

Sabbatical Leave Report for 2008-2009

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Proposal

Abstract

I propose to update my knowledge of primate and human evolution by taking classes at CSU San Bernardino and reading independently at a professional level. This would improve my classes and inform two projects with long-term benefits to the Anthropology and Biology programs and the College. First, I would improve our fossil cast collection by tracking down identifications of some of the casts; establishing a complementary collection of journal reprints; and identifying a wish list of fossil casts to augment the collection. Second, I would produce a multilayered, interactive web site illustrating the mosaic nature of human evolution that would supplement my Biological Anthropology classes and encourage members of the Community (such as K-12 students and their parents) to consider Mt. SAC as their first source of higher education.

Proposed sabbatical activities

This combination study / project sabbatical focuses on the fossil record of primate and human evolution, an area that I teach but did not specialize in. There are three proposed sets of activities:

1. Study. I would become more current in primate and human evolution by taking classes and by reading professional-level books and journal articles.

2. Project. I would augment the Anthropology collection of fossil casts by confirming identifications, establishing a complementary collection of relevant journal reprints; and identifying gaps in the collection that we should consider purchasing.

3. Project. I would produce an interactive web site illustrating the mosaic nature of human evolution. This would include taking a class on Dreamweaver web design software.

Nature of the activities

1. Evolution study

My specialty in anthropology is archaeology, specifically, ancient uses of plants in the desert Western US. Relevant gaps in my education include the fossil record of primate evolution; the recent discoveries of many paleospecies of early bipeds such as *Orrorin*, *Sahelanthropus* and *Kenyanthropus*; and the origin of modern *Homo sapiens*, with controversies over the significance of various fossils (including *Homo floresiensis*) from Africa, Europe, Indonesia and the Near East. I also have no formal background in cladistics, the modern approach to classification based on shared derived traits. Since I teach Anthropology 1, Biological Anthropology, I have tried to keep up by reading and attending professional talks, but I'd like to know more.

With these needs in mind, I propose to take upper-division courses or their equivalents, such as those offered through the Open University program at California State University, San Bernardino. These are regular offerings, not extension classes, that are tentatively planned for the Winter and Spring quarters next year:

ANTH 326. Human Origins. The archaeological, anatomical and other evidence for human origins examined within their geological and environmental contexts.

Discussion of theories that attempt to explain how we became human.

Prerequisite: ANTH 100 (4 upper-division units). According to email from Wes

Niewoehner, Ph.D., "It's too early to say for sure, but it will probably be taught again during the Winter of 09. . . . In the meantime feel free to contact me if you have any questions on human origins. Also, I am not planning any sabbaticals soon."

ANTH 327. Primate Evolution and Ecology. A comparative study of our closest relatives (the apes, monkeys and other primates): their evolution, ecology, behavior, social organization and means of communication (4 upper-division units). According to a phone message from Peter Robertshaw, Ph.D., this class will be taught either Winter or Spring of 2009; he also is not planning to be on leave.

If for some reason these classes are not offered, there is no comparable class on primate evolution in Southern California. UC Riverside has a potential alternative class in human paleontology taught by faculty with research in these areas. I would consult with the Salary and Leaves Committee to discuss this and/or other options such as additional independent reading, conference attendance, or use of MIT's OpenCourseWare course in Human Evolution.

Augmenting these classes, I also propose to read books and articles beyond those assigned. Some of the books are recent trade nonfiction summarizing recent research; others are upper-division textbooks or peer-reviewed books intended for professional audiences. The articles are from peer-reviewed journals. Please see the attached reading list.

2. Collections project

The Mt. SAC Anthropology program has a remarkably large collection of fossil casts mostly from the tenure of Kenneth Irvine, Mt. SAC's lone anthropologist for many years. Over time, many of these have lost all or most of the original identifying information. Some are famous specimens, easily recognized and identified. Others include casts of monkey jaw fragments and skulls and jaws of late archaic and early modern humans. I began to track down the identifications of the fossil monkey jaws last year. They have museum specimen numbers inked onto the casts beginning with DPC, almost certainly from the Duke University Primate Center, which has a research arm focusing on Eocene and Oligocene monkey fossils. I sent an inquiry about our specimen numbers to Duke last year but received no response. I also started collecting journal articles by Duke scientists about primate evolution. I propose to use these and other articles to identify our specimens and learn more about the current classification and interpretation of Eocene and Oligocene monkeys.

For the late archaic and early modern humans, our casts do not have museum specimen numbers. Some have names hand-printed on them, but some of these names differ from names assigned to the same casts in photos online and in reference books. In one case, we have two identical jaws with different names on them. I propose to find photos of the skulls in books (see attached reading list) and in advertisements of casts from reputable companies.

In the process of identifying these casts and taking classes, I expect to find articles that interpret or explain the significance of many of the casts in our collection. I

propose to establish a file of such articles to be stored with the casts, organized by species, and expandable in future years.

Finally, I propose to establish a list of key fossil casts that would augment our collection in key areas, particularly relating to primate evolution. This "wish list" would inform Anthropology purchasing in the future.

3. Web site project

I would apply the content learned in the previous two activities to produce an interactive web site illustrating the mosaic nature of human evolution. While I am already adept with Microsoft Front Page and PowerPoint and have many instructional web pages, the proposed web site might work better with Dreamweaver. Therefore I propose to take a class in Dreamweaver, construct a site map and draft web site for my class assignments (as much as possible within the framework of the class), and decide which software would allow me more flexibility and power with my intended design. The class I propose to take is offered every semester at Riverside Community College. Its catalog description reads:

CIS 76B. Intro to Dreamweaver. *Same as CAT-76B.* This course provides students with the knowledge and skills required to quickly design and implement Web pages and to administer and update existing Web sites using Dreamweaver. The course uses Macromedia Dreamweaver to streamline and automate Web site management on your web site. This is a hybrid class. Computer with Internet access required. [3 lower-division units]

This class is offered in two departments, under two different course listings, and at two different times for the meetings. Both versions of the course are taught in a distance learning hybrid format. I would choose the section (and hence the course number) based on which one I could get into. I would not have priority registration at RCC. If I did not get the course Fall semester despite prior contact with the faculty, I would contact the Salary and Leaves Committee and consider one of the following options: taking the class at Mt. SAC; using tutorials to teach myself Dreamweaver; or using either FrontPage or PowerPoint to design the web site.

The web site would be multilayered, starting with a public-domain, famous image of the human body (such as Michelangelo's *David*), with a title including "mosaic" or "puzzle" and a time line with no events posted on it. Visitors would move the mouse over the picture and see "hot spots", where links would take them to the next layer. For example, hovering the mouse over David's ear would reveal a hot spot. Clicking would lead to a page with an image of the earliest fossil primate and a discussion of the bony structure around the middle ear that is positioned uniquely in primates. That page would have a world map showing where that fossil was found and a brief outline of the classification of that fossil, with perhaps a portion of a cladogram (family tree) showing the relationship of that fossil to living primates, including humans.

From that page, visitors could either return to the main page or visit a links page relevant to that early primate. Every links page would include a link to www.palaeos.com, a reference site about vertebrate classification and fossils; other links about relevant fossils or living examples of similar primates; and internal links to peer-reviewed references and the main page. Back at the main page, visitors would

now see (1) the fossil primate name on the time line and (2) a photo of the relevant ear bones where David's ear should be. The spot on the time line and the border around the ear bone photo (shaped like a jigsaw puzzle piece) would be color-coded, and both would link back to the page about the earliest fossil primate.

Various body parts (including eyes, teeth, vertebrae, wrists, knees, ribs, teeth, and brain) would be similarly linked and layered, so that visitors would build up a puzzle-like image of various body parts as they filled in the time line. Visitors could move as quickly or as deliberately as they liked, experiencing the web site at the shallowest level (just to build up the mosaic effect and time line); at a medium level, opening a new window to a web site about a dig, such as the Leakey Foundation web site; or at the deepest level, finding peer-reviewed references for further study about one or two aspects of human evolution.

[The hot spots would refer only to bones, since only those are preserved in the fossil record. I would like this site to not offend parents of K-12 students. If I were to use *David* or another nude (since we are concerned with the natural body), of course many people would check for a hot spot at the crotch. My solution would be to superimpose a fig leaf and link the hot spot to a page with links about fig tree evolution and genetic phylogeny of the Y chromosome.]

I have described my vision for the website. The Salary and Leaves Committee should be aware that the final web site may differ somewhat from my vision due to technical and legal considerations (such as the Americans with Disabilities Act). For example, is it necessary or permissible (under Mt. SAC IET recommendations) to send

"cookies" to the user's computer in order to effectively build up the mosaic on the main page as the user explores the site? And of course the web site must be accessible to users of adaptive technology, with descriptive text for every hot spot and image.

Therefore this proposal includes consultation with the Online Learning Support Center and IET at Mt. SAC.

Timeline

- Fall 2008
 - Late August – Sept.: Contact RCC instructors about getting into Dreamweaver class. Start reading recent trade nonfiction books about evolution. Purchase Dreamweaver software.
 - Late Sept. – Dec.: Take CIS 76B, Intro to Dreamweaver, at RCC.
 - Start web site on mosaic evolution. Focus on structure of site with main page and site map setup (including time line).
 - Consult OLSC and IET at Mt. SAC for guidance on workability of intended web site design.
 - Read books and articles about human evolution:
 - Late Sept. – mid Oct: Late Miocene hominoids and early bipeds.
 - Mid Oct. – mid Nov.: early members of genus *Homo*
 - Mid Nov. – Dec.: archaic and modern *Homo sapiens*
 - Choose readings relevant for Anthro collection files; identify gaps in cast collection for future purchasing.
- Spring 2009

- Jan. – Late March (CSUSB Winter quarter): Take Anth 326, Human Origins. Identify hominid casts currently in collection.
- Jan. – Late March: Take Anth 327, Primate Evolution and Ecology. Identify monkey jaws currently in collection. Identify gaps in cast collection for future purchasing. *Note: This class may be taught in Spring rather than Winter. I will notify the Salary and Leaves Committee as required.*
- March – May: Continue web site on mosaic evolution. Focus on content of site showing origin of various body parts.
- April: Read additional books and articles (beyond the assigned work) about Eocene and Oligocene primates. Choose readings relevant for Anthro collection files.
- May: start writing sabbatical report.
- June: Complete and upload web site; complete sabbatical report.

Anticipated value and benefit

Applicant This sabbatical would allow me to renew my energy for teaching while learning more about something that fascinates me. Immediately before starting my service at Mt. SAC eight years ago, I was a tenured professor at Santa Monica College, where I commuted from Riverside for four years. I need a break from twelve years of teaching and commuting. Designing web sites uses my creativity in ways different from classroom teaching. And being a student again would improve the quality of my instruction both by infusing new content into my classes and by renewing my awareness of what it is like to be a student.

Department The Anthropology program in the Department of Biological Sciences would benefit from this project in three ways. First, it would bring me up to date in this area. I am 50% of the full-time Anthropology faculty. Colleagues who teach Biology occasionally ask me about recent discoveries or about human evolution in general; I would be better able to answer their questions. In 2005, I provided a departmental Flex Day session about human evolution, at a very general level, that was well received. Following this sabbatical, I would be able to provide a more detailed session about the recent discoveries if the department chose that for its Flex Day activity.

Second, the project would make the existing Anthropology collections more useful to faculty and students. This includes adjunct Anthropologists as well as other Biology faculty who must incorporate aspects of human evolution in Bio 1 and Bio 4 and who occasionally borrow fossil casts. Casts would have firm identifications. Faculty who wish to know more would have access to relevant professional-level reprints. And students, including those in the Honors section of Anthro. 1, would be able to use the reprint collection in conjunction with the casts for assignments or extra-credit activities.

Third, the proposed web site would be available to students in all Biological Anthropology (and Biology) sections to augment their textbooks and lecture notes. The "mosaic" theme and summaries of various ancient species may also be useful to colleagues.

College My taking classes at other institutions would benefit the College in two ways. First, CSU San Bernardino is a potential transfer institution for Mt. SAC students. I would be networking with CSUSB faculty and learning about the atmosphere for

students. Second, I have taught classes using distance learning and continue to actively participate in the Distance Learning program at Mt. SAC, but I have not taken a class in this format. Taking the hybrid class in Dreamweaver would give me a student's perspective that would inform me with regard to campus-wide instruction issues.

The most important benefit to the College, however, would be the availability of the proposed web site to the community. One of the Core Values of Mt. SAC is Lifelong Learning, and the Mt. SAC web site is a portal to the College for the community we serve. The proposed web site would be available to K-12 students, teachers, parents, and any community members (for example, those who see a cable TV program on human evolution and want to know more). I hope that the multilayered aspect of the web site would allow visitors to experience it at their own level of comfort and interest.

For example, the California Science Content Standards include aspects of fossils and evolution at Grades 2, 3, 7, and in high school in Biology/Life Sciences. By providing an up-to-date, accessible web resource on human evolution, the College may enable students and parents to understand evolution better while encouraging them to consider Mt. SAC as their first source of higher education.

Potential reading lists by topic

These lists represent the level of books and articles I propose to read rather than a comprehensive list of everything I intend to read. Some of the articles may prove irrelevant after skimming; some will send me to their literature cited for further reading. And I hope that professors at CSUSB will guide me to readings not on these lists.

1. Evolution study

A. Primate evolution

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2006 *Primate and Human Evolution (Cambridge Studies in Biological and Evolutionary Anthropology)*. Cambridge: Cambridge University Press.

Goodman, M, C. A. Porter , J. Czelusniak , S. L. Page , H. Schneider , J. Shoshani , G. Gunnell , and C. P. Groves

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2005 Anthropoid primates from the Oligocene of Pakistan (Bugti Hills): Data on early anthropoid evolution and biogeography. *Proceedings of the National Academy of Sciences of the United States of America* 102: 8436-8441.

Marivaux, Laurent, Yaowalak Chaimanee, Stéphane Ducrocq, Bernard Marandat, Jean Sudre, Aung Naing Soe, Soe Thura Tun, Wanna Htoon, and Jean-Jacques Jaeger

2003 The anthropoid status of a primate from the late middle Eocene Pondaung Formation (Central Myanmar): Tarsal evidence *Proceedings of the National Academy of Sciences of the United States of America* 100: 13173-13178.

Mercader, Julio, Melissa Panger, and Christophe Boesch

2002 Excavation of a Chimpanzee Stone Tool Site in the African Rainforest
Science (24 May) 296: 1452-1455.

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and Christophe Boesch

2007 4,300-Year-old chimpanzee sites and the origins of percussive stone
technology. *Proceedings of the National Academy of Sciences of the United
States of America* 104: 3043-3048.

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1998 Tarsier-like locomotor specializations in the Oligocene primate *Afrotarsius*.
*Proceedings of the National Academy of Sciences of the United States of
America* 195: 14848-14850.

Richmond, B.G.

2006 Functional morphology of the midcarpal joint in knuckle-walkers and terrestrial
quadrupeds. In Ishida, H., Tuttle, R., Pickford, M., Ogihara, N., and Nakatsukasa,
M. (Eds) *Human Origins and Environmental Backgrounds*, 105-122. New York:
Springer.

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1998 First hominoid from the Miocene of Ethiopia and the evolution of the
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2001 Forelimb function, bone curvature, and phylogeny of *Sivapithecus*. In de
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10812.

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1996 Ancient single origin for Malagasy primates. *Proceedings of the National Academy of Sciences of the United States of America* 93: 5122-5126.

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2006 *The First Human: The Race to Discover Our Earliest Ancestors*. New York: Doubleday.

Goren-Inbar, Naama, Nira Alperson, Mordechai E. Kislev, Orit Simchoni, Yoel Melamed, Adi Ben-Nun, and Ella Werker

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2002 Nuts, nut cracking, and pitted stones at Gesher Benot Ya`aqov, Israel. *Proceedings of the National Academy of Sciences of the United States of America* 99: 2455-2460.

Green, D., A. Gordon, and B.G. Richmond

2007 Limb-size proportions in *Australopithecus afarensis* and *Australopithecus africanus*. *Journal of Human Evolution* 52: 187-200.

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2003 *Lowly Origin: Where, When, and Why Our Ancestors First Stood Up*. Princeton, NJ: Princeton University Press.

Lockwood, Charles A., William H. Kimbel, John Hawks, Milford H. Wolpoff, Glenn C.

Conroy, Gerhard W. Weber, Horst Seidler, and Phillip V. Tobias

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Panger, M.A., A.S. Brooks, B.G. Richmond, and B.A. Wood

2002 Older than the Oldowan: Rethinking the emergence of hominin tool use. *Evolutionary Anthropology* 11: 234-245.

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Wood, B.A. and B.G. Richmond
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Zihlman, Adrienne, Debra Bolter, and Christophe Boesch
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C. Early modern humans

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2005 The Brain of LB1, *Homo floresiensis*. *Science* (8 April) 308: 242-245.

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2. Collections project – identification of existing collections.

Again, I do not intend this as a complete list. I hope that these will lead me to further resources that will help me to identify the casts in the Mt. SAC Anthropology collections.

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Report of activities

Statement of purpose

The purpose of this sabbatical was to update my knowledge of the human lineage including primate and human evolution, and to present it on a web site in an appealing way to Mt. SAC students and members of the community while providing a resource for colleagues. I am grateful that I was able to achieve my goals and forward to continuing to learn more as I continue to network with faculty at CSU San Bernardino, update my website and augment our fossil cast collection.

Evolution study

I started this portion of the sabbatical in October by attending a conference at Caltech entitled "Origins." Speakers included leaders in cosmology, physics, paleontology and evolutionary psychology presenting about the origin of the universe, laws of nature, life, and consciousness. The program is in Appendix 4.

My main evolution study took place at CSU San Bernardino in the Extended University for one class in the Winter quarter and one in the Spring quarter. Both classes used Blackboard for student access to readings, and for Anth 327, participation in the Blackboard discussion board was required. I earned an A in each; my term papers and transcript are in Appendix 4.

ANTH 326. Human Origins

This was taught during Winter quarter by Wes Niewohner, Ph.D., a specialist in the functional morphology of Neandertal hands. Readings included peer-reviewed journal articles that debated the taxonomic status of fossils based comparisons of their anatomy to other taxa. While I already knew the basics of human origins well (names, dates, locations), the details of anatomy added a new layer for me, and I often took notes and asked questions just as much as any of the undergraduates. Dr. Niewohner told me that he felt pressured to make the class as current as possible because I was there, and I appreciated that. He even loaned me for my term paper an in-press article he was reviewing for a journal.

The instructor also encouraged us to attend the Santa Barbara Symposium on Human Origins, which I did in mid-April at the Santa Barbara Museum of Natural History (Appendix 4). The list of speakers was a balance of Big Names and Young Turks, all of whom publish prolifically and have contributed important research. Donald Johanson organized the symposium and spoke twice.

Key points I learned from Anth 326 include:

- *Sahelanthropus tchadensis* was not bipedal, but is an important late Miocene ape.
- *Australopithecus anamensis*, *Homo heidelbergensis*, and *H. neanderthalensis* are all good species, not simply populations of other species as conservative taxonomists argue.
- *H. antecessor* may or may not be a separate species. More fossils are needed to tell.

- *H. neanderthalensis* went extinct, according to genetic and skeletal evidence.
- The cladistics approach is useful but should not be taken as dogma. It may never be possible to construct a certain cladogram of human origins because we don't know the soft tissue characteristics. Using fossils, even the experts arrive at different conclusions. As with all science, there are subjective choices of the data to be entered into the analysis.
- Important sites that I knew little about included Dmanisi (Georgia; first *Homo* in Europe, similar to *H. erectus*); Omo (Ethiopia; first modern *H. sapiens*); and Atapuerca (Spain; three important locations with two important species).
- An important time period I knew little about was the Middle Stone Age of Africa, which is equivalent to the Upper Paleolithic of Europe in that modern humans made the composite artifacts and that there are signs of symbolism, art and body decoration.

ANTH 327. Primate Evolution and Ecology

This was taught during Spring quarter by Peter Robertshaw, Ph.D., the Anthropology Department chair. As an archaeologist raised in Africa, he is fascinated by primates and teaches this class as an avocation of sorts. He also hosted and encouraged us to attend the Southern California Primate Research Forum, held in late April at CSUSB (Appendix 4). We also were required to do primate observations with a partner at the Los Angeles Zoo, using well-established field methods and producing a report.

I had hoped that this class would give at least equal time to evolution, but Dr. Robertshaw prefers ecology, so we covered primate evolution in one week, and I knew a bit more than the instructor. I intended to pursue this further in my term paper, but my topic was rejected as not ecological enough. So I delved into the ecology, since that was another weak spot in my educational background. I decided to focus on a complex community of Old World monkeys in the Tai Forest of Cote d'Ivoire, West Africa, and the more I learned, the more I became convinced that this would be a great theme for teaching the primates section of Anthropology 1 at Mt. SAC. The community illustrates and enlivens many of the key concepts that can be dry and abstract to students.

Some of the take-home points I learned in this class were:

- Ecology is hard. The methods are challenging to do even when watching a film in the classroom or in a comfortable outdoor setting like the zoo. To make consistent, reliable observations in a remote wilderness while trying to avoid tropical insects and diseases is an incredible feat.
- Ecology is hard. There are many variables even when only one species is observed. When the habits and personalities and group dynamics of seven species in the same forest are involved, trying to keep track of all their seasonal diets, predators, and defense strategies is mind-boggling.
- Monkeys are interesting in their own right, not just an evolutionary stepping stone towards apes and ourselves. We read a field study of callimicos and tamarins in Bolivia that examined a monkey I'd never heard of (callimicos) and no one had observed systematically in the wild. Callimicos are small, black monkeys that are

difficult to see in a forest and which have a special adaptation for eating mushrooms, which allows them to share habitat with tamarins.

Collections project

This project had three components: (1) to identify some of our existing fossil cast collections in Anthropology, particularly Oligocene mandibles and the skulls and jaws of late archaic and early modern humans; (2) to compile a bibliography of references about our casts; and (3) to identify gaps in the collection for augmentation with further purchases. The second and third components were much easier than the first, but all were successful.

Hominin fossil cast identifications

The Anthropology collections (fossil casts, human and primate bones, and archaeological finds) had no catalog until Frances Borella was hired in 2000 (the year before my own hire). She inherited a large collection with no accompanying information or identifications and immediately recruited students to help her do an inventory. It was a huge task, and in most cases the students and Frances were able to identify the casts at least to species. My task was to confirm these identifications and try to identify the rest of the collection. The results are tabulated in Appendix 1, with the previous work in a smaller font and my own sabbatical work added as a column in a larger font.

Most of the previous identifications were accurate. I confirmed them by matching the cast to a photo or drawing of the relevant specimen in a book (see Appendix 2), a cast supply house catalog, or a reliable source on the Internet. The supply house catalogs included France Casting, Bone Clones, and the University of Pennsylvania

casting program. The Internet sources included human evolution web sites from the American Museum of Natural History, the Boston Museum of Science, the Natural History Museum of London, the Institute for Human Origins, the Smithsonian Museum of Natural History, and Talk.Origins.org.

Twenty-two items did not match any photos in these sources. They included crania, portions of crania, and mandibles, mostly of Neandertals and early modern humans. Other issues requiring annotations included:

- anatomy (e.g., what was listed as an “ilium” was actually an “innominate”);
- specimen details (e.g., the Taung child fossil brain is an endocast, not a reconstruction as it had been listed);
- basis of identification (i.e., I was not able to verify the identification using the above sources);
- provenience
 - The supposedly archaic mandible catalogued as “Mayer” [sic] was not the Mauer mandible nor even an archaic one (since it has a chin). In fact this cast was identical to another cast labeled as a modern human mandible, only with wear and tear in different spots.
 - The cranium and mandible catalogued as “La Chapelle Aux Saints” is not from that site. The fossilized individual had lost many teeth and had resorbed bone in his jaw. Our cast does not show that.
 - One of two crania labeled “Trinil 2” actually was from Sangiran, another site in Indonesia.

Identifications of the early primate jaws were more difficult to track down. Mt. SAC owns 13 casts of ancient monkey jaws (anthropoid mandibles and maxillae), 12 of which have legible collection numbers beginning with "DPC" (e.g., DPC 1102). This refers to the Duke [University] Primate Center, where Elwyn Simon has been recovering monkey fossils since 1965 from the Fayum Province, Egypt. Using Google Scholar to search the web for DPC numbers, I was able to confirm the identifications of 11 of these jaw fragments. I followed that up with a search of the Paleobiology Database (www.paleodb.org), which provided synonymies (updated species names based on taxonomic work done since the original publication on a particular specimen). The final products of this project are:

- Displays of the jaws in Riker mounts with labels (Figures 1 and 2).
- The annotated catalog (Appendix 2).
- A list of references about these and other Eocene and Oligocene primates (Appendix 3).



Figure 1. Fossil anthropoid mandibles and their identifications.



Figure 2. Fossil anthropoid mandibles and their identifications.

Bibliography

Online access to full-text journal articles is addictive! I compiled files with close to 500 PDFs of peer-reviewed references about a range of subjects relevant to the classes I teach. I read all of the abstracts, skimmed the text of perhaps two-thirds, and read at least half in the course of writing my term papers, indentifying casts, and researching for the web site. Some I have printed out for the Anthropology Collection files, but most (to save paper and for the convenience of searching) I have saved to CD and placed in the same files in our collection room. Please see Appendix 2 for the references relevant to the proposed sabbatical projects. A copy of the CD with PDFs is in Appendix 4.

Purchasing goals

Mt. SAC has a substantial collection of primate and hominin fossil casts, but there are gaps and misidentifications. For better coverage of primate evolution, we should try to acquire casts of recently found species and/or species that represent evolutionary milestones such as *Carpolestes*, *Rooneya*, *Darwinius*, *Morotopithecus*, or *Pierolapithecus*, especially if postcranial (skeletal) material becomes available.

Our human origins purchasing goals in Anthropology should focus on acquiring the following:

- well-provenienced replacements for our unidentified *Homo Neanderthalensis* and early modern *Homo sapiens* casts, particularly Omo 1 and Qafze specimens when they become available;

- well-provenienced replacements for our unidentified *Homo Neanderthalensis* and early modern *Homo sapiens* casts, particularly Omo 1 and Qafze specimens when they become available;
- *Homo heidelbergensis* and *Homo antecessor*, two species which are poorly represented in our collections;
- juvenile specimens of these *Homo* species, since (citation and citation) have noted that taxonomic characters are more clear in juveniles;
- postcranial (skeletal) material of these species, so that Anth 1 Lab students may compare limb bone proportions of later hominins to those of Lucy (*Australopithecus afarensis*) and Turkana boy (*Homo ergaster*) already in our collection.

Table 1 lists currently available specimens that fit those criteria. It is unfortunate but understandable that the leader in fossil cast production, the Kenya National Museum (KNM), currently is not producing casts. Financial and political problems in Kenya mean that the National Museum has other priorities. It has access to many of the most important specimens, however, and should be a source of Mt. SAC collections once it resumes production, not least because purchasing from KNM supports further field research and the higher education of impoverished citizens of Kenya. KNM casts will be available through France Casting in Colorado (www.francecasts.com).

Taxon, provenience	Body Part	Vendor	Item #	Price
<i>H. erectus</i> , Modjokerto	calvaria	U Penn	I-MJ1-EX	\$138
<i>H. erectus</i> , Ngandong	cranium, infant	U Penn	I-NG10-EX	\$175
<i>H. heidelbergensis</i>, Mauer	mandible	U Penn	440	\$125
<i>H. neanderthalensis</i> , Skuhl 1	cranium, immature	U Penn	591	\$98
<i>H. neanderthalensis</i> , Skuhl 1	mandible, immature	U Penn	592	\$55
<i>H. neanderthalensis</i> , Teshik-Tash	cranium, juvenile	U Penn	BH-027	\$235
<i>H. neanderthalensis</i> , Spy	left radius	U Penn	454l	\$15
<i>H. neanderthalensis</i> , Spy	left proximal ulna	U Penn	454m	\$15
<i>H. neanderthalensis</i> , Spy	distal fibula	U Penn	454o	\$15
<i>H. neanderthalensis</i> , Spy	astragalus	U Penn	454p	\$20
<i>H. neanderthalensis</i> , Spy	calcaneus	U Penn	454q	\$20
<i>H. neanderthalensis</i> , Spy	patella	U Penn	454r	\$15
<i>H. neanderthalensis</i> , Spy	clavicle	U Penn	454s	\$15
Olduvai hominid 8	articulated foot	U Penn	F-OL49-EX	\$63
<i>Morotopithecus</i> , Miocene hominoid	palate	U Penn	F-MO4-EX	\$156
Napak V, tarsier-like Eocene primate	face	U Penn	F-NP27-EX	\$56
<i>H. erectus</i> , Sangiran 17	cranium	Bone Clones	BH-018	\$185
<i>H. ergaster</i> , Dmanisi	cranium, mandible	Bone Clones	BH-028	\$289
<i>H. heidelbergensis</i>, Kabwe	cranium	Bone Clones	BH-004	\$179
<i>H. heidelbergensis</i> , Atapuerca	cranium	Bone Clones	BH-022	\$289
<i>H. neanderthalensis</i> , Skuhl 5	cranium	Bone Clones	BH-032	\$289
<i>H. neanderthalensis</i>, La Ferrassie 1	cranium, mandible	Bone Clones	BH-019	\$259
<i>Adapis</i> , Eocene primate		Bone Room		\$26
<i>Rooneya</i> , Eocene primate		Bone Room		\$24

Table 1. Proposed purchases for Anthropology fossil cast collection. Items in bold are highest priority, for purchase in the next funding cycle.

Web site project

This portion of the sabbatical began in Fall semester with a class at Riverside Community college in Dreamweaver Creative Suite 3 (CS3) software. It continued as I designed and produced a web site called "Evolution Mosaic." This site is in testing phase while waiting for image permissions and can be viewed at the URL <http://elearn.mtsac.edu/elawlor/mosaic>. A copy on CD is in Appendix 4.

CIS 76B. Intro to Dreamweaver.

Taught by Scott McLeod, this was a hybrid distance learning class which met once a week and had substantial web-based assignments. While I have taught online and hybrid classes at Mt. SAC, I had not taken any classes through distance education before. All the assignments and the final project involved working with business-related web sites, so I was not able to start designing my evolution website as part of this class. Nevertheless it was a valuable class, and Mr. McLeod was helpful and supportive afterwards when I ran into a problem with the coding.

Beyond the Dreamweaver software itself, I learned some other things from this class:

- My proposed web site, with visitors assembling a human body from its parts, is not feasible without cookies or passworded access. So I reworked the design around the capabilities of Dreamweaver and the desire of most web visitors to protect their privacy.
- Up-to-date web design requires not just an HTML editor program like Dreamweaver, but also CSS – Cascading Style Sheets. So I bought the textbook for that class, with a CD of tutorials, and learned CSS.

- Web design also requires the adept use and management of images, including understanding different file types (JPEG vs. GIF vs. PNG), optimization, and production of images for use as buttons. So I bought the textbook for the Photoshop class, with a CD of tutorials, and learned Photoshop.
- Search engines primarily use metatags, which are portions of the code with key words, phrases, and a brief prose description of the web site. "Evolution Mosaic" has such metatags.
- CSS allows one to make certain elements on a page visible or not depending on the medium being used. So I could make my backgrounds black for a computer screen but white if someone chose to print them.

In addition to this class, I received CS3 software, instruction, support and advice from Mt. SAC's Online Learning Support Center. For example, Carol Webster gave me a couple of introductory lessons in Adobe Photoshop and steered me towards the Lynda.com online tutorials. Dwight Ayle and Paul Kittle helped me with coding problems, and they and Carol offered constructive criticism in the early stages of the design.

The resulting web site comprises 25 pages based on three templates and supported by two Javascript and three CSS files – a total of 33 files, not counting images. There are 93 images, most made by me with Photoshop, including a logo, navigation buttons, and multiple versions of a timeline and human image that appear to be interacting with the visitor.

All images that are not original will be used with permission. Getting that permission has proven more time-consuming than expected, though I should have anticipated that

individuals with copyrights would be away from their institutions for the summer field season. The scientists who have responded so far have been very supportive of the website.

“Evolution Mosaic” opens with a timeline and an image of a man covered in transparent tiles as if a mosaic (Figure 3). Moving the mouse over the timeline makes different markers appear to grow and light up, while corresponding tiles on the body glow. The same effect occurs in reverse: moving the mouse over the body makes different body tiles glow, while corresponding timeline markers grow and light up. Clicking in either location takes visitors to a secondary page (Figure 4) devoted to that body part and its appearance in the fossil record at that place on the time line. The pages are programmed so that they will print with a white background, no navigation bar, and black-and-white logo.

The web site has two goals: (1) to illustrate the mosaic nature of evolution, which tends to affect each functional system separately, and (2) to provide levels of supporting detail for students and educators in the K-12 system and higher education. The most basic level is handled on the top of the secondary page, where anatomical details and controversies have been simplified for a general audience. Inside a collapsible panel on the page (labeled “Details and Links”), links are provided with more details, with a focus on interactive, content-rich web sites from reputable sources without advertising. Finally, in the “References” collapsible panel, peer-reviewed references are provided (Appendix 3).

**EVOLUTION
MOSAIC**

[HOME](#) [LINKS](#) [ABOUT](#) [RESOURCES](#)


A jumble of parts from our past

Can you guess which changes came when? Explore the timeline and the body to check your guess and find out more!


MILLIONS of YEARS AGO (mya)

Dinosaur extinction 65 mya
Earliest mammals 220 mya
Earliest life on earth 4000 mya

About epochs



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Human image after Albrecht Durer's painting *Adam*.
Original image supplied by www.artrenewal.org (Art Renewal Center). Used with permission.

Updated August 26, 2009

Figure 3. Main page of the web site Evolution Mosaic. The visitor has just selected the torso. This view is assembled from two screenshots.


EVOLUTION

MOSAIC

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Torso shape: 12.5 mya




Here's something few people think about: the origin of the torso, the area from shoulders to hips. Why is our torso short and broad, like that of the great apes, rather than long and cylindrical, like that of monkeys? Our torso also is fairly stiff, with fewer lumbar vertebrae than monkeys; a flattened ribcage, and shoulder blades attached in back rather than at the sides.

We share these traits with living great apes (chimps, bonobos, gorillas, and orangutans) because we and they share an ancestor with the same orthograde (roughly upright) posture. That ancestor just might be *Pteropithecus catalaunicus*, found in Spain in 2002. The remarkably complete skeleton is now known to date to 12 to 12.5 mya.


Fun fact: our ancestors lost the tail much earlier. *Proconsul heseloni*, a very early ape that lived 17 mya, had no tail. Once again it's a mosaic!

[Details and Links](#)

[References](#)



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Updated August 23, 2009

Figure 4. Short format of secondary pages. From the main page, if you clicked on the torso or the relevant spot on the timeline, you would go here. There are two hidden panels on this page, under “Details and Links” and “References.”

skeleton is now known to date to 12 to 12.5 mya.

Fun fact: our ancestors lost the tail much earlier. *Proconsul heseloni*, a very early ape that lived 17 mya, had no tail. Once again it's a mosaic!

Details and Links



Pierolapithecus catalaunicus, named for the location where it was found in Spain. This is amazing preservation, with much of the skull and parts of the ribcage, spine, hands and feet, along with other bones.

Students sometimes confuse orthograde posture with upright walking or bipedalism. They're not the same. "Orthograde" simply means tending to be upright, with the shoulders higher than the hips, whether sitting still or moving through the trees.

- "Original" Great Ape Discovered (BBC)
- Ancient Ape Discovered: Last "Great Ape" Ancestor? (National Geographic)

References


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- "Original" Great Ape Discovered (BBC)
- Ancient Ape Discovered: Last "Great Ape" Ancestor? (National Geographic)

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Updated August 23, 2009

Figure 5. "Torso" page with panels expanded. Top, first panel expanded, showing details and links. Bottom, second panel expanded, showing references.

Conclusions

I achieved everything I hoped for in this sabbatical leave at a level I did not anticipate. For example, learning Dreamweaver entailed becoming comfortable with HTML. Likewise, taking the Primate Evolution and Ecology class entailed learning about complex interactions among living primates. I did not anticipate attending the conferences or corresponding with scientists across the country about my web site. And it was a surprise to discover how inconsistent the identifications of our cast collection were, so it feels good to have contributed solid identifications to the Department and College.

Value and benefit to Applicant

This sabbatical leave was a wonderful and productive break from commuting and teaching. I updated my knowledge, experienced being a student again, and got creative. It has been gratifying on my return to campus to be so familiar with our fossil casts. As one colleague put it, they're my friends now. I also am reveling in being able to read the HTML code on my instructional web pages, solving minor but vexing problems that bothered me for years. Updating my pages for the new semester took all of five minutes, whereas it used to take an hour. And returning to my classroom felt like returning home. I thank the Sabbatical Leave Committee and the Board of Trustees for allowing me this time to shake off the burnout I was developing and to return refreshed.

Value and benefit to Department

The Anthropology program in the Department of Biological Sciences has benefitted from this project in three ways. First, it brought me up to date in the areas of

primate and human evolution. I have floated the idea of providing a Flex Day presentation about these areas to the department and there is plenty of interest.

Second, the project has made the existing Anthropology collections more useful to faculty and students. This includes adjunct Anthropologists as well as other Biology faculty who must incorporate aspects of human evolution in Bio 1 and Bio 4 and who occasionally borrow fossil casts. Casts with suspect identifications have been removed from circulation. We have clear direction on how to upgrade the collection and fill in gaps. Faculty who wish to know more have access to relevant professional-level full-text PDFs of articles. Students, including those in the Honors section of Anthro. 1, also will be able to use the PDFs in conjunction with the casts for assignments or extra-credit activities.

Third, the proposed web site will be available to students in all Biological Anthropology (and Biology) sections to augment their textbooks and lecture notes. The "mosaic" theme and summaries of various ancient species may also be useful to colleagues who, like me, had been busy keeping up with other topics.

Value and benefit to the College

Being a new student on a large campus gave me more perspective on our students at Mt. SAC. The bureaucracy can be daunting; it can be hard to find the building and room; you want to make a good impression; and everyone but you seems to know what's going on. I do not know yet how I will apply these experiences beyond my classroom and hallways, but having just joined the Institutional Effectiveness

Committee, I hope that I can help to ensure that Mt. SAC continues to “welcome all students.”

Taking classes at CSU San Bernardino allowed me to get a feel for the campus and Anthropology program, and I am pleased to recommend it without reservation to students seeking a four-year transfer program in Anthropology. I was impressed with the library, the level of rigor expected of the Anthropology students and the supportive atmosphere. Professors knew student names in and out of class and invited them to their homes for parties. My professors asked me to stay in touch, and I intend to do that and to recommend CSUSB to Mt. SAC students.

My Dreamweaver class at RCC introduced me to the experience of being a student in a Distance Learning (DL) format (though I had taught DL classes and had been involved in DL issues at Mt. SAC). I saw some best practices in use and others left by the wayside. I came away convinced that DL can be rigorous and valuable, but also that peer evaluation of DL instructors should include visits to the hybrid classroom. I expect to use this experience in college-wide service as Mt. SAC continues to develop its DL program.

The most important benefits to the College, however, will be my improved web design skills and the resulting “Evolution Mosaic” web site. Already colleagues have asked me for help, and I would be glad to serve as a mentor for other faculty who have web sites and/or as a designer of sites for campus programs, time permitting.

“Evolution Mosaic” will be a valuable resource to our students and to the community. It is appealing to look at, easy to navigate, interesting to read, unique in its focus and useful in its multilayered approach. The take-home message of the site, the

concept of mosaic evolution, comes across on the main page simply by moving the mouse around, something that students in Grades 2 and 3 can do even if the reading level is beyond them. (Aspects of evolution are part of the California Science Content Standards for those grades). For students in Grade 7 and in high school, the brief summaries provide enough information, though these students probably also will try the links. For teachers, including parents who teach home school, "Evolution Mosaic" is a comprehensive source of information and links to relevant lesson plans. By providing an up-to-date, accessible web resource on human evolution, the College may enable students and parents to understand evolution better while encouraging them to consider Mt. SAC as their first source of higher education.

Appendix 1. Annotated fossil cast catalog: Hominins

Previous catalog work is shown here in the smaller font (edited by me for spelling and format).

Catalog #	Scientific name	Common name	Site/ Discoverer	General information	Quantity	Sabbatical annotations
1	<i>Australopithecus africanus</i>	STS 14	Sterkfontein, South Africa; Robert Broom & John T. Robinson 08.01.1947	2.5 million years of age; The complete STS 14 is vertebrae, pelvis, femur, & ribs, which is a very rare, find. This fossil helped to establish the australopithecines as more humanlike than apelike below the neck.	(1) one ilium	ID okay.
2	<i>A. africanus</i>	STS 5	Sterkfontein, South Africa; Robert Broom & John T. Robinson 04.18.1947	2.5 million years of age; A dynamite blast exposed this skull with its crystal-lined brain cavity. Called "Mrs. Ples" it has since been declared a male. This specimen was a turning point which gave the S. African australopithecines credibility as hominids.	(1) one skull	ID okay.
3	<i>A. boisei</i>	OH 5 zinj-nutcracker man	Olduvai Gorge, Tanzania; Mary D. Leakey 07.17.1959	1.8 million years of age; most celebrated fossil from Olduvai, "Zinj" belongs to a specialized East African hyper-robust australopithecine	(1) one skull	ID okay.
4	<i>A. robustus</i>	SK 48	Swartkrans, S. Africa; Fourie 06.30.1950	1.5-2.0 million years of age; Contained the right canine, first premolar, & left three molars. SK 48 added significant knowledge about the morphology of the robust australopithecines.	(2) two skulls	ID okay.

5	<i>A. aethiopicus</i>	KNM- WT 17000; the black skull	Lake Turkana, Kenya; Alan C. Walker 08.29.1985	2.5 million years of age; Called the black skull because of blue- black staining caused by manganese rich minerals it appears to belong to a distinct species which has nothing to do with <i>Homo</i> . It is a robust form.	(1) one skull	ID okay.
6	<i>Homo</i>	KNM- ER 3883	Koobi Fora, Kenya	Pliocene- Pleistocene <i>Homo</i> specimen with affinities to <i>H. erectus</i> . This is one of two crania, the other being KNM- ER 3733.	(1) one skull	Basis?
7	<i>Homo</i>	KNM- ER 1470; <i>Homo rudolfensis</i>	Koobi Fora, Kenya; Bernard Ngeneo 06.1972	1.8-1.9 million years of age; It is hotly debated whether or not this specimen belongs with <i>H. habilis</i> or with australopithecine or a distinct variety, but the bulk of its traits and 775 cc. Brain case supports its placement in <i>Homo</i> .	(3) three pieces: A, B, C	ID okay.
8	<i>A. robustus</i>	TM 1517	Kromdraai, S. Africa; Gert Terblanche 06.08.1938	ca. 2.0 million years of age; A schoolboy, Terblanche led Broom to this find, where he found more of the specimen. Kromdraai is only 1.5 kilometers from Sterkfontein. Broom's hunch that this specimen was different from the Plesianthropus transvaalensis at the Sterkfontein site. TM 1517 became the holotype for <i>Paranthropus</i> classification, which comes from the Greek meaning "beside man".	(2) two partial mandibles	ID okay.

9	<i>Homo neanderthalensis</i>	La Chapelle-Aux- Saints	Bouffia Bonneval, La Chapelle-Aux-Saints, France; Amadee & Jean Bouyssonie and Josef Bonneval 08.03.1908	ca. 50000 y.a. This old man was a pathological case that depicted our first impression of Neanderthal as a shuffling, brutish cave dweller. A reevaluation of the fossil has shown him to be the exception, not the rule due to his pathology.	(1) one skull	Misidentified. No cranium in collection resembles La Chapelle, which had no teeth on right mandible; bone had been resorbed there.
10	<i>Homo neanderthalensis</i>	Spy I	Spy, Belgium; H. Klaatsch 1868	Among the Neanderthal skeletons proposed to be of a deliberate burial. Demonstrated variation in Neanderthal cranial shape.	(1) one skull cap	Basis?
11	<i>Homo neanderthalensis</i>	Spy II	Spy, Belgium; H. Klaatsch 1868	Among the Neanderthal skeletons proposed to be of a deliberate burial. Demonstrated variation in Neanderthal cranial shape. Spy II is higher, rounded and lacks many Neanderthal features seen in Spy I.	(1) one skull cap	ID okay.
12	<i>Homo neanderthalensis</i>	Mt. Circeo 1			(1) one skull	ID okay on basis of descriptions. No positive ID.
13	<i>Homo neanderthalensis</i>	Gibraltar 1			(1) one Partial skull, (1) one mandible, (2) two skull frags	ID of partial skull okay, but see #18.

14	<i>A. boisei</i>	OH 28			(1) one illium	Basis?
15	<i>H. erectus</i>	KNM- ER- 3733	Koobi Fora, Kenya; Bernard Ngeneo 1975	1.75 mya. This specimen, determined to be a female, mooted the single species evolution hypothesis when it proved the coexistence of <i>Homo</i> with robust australopithecines.	(1) one skull	Basis?
16	<i>H. erectus</i>	Trinil 2 "Java man"	Trinil, Java, Indonesia Eugene Dubois 10.1891	c.a. 500000 y.a. This was the first hominid fossil to be found outside of Europe. The finder, Dubois, was a Dutch army surgeon who believed that the origins of life lay in S.E. Asia. He found Trinil 2 on the bank of the Solo river and named it <i>Pithecanthropus erectus</i> . Ernst Mayer classed Trinil 2 with the similiar Peking Man in the 1950's.	(2) two skull cap and femur	One calvaria, ID okay. Femur ID okay.
17	<i>H. sapiens sapiens</i>	Cro- magnon 1 'The Old Man'		High and well-rounded bulging forehead and little supraorbital development.	(1) one skull and mandible	ID okay.
18	<i>H. sapiens sapiens</i>	Gibraltar 1			(1) one Partial skull	Basis? See # 13.
19	<i>H. rudolfensis</i>	KNM-ER- 1802	Koobi Fora, Kenya; 1986		(1) one lower jaw	ID plausible; Portion of thick right side of mandible with relatively narrow molars. No positive ID.

20	<i>H. heidelbergensis</i>	Steinheim skull	Sigrist gravel pit, Steinheim, Germany; Karl Sigrist, Jr.	c.a. 250000 y.a. Although technically an ancestor of <i>H. neanderthalensis</i> , this creature has primitive and modern traits and in many ways appears to be an ancestor of <i>H. sapiens sapiens</i> .	(1) one skull	
21	<i>Homo</i>	KNM- ER 1481			(1) one femur	Basis?
22	<i>Homo</i>	KNM- 50 396			(1) one lower jaw	Basis?
23	<i>A. africanus</i>	Taung baby	Taung, S. Africa; M. de Bruyn 10.1924	c.a. 2.3 m.y.a.; This is the first early hominid found in Africa and provided the basis for a new genus and species <i>A. africanus</i> which is Latin and Greek (it is very unusual to mix these two languages to create names) for "southern African ape".	(1) one brain reconstruction	ID okay, but it's an endocast, not a reconstruction
24	<i>A. africanus</i>	Taung baby	Taung, S. Africa; M. de Bruyn 10.1924	See above.	(1) one facial reconstruction	ID okay, but it's not a reconstruction. Found as frontal / facial bones fused together.
25	<i>A. africanus</i>	Laetoli footprints		3.65 mya.; The best preserved hominid trail was made at the end of the dry season. B. Latimer argues that in the two sets of prints, maybe male and female walking side by side, the female is in the lead. This is quite different from Johanson and Edey's version which depicts the female	(1) one set of footprints	Okay.

				walking exactly three steps behind.		
26	<i>Australo-pithecus</i>	unknown			(1) one skull	
27	<i>H. sapiens</i>	Skhul IV			(1) one skull and mandible	Misidentified. We do not have Skhul IV skull. We do have Skhul IV partial mandible and it is labeled "43". Mandible labeled "27" is identical to # 36.
28	<i>H. sapiens</i>	Mt. Carmel Skhul			(1) one illium	Basis?
29	<i>H. sapiens sapiens</i>	Skhul			(1) one partial parietal	Basis?
30	<i>H. sapiens sapiens</i>	La Chapelle-Aux- Saints			(1) one mandible	Misidentified. See # 9.
31	<i>A. africanus</i>	STS 52b			(2) two mandibles	ID okay.
32	<i>A. afarensis</i>	Hadar composite			(1) one skull	ID okay.
33	Fraud	Pitldown man	Pitldown, England	Pitldown man was thought to be the so- called missing link but turned out to be a fraud that discredited evolutionary science for decades. A mystery still surrounds the perpetrator of the hoax.	(1) One cranial piece (1) one temporal piece	ID okay.
34	<i>H. sapiens sapiens</i>	Kanjera I 747		Late Pleistocene	(1) One cr (2) Ania	? Basis?
35	<i>A. robustus</i>	Sk- 50			(2) two partial ilia	ID okay.

36	<i>H. heidelbergensis</i>	Mayer 1			(1) mandible	Not Mauer. Our cast has a chin. #36 is identical to #27, but with different bits missing due to damage in classroom.
37	<i>H. sapiens sapiens</i>	Upper Choukoutain	F. Weidenreich Pre- WW II	15000 y.a.;	(1) one skull and mandible	Basis?
38	<i>H. sapiens sapiens</i>	Cro Magnon Skull			(1) one skull	Basis? Not a copy of the Cro Magnon skull. Should be identifiable.
39	<i>H. sapiens sapiens</i>	Swanscombe		Swanscombe and Steinheim were the first Middle Pleistocene European crania to be found. Originally only a parietal and an occipital bone were found in the mid- 1930's Report was by Swanscombe committee, headed by W.E. LeGros Clark and G.M. Morant. It has a modern skull form but an archaic combination of features.	(1) one crania	ID okay, but three cranial bones, not one cranium.
40	<i>H. sapiens sapiens</i>	Unknown			(1) one skull	Okay. Provenience?
41	<i>Homo neanderthalensis</i>				(1) one ilium	Plausible. Basis?
42	<i>Homo neanderthalensis</i>				(1) one skullcap	Okay. Provenience?

43	<i>H. sapiens sapiens</i>				(1) one mandible, left side	This partial mandible is Skhul IV. See #27 and #36.
44	<i>A. afarensis</i>				(1) one partial mandible	
45	<i>H. erectus</i>	Sangiran VI			(1) partial mandible	
46	<i>A. boisei</i>	OH 5			(1) one occipital bun (2) one occipital (2) two temporal	ID okay. No occipital bun on this species. Cast is in 5 pieces: Frontal/face; occiput, temporal, xxx?
47	<i>Homo neanderthalensis</i>	Hochdahl			(1) one skull cap	Basis?
48	<i>H. erectus</i>	Sinanthropus pekinensis			(2) two complete skulls	Basis?
49	<i>Homo neanderthalensis</i>				(1) mandible	Basis?
50	<i>Homo neanderthalensis</i>				(1) femur	Okay. Provenience?
51	<i>Homo erectus</i>				(1) one skullcap	Okay. Provenience?
52	<i>H. heidelbergensis</i>				(3) two partial crania (4)	Basis?

53	<i>Homo</i>				(2) two occipital bones	
54	<i>Homo</i>				(1) one r. parietal	
55	<i>Homo</i>				(3) three mandibles	Okay. Provenience?
56	Hominid				(2) two partial mandibles	
57					(1) one partial mandible	
58	<i>H. sapiens</i>				(1) one skull w/ mandible	Okay. Provenience?

Appendix 2. Annotated fossil cast catalog: Duke Primate Center primates

Cat #	Scientific name	Site/discoverer	General information	Quantity	Sabbatical annotations
	<i>Aegyptopithecus zeuxis</i>	Fayum, Egypt; Jebel Qatrani Formata	37- 31 mya.	(1) one skull and (1) one left mandible and (1) one right mandible and (1) one right maxilla	3 left mandibles. DPC 1027, DPC 1028 (Singleton 2003, Appendix A), DPC 1042 (Kay et al. 1981)
	<i>Parapithecid</i>		Left mandible		?
					<i>Propliopithecus ankeli</i> right mandible DPC 1103 (Simons et al. 2005). This is not a Parapithecid; this has 2 premolars.
	<i>Parapithecid fraasi</i>		Right mandible		This taxon is synonymous with <i>Apidium phiomense</i> . Could be the specimen with the rubbed-off numbers.
	<i>Parapithecid grangeri</i>		Left mandible		<i>Simonsius grangeri</i> , 1 left mandible DPC 2807, 1 right maxilla DPC 2385 (Teaford et al. 1996, Simons 2001)
	<i>Aegyptopithecus phiomense</i>		Right mandible	(2) two right mandibles	<i>Apidium phiomense</i> , 1 right mandible DPC 1102 (Kay and Simon 1983)
	<i>Parapithecus chirobalts</i>			(1) one left mandible, (1) one right mandible, (1) one left maxilla, (1) one right mandible fragment	<i>Propliopithecus haeckeli</i> 1 entire mandible DPC 1106, 1 left mandible DPC 1108, 1 maxilla fragment DPC 1029, 1 mandible fragment DPC 1069 (Kay et al. 1981)

8	<i>Proconsul africanus</i>	KNM-RU-7290A		(1) one skull, (1) one mandible	ID okay.
9	<i>Propithecus</i>			(1) skull	Not located.
10	<i>Aegyptopithecus</i>			(1) one skull	ID okay.
11	<i>Notharctus</i>			(1) one half skull	ID okay.
12	KNM- 50,700			(1) one maxilla	Not <i>Morotopithecus</i> .

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Appendix 4: Other Supporting Materials

Transcripts and term papers

Conference fliers

References on a CD

Web site on a CD

Name : Elizabeth Lawlor
 Student ID: 003562909
 Birthdate : 1960-09-29

Official Postbaccalaureate Transcript



Adria Ortega

Director of Records
 Registration & Evaluation

Federal and State Laws state that this student's record must be used only for the intended purpose and that release or disclosure to unauthorized other parties without the prior written consent of the student (or former student) is prohibited.

RAISED SEAL NOT REQUIRED
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CUM GPA : 4.000 CUM TOTALS : 4.00 4.00 16.000

Send To : ELIZABETH J LAWLOR
 422 CAMPUS VIEW DRIVE
 -
 -
 RIVERSIDE, CA 92507
 United States

----- Spring 2009 -----

<u>Course</u>	<u>Description</u>	<u>Registerec</u>	<u>Earned</u>	<u>Grade</u>	<u>Points</u>
Session : Regular Academic Session (2009-04-04 to 2009-06-15)					
ANTH 327	PRIMATE EVOL&ECOL	4.00	4.00	A	16.000

REQ DESIGNATION : Non-Resident Credit

TERM GPA :	4.000	TERM TOTALS :	4.00	4.00	16.000
CSUSB GPA :	4.000	CSUSB TOTALS :	8.00	8.00	32.000
CUM GPA :	4.000	CUM TOTALS :	8.00	8.00	32.000

----- End of Transcript -----

Print Date : 2009-08-17

----- Winter 2009 -----

<u>Course</u>	<u>Description</u>	<u>Registerec</u>	<u>Earned</u>	<u>Grade</u>	<u>Points</u>
Session : Regular Academic Session (2009-01-10 to 2009-03-23)					
ANTH 326	HUMAN ORIGINS	4.00	4.00	A	16.000

REQ DESIGNATION : Non-Resident Credit

TERM GPA :	4.000	TERM TOTALS :	4.00	4.00	16.000
CSUSB GPA :	4.000	CSUSB TOTALS :	4.00	4.00	16.000

Print Date: Dec 22, 2008

RIVERSIDE COMMUNITY COLLEGE DISTRICT OFFICIAL TRANSCRIPT



Student Name and Address	Lawlor, Elizabeth J 422 W Campus View Drive Riverside CA 92507 UNITED STATES
Student ID#	1232813
SSN	XXX-XX-0631

DOB	Sep 29, 1960
High School / Date of Graduation	

IGETC	GE	Level	Course	Course Title	Grade	Notatn	GPA	Units	Grade	G.P.A	IGETC	GE	Level	Course	Course Title	Grade	Notatn	GPA	Units	Grade	G.P.A
CSU			Number				Attempted	Comp.	Points		CSU			Number				Attempted	Comp.	Points	
----- Fall 2008 (09/2008 - 12/2008) -----																					
			CAT-768	Intro to Dreamweaver	A		3.00	3.00	12.00												
							SEMESTER TOTAL	3.00	3.00	12.00	4.0000										
							CUMULATIVE TOTALS	3.00	3.00	12.00	4.0000										
							DEGREE GPA	3.00	3.00	12.00	4.0000										
							UC TRANSFER GPA	0.00	0.00	0.00	0.0000										
							CSU TRANSFER GPA	0.00	0.00	0.00	0.0000										

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Lorraine Anderson
DISTRICT DEAN

HOLD UP TO LIGHT TO SEE "VERIFY FIRST" WATERMARKED INTO THE PAPER

What have we learned about early hominins from cladistics?

**Elizabeth Lawlor
Anth 326
Wes Niewohner
March 19, 2009**

Abstract Cladistics, or phylogenetic systematics, is a method of classification with the goal of reflecting evolutionary relationships. While used extensively in botany and zoology, paleoanthropologists variously resist or embrace strict adherence to the method. This paper investigates the question, "In case cladistics is the right approach to sorting out the hominin fossil record, what is the current thinking about the major branching points in early hominin phylogenetic systematics?" I conclude that there is little consensus except that hominins are a monophyletic group and that we need more fossils. There is hope for more success with careful consideration of development in the choice of characters, including postcrania wherever possible and excluding epigenetic factors such as masticatory complexes.

Introduction Cladistics is a method of classification (also called phylogenetic systematics) that aims to produce taxa that reflect evolution. Since its introduction (in English, in 1965), cladistics has become the standard method for sorting out and depicting phylogenetic relationships in entomology, botany, and other biological sciences (Hennig, 1965; Farris, 1979), even in museum exhibits for the public. For example, the American Museum of Natural History overhauled its Fossil Halls in the mid-1990s to form a giant walk-through cladogram, with a film narrated by Meryl Streep introducing cladistics at the entrance (Wilford, 1996). Yet current introductory anthropology textbooks, if they discuss cladistics, usually provide only a brief introduction and present various hominin phylogenies without explicit reference to key concepts such as shared derived traits. My goal in this paper is to explore how paleoanthropologists have adopted cladistics and what, if any, consensus has resulted

regarding relationships among the earliest hominids (up to and including early *Homo*). The intended audience is my colleagues who teach human evolution at community colleges.

A brief review of key concepts is in order. A clade (branch), or monophyletic (single-lineage) unit “contains *all* the known descendants, and *nothing but* the known descendants, of a common ancestor” (Wood and Chamberlain, 1986; italics in original). The goal of cladistics is to produce a tree of life in which all of the branches are monophyletic, a task which requires the sorting out of homologies (traits shared due to genetics) from homoplasies (traits shared due to other factors, such as convergence). Among the homologies, we need to further sort out the derived traits (apomorphies) from the ancestral traits (pleisiomorphies). Colleagues who find this jargon as daunting as I did might benefit from *The Compleat Cladist* (Wiley et al., 1991), a clear and brief introduction with short self-quizzes.

A phylogenetic tree (cladogram), therefore, is based on “shared *derived* homologous features, each of which developed in an intermediate ancestor later in the tree and has been retained in a specific group of descendants” (Martin, 1992). The resulting cladogram with sister groups is a hypothesis to be tested. With fossil species, the tests involve (a) the discovery of new material and/or (b) the “interrogation” of previously found material (Wood, 2000).

Note that the hypotheses to be tested are about sister groups, not ancestor/descendent relationships (Cela-Conde et al., 2000; Wood and Lonergan, 2008). That is just one of the difficulties of applying cladistics to the record of human

evolution; of course we want to know about ancestor/descendent relationships. Other challenges include identifying homoplasies (Begun, 2007; Lockwood, 2007) and determining polarity (derived vs. ancestral).

History The cladistic method of classification was proposed in the 1950s by Willi Hennig, a German entomologist whose first English paper (1965) is far clearer than many later articles by others. Hennig's influence was enormous throughout biology; his approach has been hailed as being "in a word, rational" (Farris, 1979) in contrast to "largely intuitive process" it previously had been (Tattersall, 2000).

Paleoanthropology was no exception. Its systematics had been more subjective than scientific (Clark, 1988), with so many genus and species names and classification schemes that sometimes even coauthors did not follow the same classification (e.g., Tobias and von Koenigswald, 1965). The influence of modern systematics on hominin research was "long retarded, but at last pervasive" (Howell, 1967), picking up steam in the 1970s and 80s (e.g., Tobias 1973; Skelton et al., 1986; Wood and Chamberlain, 1986) and now used "almost universally" (Wood and Lonergan, 2007). Its recent applications range from proposals to rename entire branches of hominins (Cela-Conde, et al., 2000; Cela-Conde and Altaba, 2002) to species affinities of particular material, such as the *Homo* crania from Sterkfontein and Swartkrans (Smith and Grine, 2008).

How could there be a downside to a method for classifying organisms based on an objective assessment of characters? First, as Hawks (2004) and others have noted, it is not really objective, since researchers are still choosing characters and how to codify them (Wood and Lonergan, 2008). A more fundamental issue is the monophyletic species concept (MSC) that is central to cladistics:

The problem with the MSC is that it assumes the observer knows which characters are autapomorphies [unique to the species]. But in order to determine which characters are autapomorphic one needs to perform a cladistic analysis, and in order to do that one needs to have operational taxonomic units, and in order to determine what these are one needs an alpha taxonomy (i.e. one needs to be able to recognize species in the fossil record). The MSC is the product of circular reasoning [Wood and Lonergan 2008:366].

But solving these philosophical problems would do nothing to fix the problems posed by the scanty and fragmented hominin material itself, including "the close genetic relationship of early hominid taxa, small fossil sample sizes, possible correlations among characters, and a lack of understanding about the evolutionary factors affecting characters" (Hawks, 2004). Finally, cladistics assumes that all speciation occurs by splitting, when in fact hybridization, or reticulated speciation, occurs (Groves, 2007); has been observed among colobus monkeys (Karanth, 2008); and is suspected among hominins as well (Patterson et al., 2006).

Still, despite the real limitations of both the method and the fossils, it probably is better to use cladistics as a method to ascertain one or two clear phylogenetic relationships than to have nothing at all (Hull, 1979). And the majority of paleoanthropologists at least give it lip service in recent publications. So the rest of this paper will presume that cladistics is the best method available and explore what consensus exists concerning the major branching points in early human ancestry, based on the fossil record. I will follow the "splitting taxonomy" summarized by Wood

and Lonergan (2008) but discuss "lumping" alternatives and other synonymy where appropriate.

Hominins vs. panins There is consensus that hominins are a monophyletic group (Begun, 1992). The synapomorphies of the hominin clade are generally considered to include bipedalism and "teeth that are essentially human in form" (Cela-Conde and Ayala, 2003). That sounds clear enough, but when the fossils are fragmented and/or intermediate in character, it can be difficult to determine whether a specimen was bipedal or whether its teeth are "essentially human." Even with intact specimens, dental characters may not be very useful at the base of the family tree; "the derived dental features that might unite Hominidae also characterize an orangutan clade" (Schwartz, 2007). Furthermore, Collard and Wood (2000) found that cladograms based on standard craniodental features assessed in fossil hominins were faulty; that is, these features did not predict the molecular phylogenies of living apes (with baboons as an outgroup).

Earliest possible hominins *Sahelanthropus tchadensis*, *Orrorin tugenensis*, and *Ardipithecus* spp. are the most ancient and among the most recently discovered of the possible hominins. With little published material, it is difficult to identify relevant homologous or homoplastic characters that consistently establish the relationships of these to each other or to previously discovered hominins. At least three recent comprehensive reviews have placed some or all of these early fossils differently in a

hominin phylogeny, with (Strait and Grine, 2004; Wood and Lonergan, 2008) or without (Cela-Conde and Altaba, 2002; Cela-Conde and Ayala, 2003) formal cladistic analysis.

The first issue is whether each belongs in the hominin clade. Wolpoff et al. (2006), focusing on *Sahelanthropus*, concluded that it is not a hominin, based on insufficient evidence for bipedalism and on a canine wear pattern deemed homoplastic with that of other Miocene hominoids. Other researchers have designated it *incertae sedis* (Cela-Conde and Ayala, 2003) and noted that it could be either a primitive hominin or a hominin-like ape (Wood and Lonergan, 2008). *Sahelanthropus* has been unstable (inconsistent) in formal cladistic analyses, but "there is tentative support for the hypotheses that *S. tchadensis* is the sister taxon of all other hominids" (Strait and Grine, 2004). Note that this is possible whether or not the taxon was actually a hominin.

Orrorin stands (perhaps bipedally) on somewhat more solid ground, with ape-like teeth but femoral cross-sections that suggest obligate bipedalism. One approach is to consider *O. tugenensis* as a *species geminalis* (*spec. germ.*), a "fully developed species . . . that represents the early stages of a new supraspecific taxon" *Praeanthropus* (see below) (Cela-Conde and Altaba, 2002). Alternatively, "*O. tugenensis* may prove to be a hominin, but it is equally and perhaps more likely that it belongs to another part of the adaptive radiation that included the common ancestor of panins and hominins" (Wood and Lonergan, 2008). (This genus was not included in Strait and Grine's [2004] formal cladistic analysis, probably because it was discovered shortly before the paper was submitted for publication.)

As for *Ardipithecus ramidus* and *Ar. kadabba*, the consensus seems to lump them into *Ar. ramidus sensu lato* (*s.l.*) and to consider them as apelike bipeds, a sister group

to the australopithecines (Wood and Lonergan, 2008) or to *Praeanthropus*. With the latter approach, Cela-Conde first designated *Ardipithecus* as *incertae sedis* (as opposed to within a subfamily; Cela-Conde and Altaba, 2002), and one year later in the subfamily *Praeanthropinae* (Cela-Conde and Ayala, 2003). Formal cladistic analysis does not yield consistent results, but one “most parsimonious” cladogram places *Ardipithecus* as the sister taxon of all other hominins except *Sahelanthropus* (Strait and Grine, 2004; recall that this study did not include *Orrorin*).

Early definite hominins – no megadonty This bunch includes *Australopithecus anamensis*, *Au. afarensis*, *Au. bahrelghazali*, *Kenyanthropus platyops*, and *Au. africanus*, but there’s a problem. When it includes the species *Au. africanus* and *Au. afarensis*, the genus *Australopithecus* is paraphyletic (Lieberman et al., 1996; Strait and Grine, 2004). An alternative nomenclature resurrects the generic name *Praeanthropus*, which was one of many generic names of the 1950s (Grine et al., 2006).

The upshot is that a synonym for most of these species is *Praeanthropus* sp. (e.g., *Praeanthropus anamensis*), with *Australopithecus* reserved for *Au. africanus* and perhaps the megadonts (sometimes called *Paranthropus*; see below). This synonymy led to a further problem: whether *Pr. afarensis* would have to become *Pr. africanus* due to primacy rules (due to the 1950 binomen *Meganthropus africanus*). “Because of the potential for confusion, the International Commission of Zoological Nomenclature (ICZN) acted [in 1999] on the application by Groves (1996) to suppress the specific name *africanus*” (Grine et al., 2006).

The unfortunate result in recent literature is a multiplicity of names for the “Lucy” hypodigm (total fossils recovered): *Praeanthropus africanus* despite the ICZN Opinion (Cela-Conde and Altaba, 2002); *Praeanthropus afarensis* (e.g., Strait and Grine, 2004; Grine et al., 2006); and the original *Australopithecus afarensis*, which ignores the issue of paraphyly (Wood and Lonergan, 2008). *Praeanthropus* seems the correct solution, but rather than further confuse my reader(s), I will continue to use *Australopithecus* in this paper.

Getting back to the central issues, it is possible that at least three of the early *Australopithecus* species may be lumped together. *Au. bahrelghazali* probably is a regional variant of *Au. afarensis* (Wood and Lonergan, 2008), and a “concordance of stratigraphic and character-state data support the idea that the *A. anamensis* and *A. afarensis* samples represent parts of an anagenetically evolving lineage, or evolutionary species” (Kimbel and Lockwood, 2006). This is by no means a consensus, however. In strict cladistic analysis, stratigraphy is irrelevant (Chamberlain and Wood, 1986), so *A. anamensis* appears as a sister of *Au. afarensis* in a recent cladistic overview (Strait and Grine, 2004). Likewise, *Pr. anamensis* appears as a sister of “*Pr. africanus*” (*afarensis*) (Cela-Conde and Ayala, 2003).

Kenyanthropus platyops is a puzzle, with vastly different interpretations, including the question of whether it even merits its own alpha taxonomy (species name) (Strait and Grine, 2004). Contemporary with *Au. afarensis* at about 3.5 million years ago (mya) in East Africa, but with a unique combination of facial and dental morphology, its face resembles that of *Homo rudolfensis* (Wood and Longergan, 2008). Accordingly, some place it in the genus *Homo* (as a *species geminalis*) (Cela-Conde and Ayala, 2003),

while others have suggested transferring *H. rudolfensis* to the genus *Kenyanthropus* (Strait and Grine, 2004). Rather than showing a sister group relationship between *K. platyops* and *H. rudolfensis*, however, the most parsimonious trees have shown that *Kenyanthropus* is a sister taxon of either *Paranthropus* or a *Homo/Paranthropus* clade (see below) (Strait and Grine, 2004).

Australopithecus africanus traditionally has been treated as "gracile" (e.g., Wood and Lonergan, 2008), as opposed to the "robust" hominins with heavy-duty chewing complexes including very large cheek teeth (megadonty). Recently, however, its affinities with the robust group have been emphasized. For example, *Au. africanus* shares with *Au. robustus* anterior pillars – columns of bone on either side of the nose – that are likely to be related to using the front teeth to open large, tough nuts and seeds (Strait et al., 2009). One taxonomy therefore places *Au. africanus* as the *species geminalis* of a group including the megadonts (Cela-Conde and Ayala, 2003), while cladistic analyses variously show *Au. africanus* as a sister group to a megadont clade (Strait and Grine, 2004) or to a group including *H. rudolfensis* and some, but not all, of the megadonts (Lieberman et al., 1996).

The megadonts This group includes *Australopithecus aethiopicus*, *Au. robustus*, *Au. boisei*, and *Au. garhi*, all of which have very wide cheek teeth. The first three also have sagittal crests, wide zygomatic arches, massive mandibles and very thick molar enamel, and on that basis are often assigned to the genus *Paranthropus* (Wood and Constantino, 2007; Wood and Lonergan 2008). They also sort out as a monophyletic group fairly consistently in cladistic analyses (Strait and Grine, 2004; but see Lieberman

et al., 1996). But considering that *Au. robustus* has anterior pillars like its South African cousin *Au. africanus*; that *Au. africanus* sometimes has a sagittal crest; and that the East African megadonts lack anterior pillars, *Paranthropus* could be paraphyletic. One solution is to place *Au. africanus* as the *species geminalis* of a clade that includes *Au. aethiopicus*, *Au. robustus*, and *Au. boisei* (Cela-Conde and Ayala 2003). (Since these authors transferred many taxa out of *Australopithecus* and into *Praeanthropus*, they see no need to split out the robust species into *Paranthropus*.)

What about *Au. garhi*? In cladistic analyses, this taxon very consistently lands between *Au. afarensis* and *Au. africanus* (Strait and Grine, 2004). Therefore some would transfer it to *Praeanthropus* (Cela-Conde and Ayala, 2003), a genus that appears to be the new foster home for stray hominin species. To make matters even more confusing, it is possible that the type specimen of *Au. aethiopicus*, a mandible from Omo, actually belongs to the hypodigm of *Au. garhi*. If so, then *P. aethiopicus* would have priority as the name for the material currently named *Au. garhi* (Wood and Lonergan, 2008).

Transitional *Homo* Does early *Homo* comprise one species (*H. habilis s.l.*) or two (*H. habilis sensu stricto* [s.s.] and *H. rudolfensis*)? Do the fossils traditionally assigned to early *Homo* even belong in our genus? Thirty-eight years after the discovery of skull ER-1470, these questions still are not resolved.

Many, perhaps most researchers, split early *Homo* in two (e.g., Wood and Chamberlain, 1986; Lieberman et al., 1996; Cela-Conde and Ayala, 2003; Collard and Wood, 2007). A vocal minority, however, (e.g., Wolpoff and Lee, 1996) say we cannot

reject the hypothesis that early *Homo* is just one variable species, and that cladistics has no role here because gene flow cannot be ruled out.

A larger question is whether these fossils meet the criteria for the genus *Homo*, implying the still larger question of how to define the genus *Homo*. Wood and Collard (1999) argued that a genus should have both monophyly and adaptive coherence and that by these criteria, the later members of the genus belonged in *Homo*, with obligate bipedalism and modern-sized chewing teeth; whereas *H. habilis* and *H. rudolfensis* belonged in a different genus. *H. habilis*, for example, has some postcranial traits pointing towards part-time arboreal movement. On this basis, Wood and Collard (1999) proposed transferring early *Homo* to *Australopithecus*. But this was not supported by most cladistic analyses (e.g., Strait and Grine, 2004). Australopith-like characters of *H. rudolfensis*, in particular, are likely to be homoplasies rather than homologies (Lieberman et al., 1996). Collard and Wood (2007) revisited this question in an extensive review and concluded that enough cladistic analyses were equivocal, and enough new data have surfaced about early *Homo* postcrania, that their 1999 proposal to remove *H. habilis* and *H. rudolfensis* from the genus *Homo* remained valid. But transferring them to *Australopithecus* would only increase the paraphyly of that genus (Strait and Grine, 2004), so a new genus would be needed. Collard and Wood (2007) stopped short of proposing one.

Conclusions Considering all the controversies about early hominin phylogeny, are there any points of agreement? Yes. Even Wolpoff and Tattersall (to name an extreme lumper and splitter, respectively) would agree on two things. First, the hominins are a

monophyletic group. No paleoanthropologists have adopted Jared Diamond's (2006) observation that humans and chimpanzees could very well belong in a single genus, since they are genetically more closely related than species of birds in the genus *Vireo*. Second, it's all about testing hypotheses. The best way to test a cladogram is to find new fossils, run their character states with the previous hypodigms, and see whether the cladogram survives without major changes (Martin, 1992).

Short of finding new fossils, useful approaches in the pipeline include research similar to that by Collard and Wood (2000), evaluating particular sets of characters to determine which characters will be most likely homologies or homoplasies. For example, the developmental sequence of limb bones as seen in radiographs might help with the identification of apomorphies (Blomquist, 2009). Pilbrow (2006) found encouraging applicability of molar morphology in extant *Pan* to identify species and subspecies differences. But we should avoid using character states of the palate as that appears to be part of a complex of masticatory features that responds to muscular stresses and therefore is likely at least partially epigenetic (Strait et al., 2007).

I chose this topic hoping to find some agreement on shared, derived character states that clearly marked each node in a cladogram of early hominins. What I learned is that no such agreement exists, nor is likely to exist, for years (at least). Cladistics is a useful method for *attempting* to be objective in classification. Sometimes it even sheds light on which hominins are more closely related to whom. But the field of paleoanthropology is perhaps even more contentious and speciose now than it was before Hennig started making modern systematics accessible in English. No wonder introductory textbooks in physical anthropology tend to gloss over cladistics.

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Associating with a Better Sort:

Monkeys of the Taï Forest

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This paper explores polyspecific associations among Old World monkeys in the Taï Forest. First I summarize the basics: what is special about the Taï Forest and which monkeys live there. Then I discuss how these sympatric species partition themselves into different ecological niches and what the evidence is for polyspecific associations among certain species. Finally I discuss what is known about the alarm calls of these monkeys, particularly the interspecific recognition of alarm calls.

I have structured this paper as I might present it to students, including details that might catch their attention. My goal is to understand and then convey the complexity of what it takes for a wild monkey to survive, surrounded by other species of monkeys, while trying to elude leopards, crowned eagles, and two wily, cooperative and brutal predator apes: chimpanzees and humans.

Why care about the Taï Forest?

The Taï National Park, Côte d'Ivoire, West Africa was one of the first areas of Africa to be set aside for preservation – in 1927. Today it is the largest intact expanse of African rainforest (McGraw and Zuberbühler 2007) and a World Heritage Site. Home to many endangered and/or endemic species, the Taï Forest shelters an unequalled diversity of nonhuman primates: four species of guenons; three species of colobines; two species of prosimians; sooty mangabeys; and chimpanzees.

The region consists of “tropical evergreen seasonal lowland forest” with approximately two meters of rain falling annually in two wet seasons: September - November and March - June (Buzzard 2006a: 532; McGraw and Zuberbühler 2007). Temperatures are nearly constant, ranging only between 24°C and 27°C (around 78°F), and relative humidity hovers at 85 percent or more (McGraw and Zuberbühler

2007:5). Most of the forest canopy is about 30 m tall, with emergent trees reaching twice that height (Boesch 1994).

Students probably are already familiar with film footage of some of the primates there. For example, Taï chimps are among those who crack nuts (Boesch *et al.* 1994). Students also may have seen hair-raising film of chimps hunting cooperatively for red colobus monkeys at Taï. Those who follow conservation news also may have heard of Miss Waldron's red colobus monkey (*Procolobus badius waldroni*). Thought to have gone extinct in the twentieth century, this monkey may still be hanging on in rainforest in Côte d'Ivoire (McGraw 2005).

One reason they are critically endangered is that local people hunt monkeys for their own tables and for the market. This bushmeat poaching happens daily inside the park and its bordering buffer zone (Refisch and Koné 2005). Other threats include habitat loss due to farming, logging and gold mining in the buffer zone surrounding the national park (McGraw and Zuberbühler 2007).

One more reason to care about the Taï Forest is that it harbors some of the most deadly emergent diseases, including Ebola (Wikipedia) and the simian precursors of one set of variants of the human immunodeficiency virus (HIV) (Locatelli *et al.* 2008). HIV-1 has been traced genetically to the simian immunodeficiency virus (SIV) variants infecting west-central African gorillas and chimpanzees (*Pan troglodytes troglodytes*, not the *P. t. verus* found in Taï). HIV-2 subtypes have been traced to separate cross-species transmissions from the SIVs in sooty mangabeys (McGraw and Zuberbühler 2007:20). Another SIV variant recently was found in 26 percent of tested red colobus monkeys in the Taï Forest (Locatelli *et al.* 2008). Previous transmissions to humans are thought to have occurred through butchering and consumption of bushmeat, and

since red colobus monkeys are a frequent prey of poachers in the Taï Forest (Refisch and Koné 2005), it is possible that an HIV-3 could emerge in this region. See McGraw (2005) for color photos of hunters with a recently killed sooty mangabey and Miss Waldron's red colobus monkey.

While important for many reasons, the Taï Forest primates should not necessarily be considered typical for their species. One of the hallmarks of primate behavior is its flexibility, and the long-term study projects at Taï, Gombe and elsewhere have demonstrated not only differences in chimp tool use and hunting behavior (as in Boesch 1994) but also differences in red colobus monkey "socio-ecology, diet preferences, group sizes, association tendencies and anti-predator adaptations" (McGraw and Zuberbühler 2007:12). For example, they harass chimps at Gombe but not at Taï (Boesch 1994). It is safe to presume that polyspecific group dynamics may also vary from site to site in Africa, even when the same species are involved.

Which monkeys are we talking about?

This paper focuses on seven monkey species (Table 1) present at the Taï Monkey Project study site, a field station on the western border of the national park and 20 km from the nearest village. The project was founded in 1989 as a study of red colobus monkeys and their adaptive responses to chimpanzee predation. Since then, the focus has widened, with over 35 graduate theses by European, Japanese and American scientists completed by 2007. This and all information in the summaries below about each monkey are drawn from McGraw and Zuberbühler (2007) unless otherwise cited. Conservation status is updated from the web (IUCN 2009); as is true of many species, the Taï monkeys that do well in secondary or disturbed forest are of

the least concern for conservationists; those that require primary, mature forest are considered more vulnerable or even endangered (Table 2).

Three species of guenons Guenons are a diverse group of small, sexually dimorphic arboreal monkeys that live in single-male, matrifocal groups (Rowe 1996:153). Primarily frugivorous, forest guenons defend territory with loud calls and intergroup aggression (Buzzard 2006b).

Cercopithecus diana, the Diana monkey, has been called “the central species in the Tai monkey community” for several reasons (McGraw and Zuberbühler 2007:22). Two of the three colobine species associate with *C. diana*, and where they share a home range, this species dominates the other guenons. They are conspicuous to humans as the most active, quick and agile of these monkeys, with dramatically colored fur (McGraw and Zuberbühler 2007). While they use all strata of the forest, the majority of the fruits they eat come from high in the canopy, on trees with wide diameters: mature trees (Buzzard 1996a). Thus *C. diana* requires primary rainforest and will become more endangered as mature forest is lost to farming, logging and gold mining.

Cercopithecus campbelli, Campbell’s monkey, tend to dine in the understory and on the forest floor. Like the other Tai guenons, *C. campbelli* eat plenty of fruit, but (especially in times of low fruit availability) up to 33 percent of their diet is “animal matter” including relatively immobile prey such as caterpillars, cocoons, slugs, and centipedes; nests such as spider webs and insect larvae; and mobile prey such as adult insects, spiders, and tree frogs (Buzzard 2006a).

Cercopithecus petaurista, the lesser spot-nosed monkey, is the smallest monkey found at Tai. Eating slightly more foliage than fruit and relatively little prey, it also uses middle forest strata more than the other guenons (Buzzard 2006a). Yet this species has the largest home range of the Tai guenons (Table 3), which does not fit the usual negative correlation of primate home range size with the proportion of leaves eaten (Buzzard 2006b). A small, shy, quiet monkey that easily vanishes into the forest and eludes even experienced primatologists, *C. petaurista* may be the least understood of the guenons (McGraw and Zuberbühler 2007). On the other hand, its cryptic nature may also be protecting it from predation, at least by human poachers, and its preference for young leaves of the liana vine (Buzzard 2006a) – which grows rapidly in secondary forest – means that loss of primary rainforest is less of a threat for this monkey than for other species (McGraw and Zuberbühler 2007).

Three species of colobines Colobus monkeys are among the largest monkeys, with specialized sacculated stomachs for digesting mature leaves. Although they are often called “folivorous” monkeys, most eat a more diverse diet than just leaves, and the Tai colobines are a good example; all consume significant amounts of fruit as well, and the favorite food of King colobus is seeds.

Procolobus badius, the Western red colobus, is widespread in Africa and abundant in the study area. There is disagreement about whether this is one species in Africa with 15 subspecies, or five species with a number of subspecies (McGraw and Zuberbühler 2007), but these monkeys share a number of behaviors and characteristics including loud and frequent vocalizations; frequent arboreal leaping; little sexual dimorphism; sexual swellings in estrous females; and the unfortunate

status of favorite monkey prey of both chimpanzees and humans. At Tai, *P. badius* live in large multimale groups with male philopatry and prefer a diet of leaves, fruits and flowers (McGraw and Zuberbühler 2007). They frequently associate with *C. diana*, perhaps in order to receive an early warning about chimpanzees hunting (Bshary, 2007).

Procolobus verus, the olive colobus, is restricted to West Africa. At about half the size of *P. badius*, it is the smallest colobine (McGraw *et al.* 2007: Plate 6). The two species share frequent leaping, scant sexual dimorphism, and prominent sexual swellings at estrus, but differ profoundly in other ways. *P. verus* live in small groups, vocalize rarely; and eat primarily leaves with only a little fruit, spending extended time resting during digestion (McGraw *et al.* 2007: Plate 9). If this species had an antipredator motto, it would be "blend in, keep quiet, and stay near other monkeys;" *P. verus* groups are almost always associated with other monkeys, and with *C. diana* more than 95 percent of the time (McGraw and Zuberbühler 2007). A typical group includes more than one adult male with three or more adult females and their infants, but group structure does vary, and both females and males disperse (Korstjens and Schippers 2003).

Colobus polykomos, the King colobus, is a black and white colobus and the largest arboreal monkey at Tai. Unlike the other two colobus monkeys there, *C. polykomos* actively avoids associations with other species and does well in disturbed forest areas. This species also differs in the lack of sexual swellings in females (McGraw and Zuberbühler 2007). Living in groups of one or two males with three to seven females and offspring, *P. polykomos* groups have strongly overlapping home ranges (Korstjens *et al.* 2005). Research on the Tai groups has included a focus on

female social behavior. Females disperse after targeted aggression by other females, suggesting resource competition, an explanation that is consistent with the observation that female intergroup aggression is seasonal, occurring mostly when their preferred food resources (particularly *Pentaclethra* seeds and pods) are ripe (Korstjens *et al.* 2005). These seeds, and the liana leaves they also favor, take considerable time to digest, and *P. polykomos* spend much of their time resting and digesting (McGraw *et al.* 2007: Plates 4, 5).

Mangabeys *Cercocebus atys*, the sooty mangabey, is a predominantly terrestrial species most closely related to mandrills and drills, which also inhabit forest floors. (Mangabeys are diphyletic; arboreal mangabeys are more closely related to savannah-living baboons and geladas (Range and Fischer 2004)). Their loud groups are also large – up to 100 individuals in a multi-male, multi-female group, with female philopatry and some splintering depending on seasonal resource availability. Females breed seasonally, advertising with prominent sexual swellings and attracting non-residents who invade as single males or in groups (McGraw and Zuberbühler 2007). There are linear hierarchies, coalitions among relatives, and long-term friendships between adult males and adult females; In other words, *C. atys* social behavior closely resembles that of other old world primates that live in multimale, multifemale groups (Range *et al.* 2007:124).

Most of the diet of *C. atys* is foraged from a wide home range on the forest floor: insects, mushrooms, and (especially) fallen hard foods that the other monkeys cannot process but that *C. atys* can crush with large teeth and strong jaws (McGraw and Zuberbühler 2007). These foods tend to occur in patches on the forest floor: areas

around 10 m or less in diameter, with mushrooms or termites, and circular patches around the trunks of food trees, up to 10 m in radius (Range *et al.* 2007).

How can they all survive in the same habitat?

The principle of competitive exclusion would predict that these seven sympatric monkey species exploit different resources, and in some ways they do (Table 2). It makes sense, for example, that one monkey should specialize in fallen hard foods in the forest litter; we can think of *C. atys* as the catfish of the West African rainforest. It also makes sense that guenon niche partitioning involves where most of the food comes from in the forest strata: upper (*C. diana*), middle (*C. petaurista*), or lower (*C. campbelli*) (Buzzard 2006a). The guenons overlap in plant species used, but there is some partitioning of food items from those species (e.g., leaves vs. fruit) (Buzzard 2006a). Likewise, the colobines partition themselves partly by forest stratigraphy and partly by food items: *P. badius* and *C. polykomos* use all the strata but prefer the main canopy, with *P. badius* eating primarily leaves and fruit and *C. polykomos* primarily fruit seeds when available. Meanwhile, *P. verus* forages primarily on the floor and in the understory.

As if this weren't complicated enough, foods in the forest come and go with the marked wet and dry seasons, two cycles per year. For the guenons, at least, dietary diversity increases at times of low fruit availability (Buzzard 2006a). And let's add one more layer of complexity: there are sex and age differences in diet as well. Adult males of all three guenon species eat more fruit than adult females and juveniles;

conversely, adult female and juvenile guenons eat more prey than adult males (Buzzard 2006a).

Primatologists who can keep all this information straight and make sense of it have my respect, but I wonder if this non-primatologist can add to the analysis. The considerable overlap of Tai monkey home ranges and diets allows most of these species (apart from that loner, *P. polykomos* – the “King”) to associate with other cercopithecids. Perhaps dietary flexibility in primates is an adaptation to allow for antipredatory associations.

What benefits do they get from associations?

As shown in Table 4, most of the Tai monkeys associate in polyspecific groups. The major benefit of this probably is protection from predation, particularly from chimpanzees but also from human poaching. Other predators include leopards and crowned eagles, and polyspecific associations appear to protect monkeys from these as well; *P. badius* and *C. diana* are less vigilant and use locations exposed to eagles more often when in association than when alone (Zuberbühler 2006:5). Of all these predators, it is the chimpanzee / red colobus / Diana monkey interaction that has drawn the most attention in the Tai Forest (Boesch 1994).

Chimpanzees hunt monkeys only during a hunting season of August through November. Their favorite prey is *P. badius*, which are larger and much slower than *C. diana*. Chimps will move towards either species that is calling, but once underneath the calling monkeys, chimps at Tai hunt the red colobus 44 percent of the time and Dianas only 8 percent of the time (Boesch 1994:1140).

In experiments reported by Bshary (2007), when chimp pant hoots were played over loudspeakers under *P. badius*, the red colobus monkeys consistently responded with one or more of three antipredatory behaviors: (1) avoidance, moving away from the sound (horizontally) and staying silent after an initial call; (2) crypsis, moving higher in the canopy after chimp sounds are played beneath them, making it more difficult to see them; and (3) association, actively seeking the presence of *C. diana*. These were not generalized responses to loudspeaker sounds, since playbacks of generator noise and blank tapes did not elicit these behaviors. Nor were they generalized responses to predators, since playbacks of leopard growls and eagle calls and visual models of a leopard-print cloth and a crowned eagle elicited different behaviors. Leopard growls and eagle shrieks led to an increase in *P. badius* calling (rather than in silence); visual models beneath or nearby led to mobbing or threatening calls rather than retreat into the higher canopy; and after leopard growls were played, five out of nine mingled *P. badius* / *C. diana* groups split up (Bshary 2007).

P. badius seek association with *C. diana* most often during September through November, the chimp hunting season. Furthermore, "association rates are particularly low between June and August, when members of chimpanzee communities are dispersed," thus making it impossible for chimpanzees to hunt cooperatively (Bshary 2007:159).

Why seek out Diana monkeys in particular? Dianas are alert, vigilant, and active in the forest strata, foraging from the top of the emergent layer to the ground; they are "excellent early warning signallers (sic) for predators" (McGraw and Zuberbühler 2007:21). To test this, Bshary (2007) wrapped his body in a leopard-print cloth and approached different polyspecific monkey groups to see which species would

alarm first and at what distance. *C. diana* almost always called first, often when a *P. badius* had been just as close or closer to the "leopard."

How do they use alarm calls of their own species and of other species?

Alarm calls are vocal signals an animal makes when threatened by a predator (Zuberbühler 2007). Many mammals and birds make them. These calls may deter the predator by interfering with a stealth hunting strategy (Zuberbühler *et al.* 1999), conferring a benefit directly on the caller, and/or may warn nearby group members, conferring a benefit on the caller's kin. Among the Tai monkeys, all species make them, and at least two species are known to convey semantic information such as which predator is present (Zuberbühler 2007).

Of the Tai monkeys, the alarm calls of male *C. diana* and *C. campbelli* have been studied the most. Each makes alarm calls different from each other and specific to leopards and crowned eagles, as do *C. campbelli* females (Ouattara *et al.* 2009). *C. diana* recognizes and acts appropriately on the alarm calls produced by *C. campbelli* and vice-versa. In addition, *C. diana* groups living in the core area of a chimpanzee group recognize the alarm calls of chimpanzees to leopards and respond by calling their own alarm. Those *C. diana* living on the periphery of a chimpanzee group, however, respond to both the chimp alarm call and a chimp social call in the same way: with silent flight, as if in danger of hunting (Zuberbühler 2007). Both *C. diana* and *C. campbelli* also make calls that appear to be specific to chimpanzees and humans in their habitats, but these calls are made once and are followed by silence as the monkeys try to hide from the predators. These alarm calls to chimps and humans have

not yet been studied thoroughly (Zuberbühler 2007). It should be pointed out that recent work with *Cercopithecus nictitans*, the putty-nosed guenon that also occurs at Tai, showed the same alarm call being used in the presence of a leopard model and an eagle model, so context-specific vocalizations are not representative of primates in general (Arnold *et al.* 2008).

The vocalizations of *C. atys* include grunts, growls, screams and – showing how very up to date they are – twitters (Range and Fischer 2004). Some of these are alarm calls about snakes, leopards, and eagles. *C. atys* alarm calls are similar to the “wahoo” bark of their relatives, baboons, and quite different from the trills and chirps of the Tai guenons and colobines (Range and Fischer 2004).

As for Tai colobus monkeys, very little was included about their alarm calls in any of the publications I consulted apart from a blanket statement that all the Tai monkeys make alarm calls (Zuberbühler 2007). An intriguing detail about *C. polykomos*, however, was provided in a chapter about eagle/monkey interactions. Though King colobus tend to avoid associations, they are more likely to join a *C. diana* group after an alarm call, and “more likely to give alarm calls in response to calls of other groups” (Shultz and Thomsett 2007:189).

Conclusion

Life is complicated for a monkey in the Tai Forest. You spend your day competing for food with members of your own and other monkey species, hoping to not be stalked by a leopard, seized by a large eagle, chased and torn apart by a chimpanzee or shot by a human. If you're a colobine, much of the day you're sleepily

digesting a diet of leaves that reduces the competition but also increases your chance of being eaten while napping. So you hang with the overachiever of the forest, the attractive, energetic whiz kid named Diana who always lets you know what's up – even if it's another crazy primatologist wrapped in a leopard print. And if you're lucky, you get to live another day.

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Species	English name	Threat category (IUCN 2009)
<i>Cercopithecus diana diana</i>	Diana monkey	Vulnerable
<i>Cercopithecus campbelli</i>	Campbell's monkey	Least Concern
<i>Cercopithecus petaurista buettikoferi</i>	lesser spot-nosed guenon	Least Concern
<i>Cercopithecus nictitans stampflii</i>	putty-nosed monkey	Least Concern
<i>Procolobus badius badius</i>	Western red colobus	Endangered
<i>Procolobus verus</i>	olive colobus	Near Threatened
<i>Colobus polykomos polykomos</i>	King colobus	Vulnerable
<i>Cercocebus atys atys</i>	sooty mangabey	Vulnerable
<i>Perodicticus potto</i>	potto	Least Concern
<i>Galago demidoff</i>	Demidoff's dwarf galago	Least Concern
<i>Pan troglodytes verus</i>	common chimpanzee	Endangered

Table 1. Nonhuman primates present in Taï National Park, Cote d'Ivoire (McGraw et al. 2006; McGraw and Zuberbühler 2007). Those in bold are the focus of this paper.

Species	Preferred habitat, forest succession	Preferred foods
<i>Cercop. diana</i>	extensive use of all strata, primarily upper (>20 m); require 1° forest	primarily fruit; some leaves and prey
<i>Cercop. campbelli</i>	ground and lower strata (<5 m); do well in 2° forest	primarily fruit and prey; some leaves
<i>Cercop. petaurista</i>	middle strata (5 – 20 m); do well in 2° forest	primarily leaves and fruits; some prey
<i>P. badius</i>	most strata but generally high; prefer main canopy; require 1° forest	leaves, fruit, flowers
<i>P. verus</i>	forest understory; do well in 2° forest	leaves, some fruit
<i>Col. polykomos</i>	all strata; prefer main canopy; do well in 2° forest	seeds from <i>Pentaclethra</i> and other fruit; liana leaves
<i>Cercoc. atys</i>	forest floor	hard seeds, insects

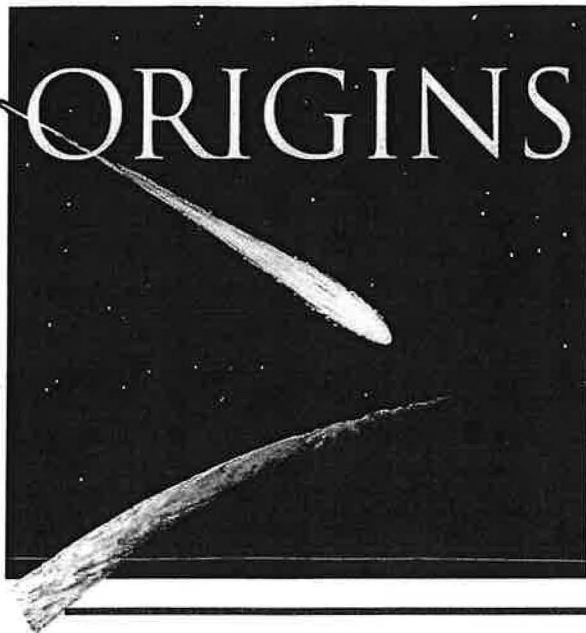
Table 2. Summary of habitat and dietary differences of the Taï monkeys (Buzzard 2006a; McGraw and Zuberbühler 2007).

Species	Mean weight male / female	Group size	Home range (km ²)	N males
<i>Cercop. diana</i>	5.2 kg / 3.9 kg	20.2	.63	1
<i>Cercop. campbelli</i>	4.5 kg / 2.7 kg	10.8	.60	1
<i>Cercop. petaurista</i>	4.4 kg / 2.9 kg	17.5	.69	1
<i>P. badius</i>	8.3 kg / 8.2 kg	52.9	.58	10.1
<i>P. verus</i>	4.7 kg / 4.2 kg	6.7	.56	1.43
<i>Col. polykomos</i>	9.9 kg / 8.3 kg	15.4	.78	1.42
<i>Cercoc. atys</i>	11 kg / 6.2 kg	69.7	4.92	9.0

Table 3. Summary of some characteristics of the Tai Monkey Project monkeys. Some data are taken verbatim from Table 1.3 in McGraw and Zuberbühler (2007:12). Group size and number of males are averages from repeated observations of groups.

Species	Associations	Alarm calls?	Response to other alarm calls?
<i>Cercop. diana</i>	Usually	Yes; leopards, eagles, chimps, humans (Zuberbühler 2007)	Yes; guinea fowl (Zuberbühler 2006), <i>P. troglodytes</i> , <i>C. campbelli</i> (Zuberbühler 2007)
<i>Cercop. campbelli</i>	Usually; other guenons	Yes; leopards, eagles, chimps, humans (Zuberbühler 2007)	Unknown?
<i>Cercop. petaurista</i>	Usually; other guenons and colobines	Yes	Yes; <i>C. diana</i> (Shultz & Thomsett 2007)
<i>P. badius</i>	Usually; esp. with <i>C. diana</i>	Yes	Yes; <i>C. diana</i>
<i>P. verus</i>	Usually; esp. with <i>C. diana</i>		Unknown?
<i>Col. polykomos</i>	Rarely; actively avoid	Yes	Yes; <i>C. diana</i> (Shultz & Thomsett 2007)
<i>Cercoc. atys</i>	Seek arboreal monkeys for dropped food	Yes; snakes, leopards, eagles (Range & Fischer 2004)	Unknown?

Table 4. Associations, alarm call production and recognition in the Tai monkeys (McGraw & Zuberbühler 2007).



OCTOBER 3-4 2008 SKEPTICS SOCIETY CONFERENCE

HOSTED BY DR. MICHAEL SHERMER
AND DR. PHILIP CLAYTON

BECKMAN AUDITORIUM, CALIFORNIA INSTITUTE
OF TECHNOLOGY (CALTECH), PASADENA, CA

TODAY, THERE IS ARGUABLY NO HOTTER TOPIC IN CULTURE THAN SCIENCE AND RELIGION, and so much of the debate turns on the “Big Questions” that involve “origins”: the origin of the universe, the origin of the “fine-tuned” laws of nature, the origin of time and time’s arrow, the origin of life and complex life, and the origin of brains, minds, and consciousness. From theologians and philosophers to creationists and intelligent design theorists, the central core of almost all of their arguments centers on filling these “origin” gaps with God. But now science is making significant headway into providing natural explanations for these ultimate questions, which leaves us with the biggest question of all: “Does science make belief in God obsolete?”

we have assembled some of the world’s greatest minds to discuss some of the world’s greatest questions.

JOHN TEMPLETON FOUNDATION

The Templeton Foundation—who worked with Skeptics Society Executive Director Dr. Michael Shermer for their Big Question essay series—is cosponsoring the 2:00-3:30 afternoon dialogue.

CONVENTION SCHEDULE

FRIDAY OCTOBER 3

BURGER CONTINENTAL RESTAURANT, 535 South Lake Ave., Pasadena, CA
6:00-10:00 PM: BUFFET Dinner, Drinks, & Social in a patio setting.

SATURDAY, OCTOBER 4

Beckman Auditorium, California Institute of Technology, Pasadena, CA
7:00-8:30 REGISTRATION, Continental breakfast, book table
Come early for first pick of our incredible \$5. book sale!

Morning sessions (8:30-12:45)

ORIGINS

- 8:30-8:45 WELCOME AND OPENING REMARKS
By DR. MICHAEL SHERMER, *Skeptic* magazine, *Scientific American*
8:45-9:30 Dr. Leonard Susskind: *The Origin of the Universe*
9:30-10:15 Dr. PAUL DAVIES: “*The Origin of the “Fine-Tuned” Laws of Nature*”
10:15-11:00 Dr. SEAN CARROLL: *The Origin of Time and Time’s Arrow*

BREAK 11:00-11:15

- 11:15-12:00 Dr. DONALD PROTHERO: *The Origin of Life & the Cambrian Explosion*
12:00-12:45 Dr. CHRISTOF KOCH: *The Origin of Brains, Minds, & Consciousness*

LUNCH 12:45-2:00 (Lunch is included in conference fee)

Saturday Afternoon sessions (2:00-6:00)

DOES SCIENCE MAKE BELIEF IN GOD OBSOLETE?

COSPONSORED BY THE TEMPLETON FOUNDATION

- 2:00-3:30 DIALOGUE MODERATED BY DR. PHILIP CLAYTON
DR. STUART KAUFFMAN • DR. KENNETH MILLER
DR. NANCEY MURPHY • DR. MICHAEL SHERMER

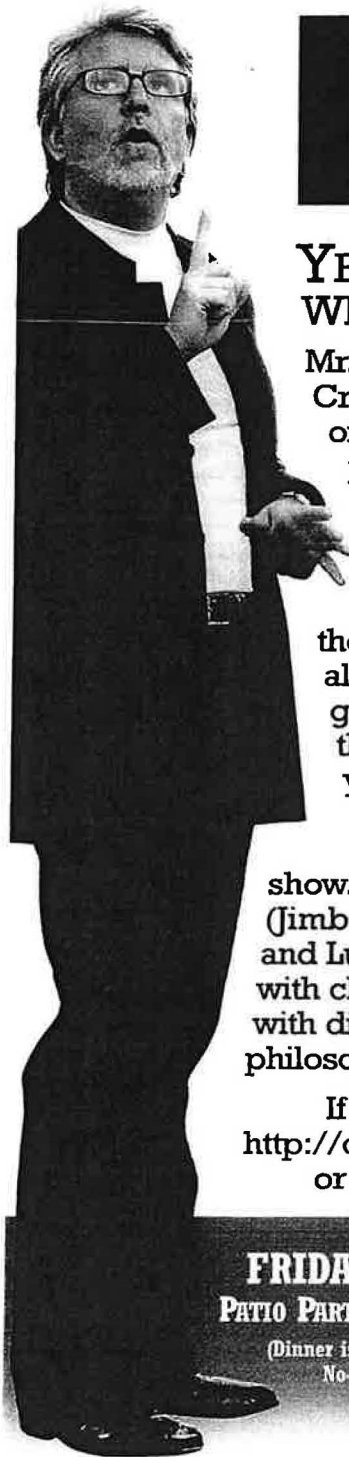
BREAK 3:30-4:00

DEBATE

- 4:00-5:30 GREAT GOD DEBATE: DOES SCIENCE SUPPORT BELIEF IN A DEITY?
Dr. Hugh Ross v. Dr. Victor Stenger
5:30-6:00 Audience Q & A WITH ALL SPEAKERS

DINNER BREAK 6:00-7:30
(Buffet Dinner is included in conference fee)

7:30-10:00 Evening entertainment:
Mr. DEITY



YES, THAT'S RIGHT, THE DETTY WILL BE IN ATTENDANCE.

Mr. Deity that is—the Internet You Tube and Crackle sensation. Mr. Deity video clips offer a humorous (and slightly irreverent) peek into the day-to-day operations of the universe and the Big Man in charge—a behind-the-scenes look at how Mr. Deity and his long-suffering assistant, Larry, grapple with the complications of their new Creation. “What kind of Evil will be allowed in this new universe?” “How do you go about recruiting a ‘Savior?’” “Why won’t these darned lights work?” And “How do you relate to your girlfriend when she’s the devil (literally)?” are just some of the thought-provoking questions raised by the show. Mr. Deity (Brian Keith Dalton), Larry (Jimbo Marshall), Jesus/Jesse (Sean Douglas), and Lucy/Lucifer (Amy Rohren) will entertain us with clips and behind-the-scenes stories, along with discussing the more serious theological and philosophical issues raised in individual episodes.

If you haven't seen Mr Deity go to http://crackle.com/c/Mr._Deity or just google “Mr. Deity.”

FRIDAY-SKEPTICS SOCIAL: PATIO PARTY & ALL U CAN EAT BUFFET

(Dinner is included in the conference fee.
No-host alcoholic beverages available.)



6:00-10:00
Friday

Patio Party

Burger
Continental
Restaurant,
535 S Lake Ave
Pasadena

Our distinguished speakers...



DR. SEAN CARROLL

is a Senior Research Associate in Physics at the California Institute of Technology. His research ranges over a number of topics in theoretical physics, focusing on cosmology, field theory, particle physics, and gravitation. He is currently studying the nature of dark matter and dark energy, connections between cosmology, quantum gravity, and string theory, and whether the early universe underwent a period of inflationary expansion. He is the author of *Spacetime and Geometry: An Introduction to General Relativity*, recorded a set of introductory lectures on cosmology for the Teaching Company, and is a contributor to the blog Cosmic Variance.

DR. PHILIP CLAYTON

is Professor of Religion and Philosophy at Claremont Graduate University and Ingraham Professor at Claremont School of Theology. He is a philosopher and theologian specializing in the intersection of science and religion and is the author of *In Quest of Freedom: The Emergence of Spirit in the Natural World*, *Adventures in the Spirit*, *Beyond the Religion Wars*, and *This Sacred World: What the New Integration of Science and Religion Has to Say about Ecology, Politics, and Human Spirituality*. A panentheist, he defends a form of process theology that is hypothetical, dialogical and pluralistic.



DR. PAUL DAVIES

is a theoretical physicist, cosmologist, astrobiologist, author and broadcaster. He is a professor at Arizona State University where he is setting up a research institute to examine fundamental concepts in science. Davies previously held academic appointments in the UK, at the Universities of Cambridge, London and Newcastle upon Tyne. His research has ranged from the origin of the universe to the origin of life, and includes the properties of black holes, the nature of time and quantum field theory. Davies is known as a passionate science communicator. He gives numerous public lectures throughout the world and has written 27 books, including *The Mind of God*, *The Goldilocks Enigma*, *God and the New Physics*, and *Cosmic Jackpot*. He is the recipient of the 1995 Templeton Prize.



DR. STUART KAUFFMAN

is the founding director of the Institute for Biocomplexity and Informatics and a professor of biological sciences, physics, and astronomy at the University of Calgary. He is Emeritus Professor of Biochemistry at the University of Pennsylvania, a MacArthur Fellow, and an external professor at the Santa Fe Institute. His books include *The Origins of Order* and *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity*. His latest book is *Reinventing the Sacred: A New View of Science, Reason, and Religion*.



DR. CHRISTOF KOCH

obtained his Ph.D. in (bio)-physics with a minor in Philosophy. After four years at MIT, he joined the California Institute of Technology, where he is the Lois and Victor Troendle Professor of Cognitive and Behavioral Biology. His laboratory focuses on experimental and computational research pertaining to neuronal correlates of selective visual attention and consciousness in the mammalian brain, a topic he worked on for nearly two decades with Francis Crick. He is the author of the highly acclaimed book, *The Quest for Consciousness: A Neurobiological Approach*.



DR. KENNETH MILLER

is Professor of Biology at Brown University. He is a cell biologist, and chairs the Education Committee of the American Society for Cell Biology. He serves as an advisor on life sciences to the PBS television news program NewsHour, and is the author of the bestselling book *Finding Darwin's God*, as well as the controversial biology textbook that triggered the Dover creationism trial, at which he testified as an expert witness. His new book, based on his experiences at the trial, is *Only a Theory: Evolution and the Battle for America's Soul*.



DR. NANCEY MURPHY

is Professor of Christian Philosophy at Fuller Theological Seminary. Her first book, *Theology in the Age of Scientific Reasoning*, won prizes from both the American Academy of Religion and the Templeton Foundation. She is a member of the Board of Directors of the Center for Theology and the Natural Sciences and an ordained minister in the Church of the Brethren. Her most recent books are: *Did My Neurons Make Me Do It? Philosophical and Neurobiological Perspectives on Moral Responsibility and Free Will*; *Physics and Cosmology: Scientific Perspectives on the Problem of Natural Evil*; and *Evolution and Emergence: Systems, Organisms, Persons*.



DR. DONALD PROTHERO

is Professor of Geology at Occidental College and Lecturer in Geobiology at Caltech. He is the author, co-author, editor, or co-editor of 21 books and almost 200 scientific papers, including five leading geology textbooks and three trade books. He has served as an associate or technical editor for *Geology*, *Paleobiology*, and *Journal of Paleontology*. He is a Fellow of the Geological Society of America, the Paleontological Society, and the Linnaean Society of London. His latest book is *Evolution: What the Fossils Say and Why it Matters*.



DR. HUGH ROSS

earned a Ph.D. in astronomy from the University of Toronto and was a research fellow in radio astronomy at Caltech in the 1970s. In addition to publishing many technical scientific papers, he is the author of numerous popular science books that defend his faith: *The Fingerprint of God*, *The Creator and the Cosmos*, *Creation and Time*, *Beyond the Cosmos*, *The Genesis Question*, *The Origins of Life*, and *Creation as Science*. Ross is the founding director of Reasons to Believe, an international interdenominational science-faith think tank.

DR. MICHAEL SHERMER

is cofounder of the Skeptics Society, the Publisher of *Skeptic* magazine, a monthly columnist for *Scientific American*, the host of the Skeptics Society Distinguished Science Lecture Series at Caltech, and an adjunct professor at Claremont Graduate University. He is the author of many books including *Why People Believe Weird Things*, *How We Believe*, *The Science of Good and Evil*, *The Borderlands of Science*, *Science Friction*, and *Why Darwin Matters*. His latest book is *The Mind of the Market*.



DR. VICTOR STENGER

is emeritus professor of physics and astronomy at the University of Hawaii and adjunct professor of philosophy at the University of Colorado. His research career helped establish the properties of strange particles, quarks, gluons, and neutrinos, and helped pioneer the emerging fields of very high-energy gamma ray and neutrino astronomy. He is the author of a number of popular science books also well received by professional scientists, including *Has Science Found God?*, *The Comprehensible Cosmos*, *Timeless Reality*, *The Unconscious Quantum*, *Not by Design*, and the *New York Times* bestseller, *God: The Failed Hypothesis*. He has debated many of the top theologians of our time.



DR. LEONARD SUSSKIND

is the discoverer of string theory, is the Felix Bloch Professor in theoretical physics at Stanford University and the author of the controversial new book *The Black Hole War: My Battle with Stephen Hawking to Make the World Safe for Quantum Mechanics*. His contributions to physics include the discovery of string theory, the string theory of black hole entropy, the principle of "black hole complementarity," the holographic principle, the matrix description of M-theory, the introduction of holographic entropy bounds in cosmology, and the idea of an anthropic string theory "landscape." He has written numerous articles for the non-specialist including an award winning article on black holes in the *Scientific American*.



New Discoveries in Primate Behavior

25 April 2009

CSU San Bernardino, UH 106

Parking: Lot D [ONLY!]

MAP

8:30 am

Check-in, coffee & bagels

9 - 9:15

Norm Rosen (SCPRF/CSUF) & Peter Robertshaw (CSUSB): Welcome & introduction

9:15

Nga Nguyen (Cal State Fullerton & Cleveland Metroparks Zoo)

The behavioral endocrinology of motherhood in wild baboons of Amboseli

10:15

Break

10:30

Ulrich Reichard (University of Southern Illinois)

Revisiting gibbon monogamy

11:30

Lunch details: Peter Robertshaw

1:30

Jim Moore (UCSD; presenting) & Adriana Hernandez-Aguilar (Cambridge University)

Chimpanzees in a dry, open, and seasonal habitat: Ugalla, Tanzania

2:30

Jill Pruett (Iowa State)

Tool use of Senegal chimpanzees [Dr. Pruett missed her flight, was unable to come]

3:30

Break

3:45

Roundtable discussion (moderated by Lynne Miller, Mira Costa College)

4:15

Close

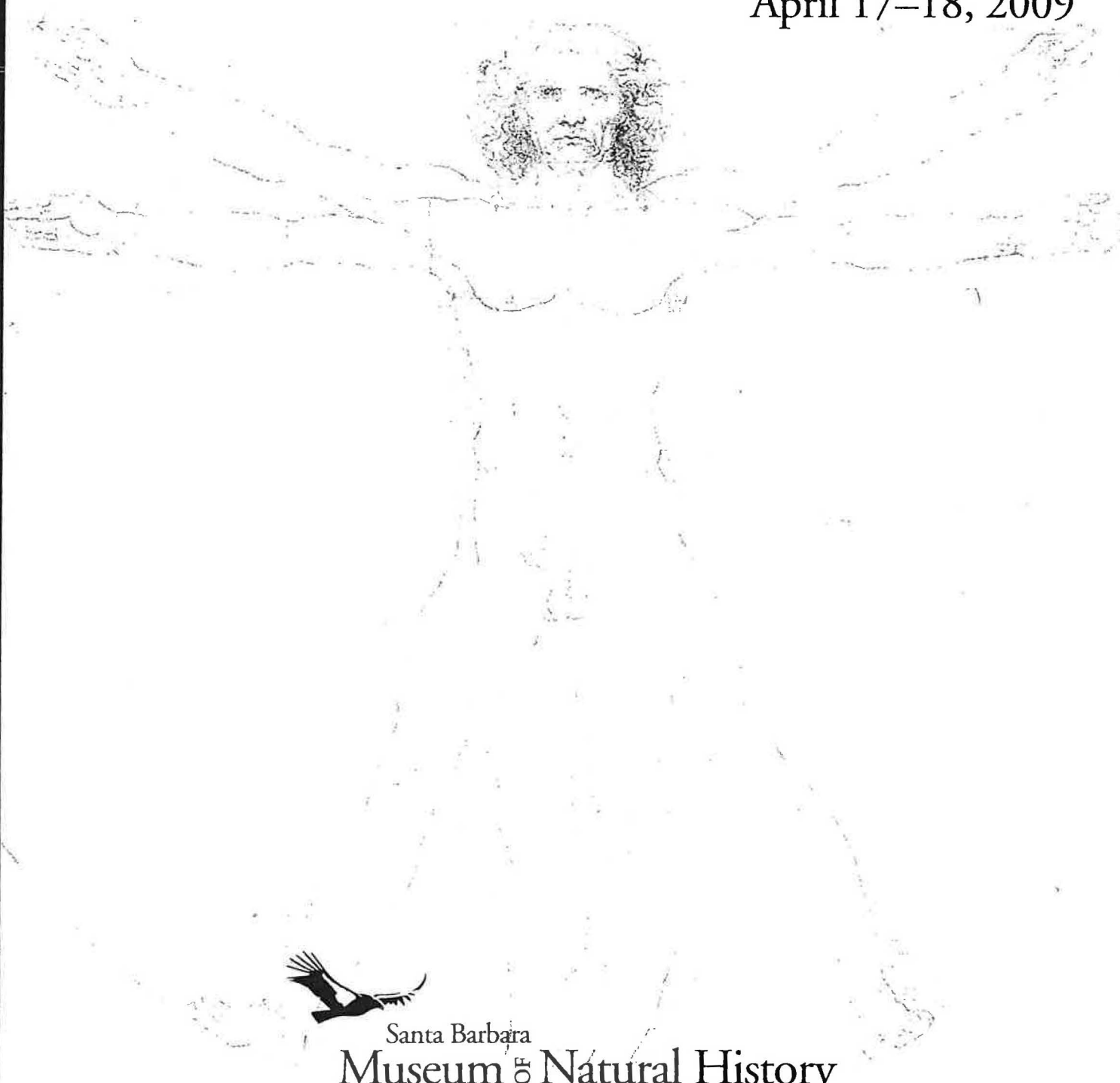
SCPRF Advisory Committee: Norm Rosen (SCPRF), Jim Moore (UCSD), John Bock (CSUF), Sara Johnson (CSUF), Lynne Miller (Mira Costa Community College)

Registration: Students with ID - \$7.00; all others \$12.00

Santa Barbara

**SYMPOSIUM on
HUMAN ORIGINS**

April 17-18, 2009



Santa Barbara
Museum of Natural History

SANTA BARBARA SYMPOSIUM ON HUMAN ORIGINS

A Discussion of Current Evidence during the Darwin Year

April 17–18, 2009

Hosted by:

Santa Barbara Museum of Natural History

Organized in Collaboration with:

Institute of Human Origins at Arizona State University and American Museum of Natural History

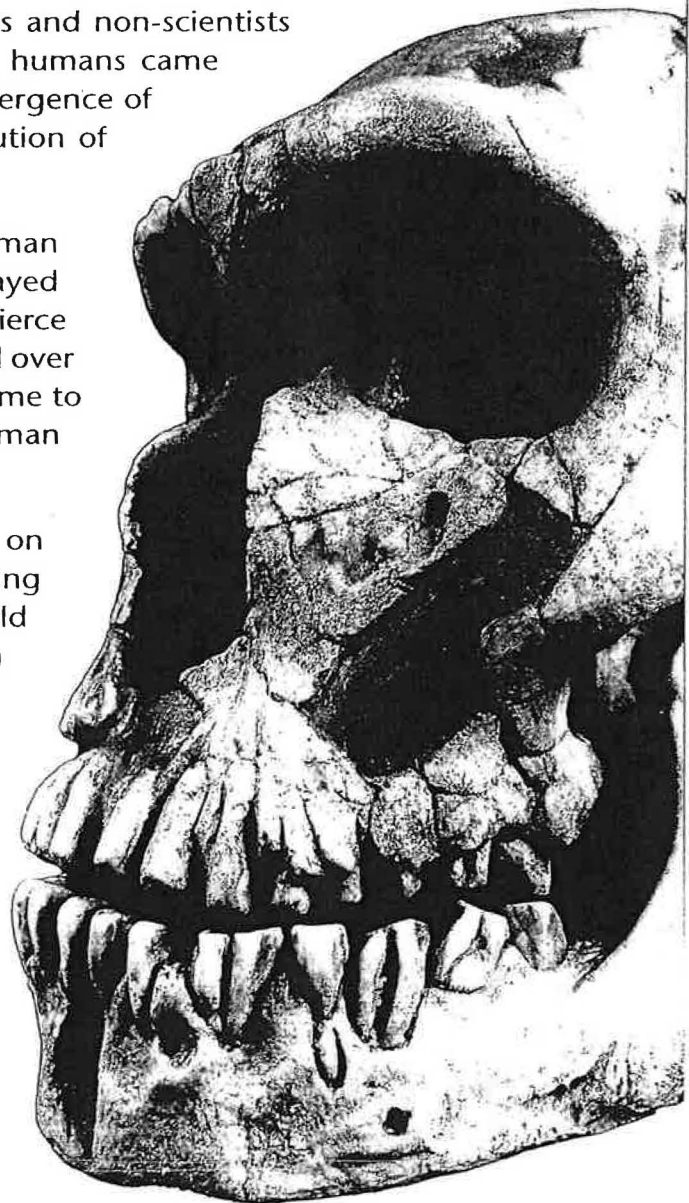
Few topics are more compelling to scientists and non-scientists alike than the question of when and how humans came into being as a distinctive species and how the emergence of humans as biological beings is linked to the evolution of peculiar sets of behaviors described as culture.

Given the intense interest in the topic of human origins, the central role evolutionary theory has played in the course of human origins research, and the fierce scientific and popular debates the topic has aroused over the centuries, the Darwin Year of 2009 is a fitting time to consider the most current findings and status of human origins research.

Toward this end, the Santa Barbara Symposium on Human Origins on April 17–18, 2009, will bring together some of the leading specialists in the field to survey and discuss contemporary evidence in biology, geology, archaeology, anthropology, psychology, and linguistics.

On the first day of the symposium, two scientific panel discussions will be open to a general audience. On the second day, six leading scholars will present talks to the general public followed by question-and-answer sessions. An evening dinner reception will offer special guests a chance for close encounters with the attending scientists.

Throughout the symposium, there will be various opportunities to meet and mingle with the scholars.



PROGRAM AND TICKET INFORMATION

Friday, April 17: Scholarly Sessions

Santa Barbara Museum of Natural History,
Fleischmann Auditorium

9:00 AM–Noon: Morning Session

Welcome

Karl Hutterer, Executive Director
Santa Barbara Museum of Natural History

Donald Johanson, Founding Director
Institute of Human Origins

Topic: *What is a Hominid?*

Moderator: Donald Johanson
Presentation by William H. Kimbel
Discussants: Jeffrey H. Schwartz
Terry Harrison
Carol V. Ward

Noon–2:00 PM: Lunch Break

2:00–4:30 PM: Afternoon Session

Topic: *How Far Back in Human Evolution did Hominids Acquire Language?*

Moderator: Ian Tattersall
Presentation by W. Tecumseh Fitch
Discussants: Philip Lieberman
Daniel L. Everett
Michael Gazzaniga

Saturday, April 18: Public Lectures

Marjorie Luke Theater

9:00 AM–Noon: Morning Session

Welcome

Donald Johanson, Founding Director
Institute of Human Origins

Karl Hutterer, Executive Director
Santa Barbara Museum of Natural History

Lectures

Donald Johanson: *The Earliest Hominids*
Bernard Wood: *Recognizing the Genus Homo*
Thomas W. Plummer: *Evolution of Hominid Cultural Behavior*

Noon–2:00 PM: Lunch Break

2:00–4:30 PM: Afternoon Session

Lectures

Ian Tattersall: *The Neanderthals: Mirror to Mankind*
Curtis Marean: *Origins of Modern Human Behavior*
Leslie C. Aiello: *Human Evolution and Evolutionary Theory*

7:00 PM: Celebration Dinner with Keynote Speakers

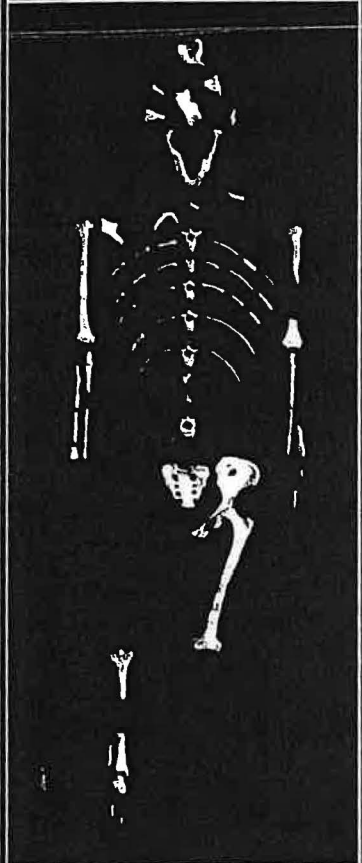
Donald Johanson and John Johnson
Santa Barbara Museum of Natural History

Tickets - Go to www.sbnature.org/tickets or call 805-682-4711 ext. 116	Price
Friday, April 17: Scholarly Sessions (<i>Morning Session Only</i>)	\$10
Friday, April 17: Scholarly Sessions (<i>Afternoon Session Only</i>)	\$10
Friday, April 17: Scholarly Sessions (<i>Whole Day</i>)	\$15
Friday, April 17: Pre-Ordered Box Lunch (<i>Choice of Vegetarian, Turkey, or Roast Beef Sandwich, plus Chips, Cookie, and Beverage. Must be ordered by April 10.</i>)	\$15
Saturday, April 18: Public Lectures (<i>Morning Session Only</i>)	\$15
Saturday, April 18: Public Lectures (<i>Afternoon Session Only</i>)	\$15
Saturday, April 18: Public Lectures (<i>Whole Day</i>)	\$25
Saturday, April 18: Celebration Dinner with Keynote Speakers (<i>Limited Tickets Available</i>)	\$150

Students receive a 50% discount with valid student I.D. (except Celebration Dinner and Box Lunch)

For more information, go to www.sbsoho.org

LIST OF SPEAKERS



Top: Dr. Donald Johanson holding an *Australopithecus* skull; middle: the fossil "Lucy," discovered by Dr. Johanson in 1974; bottom: on location in Ethiopia where the Dikika baby, a juvenile *Australopithecus alarensis*, was discovered. *

Dr. Leslie Aiello, President

The Wenner Gren Foundation, New York, NY

Dr. Daniel L. Everett, Chair, Department of Languages, Literatures, and Cultures

Illinois State University, Normal, IL

Dr. W. Tecumseh Fitch, School of Psychology

University of St. Andrews, St. Andrews, Fife, Scotland, UK

Dr. Michael Gazzaniga, Director, SAGE Center for the Study of Mind

University of California Santa Barbara, Santa Barbara, CA

Dr. Terry Harrison, Director, Center for the Study of Human Origins

New York University, New York, NY

Dr. Donald Johanson, Founding Director, Institute of Human Origins

Arizona State University, Tempe, AZ

Dr. John R. Johnson, Curator of Anthropology

Santa Barbara Museum of Natural History, Santa Barbara, CA

Dr. William H. Kimbel, Director, Institute of Human Origins

Arizona State University, Tempe, AZ

Dr. Philip Lieberman, Department of Cognitive and Linguistic Sciences

Brown University, Providence, RI

Dr. Curtis Marean, Institute of Human Origins

Arizona State University, Tempe, AZ

Dr. Thomas W. Plummer, Ph.D. Program in Anthropology

CUNY Graduate Center, New York, NY

Dr. Jeffrey H. Schwartz, Departments of Anthropology and History of Science

University of Pittsburgh, Pittsburgh, PA

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