some cases between the different components analyzed on each bone. These tests were performed in an effort to better understand which component of the aging technique was the most error prone so that these components of the method may then be further revised or their aging criteria better explained in order to improve understanding of key points by potential users.

### **The missing Omo L338y-6 occipital marginal drainage pattern: There it isn't, is, isn't...**

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Using direct sectioning and CT scanned materials on the fine-quality cast of the Omo L338y-6, we find no evidence for a left enlarged occipital/marginal (O/M) sinus system as claimed by others and confirm the original reports of Holloway (1981), Kimbel (1984), and Rak and Howell (1978).

A series of enlargements of these sections fail to demonstrate any "4 mm" or otherwise elevation or depression in the regions adjacent to the left cerebellar lobe as artistically depicted by White and Falk (1999) in their Figure 2, which could be interpreted as an O/M sinus system. Sections of OH 5 and SK 1585 were used as models to demonstrate the identification of occipital marginal sinuses.

While this research does not resolve the taxonomic status of this specimen, we believe the specimen in question could certainly be a robust australopithecine as admitted by Holloway in 1988. Clearly, the absence of an enlarged O/M sinus cannot adjudicate this controversy.

### **Ethics, culture and barriers to human biology research nationally and internationally.**

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The conduct of human subjects research has evolved to the point where in the United States, ethics and law require that protocols and scientific issues must be reviewed and approved by a trained board of professional and lay persons. Informed consent and protocol review have become cornerstones of the research endeavor in the United States. But the formal task of approving consents and research protocols has steadily grown more complicated over the past decade. The

scope of research efforts that are now subject to Institutional Review Board (IRB) approval has also changed dramatically, and some of these changes have negatively impacted our ability to conduct research in a cost-effective and efficient manner.

This paper will review three areas of concern in the conduct of human biological research. First, changes in the federal-level and Institutional procedures required to protect human subjects have led to an increasingly complicated and time-consuming approval process. That oversight is now being extended to even the simplest protocols (formerly exempt) may negatively impact teaching (classroom projects such as learning how to do open-ended and structured interviews and other field skills) and students' interest in doing research. Second, the changing culture of and the for-profit commercialization of medicine has and will increasingly inhibit human subjects research in the United States. Finally, the federally mandated IRB procedures are not sufficiently flexible in accommodating research in nations with cultural values and authority structures that do not mesh with those of Western industrial nations. The liability of investigators in these cases is of concern, as is the ill-will generated by imposition of Western cultural values on collaborating foreign scientists.

Specific examples of these three issues of concern will be presented and discussed, along with a summary of our colleagues' field experiences in human subjects research around the world.

### **Testing the validity of metacarpals for sex determination of human skeletal remains.**

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Determination of sex is one of the most important steps during forensic and archaeological analyses of human skeletal remains. It has been well documented that the pelvis and skull are most useful for this process. However, skeletal remains are seldom complete or undamaged and other bones must be used. Non-weight bearing bones show a higher degree of dimorphism than weight bearing bones, and the smaller long bones of the hand (such as the metacarpals) often remain more intact. In order to determine the utility and accuracy of metacarpals in assessing sex, Scheuer & Elkington (1993) used six measurements on each metacarpal. Their overall accuracy was 74-94% with greatest accuracy produced in metacarpal I. This study seeks to validate those results.

Metacarpals from 13 human cadavers used in gross anatomy courses were harvested and cleaned of all soft tissue. All cadavers were white and all were of known

sex (5 female; 8 male). Age at death ranged from 64-90 years. Measurements were taken without knowledge of the sex of the cadaver from which the bone was harvested. The six measurements defined by Scheuer & Elkington (1993) were repeated. All measurements were taken with digital sliding calipers to the nearest 0.001 millimeter. All data were subjected to the regression equations developed by Scheuer & Elkington (1993). In this sample, accuracy in determination of skeletal variation ranged from 61.54%-92.31 %, much lower figures than those reported by Scheuer & Elkington (1993). Metacarpals II and IV produced the highest degree of accuracy, while metacarpal III produced the lowest degree. These results conflict with those reported in previous studies, both for range of accuracy and which individual metacarpals are most accurate. Further work on this subject with a larger, known sex sample is certainly warranted in order to understand these conflicting results.

### **Sherwood Washburn: the whole earth pedagogue.**

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Derived from his early experimental research on muscle-bone interaction, Sherwood Washburn used his divided human skeleton - thorax, pelvis (lower limbs and hands), and skull - to teach visually the functional regions of the body and the mosaic nature of human evolution - bipedal locomotion earlier and large brain later. His form-function approach revitalized human paleontology and fossil reconstruction. Inspired by his research on primates, he generated considerable interest in the behavior of ancient hominids. Through a series of papers and a conference he organized in 1960, *Social Life of Early Man*, Washburn brought the study of social life to center stage. His reconstructions synthesized several lines of evidence and were intended as a basis for discussion and debate. Following Washburn's example, I take a look at human evolution now and assess where we are in terms of bipedal origins and hominid social life. A number of Washburn's early ideas have held up well, whereas others remain the focus of debate. Nonetheless, his holistic approach to the teaching of physical anthropology still serves as a model for those of us in the teaching profession today.

### **Computer-assisted reconstruction and morphometry of a "new" specimen from Qafzeh**

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The Qafzeh 21 specimen, known as "The Pitta", is represented by a virtually complete but totally collapsed and fragmented cranium and mandible. The complex state of preservation of these remains makes physical restoration and reconstruction impractical, notably because fragments cannot be separated from each other without damaging them.

We report on the non-invasive computer-assisted restoration and reconstruction of this specimen. Following volume data acquisition with computer tomography (CT), the fossil fragments were isolated electronically, using automated and interactive image data segmentation procedures. Once freed from surrounding matrix, the pieces were reassembled in virtual anatomical space according to pre-defined morphological criteria. This preliminary reconstruction exhibited considerable diagenetic deformation. Various scenarios of taphonomic deformation were simulated in virtual reality to infer the nature of deformation and reverse its effects on the fossil morphology.

The finalized virtual reconstruction (which was converted into a stereolithographic cast) represents a "new" specimen, which is now accessible to morphological and morphometric analysis and adds to our understanding of craniomandibular variability in early anatomically modern human populations.

### **The influence of exercise on muscle insertion scars in sheep.**

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The size and morphology of muscle insertion marks are often used to assess activity levels in skeletal and fossil material, but very little is known about the effect of muscle use on the morphology of muscle and tendon insertion scars. This study experimentally tests the hypothesis that increased muscle use influences muscle insertion morphology by comparing the areas of muscle scars on exercised and sedentary sheep. The exercised sheep trotted for one hour a day for 90 days, a moderate regime that induced increased but not extreme skeletal loading. Sheep from two age groups were used in this study: juveniles (40 days old at the start of the experiment; n=10) and adults (400-430 days old; n=16).

The attachment sites of seven muscles (infraspinatus, teres major, biceps brachii, triceps, gastrocnemius [lateral head origin and calcaneal insertion] and quadriceps femoris) were measured using latex molds. The areas of the sites in runners and controls were compared within each age group using non-parametric (Mann-Whitney U)

tests. In the juveniles, there are no differences between runners and controls for any insertion except the teres major tuberosity (p=0.053), which is larger in runners. In adults, runners and controls are indistinguishable for all insertions except the teres major tuberosity (p=0.03) and the gastrocnemius insertion on the calcaneus (p=0.08), both of which are larger in the control group than in runners.

The results of this study indicate that moderate exercise has little to no influence on the size of muscle insertion sites. Even the teres major tuberosity, which seems to be more responsive to changes in load than the other insertion sites, reacted to exercise differently in the two age groups. It is possible that the short duration of the exercise regime did not allow time for the bones to respond to the increased skeletal activity. Additionally, macroscopic assessments of insertion marks may be inappropriate for gauging muscle use. Further studies should focus on examining the effects of muscle use at the microscopic level of the muscle/tendon-bone interface.

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