

## MIDWEST PRIMATE INTEREST GROUP 2010 SCHEDULE



**Friday September 24<sup>th</sup>**

**Field Museum of Natural History**

**West Entrance Lobby and A. Montgomery Ward Lecture Hall**

**Exhibit Tours** 3:45-4:45

**Registration** 4:45---

**Welcome** 5:45

**Thomas Diekwisch**, Head and Professor of Oral Biology, Director of the Brodie Laboratory of Craniofacial Genetics, College of Dentistry at the University of Illinois at Chicago

**Robert Martin**, A. Watson Armour III Curator of Biological Anthropology, Field Museum of Natural History

**Distinguished Primatologist Award** 6:00

**presentation to Russell Tuttle**, Professor of Anthropology and of Evolutionary Biology, University of Chicago

**Dr. Tuttle's address:** 6:10-7:00

***Who Are You Calling An Ape!***

**Reception** (paid registrants & volunteers only, please) 7:00-9:00

MPIG 2010 SCHEDULE

Saturday September 25<sup>th</sup>

UIC College of Dentistry

Fourth floor commons and Lecture Hall South

<b>Registration</b>	<b>8:15---</b>
<b>Breakfast &amp; Poster Setup</b>	<b>8:15-8:50</b>
<b>Welcome</b>	<b>8:50-9:00</b>
Social bonds between adult white-faced sakis ( <i>Pithecia pithecia</i> ) are strongest between male/female pairs, despite absence of monogamy and pair-bonding behaviors. <b>C.L. Thompson &amp; M.A. Norconk</b>	9:00-9:15
Reproductive senescence and terminal investment in free-ranging female rhesus macaques <b>Dario Maestriperi, Christy L. Hoffman, James P. Higham</b>	9:15-9:30
Sex And Age Based Differences In Antipredator Behavior In Wild Saddle-Back Tamarins ( <i>Saguinus fuscicollis</i> ) <b>Nadia Lopez-Rebellon</b>	9:30-9:45
Comparative analysis of dispersal patterns, mating strategies, and social structure in platyrrhines and catarrhines <b>Dinah Davison</b>	9:45-10:00
Why Leave a Feeding Patch: Patch Depletion and Resource Mixing in Peruvian Tamarin monkeys ( <i>Saguinus mystax</i> and <i>Saguinus fuscicollis</i> ) <b>Paul A. Garber, Martin K. Kowalewski, and Nicoletta Righini</b>	10:00-10:15
Applications of carbon and nitrogen stable isotope analysis for understanding modern and extinct primate feeding ecology <b>James E. Loudon</b>	10:15-10:30
<b>Break &amp; Poster Setup</b>	<b>10:30-10:45</b>
Numerical composition of the vertebral column: Implications for hominoid evolution <b>Scott A. Williams</b>	10:45-11:00
Bone strain and finite element modeling of the <i>Cebus</i> mandible during hard object feeding. <b>Callum Ross, Laura Porro, and David Reed</b>	11:00-11:15
Morphological variation of a Neotropical primate hybrid <b>Mary April Kelaita, &amp; Liliana Cortés-Ortiz</b>	11:15-11:30

Prenatal Androstenedione Levels are Associated with Juvenile Play Behavior in White-Faced Marmosets (*Callithrix geoffroyii*)  
**Andrew K. Birnie, Shelton S. Hendricks, Aaryn C. Mustoe, & Jeffrey A. French** 11:30-11:45

Correlates of paternal care in three hylobatid species  
**Michelle L. Rafacz, Susan W. Margulis, Rachel M. Santymire** 11:45-12:00

The evolution of serotonin receptors in five species of macaques.  
**Milena R. Shattuck and Ripan S. Malhi** 12:00-12:15

**Lunch & Poster Setup** **12:15-2:00**

Right place, right time: discoveries made & to be made at Chimfunshi  
**Mark D Bodamer, Innocent Mulenga, Edwin J C van Leeuwen, and Katherine A Cronin** 2:00-2:15

The effects of deforestation on feeding tree use in red colobus monkeys (*Procolobus rufomitratus*) in Kibale National Park, Uganda  
**Krista M. Milich and Josephine M. Chambers** 2:15-2:30

Seasonal Fluctuations in Guianan Bearded Saki (*Chiropotes sagulatus*) Ecology in Brownsberg Nature Park, Suriname  
**Tremaine Gregory and Marilyn Norconk** 2:30-2:45

Studies of the hybrid zone between Kinda baboons (*Papio kindae*) and Grayfoot baboons (*Papio ursinus griseipes*) in Kafue National Park, Zambia  
**JE Phillips-Conroy, CJ Jolly, AS Burrell, C Bergey, JA Rogers** 2:45-3:00

**Coffee break & Poster Setup** **3:00-3:15**

**LPZ poster symposium introduction (in Lecture Hall South)** **3:15-3:30**

**Poster session (Fifth floor commons)** **3:30-5:00**

**Party** (paid registrants & volunteers only, please) **7-onward**

**MPIG 2010 POSTER SYMPOSIUM: Great Ape Research at the Lincoln Park Zoo**

- 1. Behavioral correlates of staff-mediated interactions in zoo-housed chimpanzees and gorillas**  
Gita I. Chelluri, Steven R. Ross, Katherine E. Wagner
- 2. Assessing food preferences of zoo housed Chimpanzees (*Pan troglodytes*): Preliminary Results**  
E. Finestone, K. Bonnie, S.R. Ross, M. Milstein, S. Calcutt, E. Lonsdorf
- 3. Prey Item Handling By Captive Chimpanzees**  
Andrea Holmes
- 4. Lincoln Park Zoo's Biggest Loser- Gorilla Style: How small husbandry changes resulted in significant weight losses.**  
Maureen Leahy
- 5. Effects of combination birth control on estrous behavior in captive western lowland gorillas, *Gorilla gorilla gorilla***  
Susan W. Margulis, Anna Sarfaty, and Sylvia Atsalis
- 6. Blood Groups in Great Apes – Comparison of Captive and In situ populations**  
Jill Moyse and Kathryn Gamble
- 7. Space use efficiency and selectivity by zoo-housed chimpanzees (*Pan troglodytes*) and gorillas (*Gorilla gorilla gorilla*)**  
S.R. Ross, K. Anderson, and S. Calcutt
- 8. Acclimation response to novel surroundings of two species of African great ape in a naturalistic zoo environment**  
Stephen R. Ross, Marisa A. Shender, Katherine E. Wagner
- 9. Project ChimpCARE: The status of the privately-owned chimpanzee population in the United States**  
V.M. Vreeman and S.R. Ross
- 10. Conspecific access influences chimpanzee performance on a computerized sequencing task**  
K.E. Wagner and S.R. Ross

**MPIG 2010 POSTERS**

- 11. Sex Ratio Bias in Zoo-Housed Hylobatids**  
Faith Burns, Adrienne Rothenberg, and Susan W. Margulis
- 12. Microsatellite diversity and divergence in highly threatened species of West African colobus monkey**  
Joel Corush, Gail Hearn, Nelson Ting
- 13. Characterizing the vervet monkey placenta: morphology, gestational age, and fetal growth**  
Victoria deMartelly & Julienne Rutherford
- 14. Fur rubbing behavior in a wild population of Bolivian gray titi monkeys, *Callicebus donacophilus***  
Kimberly A. Dingess, Yuvinka Gareca Valdez and Ryan Driscoll

- 15. *LRP5* Sequence and Polymorphisms in the Baboon**  
Alison F. Doubleday, Frederika A. Kaestle, Laura A. Cox, Shifra Birnbaum, Michael C. Mahaney, Lorena M. Havill
- 16. Divergent patterns of integration and reduced constraint in the human hip and the origins of bipedalism**  
Mark Grabowski
- 17. Sexual dimorphism and aging of sub-cortical structures in the adult human brain using MRI.**  
Petra E. Jelenik, Steven R. Leigh, Kirk Erickson
- 18. Species diversity and relative abundance of lactic acid bacteria in the milk of Rhesus monkeys (*Macaca mulatta*)**  
Ling Jin, Katie Hinde, and Lin Tao
- 19. Development of a GIS-based habitat suitability model for *Indri indri* and *Propithecus diadema diadema* in Betampona Nature Reserve, Madagascar**  
Lana Kerker
- 20. The Effects of Sensory Integration Disorder on the Behavior of a Captive Chimpanzee (*Pan troglodytes*)**  
Kristin Kuntz, Stephanie Braccini, Ingrid Porton
- 21. Interactions between spatial genetic structuring and parasite burdens and spread in long-tailed macaques (*Macaca fascicularis*) on Bali, Indonesia.**  
Kelly E. Lane, Hope Hollocher, and Agustin Fuentes
- 22. Targets of intra-group and inter-group lethal aggression sorted by chimpanzee research site**  
Joshua L. Marshack
- 23. Patterns of *Giardia* spp. infection in howler monkeys living at the extremes of their distribution**  
Rodolfo Martinez-Mota, Martin Kowalewski, and Thomas R. Gillespie
- 24. Modeling the Ecological Niche of the Angolan Black and White Colobus Monkey, *Colobus angolensis palliatus***  
Monica McDonald
- 25. Analyzing alarm call prosody to census a population of *Cebus capucinus*: a comparative study with a traditional census methodology.**  
Amy Milin, Andrew Halloran, and Falk Huettman
- 26. Inference of Chewing Muscle Cross-Sectional Area from Bony Landmarks in Subfossil Lemurs and Adapids**  
Jonathan M. G. Perry
- 27. Use Of Gesture In Great Ape Mother-Offspring Dyads: A Comparative Analysis Of Captive Populations Of Bonobos, Orangutans & Gorillas**  
Alexandra Joy Reddy

**28. Patterns of Predation on Wild Lemurs at Beza Mahafaly Reserve, Madagascar.**

Michelle L. Sauther, Frank P. Cuzzo, Ibrahim Antho Jacky Youssouf, Jenifer Ness, Marni LaFleur, Scott Larsen, Vasyi Tkach.

**29. Developmental simulation of captive *Mandrillus* cranial ontogeny**

Michelle Singleton

**30. Effect Of Group Dynamic Changes On Behavior Of Western Lowland Gorilla**

Gary R. Steele and Susan W. Margulis

**31. Does anthropogenic habitat change effect gastrointestinal parasite infections in *Semnopithecus entellus*, a South Asian arboreal folivorous primate?**

Rajnish P Vandercone, Gayani Geethadari, Jayantha Rajapakse, Chameera Dinad, Gayan Wijethunga, David T Rasmussen

**32. Behavioral thermoregulation in captive colobus monkeys (*Colobus guereza*)**

Jason D. Wark, Christopher W. Kuhar, and Kristen E. Lukas

**33. Methodological considerations of daily path length measurements of West African chimpanzees (*Pan troglodytes verus*)**

Erin Wessling

## MPIG 2010 ABSTRACT LIST

### **Prenatal Androstenedione Levels are Associated with Juvenile Play Behavior in White-Faced Marmosets (*Callithrix geoffroyii*)**

Andrew K. Birnie<sup>1,\*</sup>, Shelton S. Hendricks<sup>1</sup>, Aaryn C. Mustoe<sup>1</sup>, & Jeffrey A. French<sup>1,2</sup>

<sup>1</sup>*Department of Psychology, University of Nebraska at Omaha, Omaha, NE, 68182, USA,* <sup>2</sup>*Department of Biology, University of Nebraska at Omaha, Omaha, NE, 68182, USA*

Exposure to androgens during sensitive periods of can influence an array of developmental trajectories. In new world primates, exposure to androgens early in postnatal life can influence both sexual and non-sexual behavioral patterns later in life. However, few studies have investigated the organizational effects of prenatal androgens on behavior in new world primates. This study evaluated the relationship between exposure to prenatal androstenedione (A<sub>4</sub>) and juvenile play behavior in the white-faced marmoset. Eighteen pregnancies yielded a total of 29 subjects (13 females; 16 males). One to three first-void morning urine samples were collected from gestating females each week and analyzed for A<sub>4</sub> concentrations using a radioimmunoassay (RIA), corrected for urinary solute concentrations by creatinine. Social play behaviors were recorded two to five times per week for all juveniles ages 5-10 months. An index of play effort was computed by summing the number of play initiations and the number of attempted play initiations for each observation. Mean gestational A<sub>4</sub> varied significantly across trimesters, and second trimester A<sub>4</sub> was higher than both first and third trimester A<sub>4</sub>. Higher levels of first, second and third trimester A<sub>4</sub> levels were all associated with higher rates of play effort directed toward fathers for juvenile females, but not males. Exposure to androgens during fetal life may be one epigenetic route by which marmoset mothers influence the behavioral phenotype of their offspring.

### **Right place, right time: discoveries made & to be made at Chimfunshi**

Mark D Bodamer<sup>1,2</sup>, Innocent Mulenga<sup>2</sup>, Edwin J C van Leeuwen<sup>2,3</sup>  
Katherine A Cronin<sup>2,4</sup>

1 Gonzaga University Department of Psychology, Spokane, Washington

2 Chimfunshi Wildlife Orphanage Trust, Zambia

3 Vrije Universiteit Amsterdam, The Netherlands

4 Max Planck Institute for Psycholinguistics, Nijmegen, The Netherlands

Chimfunshi Wildlife Orphanage Trust (CWOT) is a 24,000 acre sanctuary in Zambia dedicated to the long term care of over 120 chimpanzees living in semi-wild conditions and species-typical social groups. The research mission of CWOT is to improve the care and management of chimpanzees in sanctuaries and foster greater appreciation for their complex emotional, cognitive and social lives. CWOT is eager to identify and develop new behavioral research opportunities for students and faculty that will augment this mission. CWOT is situated in miombo forest that also supports free-ranging vervet monkeys and over three hundred species of birds. CWOT also offers opportunities for educational outreach and humanitarian service, as the sanctuary is integrated with two local villages and a short distance from an affiliated community women's center. New data resulting from research collaborations initiated at the 2009 MPIG conference will be presented, including preliminary data on the culturally-transmitted behavior of handclasp grooming (over 500 events recorded) and thought-provoking video of chimpanzee reactions to the death of a young male in their social group. This video shows for the first time, to our knowledge, detailed responses of all group members to finding the dead body of one of their

members, shedding light on both the extent to which social relationship qualities affect death responses and the way chimpanzees react to death on a group level.

### **Sex Ratio Bias in Zoo-Housed Hylobatids**

Faith Burns, Adrienne Rothenberg, and Susan W. Margulis  
Canisius College, 2001 Main Street, Buffalo NY 14208

Various explanations have been proposed for the occurrence of sex ratio bias in primates. Multiple theories have been suggested as to why sex ratio biases may occur in populations. Two of the most common theories are the Trivers and Willard theory which states that a female in good condition will produce an offspring of the sex that will most benefit from extra maternal investment, and Clark's theory of local resource competition which states that a female will produce the sex that disperses in order to decrease competition in the area. Here, we use zoo records, in the form of studbooks, to determine if a sex ratio bias exists in zoo-housed populations of gibbons. We analyzed 40 years of demographic data on three species: white-cheeked gibbons (*Nomascus leucogenys*), white-handed gibbons (*Hylobates lar*), and siamangs (*Symphalangus syndactylus*). We identified a strong male-biased sex ratio only in *N. leucogenys*. The male bias was significant for the whole 40-year period (61% male births) and for the most recent 10 year period (70% male births). In addition, male infant mortality was consistently higher than female infant mortality, but this difference was not significant. We discuss these findings in light of current theories on sex ratio bias in primates.

### **Behavioral correlates of staff-mediated interactions in zoo-housed chimpanzees and gorillas**

Gita I. Chelluri<sup>1,2\*</sup>, Steven R. Ross<sup>2</sup>, Katherine E. Wagner<sup>2</sup>

<sup>1</sup>Division of Social Sciences, University of Chicago, Chicago, Illinois

<sup>2</sup>Lester E. Fisher Center for the Study and Conservation of Apes, Lincoln Park Zoo, Chicago, Illinois

In captive animal institutions, humans are not only the source of food and other environmental needs, but are also an important part of the social environment. Highly social species in particular are susceptible to behavioral changes stemming from the nature of the animal-caretaker relationship. This study examined the behaviors that correlated with unstructured, day-to-day zookeeper-mediated interactions in chimpanzees (*Pan troglodytes*) and Western lowland gorillas (*Gorilla gorilla gorilla*). Chimpanzees exhibited an increase in both agonism and sexual behavior in focal samples containing a staff intervention, which is consistent with the characteristic high-arousal temperament of the species. This change was accompanied by a decrease in prosocial behaviors. In gorillas, abnormal and self-directed behaviors decreased significantly, although this was also accompanied by an increase in agonism. The potential welfare implications of these findings, including an apparent decrease in stress among gorillas, is discussed.

### **Microsatellite diversity and divergence in highly threatened species of West African colobus monkey**

Joel Corush<sup>1\*</sup>, Gail Hearn<sup>2</sup>, Nelson Ting<sup>1</sup>

<sup>1</sup> University of Iowa, Department of Anthropology

<sup>2</sup> Drexel University, Department of Biology



Bioko (Equatorial Guinea, West Central Africa) is an island found 32 kilometers off the coast of Cameroon and harbors one of the most species rich insular primate communities in the world. These taxa include the Endangered Pennant's red colobus (*Procolobus pennantii*) and the Endangered Bioko black colobus (*Colobus satanas satanas*), whose closest mainland relatives are the Critically Endangered Preuss's red colobus (*Procolobus preussi*) and the Vulnerable Gabon black colobus (*Colobus satanas anthracinus*), respectively. The two red colobus species and the Bioko black colobus are among the most threatened primates in Africa as these taxa suffer from extremely restricted ranges, habitat destruction, and human hunting. DNA was extracted from fecal and tissue samples from the Bioko black colobus and both red colobus species and screened at 12 microsatellite loci to infer levels of genetic diversity. Preliminary data show molecular differentiation between mainland and island species as well as variation in the genetic diversity of the two insular populations. We also aim to collect similar data for other Bioko-mainland cercopithecoid taxon pairs. By gaining insight into their levels of molecular diversity and divergence we will have a better understanding of their evolutionary history, colonization and speciation processes, and the biogeographic history of the region. This information will ultimately aid in designating conservation priorities for the region and developing more effective conservation strategies.

### **Comparative analysis of dispersal patterns, mating strategies, and social structure in platyrrhines and catarrhines**

Dinah Davison  
University of California, Davis

Dispersal in non-human primates occurs when group members leave their natal social groups prior to reaching reproductive maturity. Dispersal in primates is generally biased towards one sex, and dispersal patterns vary greatly both between and within species. Dispersal has been closely tied to many different aspects of primate social ecology and group dynamics.

This study examines the relationship between dispersal patterns and the frequency of agonistic and affiliative inter-group interactions across primate species. Data from previously published studies on dispersal and contact between social groups in both platyrrhines and catarrhines is used to create a dataset that contains information on the majority of monkey and ape subfamilies. A number of variables related to dispersal patterns, mating strategies and social structure are included in this analysis in order to better understand some of the complex interactions between inter-group interactions and dispersal. The results of this study will be presented at the conference.

### **Characterizing the vervet monkey placenta: morphology, gestational age, and fetal growth**

Victoria deMartelly<sup>1,2</sup> & Julienne Rutherford<sup>2,3,4</sup>

<sup>1</sup>Field Museum of Natural History, Chicago, Illinois

<sup>2</sup>Comparative Primate Biology Laboratory, University of Illinois at Chicago

<sup>3</sup>College of Dentistry, Department of Oral Biology, University of Illinois at Chicago

<sup>4</sup>Department of Anthropology, University of Illinois at Chicago

Little is known about placental growth and morphology across gestation in nonhuman primates. A rare time-series of 50 vervet monkey (*Chlorocebus aethiops*) placentas from the St. Kitts Biomedical Research Foundation was characterized in terms of gross morphology and shifts in efficiency across the latter half of a species-typical 167-day gestation. The vervet placenta typically consists of two separate discs; in the current sample, 15% of the placentas were fused into a single mass. Fixation caused an average decrease in mass of

14%; shrinkage was not correlated with gestational age, but shrinkage shared a positive association with placental weight ( $p=0.0001$ ). Although both fetal mass and placental mass increased significantly with gestational age (Pearson's correlations:  $r=0.85$ ,  $p<0.001$ ;  $r=0.64$ ,  $p<0.01$ , respectively), growth was not symmetrical. Placental efficiency during period 2 (d. 131-159) was 43% greater than that of period 1 (d. 83-130) (T-test:  $t=-3.60$ ,  $p<0.001$ ), indicating that there is a significant reduction in the relative size of the placenta as gestation progresses in the vervet monkey. Placental growth in the vervet plateaus around day 130, signifying an important shift in the metabolic capacity of the placenta, perhaps in relation to investment in developmental events such as brain growth. Future functional analyses of the microscopic placental morphology in the vervet will take into consideration the implications of placental fusion, the mechanisms of increased efficiency, and fetal brain development.

### **Fur rubbing behavior in a wild population of Bolivian gray titi monkeys, *Callicebus donacophilus***

Kimberly A. Dingess<sup>1</sup>, Yuvinka Gareca Valdez<sup>2</sup> and Ryan Driscoll<sup>3</sup>

<sup>1</sup> Department of Anthropology, Indiana University Bloomington, DANTA: Association for Conservation of the Tropics and Wildlife Conservation Society, Bolivia

<sup>2</sup> Museo de Alcide D'Orbigny, Bolivia

<sup>3</sup> DANTA: Association for Conservation of the Tropics

We report on the first documented event of fur rubbing in the genus *Callicebus* for possible medicinal purposes. From February to March, 2010, five instances of fur rubbing were recorded in a wild population of *Callicebus donacophilus* on the outskirts of Santa Cruz, Bolivia. Leaves of a *Piper* species, a species known for its insecticidal and antiseptic properties, were used in each instance and by 3 different individuals (breeding pair and sub-adult offspring) of the same group. Multiple leaves were applied in a stereotypical fashion to largely the chest and arms before being discarded. All observed cases of fur rubbing occurred when humidity was high suggesting an increase in the number of insects and risk of bacterial and fungal skin infections.

### ***LRP5* Sequence and Polymorphisms in the Baboon**

Alison F. Doubleday<sup>1</sup>, Frederika A. Kaestle<sup>2</sup>, Laura A. Cox<sup>3,4</sup>, Shifra Birnbaum<sup>3</sup>, Michael C. Mahaney<sup>3,4</sup>, Lorena M. Havill<sup>3</sup>

<sup>1</sup>Department of Oral Biology, University of Illinois at Chicago College of Dentistry, Chicago, IL

<sup>2</sup>Department of Anthropology, Indiana University, Bloomington, IN

<sup>3</sup>Department of Genetics, Southwest Foundation for Biomedical Research, San Antonio, TX

<sup>4</sup>Southwest National Primate Research Center, San Antonio, TX

The gene *LRP5* is known to have an important relationship with bone density and a variety of other biological processes, such as type I diabetes, hypercholesterolemia, and atherosclerosis. Mapping to human chromosome 11q13.2, *LRP5* shows considerable evolutionary conservation. Orthologs of this gene exist in many species, although comparison of human *LRP5* with other non-human primates has not been performed until now. We report the complementary DNA (cDNA) sequence and deduced amino acid sequence for baboon *LRP5*, and compare the baboon and human sequences. cDNA sequences for 21 baboons are examined to identify single nucleotide polymorphisms (SNPs). Results of the comparison demonstrate that sequences of coding regions in human and baboon *LRP5* show 97% to 99% homology. Twenty-five SNPs are also identified in the coding region of baboon *LRP5*. The observed degree of coding sequence homology in *LRP5* leads us to expect

that the baboon may serve as a useful model for future research into the role(s) of this gene in primate metabolic diseases.

### **Assessing food preferences of zoo housed Chimpanzees (*Pan troglodytes*): Preliminary Results**

E. Finestone<sup>1</sup>, K. Bonnie<sup>2</sup>, S.R. Ross<sup>1</sup>, M. Milstein<sup>1</sup>, S. Calcutt<sup>1</sup>, E. Lonsdorf<sup>1</sup>

<sup>1</sup>Lester E. Fisher Center for the Study and Conservation of Apes, Lincoln Park Zoo, Chicago, IL 60614

<sup>2</sup>Beloit College, Department of Psychology, 700 College St., Beloit, Wisconsin, 53511

Individual preferences, and the choices made based on those preferences, are key components of behavioral economics (Schwartz, 2008) and foraging strategies (Remis, 2002). To determine individual preferences, we presented seven zoo-housed chimpanzees (3 male, 4 female) with six pair-wise combinations of hoisin, ketchup, mustard and peanut butter. In each session, substances were presented in pairs, and testing sessions were repeated on subsequent days until at least 10 trials were completed for each pair. We randomly assigned the location of each substance to the left and right in each session. Preliminary results indicate an interaction between individual substance preference and side bias. A significant substance preference ( $p < 0.05$ ) was evident in 54.8% of all pairings with subjects all showing a significant preference in at least one of the six substance pairings. A significant side bias ( $p < 0.05$ ) was evident in 23.8% of substance pairings, with all individuals exhibiting a significant side bias in at least one substance pair. However, substance and side bias occurred almost mutually exclusively. When a subject expressed a substance preference ( $p < 0.05$ ) they rarely expressed side biases (8.7% of cases). However, when presented with more “evenly matched” substances, where preferences were not significant ( $p > 0.1$ ), a significant side bias was evident in 50.0% of cases. These preliminary results suggest that side-biases in chimpanzees may be conditional on their preference for the particular items being presented.

### **Why Leave a Feeding Patch: Patch Depletion and Resource Mixing in Peruvian Tamarin monkeys (*Saguinus mystax* and *Saguinus fuscicollis*)**

Paul A. Garber<sup>1</sup>, Martin K. Kowalewski<sup>2</sup>, Nicoletta Righini<sup>1</sup>

<sup>1</sup> Department of Anthropology, University of Illinois at Urbana-Champaign, USA

<sup>2</sup> Estación Biológica de Usos Múltiples de Corrientes (EBCo), Museo Argentino de Ciencias Naturales-CONICET, Argentina

Tamarins are small-bodied primates whose diet includes ripe fruit, insects, nectar, and plant exudates. These resources differ in nutritional content, seasonal availability, patch size, rates of renewal, and require different foraging strategies for their efficient acquisition. Models of optimum foraging generally assume that foragers leave a patch when food is depleted, falls below the average value of patches in the habitat, and/or the forager is satiated. In this study we present the results of a 7 month field study of tamarin diet, patch choice, and patch productivity to examine the question: Why leave a patch? Data on tamarin feeding behavior was collected at 2 minute intervals throughout the day ( $N=3180$  feeding records). Feeding bouts were scored as satiation (when after feeding, tamarins rested or engaged in social interactions for  $> 30$  min), nutrient mixing (when tamarins fed on one food type and then switched to a different food type), or patch depletion (when the tamarins left a food patch and then traveled to another tree of the same species to feed and did not revisit the patch the same day or the following day). Results indicate that nutrient mixing accounted for 46.9% of all feeding bouts, with switching from fruit to insect most common. In only 14.6% of cases were tamarins scored as satiated. We argue that resources exploited by tamarins are not nutritionally interchangeable and that

requirements of nutrient-mixed need to be considered in understanding primate responses to resource scarcity and distribution.

### **Divergent patterns of integration and reduced constraint in the human hip and the origins of bipedalism**

Mark Grabowski

Department of Anthropology, University of Illinois at Urbana-Champaign

Bipedal locomotion is generally accepted as being the first characteristic that separated hominins from our most recent common ancestor with the chimpanzee. When compared to all other extant apes, the human hip reveals a fundamental reorganization of bony morphology comprised of multiple trait-level changes, many of which are associated with this novel locomotor behavior. In addition to shape and size changes, establishing how the pattern of phenotypic integration — associations between traits — within the hip has evolved is essential to explaining this evolutionary transition as integration patterns may facilitate or constrain morphological change. This analysis reveals that the human hip bone is less integrated than that of all other apes, and many traits thought to be important in the shift to bipedalism are individually less integrated and less constrained when compared either to other pelvic traits in humans, or the same traits in all other apes. In addition, the human hip exhibits a pattern of integration that is distinct from all other apes not only in the levels of integration but also in the evolutionary response to selective forces this pattern could produce. These results suggest that natural selection for bipedalism likely broke down earlier hominid integration patterns and realigned patterns of variation (i.e. reintegrated traits) in response to the shape of the adaptive landscape. These findings are the first indicator that changes in integration patterns played a significant role in the evolution of bipedalism.

### **Seasonal Fluctuations in Guianan Bearded Saki (*Chiropotes sagulatus*) Ecology in Brownsberg Nature Park, Suriname**

Tremaine Gregory and Marilyn Norconk

Department of Anthropology, Kent State University

Bearded saki monkeys (*Chiropotes*) are amongst the most mobile New World primates, with day and home ranges exceeding those of the larger-bodied, frugivorous atelines. Along with closely related uakaris (*Cacajao*), they form the largest social groups amongst the playrrhines. In this study, we added to the existing ecological data on bearded sakis, with a study in continuous forest containing the highest densities of sakis recorded. This study was conducted in Brownsberg Nature Park, Suriname from March 2008 to April 2009 and found that group size ranged from 3 to 45 (mean=17.54±12.8), with travel rates of 38.0±55.1m/10 minute sample. Average day paths of 2.4±0.8km/day resulted in an average change in elevation of 544±198m/day and a maximum home range of 742ha. Results from the long dry and short wet seasons combined show a seed-dominated diet (85.3%). As others have suggested, high levels of mobility are correlated with high intake of seeds. This correlation was substantiated in this study with ecological and behavioral adjustments during the long dry season: smaller groups, shorter day paths, lower percentage of seeds in the diet, more time spent in each feeding tree, and more feeding trees used. These results suggest that while exploitation of a highly nutritious resource available over a wide time range is consistent with being highly mobile, bearded saki ecology is variable dependent on seasonal fluctuations in the forest.

## Prey Item Handling By Captive Chimpanzees

Andrea Holmes  
Northern Illinois University

While much attention has been given to the hunting behavior and subsequent meat consumption exhibited by wild chimpanzees, very little data has been published regarding chimpanzees in captivity. Captive apes that capture prey subsequently engage in a wide array of behaviors, including play, disembowelment, and aggressive displays. This study builds upon that information, focusing on the individual in possession of a prey item.

Hypothesis 1) Male chimpanzees will capture prey more frequently than females. Null hypothesis 1) Male and female chimpanzees will capture prey with equal frequency. Hypothesis 2) Males that capture prey will engage in more violent and destructive behaviors with prey carcasses than females. Null hypothesis 2) Males and females who capture prey items will engage in equally destructive behaviors of the carcass. Within the subject group, female chimpanzees captured local animal species more frequently than males. This is in contrast to chimpanzee behavior in the wild. Females of the group also exhibited affiliative behaviors with local animal species at a higher frequency than males. Males of the group exhibited behaviors that were categorized as harmful and dangerous for the captured individual. There were no behaviors observed that would expose the subject group to blood-borne illnesses. However, the duration of close contact observed within the subject group would potentially place group members at risk for contracting parasites.

## Sexual dimorphism and aging of sub-cortical structures in the adult human brain using MRI.

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Current research on brain volumetrics reveals conflicting results about human brain dimorphisms. Although it is apparent that dimorphisms are not homogeneously spread throughout the brain, studies are also notably inconsistent in the direction and extent of dimorphism, and whether senescence may affect male and female brains differently (Allen et al., 2003, 2005). Measurements of interest include total brain volume, accumbens, amygdala, caudate, hippocampus, pallidum, putamen, and thalamus. These measurements were acquired through an automated segmentation program available through FSL (FMRIB's Software Library) version 4.1, written by the Analysis Group, FMRIB, Oxford, UK (<http://www.fmrib.ox.ac.uk/fsl/index.html>). Subjects include 192 healthy individuals, consisting of two age categories: ages 18 to 35, and ages 50 to 80. Results support previous studies that indicate that total and structural brain volumes are "age-dependent biological variables" (Allen, 2005). Principal component analysis indicates that the first principal component accounts for 56% of the variation in sub-cortical structures, meaning overall brain size (and size-correlated shape) are driving much of the variation we see in sub-cortical size. However, there are also differences in how much the first principal component describes size variation for each of the sub-cortical structures individually, and how it describes the age and sex categories. The sub-cortex as a whole may be configured differently based on size, sex, and age. Possible functional significance of these differences is discussed.

## Species diversity and relative abundance of lactic acid bacteria in the milk of Rhesus monkeys (*Macaca mulatta*)

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**Background** Mother's milk is a source of bacteria that influences the development of the infant commensal gut microbiota. To date the species diversity and relative abundance of lactic acid bacteria in the milk of non-human primates has not been described.

**Methods** Milk samples were aseptically obtained from 54 female rhesus monkeys (*Macaca mulatta*) at peak lactation. Following GM17 and MRS agar plating, single bacterial colonies were isolated based on difference in morphotypes, then grouped based on whole-cell protein profiles on SDS-PAGE. Bacterial DNA was isolated and the sequence the 16S rRNA gene was analyzed.

**Results** A total of 106 strains of 19 distinct bacterial species, belonging to five genera, *Bacillus*, *Enterococcus*, *Lactobacillus*, *Pediococcus*, and *Streptococcus*, were identified.

**Conclusions** Maternal gut and oral commensal bacteria may be translocated to the mammary gland during lactation and present in milk. This pathway can be an important source of commensal bacteria to the infant gut and oral cavity.

### Morphological variation of a Neotropical primate hybrid

April Kelaita & Liliana Cortés-Ortiz  
University of Michigan

Interbreeding between different primate species is now widely recognized. However, the variability of morphology that can be exhibited by the resulting hybrid offspring is poorly understood. Early studies of primate hybridization involved the detection of hybrid individuals using external morphological features. Here we present data from the sister species, *Alouatta palliata* (mantled howler monkey) and *A. pigra* (black howler monkey), which diverged approximately 3mya. Offspring of *A. palliata* and *A. pigra* crosses usually resemble individuals of the species with whom they reside in appearance and thus could only be identified with confidence using diagnostic microsatellite loci. We compare several morphometric traits of hybrid individuals with pure individuals for each sex. An ANOVA was carried out to detect where differences between *A. palliata*, *A. pigra*, and hybrids were significant along with a post-hoc Tukey's test to ascertain which means were significantly different from one another. Results indicate that for weight, hybrid females resemble *A. pigra*, but are intermediate in body length between the two parent species. Hybrid males are like *A. pigra* in weight and body length but are intermediate in testicular volume between the two parent species. We show that hybrids that are difficult to identify based on appearance may still exhibit quantitative differences in morphology as compared with the parent species, demonstrating the extent of morphological variation that can exist in hybrid individuals.

### Development of a GIS-based habitat suitability model for *Indri indri* and *Propithecus diadema diadema* in Betampona Nature Reserve, Madagascar

Lana Kerker  
Washington University in St. Louis

Using Geographic Information Systems (GIS) technology, researchers are now able to combine information from satellite images, GPS data and field studies to determine the probability of species occurrences based on ecological and environmental variables. The purpose of this study was to create a GIS-based habitat

suitability model for 2 sympatric lemur species (*Indri indri* and *Propithecus diadema diadema*) within Betampona Nature Reserve (BNR), a 2228 ha lowland rain forest located in northeastern Madagascar. GPS data was collected in 2007-2008 for 5 groups of *I. indri* and 2 groups of *P. d. diadema* within BNR. This data was then combined with remotely sensed Landsat TM and SRTM images to create 4 measurable environmental variables (NDVI, elevation, slope and aspect). The GPS data was used to determine the importance of each of the environmental variables in the prediction of the occurrence of each lemur species. The 4 variables were then weighted specifically for each species in an effort to create 2 habitat suitability models. Based on the models, *I. indri* is predicted to occur in a larger area of the forest than *P. d. diadema*. This finding is consistent with a previous census of these 2 species within BNR that showed a larger *I. indri* population than *P. d. diadema*. This model will now be used to locate previously unstudied groups of each species within the reserve.

### **The Effects of Sensory Integration Disorder on the Behavior of a Captive Chimpanzee (*Pan troglodytes*)**

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Holly, a female chimpanzee at the Saint Louis Zoo, presented symptoms similar to those of Sensory Integration Disorder (SID), a human condition characterized by the inability to perceive, attach meaning to, and respond to multiple sensory inputs. This study was conducted in order to assess the severity of Holly's irregular patterns of behavior through comparison to two other females in her age cohort, Bakhari and Tammy. A total of 40 hours of data were collected, with observations taking place in both the indoor and outdoor enclosures. Continuous focal sampling was carried out in 10-minute intervals in order to create activity budgets for each focal chimpanzee and assess duration of abnormal behavior. All occurrence sampling was used to assess frequency of stress-related behaviors. The results indicated that Holly's activity budget differed noticeably from those of Bakhari and Tammy, marked by an increase in abnormal and social behaviors and a decrease in solitary behavior. Abnormal and stress-related behaviors were found to increase markedly upon moving from the indoor to outdoor habitat. While Holly was found to socially groom all nine of the chimpanzees in the enclosure, she rarely received grooming. The nature of the abnormal behavior and evidence of social rejection by peers are congruent with the diagnosis of SID; however, Holly's pursuit of social interaction is a discrepancy that should be explored with other diagnoses.

### **Interactions between spatial genetic structuring and parasite burdens and spread in long-tailed macaques (*Macaca fascicularis*) on Bali, Indonesia.**

Kelly E. Lane, Hope Hollocher, and Agustin Fuentes  
University of Notre Dame

The spatial relationship between host and parasite is one of ultimate importance in understanding infectious disease. On the Indonesian island of Bali, long-tailed macaques (*Macaca fascicularis*) thrive in populations associated with large temple complexes across the island. The interactions of macaques within and between temple sites create a dynamic system to study the role of host population structure on parasite burdens. Using GIS tools combined with genetic analyses of 15 macaque populations, we are applying three analytical approaches for understanding these relationships. In the first approach, we make a direct comparison between genetic and geophysical space using Mantel tests to see how well genetic and physical measures of distance correspond. In the second approach, we integrate the phylogenies of mitochondrial, Y chromosomal,

and nuclear DNA with GIS maps of Bali to explore the spatial structure across multiple gene genealogies in order to understand how differential patterns of inheritance are influenced by spatial structure. And finally, we incorporate shared parasite burden into our analysis to evaluate how well spatial and genetic structuring of host populations corresponds to parasite distributions and to identify potential barriers and corridors for macaque dispersal and parasite transmission.

**Lincoln Park Zoo's Biggest Loser- Gorilla Style:  
How small husbandry changes resulted in significant weight losses.**

Maureen Leahy

Maureen Leahy is the Curator of Primates at Lincoln Park Zoo overseeing the Regenstein Center for African Apes and the Helen Brach Primate House. She has been working with primates in a zoological setting for nearly 15 years both as a primate keeper and a manager. Maureen is currently a member of the Gorilla SSP Management Group.

Body weight management can be a challenging component of animal care, especially for individuals who are more prone to obesity, which can include domestic, companion, and even some zoo animals. Western lowland gorillas (*Gorilla gorilla gorilla*) is one species that may have a greater propensity towards obesity in a zoological setting because of risk factors including, but not limited to: social dynamics in group-feeding contexts often impede dietary portion control; dietary rations may be especially calorically dense and higher in fat and carbohydrate content; and exhibit size and design may limit energy devoted to food-collection and processing. Given the interaction between obesity and long-term health issues including cardiovascular disease, diabetes, and arthritis, captive weight management poses a critical challenge to gorilla caretakers.

At Lincoln Park Zoo, a few of the 12 resident gorillas were previously diagnosed as significantly overweight by veterinarian and nutritionist staff. In response, the animal care staff at the Regenstein Center for African Apes implemented a number of small changes in husbandry practices to promote weight loss. Caretakers incorporated daily exercise and routine weighing in positive reinforcement training sessions, along with modifications in diet composition, presentation, and distribution. Over the course of two years, these practices resulted in significant weight loss in all affected individuals: the heaviest silverback lost over 60 pounds, while the heaviest female lost a total of 55 pounds. This presentation will describe how we incorporated these weight loss practices into our daily husbandry routine and can provide other institutions with a low-cost model for a gorilla weight management program.

**Sex and Age Based Differences in Antipredator Behavior in Wild Saddle-Back Tamarins (*Saguinus fuscicollis*)**

Nadia Lopez-Rebellon

Northern Illinois University

Antipredator behaviors are observed in a wide range of animal taxa. Due to their relatively small body size, callitrichines are expected to be at a greater risk of predation than larger bodied primates as they can be preyed upon by a wider range of predators. The effects of predation on primate behavior can be observed in the antipredator strategies they adopt when predators are not present. The purpose of this study was to assess sex and age based differences in antipredator and risk-taking behavior in three groups of wild saddle-back tamarins (*Saguinus fuscicollis*). In the first part of this study, experimental feeding platforms baited with bananas were set up in the forest under different conditions of risk using height support and forest cover as variables. In the second part of the study one group was habituated and followed to obtain naturalistic



observations on the monkeys' predator sensitive behaviors in their natural environment. The results from the experimental and naturalistic portions of this study support the idea that juvenile saddle-back tamarins follow a risk-aversion strategy. However, there was no support to suggest that female saddle-back tamarins differ from males in the manner in which they engage in risky behavior. By documenting intraspecific differences in antipredator behavior, this study provides important insights into questions concerning behavioral adaptability and plasticity.

### **Applications of carbon and nitrogen stable isotope analysis for understanding modern and extinct primate feeding ecology**

James E. Loudon

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A number of studies have demonstrated the usefulness of carbon and nitrogen stable isotope analysis for understanding the feeding ecology of a broad fauna. However, stable isotope analysis remains embryonic for those interested in primate feeding ecology. Isotopic ratios of carbon and nitrogen are recorded in animal tissues and fecal matter allowing for the analysis of both modern and fossil specimens. Thus, stable isotope analysis can provide insights into understanding living and extinct primate communities. This presentation discusses our current research on ring-tailed lemur (*Lemur catta*) and chimpanzee (*Pan troglodytes*) isotope ecology. Carbon and nitrogen stable isotope studies of lemurs have demonstrated the ability to track male migration patterns and differentiate healthy vs. unhealthy individuals. Moreover, these data can be compared to the values exhibited by subfossil lemurs to provide a better understanding of extinct lemur feeding ecology. Our ongoing research on the isotope ecology of savanna and forest-dwelling chimpanzees allow for inter-community comparisons of extant populations and this may be helpful in understanding the degree to which communities are incorporating animal proteins and/or crop raiding for C<sub>4</sub> foods such as maize and sorghum. These data are also applicable for understanding the divergent feeding habits between chimpanzees and hominins. Published isotopic values of *Australopithecus*, *Paranthropus*, and early *Homo* suggest that our hominin ancestors incorporated significantly more C<sub>4</sub> foods than savanna-dwelling chimpanzees or papionins.

### **Reproductive senescence and terminal investment in free-ranging female rhesus macaques**

Dario Maestriperi, Christy L. Hoffman, James P. Higham.

Department of Comparative Human Development and Institute for Mind and Biology, The University of Chicago.

Long-lived species show age-related changes in reproduction that may be explained by two non-mutually exclusive processes. The process of senescence predicts decreased female reproductive output with increasing age due to an age-related decline in body condition. The terminal investment hypothesis predicts increased female reproductive effort with increasing age, as there is a reduced likelihood of aged individuals successfully reproducing in the future. Non-human primates are ideal organisms for testing the relative effects of these processes, as they are long-lived and produce offspring heavily dependent on maternal investment. In this study, we integrated data collected over 48 years from 637 adult female rhesus macaques (*Macaca mulatta*) and their offspring residing on Cayo Santiago, with new morphometric and behavioral data collected from 26 adult females and their infants, to test the predictions of the senescence and the terminal investment hypotheses. We examined relationships between maternal age and the body condition of both mothers and infants, mother's interbirth intervals, measures of mother's behavioral investment in offspring, and offspring

survival and fitness. Older mothers had lower body mass indices and were less active, had longer interbirth intervals, invested more behaviorally in infants, but nonetheless had infants of lower masses and survival rates. Our results provide strong evidence for reproductive senescence in free-ranging female rhesus macaques, but are also consistent with some of the predictions of the terminal investment hypothesis.

### **Effects of combination birth control on estrous behavior in captive western lowland gorillas, *Gorilla gorilla gorilla***

Susan W. Margulis<sup>1,2,3</sup>, Anna Sarfaty<sup>1</sup>, and Sylvia Atsalis<sup>4,5</sup>

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5. The Field Museum, Chicago, IL

Combination birth control pills (CBC) are one of the most common birth control methods used for western lowland gorillas (*Gorilla gorilla gorilla*) housed in zoos. Since zoos are interested in maintaining as many natural behaviors as possible, it is important to know how contraception may affect social and sexual interactions among group members. Although some data are available regarding the influence of the pill on sexual behavior in human females, no data are available on its effects on gorilla estrous behavior. We examined temporal trends of estrous, aggressive, affiliative, and activity budget data in four females on CBC at the Lincoln Park Zoo in Chicago, IL. Behavioral data were collected using point sampling, all-occurrence records, and one-zero sampling. Estrous behavior occurred in less than 1% of observations. Using all-occurrence and one-zero sampling, estrous behavior occurred more frequently in week 1 of the cycle than any other week. The focal females exhibited affiliative, aggressive, and activity budget data evenly across their cycles. There were also no temporal trends in proximity to the silverback. We give a hormonal explanation for the prevalence of estrous behaviors in week 1, and recommendations for effective behavioral sampling of gorilla estrous behavior.

### **Targets of intra-group and inter-group lethal aggression sorted by chimpanzee research site**

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Department of Anthropology, Washington University

Chimpanzees, like their human relatives, have been observed to kill members of their own species, a behavior not common in the animal kingdom (Wrangham, 1999). It is generally believed that this behavior is adaptive in both species, and natural in chimpanzees, rather than the result of aberrant conditions, such as ones imposed by humans (Mitani *et al.* 2010).

Here, based on lethal attacks directly observed by researchers and those deduced from fresh carcasses, I present all of the current published data on targets of both within- and between-community lethal aggression for 11 research sites: Gombe, Mahale, Kibale, Budongo, Kalinzu, the Triangle, Loango, Goulougo, Taï, Bossou, and Fongoli. Attacks on adults as well as instances of infanticide are included. In summary, there were 27 cases of within-group lethal aggression and 67 cases of between-group lethal aggression. Of these, 21 of the former and 27 of the latter were infant deaths.

Lethal aggression is not ubiquitous across chimpanzee populations and is absent or nearly so at four of the eleven sites. Highly aggressive and lethal social interactions are perhaps not a universal characteristic of

chimpanzees, and may only be endemic to sites with specific environmental and demographic factors. The occurrence of lethal aggression also seems to vary among the subspecies.

### **Patterns of *Giardia* spp. infection in howler monkeys living at the extremes of their distribution**

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Giardiasis constitutes a neglected disease caused by the zoonotic protozoan *Giardia* sp. that is often associated with poverty and sanitary deficiencies in developing countries where infecting humans, domestic animals, and wildlife. We explored patterns of *Giardia* infections in *Alouatta caraya* (black and gold howler monkeys) in Argentina and *A. pigra* (Mexican black howlers) in Mexico, at the two extremes of the geographic distribution of *Alouatta*. We collected 30 fecal samples from different groups of both howler species at two sites: 1) Isla Brasilera, Chaco Province, Argentina (27°20'S-58°40'W) which is a 290 ha island characterized by a continuous flooded forest interrupted by small lagoons and streams; and 2) "El Tormento", State of Campeche, Mexico (18°16'N, 90°43'W), a 1400-ha protected area of tropical semi-deciduous forest located near the town of Escárcega. Both areas are characterized by minimal human presence, absence of cattle ranching and agriculture practices, and howler groups showing extensive home range overlap. We examined all samples (N=60) for *Giardia* sp. infections via immunofluorescent antibody (IFA) detection. Interestingly, we found a 57% prevalence of *Giardia* infection in black and gold howlers and 0% in Mexican black howlers. We suggest that 1) this pathogen is not a natural component of the howler parasite communities at the Mexican site, and/or 2) even a minimal contact with humans and associated domestic animals, combined with the presence of water bodies from where howlers occasionally drink, produces rapid increases in the rate of *Giardia* infections. We encourage future research on the epidemiology and cross-species transmission ecology of *Giardia* and other infectious agents, not only in humans and livestock, but also in wild animals that sharing their environments, to understand their role in the cycle of this disease.

### **Modeling the Ecological Niche of the Angolan Black and White Colobus Monkey, *Colobus angolensis palliatus***

Monica McDonald

Department of Anthropology - Washington University

Ecological niche models can aid in understanding the relationship between environmental factors and an animal's geographic distribution. In this study, ArcGIS 9 and Maxent were used to predict the distribution of *Colobus angolensis palliatus*, a subspecies of Angolan Black and White Colobus monkey that resides in fragmented forests throughout East Africa. In particular, this study was undertaken (1) to discover the predicted distribution of *C. a. palliatus* in Kenya and Tanzania under two different taxonomic scenarios, (2) to ascertain the probability of their occurrence in these areas, (3) to see how these results compare to the IUCN habitat map, and (4) to recognize which environmental variables best explain their geographical distribution. Results of this study suggest that while the predicted distribution differs under the two taxonomic scenarios, precipitation and temperature variability measures seemed to be important in determining *C. a. palliatus* distribution. These results were similar to the IUCN habitat map; however, compared to the IUCN habitat map, these results both over-predicted and under-predicted their distribution. This study highlights current environmental differences in *C. a. palliatus* habitat in Kenya versus Tanzania. It also uncovers probable areas in which to find these monkeys,

which is invaluable when undertaking additional behavioral or genetic research. Finally, these results serve as a starting point from which to uncover past *C. a. palliatus* distributions or make future climate change predictions.

### **The effects of deforestation on feeding tree use in red colobus monkeys (*Procolobus rufomitratu*s) in Kibale National Park, Uganda**

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Investigations of resource abundance across logged and unlogged forests have revealed associations between considerable reductions in tree density and food availability, which further correlate with significant adjustments in behavioral strategies of primate inhabitants. This study examines the impacts of logging on feeding tree resources for red colobus monkeys (*Procolobus rufomitratu*s) living in logged and unlogged areas of Kibale National Park, Uganda. Kibale National Park includes unlogged areas of the forest, partially logged areas, and areas that were heavily logged prior to the establishment of the national park. This study includes six groups of red colobus (three living in unlogged areas and three living in heavily logged areas). Feeding trees were marked and measured as focal individuals were feeding. Measurements included the diameter at breast height (DBH), total height of the tree, size of the crown, and the percentage of fruits, young leaves, mature leaves, flowers, and bare branches on each tree. We have used these measurements to examine how logging may impact food resources for red colobus monkeys. We further compared the different species of trees being utilized in each type of habitat to understand the long-term effects of logging on forest species composition, and how this may affect red colobus behavior. These findings are imperative to understanding the effect of logging activities on wild primate populations, even many years after the initial destruction.

### **Analyzing alarm call prosody to census a population of *Cebus capucinus*: a comparative study with a traditional census methodology.**

Milin, Amy 1,2

Halloran, Andrew R. 1,2

Huettman, Falk, 1,3

1. Maderas Rainforest Conservancy
2. Florida Atlantic University, Department of Anthropology
3. University of Alaska, Fairbanks. EWHALE

Halloran et al (2010) detailed a census by analyzing the individual variances of *Cebus capucinus* alarm calls. In order to study the effectiveness of such an approach, this methodology was performed and compared with a concurrent traditional grid sampling methodology. A total of 65 alarm calls were collected at a site on Ometepe, Nicaragua. These calls were analyzed for prosodic features such as duration, onset abruptness, and the first three spectral peaks. These results were standardized to euclidean distance units and then clustered by using Ward's minimum variance cluster analysis. The analysis revealed 5 unique alarm call clusters denoting 5 individual callers. Assuming all males were vocalizing plus one alpha female, a general sex ratio for *Cebus capucinus* of .71 was assigned. One caller was then subtracted for the alpha female, resulting in 4 males. These 4 males were then divided by the .71 sex ratio equalling 5.6 females with an added individual for the alpha female, resulting in 6.6 females. These 7 females and 4 males gave a total census number of ~11 (~10.6). This count was compared with the concurrent grid sampling, which also revealed ~11 (~10.5) individuals in the study area. This

gives evidence that a census by analyzing vocal variance maybe an effective means to counting both a transient and arboreal species such as *Cebus capucinus*.

### **Blood Groups in Great Apes – Comparison of Captive and In situ populations**

Jill Moyses and Kathryn Gamble DVM, MS, Dipl ACZM  
Lincoln Park Zoo

While blood groups of humans and great apes are not interchangeable, they are quite similar. However, no standard blood type data has been determined for great ape populations in zoos. Human monoclonal antibody technology (Eldoncard) was used to assign human ABO blood groups to great apes housed in North American and European zoos and, for comparison, *in situ* managed populations. Knowledge of blood types would provide better acute and critical veterinary care, reduce transfusion reactions by improving selections of donor blood, and increase awareness of potential maternal-fetal incompatibility following transplacental immunization. When no appropriate in-collection donor was available, knowledge of blood groups by institution would permit identification of potential donors from other institutions in proximity. From a subset of each of the species evaluated (bonobo, common chimpanzee, gorilla and orangutans) DNA sequence analysis was performed to determine blood group genotype. This presentation will outline the history of the study and current results of blood groups in the great apes tested.

### **Inference of Chewing Muscle Cross-Sectional Area from Bony Landmarks in Subfossil Lemurs and Adapids**

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Several landmarks that approximate the extent and locations of the chewing muscles were found to correlate with muscle physiological cross-sectional area (PCSA) in extant strepsirrhines, even after accounting for body size variation. The most reliable of these were used to estimate PCSA for the temporalis, masseter, and medial pterygoid muscles of extinct European adapids and subfossil lemur of Madagascar. Estimated PCSAs for all muscles for most adapids are great relative to extant strepsirrhines. Except for *Pachylemur* and *Prolemur simus*, estimated PCSAs for the masseter and medial pterygoid are relatively great in subfossil lemur. However, estimated PCSAs for the temporalis in subfossil lemur are not especially great. Large body size and/or great food resistance likely selected for great PCSA in both adapids and subfossil lemur. Apparently for subfossil lemur this did not apply to the temporalis muscle. In early fossil primates bite force increase likely evolved via PCSA increases in all chewing muscles, whereas in subfossil lemur it did so via increases in PCSA of masseter and medial pterygoid only. Differences in food structural properties might explain this difference because the temporalis and masseter/medial pterygoid differ in mechanical advantage as gape increases. These conclusions remain tentative as data for some fossil taxa lie beyond the ranges of data for extant taxa.

### **Studies of the hybrid zone between Kinda baboons (*Papio kindae*) and Grayfoot baboons (*Papio ursinus griseipes*) in Kafue National Park, Zambia**

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In the southern part of Kafue National Park in Zambia, the ranges of the smallest known baboon (the Kinda baboon, *Papio kindae*) and the much larger grayfooted chacma (*P. ursinus griseipes*) baboons meet. We conducted visual surveys and collected fecal samples at 48 sites to examine the nature of the species border and evidence for hybridization. Contrary to earlier reports, we found that groups at the species interface were phenotypically diverse, presumably formed by multi-generational hybridization. Analysis of mitochondrial and Y-chromosome markers showed that the distribution of mitochondrial haplotypes largely mirrored that of external phenotypes. However, a significant proportion of male specimens from grayfoot as well as hybrid groups carried kinda Y-chromosomes. Surprisingly, given the size discrepancy between the two taxa, in all cases of mitochondrial/Y-chromosome discordance, Y chromosomes were of the kinda variety.

These observations suggest that, unexpectedly, kinda male x chacma female matings are much more common than the reciprocal cross in the ancestry of hybrids. We suggest that distinctive male kinda behavior, and the "juvenile" appearance of kinda baboons of both sexes, perhaps combined with obstetric difficulties of a small kinda female carrying the large offspring of a chacma male, may account for this bias.

### **Hormonal correlates of paternal care in three hylobatid species**

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Among primates extensive maternal care is the general pattern of parental care. However, there are a limited number of monogamous primate species, including the Hylobatidae, in which males contribute varying degrees of paternal care to ensure the successful rearing of offspring. The hylobatids are the least studied apes, and limited information is available related to variation in paternal care. Only one hylobatid species, the siamang (*Symphalangus syndactylus*), demonstrates direct paternal care in the form of infant-carrying. All other hylobatids exhibit paternal care more indirectly through territory defense and protection of the family group. The findings presented here result from the first investigation of the role of hormones in variation in paternal care among the hylobatids. We hypothesized that patterns of androgens and glucocorticoids would be associated with varying degrees of paternal care observed in three species of zoo-housed hylobatids. Father-infant proximity was found to be the best measure of paternal care, and this increased over the post-partum period in siamangs but not in other hylobatid species. Fecal androgen metabolite concentrations decreased over the post-partum period in siamang fathers but not in gibbon fathers. Finally, fecal glucocorticoid metabolite concentrations during 1 month post-partum showed the greatest increase from individual baseline in the siamang males than all other gibbon males. Taken together, these results suggest a relationship between specific hormonal patterns and species differences in paternal care.

### **Use of Gesture in Great Ape Mother-Offspring Dyads: A Comparative Analysis of Captive Populations of Bonobos, Orangutans, and Gorillas**

Alexandra Joy Reddy

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Biological Anthropology Master's Student,

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This study explores the use of gesture in three species of great apes. Principally examined are the interactions between mothers and infants. To advance the current understanding of gestural communication in apes, the following is included: (1) a thorough investigation of the patterns of gestures used both within and between a variety of ape species (captive populations of bonobos, orangutans and gorillas), (2) a cross comparison of how these gestures are utilized in different contexts, and (3) an examination of the evolutionary significance of gestural communication.

### **Bone strain and finite element modeling of the *Cebus* mandible during hard object feeding.**

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The relationship between mandible morphology and material properties of the diet is poorly understood. This relationship, if it exists, might be revealed by studies of hard object feeding which presumably entails generation of high force magnitudes. Peak mandibular corpus bone strain magnitudes during the power stroke of mastication vary across food types that differ in qualitative descriptors such as “toughness” or “hardness”. However, measures of strain have not been made while the animals eat foods of known material properties. We hypothesized that the nature of the loading regime would vary according to the direction of movement of the mandible during mastication which would in turn be related to food material properties. Hard-object feeding was studied in *Cebus* monkeys using in vivo bone strain, finite-element modeling, EMG and 3-d jaw kinematic techniques. Three rosette gages placed around the cross-section of the mandible were used to collect strain data during powerful incision, premolar biting and mastication. Strains measured in vivo were compared with surface strains from a finite-element model of the capuchin mandible. These data suggest that the mandible is bent, twisted and sheared during premolar biting on hard objects. The data suggest that variation in ER<sup>0.5</sup> affects mean orientation of the neutral axis of bending in a chewing sequence. These data suggest that differences in food material properties can affect loading regimes in the primate mandible primarily by affecting the way animals ingest food, and less through variation in the way they chew.

### **Space use efficiency and selectivity by zoo-housed chimpanzees (*Pan troglodytes*) and gorillas (*Gorilla gorilla gorilla*)**

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Few studies have examined how captive primates use the enclosure spaces provided to them even though this information has important impacts on animal care, management, and welfare. We examined how efficiently chimpanzees and gorillas spread their use across all potential areas of four naturalistic, indoor-outdoor enclosures. Data was collected using a digital map-interface which recorded the apes' three-dimensional position within 1x1x2m quadrats. After four years of study we found that chimpanzees and gorillas used 56.5% and 28.5% of their indoor-outdoor space respectively and that both species spent 50% of their time in less than 5% of this space. Influencing our findings was the fact that chimpanzees and gorillas spent only 33.2% and 7.1% of their time outside, respectively. While it is clear the great apes were highly selective in their spatial choices we do not advocate housing apes in smaller enclosures. Providing choice and control, such as the choice to use outdoor areas, may prove to be an important consideration in housing captive primates and future studies may reveal the effect outdoor access has on ape behavior and well-being.

## **Acclimation response to novel surroundings of two species of African great ape in a naturalistic zoo environment**

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The transfer of animals to new or different enclosures is a practice that occurs frequently within and between zoological parks. However, assessments of acclimation to a novel enclosure remain relatively sparse in the extant literature. Great apes' sophisticated cognitive, social and manipulatory behaviors make tracking this response to novel environments not only interesting but critical in ensuring their welfare in captive settings. Behavioral data was collected on chimpanzees and gorillas over a three year period following their translocation into a new naturalistic enclosure. Analyses revealed that both species demonstrated a period of higher inactivity rates (chimpanzees,  $t=1.04$ ,  $p=0.179$  gorillas,  $t=3.442$ ,  $p=0.003$ ) in year one compared to subsequent years. Likewise, both species demonstrated an elevated rate of scratching in the first year following the move to the new facility (chimpanzees,  $t=0.63$ ,  $p=0.281$  gorillas,  $t=1.764$ ,  $p=0.054$ ). The results are illustrative of a progressive behavioral adjustment to the novel surroundings and suggest that these effects are important to consider in longitudinal analyses.

## **Patterns of Predation on Wild Lemurs at Beza Mahafaly Reserve, Madagascar.**

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We systematically assessed predation threats to the lemur populations at Beza Mahafaly. Using camera traps we determined the relative abundance of potential predators. We confirmed that the fossa, *Cryptoprocta ferox* is still present in the area, but at very low numbers, with wild cats and domestic dogs equally present. Wild cat sightings were positively correlated with lemur sightings, indicating that wild cats are attracted to areas used by lemurs. In June 2009 an eye-witness account of a wild cat running from a freshly killed sifaka corroborated that they are efficient predators of larger lemurs. Felid and canid scat samples document that felids are using lemurs as prey, and at a much higher percentage than are canids, but that they also eat birds and insects. Lemur remains include the distal phalanges of fingers and toes, eyes, and hair. During June and July 2008 we also identified 5 cases of lemur predation. In all cases the body was processed in a manner consistent with that reported in fossa predation. However, in at least one case our genetic analysis of buried scat near the body was identified as wild cat, not fossa. These results indicate that wild cats can take larger lemur prey, kill and process their prey in a manner similar to fossa, and strongly suggest that this species may be competing with fossa for lemur prey.

## **The evolution of serotonin receptors in five species of macaques.**

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Research has increasingly highlighted the role that serotonin plays in shaping behavioral patterns. Across taxa, serotonin has been associated with impulsive and aggressive behavior and many psychiatric drugs work by manipulating the serotonin system. Moreover, numerous genetic studies have shown that polymorphisms in genes associated with the serotonin system correlate with behavior. Therefore, an understanding of how the serotonin system evolved is critical for understanding behavioral evolution.

The macaque genus is comprised of behaviorally and geographically diverse species, making it a useful model for studying the evolution of genes and behavior. Many genetic features of the macaque serotonin system parallel humans, possibly due to similar selective pressures acting on the serotonin system. We address whether selection has played a significant role in the macaque serotonin system by comparing the evolution of two genes which code for two types of serotonin receptors – *HTR1A* and *HTR1B* – across 5 species of macaques (*Macaca mulatta*, *M. fascicularis*, *M. fuscata*, *M. nemestrina*, and *M. sylvanus*). Overall we find that the pattern of evolution is significantly different for *HTR1A* compared to *HTR1B*. Specifically, we show that there has been a general increase in between-species variation compared to the within-species variation for *HTR1A*. These results indicate that positive selection likely acted on this gene in the macaque lineage. The implications of these results are discussed.

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### **Developmental simulation of captive *Mandrillus* cranial ontogeny**

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Craniofacial development is characterized by phenotypic plasticity, the production of alternative phenotypes in response to environmental variation. While the effects of environmental influences such as nutrition and dietary consistency are well known, the impact of social environment has yet to be fully explored. Captive males of genus *Mandrillus* display a distinctive cranial morphotype characterized by decreased klinorhynchy, increased facial dimensions, and hypertrophy of craniofacial superstructures. Adolescent male development in *Mandrillus* is known to be mediated by multiple social factors, principally through their influence on serum testosterone, and prior studies have demonstrated variation in growth rates and adult facial dimensions linked to social dominance. It is therefore plausible that captive males, who typically lack male peers and, thus, experience unchallenged dominance, grow faster and/or longer under the influence of prolonged, elevated testosterone levels. This study applies developmental simulation to evaluate the hypothesis that captive-type morphology results from extension of normal ontogeny. 3D landmarks were collected on a cross-sectional ontogenetic series of *Mandrillus* crania, and the male developmental trajectory was estimated by regressing Procrustes-aligned coordinates on dental stage. This trajectory was applied to a 3D model of a wild-male cranium to project its development beyond the normal terminus. The simulated “peramorph” exhibits captive-type characteristics, primarily in sexually dimorphic, androgen-sensitive cranial regions. The results of this “virtual experiment” suggest that social environment may influence cranial development in *Mandrillus*.

### **Effect of Group Dynamic Changes on Behavior of Western Lowland Gorilla**

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Gorillas are social animals that naturally live in groups, typically composed of a single dominant male and multiple females. In wild situations it is not uncommon for females to leave a group and join another group, whereas a change in silverback can cause social disturbances and possible disbanding of the group. Thus, we would expect that the departure of a female to have little effect on behavior, while the departure of a male would have a large impact. This study focused on the Western lowland gorillas at the Buffalo Zoological Gardens (one male, four females). Here, we compare the changes in behavior and interactions following the removal of one female from the group. We predicted that behavioral changes would be minimal among the remaining animals in the group, with the greatest changes occurring immediately after removal of the female. We further expected to see the most significant change in the adult daughter of the female that was removed. Results generally supported our conclusions. The daughter of the removed female however, did not show any significant behavioral changes. The remaining females (a mother-daughter pair) showed the most dramatic changes in behavior. These results support the contention that female social dynamics are less important to the stability of gorilla groups than male-female dynamics. Our findings can inform zoo management decisions with respect to group changes.

**Social bonds between adult white-faced sakis (*Pithecia pithecia*) are strongest between male/female pairs, despite absence of monogamy and pair-bonding behaviors.**

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Wild white-faced sakis show variation in social organization and mating system, displaying both two adult groups as well as small polygamous mating groups. Furthermore, white-faced sakis lack most of the traits typical of primate monogamy. This study draws on data from three habituated groups of white-faced sakis to determine if social bonds in this species reflect patterns displayed by pair-bonded groups or larger multi-male, multi-female groups. We analyzed within-group social bonds by measuring grooming time and approach/leave patterns between adult and subadult group members. We found that both two adult and polygamous groups showed significantly stronger social bonds between a single male-female dyad within each group (primary dyad). These dyads were always composed of the eldest adult male and a reproductive female, and had significantly higher levels of grooming than other dyads in the group ( $t=4.2$ ,  $p<.001$ ), grooming between 4.5-11.6 times as much as the average of other within group dyads. Primary dyads were also in close proximity ( $<1m$ ) more often than other dyads ( $t=3.0$ ,  $p<.01$ ). Grooming between the primary dyad was always highly non-reciprocal, with females investing more time grooming males; other dyads varied in reciprocity, but were often more reciprocal. These results suggest that while white-faced sakis do not show traits typical of monogamy or pair-bonding, social bonds are still strongest between a single breeding male/female pair.

**Does anthropogenic habitat change effect gastrointestinal parasite infections in *Semnopithecus entellus*, a South Asian arboreal folivorous primate?**

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Over the last couple of decades humans have been responsible for drastic changes to ecosystems, which have resulted in altering host-parasite dynamics of species living in these systems, often with negative consequences for hosts. We compare 134 fecal samples from forest dwelling hanuman langurs (*Semnopithecus entellus*) and animals living in a fragmented landscape in the north central dry zone of Sri Lanka. Five species of parasites were identified and were present in animals from both habitats. However, the number of parasites per host was significantly higher in langurs from degraded habitat in comparison to langurs from undisturbed forest habitat. The overall prevalence of gastrointestinal parasites was significantly higher in langurs from degraded habitat in comparison to langurs from undisturbed habitat. The prevalence of specific parasites also varied between the two populations. The prevalence of an unidentified strongyle species, along with *Strongyloides fuelleborni*, and *Cyclospora* sp., was significantly higher in langurs from degraded habitat in comparison to animals from undisturbed habitat. The overall intensity of infection of nematode parasites (EPG) and the intensity of infection of *Strongyloides fuelleborni* and the unidentified strongyle was significantly higher in langurs inhabiting degraded habitat in comparison to langurs from undisturbed forest habitat. Our findings are consistent with previous studies that demonstrate changes in patterns of parasitism in response to anthropogenic habitat alteration.

### **Project ChimpCARE: The status of the privately-owned chimpanzee population in the United States**

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Project ChimpCARE is an initiative whose primary goals are to accumulate a comprehensive understanding of the privately-owned chimpanzee population in the United States by objectively assessing the welfare of these individuals and investigating the impact of inappropriate presentations on public perception of chimpanzees. Standardized data on demographics, housing and management from various facilities housing chimpanzees have been collected through in-person facility assessments. Currently, there are approximately 2,073 chimpanzees in the United States. Through the first thirteen months of site visits and investigation, 214 privately-owned chimpanzees (those not living in accredited zoos, research centers or legitimate sanctuaries) have been identified, including 78 pets, 33 individuals in the pet breeding industry, 84 at unaccredited animal attractions, and 19 in the entertainment industry. Of the 55 facilities housing privately-owned chimpanzees a total of 23 have been visited housing 92 chimpanzees. Project ChimpCARE has utilized a cooperative and multidisciplinary approach in order to work towards sustainable solutions for the privately-owned chimpanzee population. These approaches have resulted in the successful transfer of 16 chimpanzees to more appropriate housing facilities. Continued evaluation of the privately-owned chimpanzee population and increased cooperation between groups housing chimpanzees is essential for determining the scope of the issues that surround the captive chimpanzee population. Utilizing these and other data is critical to forming the empirical basis for long-term sustainable solutions for chimpanzees across the United States.

### **Conspecific access influences chimpanzee performance on a computerized sequencing task**

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As a group-living species, chimpanzees interact with conspecifics in the context of both affiliative encounters and resource competition. The influence of these competing characterizations on responses to cognitive challenge has been rarely examined. In the current study, we assessed chimpanzee performance on a computerized sequencing task in two contexts: in a “free social access” (FA) setting, the subject and group mates had free access to each other, the computer interface and the food reward dispenser; during “individual sessions” (IS) the subject was physically separated from conspecifics during the task (visual, olfactory and auditory contact maintained). Two female chimpanzee subjects exhibited higher overall performance in the free social access protocol compared to separation trials (S1: M(FA)=71.7%,  $t=3.01$ ,  $p=.004$ ; S2: M(FA)=64.1%,  $t=2.57$ ,  $p=0.01$ ). We also examined the subjects’ expression of self-directed behavior, as a measure of arousal. Overall subjects showed similar changes in scratching frequency in relation to performance. However, between conditions, the dominant subject showed no differences in scratching rates while the submissive subject exhibited a two-fold decrease in the free access setting (S2: M(IS)=0.28 strokes per trial; M(FA)=0.14 strokes per trial;  $t=2.41$ ,  $p=0.01$ ). These preliminary results suggest that 1) social and environmental attributes influence responses to cognitive testing and 2) the interaction between cognitive challenge and arousal is subject to individual variation, including that dominance status and disposition.

### **Behavioral thermoregulation in captive colobus monkeys (*Colobus guereza*)**

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This study was conducted to identify behavioral thermoregulation strategies of a group of zoo-housed colobus monkeys. Because of limited structural opportunities to be arboreal, these colobus spend the majority of their time on the ground, which may pose unique thermoregulatory challenges. Colobus ( $n=7$ ) housed at the Monkey Island exhibit at Cleveland Metroparks Zoo were observed in summer of 2008 and fall of 2009. Behavior was recorded using continuous sampling during 10 minute focal observations. Environmental variables were recorded during behavioral observations and included both air and surface temperatures. Results suggest surface temperatures were better indices of environmental temperatures than air temperatures. Surface temperatures during this study ranged from 0.22°C to 52.67°C. Resting in shade appeared to be the primary strategy to cope with high temperatures – colobus rested in shade greater than 80% of the time when the average surface temperature exceeded 25°C although only 10-15% of the exhibit was shaded during this time. These results underscore the importance of providing shade when surface temperatures exceed 25°C (air temp approx. 23.5°C). Additional research is needed to compare these colobus to other colobus groups to investigate the effects of terrestrial behavior on thermoregulatory behaviors.

### **Methodological considerations of daily path length measurements of West African chimpanzees (*Pan troglodytes verus*)**

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Daily travel patterns hold a considerable importance to studies of primate socioecology, namely in measuring the effects of competition among group members, as primates must balance between minimizing the costs of travel itself while maximizing access to food and social resources. Despite its prominence in the primatological literature, methods of capturing daily distance traveled (DPL) by groups and individuals vary

among researchers. Because researchers are often unable to record continuous location data, researchers frequently employ a straight-line distance method, where locations are sampled at pre-determined intervals, and the distances between these intervals represent the distance traveled. This study examines the effect that differing sampling methods have on estimated DPLs in a group of wild chimpanzees at Fongoli, Senegal. Data were collected as true or offset locations during full day follows of focal individuals at five-minute intervals of eight focal chimpanzee (*Pan troglodytes verus*) adult males of the Fongoli community between May and August 2010. Subsets of these data were selected from and compared to the original "true" set of 5-minute interval location distances at 10-, 30-, and 60- minute intervals, and at significant locations (more than 20 minutes spent at a location). As expected, longer or fewer sampling intervals showed a trend toward underestimation of travel distance. These analyses illuminate important research considerations for future studies of DPL.

### **Numerical composition of the vertebral column: Implications for hominoid evolution**

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The numerical composition of the vertebral column has generated newfound interest in recent years, particularly in light of our modern understanding of phylogenetic relationships among vertebrates. The role of vertebral formula variation in the evolution of hominoid primates has likewise experienced resurgence, in large part due to the implications for hominin origins and the evolution of bipedalism. Recently, three research groups proposed very different evolutionary scenarios to explain numerical variation in vertebral formulae among hominoids: a "short-backed," "chimp-like" ancestry, a "long-backed," "*Proconsul*-like" ancestry, and a "human-like" ancestry, all referring to the modal number of lumbar vertebrae present in the last common ancestor of humans and chimpanzees (LCA). In this study, I combine my own data with that of previous authors to compile a large dataset of vertebral formulae for over 1,800 hominoid specimens and more than 4,000 other mammals. Based on this large survey of mammals, it is argued here that a 7-13-6-3 (cervical-thoracic-lumbar-sacral) vertebral formula evolved in the ancestor of therian mammals and persisted throughout mammalian evolution. The ancestor of crown hominoids achieved a 7-13-5-4 formula by a caudally-directed homeotic shift at the lumbo-sacral border, a rare occurrence among mammals. The LCA of hominoids experienced a subsequent shift at this border, rendering the vertebral formula 7-13-4-5, a "great-ape-like" pattern that persisted through to the LCA. Therefore, a "short-backed" scenario is supported in this study.

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