Olfactory bulb, visual cortex, and motor cortex are constrained in size by their peripheral representations in the body; auditory areas and parietal areas are probably less constrained; and prefrontal cortex (including Broca's area) seems to have inherited twice as much space as would have been predicted from brain size (six times larger than predictions based on body size).

Figure 3. Relative deviation of some major cortical areas in the human brain from the typical monkey-ape scaling pattern. Olfactory bulb, visual cortex, and motor cortex are constrained in size by their peripheral representations in the body; auditory areas and parietal areas are probably less constrained; and prefrontal cortex (including Broca's area) seems to have inherited twice as much space as would have been predicted from brain size (six times larger than predictions based on body size).
Human Brain Evolution: The Inside Story
TERRENCE W. DEACON

Terrence Deacon is Assistant Professor of Biological Anthropology at Harvard. A native of Seattle, he received his undergraduate degree (1976) in Biology and Communication Theory from Fairhaven College in Washington State, a Master of Education degree from the Graduate School of Education at Harvard and the Ph.D. in Biological Anthropology from Harvard (1984). (An article on the appointment of Prof. Deacon to the Dept. of Anthropology is on pg. 8).

What makes humans so different from other animals? Is it our increased intelligence? Our use of language? Our ability to make and use tools? Culture? Whatever answer we eventually find for these questions, a discussion of the unique attributes of the human brain will inevitably play a central role. Anthropologists have been interested in human brains since the birth of the field, and although comparative neuroanatomy has never played as dominant a role in Anthropology as has paleontology or functional morphology it is fair to say that many of the greatest comparative neuroanatomists of the past were also anthropologists.

For example, in 1861 when Paul Broca first identified a speech area in the human brain he presented his findings to the Paris Anthropological Society. Broca’s researches also set the stage for a century of studies of human brain size. Eugene Dubois, the renowned discoverer of Pithecanthropus (Homo erectus), also had a profound influence over the study of brain evolution and comparative neuroanatomy. His pursuit of an explanation for the factors controlling relative brain and body size in mammals and humans guided generations of researchers in this area. Raymond Dart, who first recognized the Taung skull as a representative of an ancestral hominid lineage (Australopithecus africanus), also contributed important research on the anatomy of lizard brains that has played a central role in theories of the origins of the cerebral cortex in mammals. And the great comparative anatomist W. LeGros Clark made substantial contributions to primate neuroanatomy. Arguably his most important scientific contribution was the experimental demonstration that the concept of association cortex could not be supported by neuroanatomy. These are but a few whose names have become hallmarks in both Anthropology and Neuroanatomy.

Unfortunately, this great tradition has languished in recent decades to the point where the study of neuroanatomy and brain evolution have essentially been eliminated from Anthropology. What remains is a scattered interest in casts of fossilized crania and a continuing statistical debate about the evolutionary significance of total brain volume. This would not be such a loss if the investigation of human brain evolution was now being definitively pursued in some other discipline, but the study of human brain evolution has been essentially ignored outside of Anthropology as well. Nonetheless, I feel confident that we are about to see a reversal of this trend. There is only so much that can be gleaned from an inspection of the bumps and valleys on an endocast from a fossil cranium, and the many different ways of calculating the extra volume of the human brain can convey almost nothing about the complex brain structure itself. In contrast, new neuroanatomical techniques have made it possible at last to investigate the full complexity of brain structure in living species.

At present, we are only just beginning to develop a picture of the significant morphological differences that distinguish human brains from ape and monkey brains, and we are far from an understanding of their functional differences. This is not only because of a lack of relevant descriptive work in the field but also because we remain unclear about how best to make comparisons that focus on biologically relevant similarities and differences. This problem is not confined to comparative neuroanatomy. The identification of structural homologies in different species (i.e. similarity based on common descent), with the presumption that these reflect common underlying genetic factors, is one of the oldest and yet most persistently troubling problems of comparative anatomy in general. In order to understand the processes involved in changes of structure during evolution we must be able to partition the old from the new, the inherited conservative aspects from the modified aspects.

In the study of brain structure this is complicated by the complexity of the system, the relative inaccessibility of its parts, and our lack of a general theory of its function to guide our speculation. The comparative anatomist has long been able to rely on mechanical and engineering models to help organize the analysis of musculoskeletal functions. Changes in the relative lengths, masses, and shapes of bones have calculable influences on locomotor functions. But what are the effects of changes in size and shape of brain structures or of changes in neural con-
nections? Although we are a long way from having answers to these questions we are finally in a position to begin collecting the sorts of data that can help answer them.

The relevant features for the study of musculo-skeletal function are largely visible to the naked eye or through the microscope. But even microscopic investigation of brain structure is not by itself capable of revealing the most important features for investigating brain function: the patterns of connections between neurons. Only within the last decade have neuroanatomists discovered techniques that can unambiguously reveal the actual circuits of the brain. It is as though a whole new field of comparative anatomy has been opened up. Armed with these new techniques and informed by findings in many subfields within the neurosciences it is now possible to approach the problem of human brain evolution with a new level of detail and rigor. In our laboratory in the Peabody Museum we hope to bring some of these possibilities to fruition.

The first sort of data that we are beginning to gather is connectional data. Using a series of recently developed techniques for tracing individual microscopic neural connections across long distances within the brain we are beginning to construct maps or “wiring diagrams” of selected brain circuits in different species. In the early days of this research it was thought that connection patterns would be as diverse as the shapes of different brains. However, this now appears not to be the case. In general, workers in the field are beginning to realize that the wiring diagram for one species of vertebrate brain has a great deal in common with that of any other. Despite considerable morphological differences between the brains of different species, the fundamental plan of “wiring” is remarkably conservative. In many ways I would compare this wiring to the conservative nature of the vertebrate skeletal plan. Although the sizes and shapes of the various bones may vary within a structure like the vertebrate forelimb, the connection

Continued on next page

---

**Figure 1.** Diagram of the left hemisphere of a macaque and human brain indicating the position of areas within the macaque brain that correspond to language specialized areas in the human brain. Broca’s area in the frontal lobe plays a critical role in organizing the sequence of speech sounds and in the analysis of grammar. Wernicke’s area in the posterior temporal lobe and the angular gyrus (that portion of the posterior language zone posterior to the sylvian fissure which divides the temporal and parietal lobes) play a critical role in the analysis of sounds and synthesis of sounds into words as well as analyzing the semantic content of words. In the monkey brain much of the corresponding homologous cortex indicated by shading is buried within sulci and so is not shown.
patterns among bones change very little from lobe-fins, to reptilian feet, to bird wings, to ungulate hooves, or to human hands. That such an enormous range of functions can be realized without a major reorganization of connection patterns may be instructive for understanding brain evolution as well.

Along these lines I have been investigating circuits in monkey brains that I believe are homologous to language circuits in the human brain. The major areas in the human brain that have been associated with language functions are located in the left hemisphere surrounding the Sylvian fissure, a deep cleavage that separates the temporal lobe of the brain from the frontal and parietal lobes. The two most prominent language areas are called Broca’s area and Wernicke’s area after their discoverers. Their functions are best known from cases of stroke or other brain damage. Brain damage to Broca’s area disrupts the fluency of speech and often the ability to use or comprehend grammatical constructions. Brain damage to Wernicke’s area disrupts the reception of speech, but not speech fluency, and typically causes both production and comprehension of speech to be filled with inappropriate phonetic or semantic substitutions. These areas in the human brain have distinct locations with respect to other areas and characteristic patterns of cellular organization when viewed under the microscope. Fig. #1. This allows us to identify areas in monkey brains that are similar in these respects, and then study their underlying circuitry. Discovering whether these areas in the monkey brain are similar or different from our expectations of the human brain promises to tell us much about the nature and origins of human language.

What we have learned about these structures in our laboratory is that the homologous connection patterns in the monkey brain are completely appropriate to the demands of vocal communication. For example, the monkey homologue to Broca’s area receives information from the auditory system, particularly from the area that corresponds to Wernicke’s area; it receives tactile information from the mouth, jaw, tongue, and larynx; and, both directly and indirectly influences motor systems for the mouth, jaw, tongue, and larynx. Fig. #1. Unlike our work on monkey brains it is not yet possible to directly trace the corresponding circuits in the human brain. However, indirect evidence from electrical stimulation of the language areas in awake, locally anesthetized neurosurgical patients has demonstrated a similar pattern. It appears that, at least in their major connectional and functional attributes, the circuits underlying human language have their counterparts in monkey brains — a remarkable “preadaptation.”

But monkeys do not speak, nor have we succeeded in teaching any ape to speak (although people have been moderately successful at teaching them to sign). Even more troubling is the fact that the monkey homologue to Broca’s area does not appear to be even necessary for monkey vocalization. Monkeys continue to vocalize with relative normality even when this Broca’s area homologue is removed! Electrical stimulation of various areas in the monkey brain have shown that typical vocal calls are elicited from structures deep in the relatively more primitive emotional centers of the brain (collectively known as the limbic system), and never from the cortical areas corresponding to human language areas. As is so often true in science, new findings often beg more questions than they answer.

In response to this apparently paradoxical finding, I have turned to quantitative studies of the various parts of the brain. By analogy to the evolution of vertebrate forelimb adaptations, it might be argued that a quantitative reorganization of these same circuits could account for the great differences between monkey and human functions of this area. Of course there are independent reasons for suspecting quantitative effects to be important. The human brain is anomalously large for our body with respect to other primates and most mammals. Could size reorganization preferentially affect these circuits? To this question I can give a tentative “yes.” Tentative because there is still much data to be gathered and analyzed before a definitive description of the quantitative differences emerges, and also because there are still many gaps in our understanding of how these circuits work in the first place. It’s one thing to hold in your hands the complete wiring diagram to a computer and quite another to know what it all means.

At present, data are incomplete and numerous theoretical questions remain to be worked out with regard to their statistical analysis. Still, some very interesting findings have already emerged. For example, the human brain has enlarged by a factor of three during the course of our divergence from the African apes, nearly all of this within the last two million years. However, this enlargement has not been uniformly distributed throughout the brain (“isometric enlargement”), nor has it been distributed according to primate trends with respect to either brain or body size (“allometric enlargement”). On the other hand, it would be inaccurate to characterize this enlargement as “mosaic evolution” if by that we mean that the various parts enlarged at different rates independent of one another. The brain is a structure in which there is extensive interconnectivity among the parts, and so it turns out that the sizes of different parts are influenced and constrained in complicated ways by one another.

In trying to sort this out I have approached the problem from an embryological point of view. The enlargement of the human brain with respect to the body can best be understood by distinguishing two distinct processes that play a role in determining the sizes of brain structures. The first process determines the total size of the major neural populations within the brain. This can be called the mitotic phase, because it is during this very early period in embryogenesis that proto-neurons “give birth” to the entire population of neurons that will be available for building the brain. The second process follows after the mitotic phase is essentially complete. This second period can be called the parcellation phase since it is at this point that connections between neurons are formed, and by a competitive process between connections, the
Figure 2. Depiction of the major processes determining the adult size of brain structures in humans as opposed to a typical primate. Dots and branching structures represent neurons and their axons. Areas shaded differently in the last stage represent structurally and functionally distinct brain areas. The major difference between humans and other primates begins with the relative disproportion between cortical and nuclear structures in the first phase and translates into a pattern of biased parcellation in the third phase.

In the human brain the first phase is characterized by overproduction of a widely dispersed class of neurons, with the result that there is a disproportional enlargement of most of the surface (cortical) structures within the brain as opposed to the deep (nuclear) structures. This disproportion is responsible for the large size of the human brain with respect to the body (the target size of which is determined by a non-enlarged region of the brain), but it also has considerable consequences for the brain's internal organization. The disproportions between the surface and deep structures of the brain and between the brain and the body significantly bias the parcellation process so that smaller systems are at a competitive disadvantage for carving out neural "space."

With a brain too big for our body, many developing circuits within the human brain are constrained by the small size of their peripheral input sources or output targets. For example, the visual system appears constrained to body proportions by the size of the retinas and the motor system appears constrained by our total muscle mass. But this means that the "extra space" within the brain unutilized by these systems must instead be recruited to subserve systems not so constrained by the periphery. One such system appears to be the prefrontal area of the brain. Fig. #3 (page 1). With respect to primate trends this area is twice too big for our brains and six times too big for our bodies. Coincidentally, Broca's area resides within this prefrontal region. Could this all be a rather round about means for producing an enlarged Broca's area? This is my strong suspicion, but data specific to Broca's area are lacking. There are also many other quantitative disproportions within the human brain that one might focus on. And what are the effects of changing the size of one brain structure with respect to another any way?!

Despite the fact that these studies only scratch the surface of a complex problem, I already feel that some exciting findings are emerging. However, it is not just the availability of new experimental tools that makes such research possible. The most important tool is basic knowledge. It is the rapid growth of information in the neurosciences that is the most important source for new approaches and insights into human brain evolution. This points out the necessity of retaining some level of neuroanatomical sophistication in the training of the next generations of biological anthropologists. Without it the study of the uniqueness of the human mind and its evolution will pass outside the purview of Anthropology. We should no longer be satisfied with just looking at the surface of human brain evolution. The application of new experimental techniques and the integration of recent neurobiological discoveries into the study of human brain evolution can once again bring to the foreground that age-old problem of the origin of the human mind.
Scholars, symposia, and seminars

Department of Anthropology

Assoc. Prof. Charles Lindholm gave a lecture on "Emotional Constraint and Social Structure: Swat Pukhtuns and French Court Society" at the Annual Conference on South Asia in Madison, Wis. He was co-organizer of a Conference on Muslims as Minorities held at Harvard in February. Recent publications by Prof. Lindholm are "Kinship Structure and Political Authority: The Middle East and Central Asia" in Comparative Studies in Society and History, 28, 1986, and "Leadership Categories and Social Processes in Islam" in the Journal of Anthropological Research, 42, 1986. Prof. Lindholm is continuing his research on idealization.

Prof. David Maybury-Lewis organized and chaired a symposium at Harvard's 350th celebration on The Search for Freedom and Dignity. He presented a paper at the symposium entitled "Human Rights, Group Rights, and Human Dignity." He also organized and chaired a symposium at the Latin American Studies Assoc. Meetings held in Boston on Political Forces and Indian Peoples in Latin America. He read a paper on "Indian Peoples and Development Policies in Lowland South America. Prof. Maybury-Lewis was awarded a John Simon Guggenheim Fellowship and a Fellowship at the Woodrow Wilson Center, Washington D.C. where he is currently writing books on contemporary pressures on the Indian peoples of Latin America, and structuralism and social organization.

Prof. Gordon R. Willey will receive the American Academy of Achievement Award in Phoenix in June. Recent articles by Prof. Willey are: "The Postclassic of the Maya Lowlands: A Preliminary Overview", in Late Lowland Maya Civilization: Classic to Postclassic, Univ. of New Mexico Press, 1986; and "The Classic Maya Socio-Political Order: Coherence and Instability", Middle American Research Institute, Tulane, 1986. Prof. Willey is completing his Copan and Seibal monographs and is beginning writing on a series of archaeological biographies.

Assoc. Prof. Byron Good gave a lecture on "Meanings and Madness: Anthropological Studies of Psychopathology in the 1980's" to members of the Dept. of Anthropology at Case Western Reserve. "Culture and the Study of Anxiety Disorders" was the title of a lecture he gave to the Groupe Interuniversitaire de Recherche en Anthropologie Medecine et en Ethnopsychiatrie, Universite de Montreal.

Prof. Good and his wife, Dr. Mary Jo Good will be doing a study on epileptics in Turkey during the summer.

Prof. Arthur Kleinman gave the keynote address at the World Psychiatric Association's Twenty-fifth Anniversary Meeting in Copenhagen. He is the author of a book published by Yale Univ. Press, Oct. 1986, entitled Social Origins of Distress and Disease: Neuroasthenia, Depression and Pain in Modern China. In Nov. 1986 Prof. Kleinman was named Honorary Professor, Hunan Medical College, Changsha, People's Republic of China. The College was founded in 1914 and prior to 1949 was called Yale-in-China Medical College. Only three foreign scholars have received this honor. Prof. Kleinman spent six months as a CSCPRC (National Academy of Science) National Scholar in China and conducted research on the modernization of the Chinese mental health profession.

In Sept. Prof. C.C. Lamberg-Karlovsky gave a series of invited lectures on the ancient Near East at the Univ. of Beijing. He was elected a Trustee of The American School of Oriental Research and a Corresponding Member of the Instituto Italiano Medio e Estremo Oriente in Rome. His publications include: "Third Millennium Structure and Process: From the Euphrates to the Indus and the Oxus to the Indian Ocean," in Oriens Antiquus, 25:1-2. Cambridge Univ. Press is publishing his edited volume entitled American Archaeology in the late Eighties, a series of essays on method and theory practiced by American archaeologists. Prof. Lamberg-Karlovsky's research continues to be involved in the collaborative archaeological excavations in the Soviet Central Asian Republic of Tadjikistan SSR.

Assoc. Prof. Izumi Shimada gave two papers at the Vth Northeast Conference on Andean Archaeology and Ethnohistory held in November at Cornell: "Experimental Smelting of Copper: Behavioral Insights" (with John Merkel and Stephen Epstein), and "Paleteada Ceramics from Batan Grande: Chronology and Functional Classes" (with Kate Cleland). At the Annual Meeting of the Society of American Archaeology in New Orleans he gave a paper on "Architectural and Functional Characterization of the Sican Precinct, Batan Grande, Peru." In February he served as an evaluator at a conference in Lima, Peru to evaluate accredited seminars on Anthropology, History and Medicine related to Peruvian Pre-Columbian Cultures. Recent publications by Prof. Shimada are: "El Nino Flood Deposits of Batan Grande, Northern Peru" (with A.K. Craig) in Geoarchaeology: an International Journal 1(1) 1986; "Batán Grande and Cosmological Unity in the Andes" in Andean Archaeology: Papers in Memory of Clifford Evans, R. Matos, S. Turpin, H. Eling eds., Institute of Archaeology, UCLA 1986; and "Monumental Adobe Architecture of the late Prehispanic Northern Coast of Peru" in Journal de la Societe des Amerindianistes LXI Paris. Prof. Shimada gave a lecture entitled "The Sican Culture" in Chiclayo, Peru in July. He is continuing the Sican Archaeological Project in Batan Grande on Peru's North Coast. The ninth season (1986) included excavations at the ceremonial center of the Sican Precinct and replicative smelting experiments with John Merkel and Stephen Epstein.

Prof. Sally Falk Moore gave a
DeVore appointed
department chairman

B. Irven DeVore.

Professor B. Irven De Vore has been appointed Chairman of the Department of Anthropology for 1987-1990.

Born in Joy, Texas in 1934, DeVore received his AB from the University of Texas and his Ph.D. from the University of Chicago. Trained in the Social Anthropology program at the University of Chicago, DeVore’s first field experience was with the Mesquakie Indians of Iowa. In 1959, collaboration with Sherwood L. Washburn led him to undertake his dissertation fieldwork in Kenya, observing the behavior of free-ranging baboons. Continuing research on these and other primates led to the publication of Primate Behavior, Holt, Rinehart and Winston, New York and London 1965, and, with Sarel Eimerl, The Primates, Time, Inc., New York 1965.


In the 1960s DeVore helped design an anthropology course for elementary schools, “Man: A Course of Study”, developed with the psychologist Jerome Bruner, which has been taught in all 50 states and some 20 foreign countries.

DeVore was elected a Fellow of the American Association for the Advancement of Science in 1967 and a Fellow of the American Academy of Arts and Sciences in 1968. He has been awarded the Walker Prize for Science. He has been a Fellow at the Center for Advanced Study in the Behavioral Sciences in Palo Alto, and a Fellow at the Miller Institute for Basic Research in Science, Berkeley.

DeVore has served on the Executive Board of the American Anthropological Association, and on the Advisory Council of the Wenner-Gren and Danforth Foundations. He is presently a Member of the Board of Cultural Survival, Inc. and serves on the Science and Grants Committee of the LSB Leakey Foundation. At Harvard, DeVore has served on the Faculty Council, holds a joint appointment in the Biology Department, and is a member of the Avoiding Nuclear War Faculty Seminar in the John F. Kennedy School of Government.

He is President-elect of Section H (Anthropology) of the American Association for the Advancement of Science.

Continued on next page
Terrence Deacon was appointed Assistant Professor of Biological Anthropology in the Department of Anthropology. Before coming to Harvard Prof. Deacon studied at the University of Washington, Western Washington University, and Fairhaven College in Washington State. His undergraduate education was punctuated by a year working as a laboratory technician in the Seattle Medical Examiner’s Office. After receiving his B.A. in 1976 at Fairhaven College where he studied biology and communication theory he took a position as Lecturer there for one year. He came to Harvard in 1977 as a graduate student in the Graduate School of Education where he studied cognitive development and philosophy. He received an Ed.M. from there and transferred into the Department of Anthropology in 1978. After playing a central role in helping to develop the Biological Anthropology Laboratories that now occupy a large part of the Peabody Museum’s fifth floor, he received his Ph.D. in Biological Anthropology in 1984. His Ph.D. research focused on the use of neuroanatomical tracer techniques to study areas of the monkey brain that correspond to language areas in the human brain. Most of his training in neuroanatomical techniques was acquired through collaborations with members of the Neuroanatomy program at MIT and with Prof. Howard Eichenbaum, a neurophysiologist at Wellesley College. After receiving his Ph.D. he was hired as a Lecturer for the Science Core Program and the Department of Anthropology, a position he held until his appointment to Assistant Professor in 1986.

Besides his Ph.D. study his research interests have resulted in studies of the anatomy of the limbic system (primitive emotional centers in the brain) of rats and monkeys, development and plasticity of the cerebral cortex, development of neurotransmitter systems, investigation of frontal lobe — midbrain interrelationships, brainstem innervation of the tongue musculature, studies of the laminar organization of neocortical circuits, and studies of the quantitative reorganization of brain structure in human brain evolution. He has also been involved in the collection and study of whale brains and the study of the vocalizations of a seal who spontaneously learned to mimic human speech at the New England Aquarium.

He is also well known for his work with microcomputers and has co-authored a book on the Apple II family of computers and how they work. He is currently developing a computer image analysis system for use in neuroanatomical studies. This system is capable of capturing microscope images, enhancing them, manipulating them, and storing them in digitalized form. It will also be capable of reconstructing three-dimensional representations from a series of microscopic sections helping students and researchers visualize and quantify the complex three-dimensional geometry of brain structures.

Besides neuroanatomical and computer interests Prof. Deacon maintains an active research interest in human language disorders, neuropsychology, and the semiotic analysis of communication. He has been working for some time on a reinterpretation of the semiotic theory of Charles Sanders Peirce, an interest that dates back to his undergraduate thesis research and in many ways has directed his research interests in the neurobiology of human language ever since.

### Visiting lecturers

During the academic year 1986-87, a number of scholars from the United States and abroad gave lectures to students and faculty of the Anthropology Department and at meetings of the Peabody Museum Association.

**Prof. Margaret W. Conkey**, Dept. of Anthropology, State Univ. of New York at Binghamton lectured on “Paleolithic ‘Art’ and Some Issues in the Archaeology of Early Modern Humans.” “Olmec Jades and Early Maya Pottery” was the title of a lecture by **Prof. E. Wyllys Andrews**, Dept. of Anthropology, Tulane Univ.

**Prof. Juris Zarins**, Southwest Missouri State Univ. lectured on “The Development of Pastoral Nomadism in Arabian Archaeology.” A discussion following the showing of the film “The Word of Words: A Cultural Ecology of an Eastern Indonesian Island” was led by **Prof. James Fox**, Univ. of Chicago. **Dr. Anabel Ford**, Research Archaeologist at the Univ. of California, Santa Barbara gave a talk on “Recent Research in Belize.”

“Adat and Resistance in Adonara, Eastern Indonesia” was the title of a lecture by Bowdoin College Anthropologist **Prof. Nancy Lutz**, Dr. Raymond Allchin, Churchill College, Cambridge Univ. lectured on “Heavenly Incest and Creation: the Interpretation of a Seal from Chanhu-daro.”

**Prof. Tanya Luhrmann**, Christ’s College, Cambridge lectured on “Interpretive Drift: Ritual Magic in Contemporary London.” **Prof. George E. Marcus**, Dept. of Anthropology, Rice Univ. gave a talk on “A Sensible Anthropological Reception of Recent Postmodernist
Provocations.’’ ‘‘Rethinking the Maya Murals of Bonampak’’ was the title of a lecture by Dr. Mary Ellen Miller, Dept. of the History of Art, Yale Univ.

Prof. Khaled al Nashef, Univ. of Tubingen, gave a lecture entitled ‘‘Old Assyrian Caravan Routes.’’ The topic of a lecture by Prof. Joseph Errington of Yale’s Dept. of Anthropology was ‘‘Language Universals as Culture Universals: Evidence from Javanese.’’

Dr. Sándor Bókonyi, Director of the Archaeological Institute of the Hungarian Academy of Sciences lectured on ‘‘The Prehistoric and Early History of the Domestic Horse.’’ M. N. Srinivas, Visiting Prof. of Anthropology at Wellesley gave a lecture on ‘‘Some Reflections on the Nature of Caste.’’

The title of lectures by Prof. Ofer Bar-Yosef, Hebrew Univ. were ‘‘The Changing Socio-economic Landscapes of the Levant During the Early Neolithic’’ and ‘‘Recent Discoveries Concerning Early Farming Communities in Israel.’’ Dr. Garth L. Bawden, Director of the Maxwell Museum of Anthropology, Albuquerque, gave a lecture on ‘‘Domestic Space and Social Structure in Pre-Columbian Peru.’’

Linda Schele, Prof. of Art History, Univ. of Texas, Austin gave a lecture on ‘‘Dynastic History and Political Strategy in the Art and Architecture of Copan, Honduras.’’

‘‘Lapita: Island Colonization, Long-distance Exchange and Oceanic Cultural Origins’’ was the title of a lecture given by Prof. Patrick Kirch, Director of the Burke Museum, Univ. of Washington. Dr. Evelyn C. Rattray, Visiting Scholar from the Instituto de Investigaciones Antropológicas, National Univ. of Mexico, gave a lecture entitled ‘‘Recent Excavations in Merchants’ Barrio, Teotihuacan.’’

‘‘Earliest Man in Pakistan, Their Tools. How Early?’’ was the topic of a lecture by Dr. Bridget Allchin, Wilson College, Cambridge Univ.

‘‘The Enigmas of Nazism: Toward an Anthropological Analysis of the Hitler Movement’’ was the title of a lecture by Dr. George Sherman of Southern Illinois Univ., Carbondale. Prof. E. Valentine Daniel, Institute for Advanced Study, Princeton gave a lecture entitled ‘‘Violent Measures: The Case of Sri Lanka’s Plantation Tamils.’’

Dr. Ilana Silber, Visiting Scholar from the Dept. of Sociology, Hebrew Univ. lectured on ‘‘Virtuosi and Laymen in Theravada Buddhism and Medieval Catholicism: The Comparative Analysis of a Gift-relationship.’’ Prof. Marshall Sahlins, Dept. of Anthropology, Univ. of Chicago gave a lecture on ‘‘The Cosmology of the Transpacific Sector of the World System.’’

Prof. Anthony Seeger, Director of Archives of Traditional Music at Indiana Univ. lectured on ‘‘Amazonian Voices, Flutes and Shaman’s: What an Anthropologist Can Learn from Musical Performances.’’

‘‘Trace Element Chemistry of Fossil Bone as a Tracer of Diet and Environment: New Developments’’ was the title of a lecture by Dr. Andrew B. Sillen, Dept. of Archaeology, Univ. of Cape Town.

Prof. Loki Madan, Institute of Economic Growth, Delhi Univ. gave a talk on ‘‘Images of India in American Anthropology.’’ ‘‘Pigs from the Ancestors: Feeding and Eating in Cantonese Mortuary Rites’’ was the title of a lecture by Prof. James Watson, Dept. of Anthropolgy, Univ. of Pittsburgh.

Prof. Joseph Yellin, Head of Archaometry at the Institute of Archaeology of Hebrew Univ. lectured on ‘‘Sourcing Pottery by Neutron Activation Analysis at the Hebrew University: Entering the Second Decade.’’

Prof. Unni Wikan, Visiting Scholar from the Ethnographic Museum, Oslo lectured on ‘‘Person, Conduct and Morality in Bali: Reappraisal from New Evidence.’’

Prof. Adam Kuper, Editor of Current Anthropology, gave a lecture on ‘‘The Invention of Primitive Society’’.

‘‘Fishermen in Arabia — Stone Age Research on the Gulf Coast of Oman’’ was the title of a lecture by Dr. Hans-Peter Uerpmann, Research Scientist, Univ. of Tubingen. Roger Moorey, Prof. of Archaeology, Oxford Univ., and Keeper of W. Asian Antiquities, Ashmolean Museum, gave a lecture entitled ‘‘First Impact of Horses and Chariots in the Near East.’’

Continued on next page
Royal Anthropological Institute, the Pitt Rivers Museum, and the Horniman Museum.

Dr. John Tomenchuk (Peabody Museum Post-Doctoral Fellow) wrote a paper entitled "Effects of Loading Rate on the Reliability of the Engineering Use-Wear Models" in Proceedings of the C.N.R.S. Conference on Lithic Industries: Microwear Analysis and Technology, Nov. 18-20, 1986. "A Parametric Use-Wear Study of Areas C and C-East of the Fisher Site" by Dr. Tomenchuck will be published in The Fisher Site: An Early Paleo-Indian Site in Southern Ontario, P. Storck, ed. He is writing a user manual for computer software he has developed which can be used to investigate differences between modern and archaic forms of Homo sapiens in terms of absolute physical strength, group size and composition, and division of labor.

Dr. John Merkel (Center for Archaeological Research and Development) attended the General Meeting of the Archaeological Institute of America in San Antonio, and gave a paper on "Typological and Technological Comparisons of Late Third Millennium B.C. Metal Implements from Palestine."

After returning from 18 months in West Africa, Dr. Monni Adams, Assoc. in African and Oceanic Ethnology gave lectures on her research on the art and culture of the Guéré (Wè) in western Ivory Coast at Boston Univ., Tufts, Yale, and the Denver Art Museum.

"African Art and Politics" was the title of a lecture given to members of the Univ. of Chicago Alumni Assoc. "Women and Masks among the Wè (Guéré)" is the title of an article published in African Arts. Indonesian textiles and jewelry was the subject of lectures given at the Seattle Art Museum, Museum of Fine Arts, Boston, and the Museum of Art in Richmond.

Richard Riccio appointed Exhibition Designer

Richard Riccio has been named Exhibit Designer for the Peabody Museum. He will be responsible for designing and overseeing the construction and installation of three major permanent galleries: Hall of the North American Indian, Pre-Columbian Hall, and a third to be determined.

Mr. Riccio was born in Lansdale, Pennsylvania and received his undergraduate degree in Anthropology from Clarion State College in 1973. He holds a Master of Art degree in Anthropology/Museum Studies from the Univ. of Arizona, Tucson.

A talented artist, Mr. Riccio has done a number of freelance projects in addition to the many exhibitions he has designed. He was the Exhibit Designer for the Renovation of the Visitor Center at Kitt Peak National Observatory, and the Arizona Mining Hall at the Arizona Historical Society. From 1979-1983 he was Curator of Exhibits at the Kansas State Historical Society, and since 1983 has been the Curator of the Worcester (Mass.) Historical Museum.


Schele given Proskouriakoff award

The first Tatiana Proskouriakoff Award was presented to Linda Schele, Prof. of Art History, Univ. of Texas, Austin on November 10, 1986 at a meeting of the Peabody Museum Association. Prof. C.C. Lamberg-Karlovsky, Director of the Peabody Museum gave the award "In recognition of outstanding achievement in the study of New World archaeology with particular reference to Maya hieroglyphics and Mesoamerican civilization."

The award was established by an endowed gift from Mr. Landon T. Clay and will be given every two or three years to a leading scholar involved with New World indigenous cultures. The gift represents a significant addition to the Peabody Museum's research involvement in New World archaeology.

Tatiana Proskouriakoff (1909-1985) was Honorary Curator of Maya Art at the Peabody Museum and a nationally respected scholar. She began her career in architecture and was one of the pioneers whose research led to our present ability to read the Maya hieroglyphs.
In December, 1986 the Peabody Museum launched the largest fund-raising endeavor for exhibitions in its history. The new Hall of the North American Indian and the Precolumbian Hall will display the very finest objects from our collections. We gratefully acknowledge the generosity of all those who have contributed to the Peabody Museum Permanent Galleries Fund.

### SPECIAL GIFTS

- Mr. and Mrs. Bruce Heafitz
- Mrs. Roger T. Stone

### BENEFACTORS

- Mr. Lee C. Bradley III
- Mr. Landon T. Clay
- Mr. and Mrs. Douglas B. Elam
- Mr. Albert H. Gordon
- Prof. William W. Howells
- Mrs. William W. Howells
- Mrs. Laurence K. Marshall
- Mr. and Mrs. S. Watson Smith

### PATRONS

- Anonymous
- Dr. and Mrs. Wilbert K. Carter
- Mr. and Mrs. Decoursey Fales, Jr.
- Mrs. Robert Leventhal
- Mr. and Mrs. Stanley Marcus
- Mr. and Mrs. Heinz Vaterlaus

### DONORS

- Mr. and Mrs. Ricardo Alegria
- Mr. and Mrs. Lawrence C. Bauer
- Mrs. William R. Bullard, Jr.
- Mr. and Mrs. Joseph Campbell
- Dr. George L. Cowgill
- Dr. and Mrs. Charles V. Crocetti
- Dr. and Mrs. Charles Dickinson
- Mrs. Faith Kidder Fuller
- Mr. and Mrs. John L. Gardner
- Dr. and Mrs. Stanley M. Garn
- Mr. and Mrs. George Heller
- Mr. and Mrs. J. Philip Kistler
- Mr. Richard Leventhal
- Dr. and Mrs. Boris Magasanik
- Mr. and Mrs. Thomas Marill
- Mrs. Genevieve McMillan
- Mr. and Mrs. John E. Reinhardt
- Dr. and Mrs. Carl C. Seltzer
- Mrs. Philippa D. Shaplin
- Mr. and Mrs. Robert Shenton
- Mrs. Martha Belknap Smith
- Dr. and Mrs. James N. Spuhler
- Mr. Lauriston Ward, Jr.
- Mrs. Leonard Wheeler

### CONTRIBUTORS

- Mr. Richard Chute
- Dr. and Mrs. Richard Ciccarelli
- Dr. E. Mott Davis
- Evelyn D'Ovidio
- Aline Elliot
- Dr. Karen Elise Fields
- Marian R. Goldsmith
- Mr. and Mrs. Rob Goldsmith
- Mr. and Mrs. James H. Gunnerson
- Prof. and Mrs. Mason Hammond
- Mrs. John F. Hendon
- Ms. Lucinda Hutchison
- Mr. and Mrs. Hartman Lomawaima
- Miss Janet Loring
- Dr. Walter Mann
- Mrs. Mary K. Merrill
- Mrs. Earle H. Morse
- Mrs. Henry Morss, Jr.
- Mrs. Louise E. Randall
- Mr. and Mrs. Stanley Robbins
- Mr. and Mrs. Harold Rubenstein
- Mrs. Albert O. Seeler
- Mrs. Edythe Shulman
- Mr. Jose Suarez
- Mrs. Max Wasserman
- Dr. John Wilson
- Miss Anne C. Wyman
- Dr. and Mrs. Maurice L. Zigmond
Sacred Landscape and Maya Kingship

LINDA SCHELE

Linda Schele is Professor of Art History at the Univ. of Texas, Austin. An expert on Maya iconography, hieroglyphic writing, and cosmology, she was born in Nashville and educated at the Univ. of Cincinnati (B.S. in Education, B.F.A. and M.F.A.) and the Institute of Latin American Studies at the Univ. of Texas, Austin (Ph.D. 1980).

Prof. Schele has written a number of scholarly articles and is the author of Maya Glyphs: The Verbs, Univ. of Texas Press 1982, and The Blood of Kings: Dynasty as Ritual in Maya Art, with Mary Ellen Miller, Kimbell Art Museum, Fort Worth 1986. She has trained many archaeologists, art historians, and laymen in her Workshops on Maya Hieroglyphic Writing at the Institute of Latin American Studies, Univ. of Texas, Austin.

Prof. Schele was the first recipient of the Tatiana Proskouriakoff Award given by the Peabody Museum in 1986 (see page 10).

The 1984-1985 issues of Symbols presented a provocative exchange of ideas between K. C. Chang, C.C. Lamberg-Karlovsky, G. Willey, M. Hammond, and D.H.P. Maybury-Lewis on the rise of civilization in Ancient China, the Near East, and Mesoamerica. Central to all of their comments were the premises that world-view was at the heart of the transformational processes yielding a civilized state, that the assumptions about the world and the way its works underly the Chinese and Near Eastern world views were fundamentally different and this difference was retained through subsequent development, that the Maya were in the Chinese mode, and that to a greater or lesser degree the differences between the world views of the west and the developing world are the direct developmental result of the underlying basis of these pristine civilizations.

K.C. Chang’s insights into the mechanisms of early Chinese transformations opened, for me, new ways of viewing the nature of political power and kingship among the Classic Maya, and perhaps their predecessors, the Olmec. As Willey and other scholars have observed, the Chinese and Maya visions of the cosmos share many characteristics, including a multi-leveled structure populated by humans, gods, spirits, and, most importantly, the ancestral dead. For the Classic Maya, we can document in their images of the cosmos, three levels — the Middleworld inhabited by humans, animals, plants, and the stuff of life; Xibalba, an Underworld where the gods lived and to which all the dead must go; and an Overworld, perhaps best described as the heavens, in which reside those ancestors who have defeated the Lords of Death and undergone apotheosis. Chang describes the intercommunication between Heaven and Earth as the critical focus of ritual for the Chinese. For the Maya it was the Xibalba-Earth connection.

We have a remnant of the great mythic cycle of Xibalba and the defeat of death in the seventeenth century Quiche Maya Popol Vuh. This same mythic cycle appears in the art of Izapa as early as the second century B.C. and it is found today, often with a Christian overlay, in the oral traditions of many modern Mayan speaking groups. Its protagonists, the Hero Twins, and their confrontation of the Lords of Death and other supernaturals provided the Classic Maya with their model of kingship, correct human behavior, and explanation of cosmos and afterlife. Michael Coe has suggested, rightly I believe, that this great mythic cycle and its effects as the central model of life and political power distinguished Classic civilizations in Mesoamerica from their Preclassic prototypes.

Xibalba was for the Classic Maya underearth and underwater, for the surface of the earth floated in a great primordial sea. Sacred mountains with the cave portals leading to Xibalba were represented in Maya art as huge monsters marked with the signs of stone and lightning, which, like rain clouds, sprang from the interior of caves. David Stuart has recently read the inscriptive equivalent of this monster as witz’, the Maya word for ‘mountain’ or ‘hill’.

Iconographically, the sacred mountain, otherwise known as the Cauac Monster, has a stepped fontanel, and maize, the substance from which human beings were made, grows from its summit. Most importantly, doorways leading to the interior of Maya temples were often sculpted as this witz’ monster. The Maya pyramid was quite literally, by Maya definition, a sacred mountain, and the interior space of the temple was analogous to the interior of a cave — a portal to Xibalba. The Maya city can be seen as a mountain range, composed of witz’ built in both the horizontal and vertical dimensions as the ritual focus of living kings and the ancestral dead. The word for stela was te-tun, ‘tree-stone,’ making the rows of monuments set up in
the plaza spaces of Maya cities, the forests surrounding the mountains. The Maya habit of vertical rebuilding also makes remarkable sense within this ideological context, since the pyramid was a portal to Xibalba, it was a potent and highly charged point in the geopolitical and cosmic landscapes. As the door was used more and more through time, especially by powerful rulers, power accrued to it; to later generations, it would have been illogical to move away from that growing power nexus.

Chang’s model of shamanistic kingship can be detected in Maya archaeology from the earliest time that we can identify a civilized state — the Late Preclassic, 200 B.C. to 150 A.D. At site after site, Maya society converted with remarkable rapidity from long stable agricultural villages with few buildings that can be adjudged as monumental and no publicly displayed symbol system in permanent media, to a pyramid-building, symbol-using society of the first rank. The iconography of all sculpted temples so far discovered from this period replicates the cosmos through its symbolic array in a way related to the early form of Maya kingship.

These temples are usually erected on a stepped pyramid bearing huge plaster masks depicting the main gods of the Maya cosmos — including earlier manifestations of the Hero Twins, especially as the Jaguar Sun and the Mountain Monster. David Freidel has suggested that huge postholes in Temple 5C-2nd at the Belizean site of Cerros once held huge wooden shafts representing the four trees standing at the world directions in this cosmology. These temples and their sculptures then were more than just artistic display. They replicated the Maya cosmos in symbolic form as the environment for political and religious ritual.

The principal Maya ritual documented both archaeologically and through their writing and imagery was the offering of blood, either through self-inflicted sacrifice or captive mutilation. The latter type of ritual is documented at Cuello, as early as 400 B.C. At most Maya sites, the dismember-
ment sacrifices are particularly associated with the dedication of new construction or the termination of an old one. Auto-sacrifice is documented at many sites, especially in the lip-to-lip caches of which the most important excavated to date is Operation 2012 at Colha. When the Lowland Maya began making images of rulers in permanent media and at monumental scale, the first ritual they recorded was bloodletting and the associated vision quest — as in the San Diego cliff drawing and the Hauberg Stela, and presumably also the Loltun drawing, which is located at the entrance to a cave.

The function of auto-sacrifice in Maya thought is also clearly documented — blood offerings sustained the gods as food and, as David Stuart has shown (RES 7/8 1984), the blood ritual quite literally “gave birth” to the gods or the ancestor who was manifested by the ritual. Maya archaeology and representations of these rites suggest they did not think of them as merely symbolic actions, but as transubstantiations that created sacred power tools of mundane objects used in rituals, the persons participating in them, and, most interestingly, the structures that housed them.

David Stuart, in his work at Copán, has identified a set of texts recording the dedication of these houses, of stelae, and of the many of these ritual objects. Interestingly, these dedication events composed one of the largest areas of the inscriptional system that had not yet been deciphered, and they provide enormously valuable information about how the Maya thought about these things. For instance, at Palenque the first act of a god after the beginning of this creation was the dedication of a house representing the order of the cosmos, and named apparently for the great World Tree at the center of the world. The dedications of the inner sanctuaries of the Group of the Cross at Palenque are recorded as the actions of the patron god of each temple. Apparently the house became alive when the god came into it, thus accounting for the well-documented practice of killing ritual objects and architecture at the end of their functional life. The activation of such objects brought supernatural power, transforming their substance from that of the normal world. If these objects were used long enough, by humans of particular power, or in powerful ritual, powerful charges of sacred energy accumulated in them that the Maya saw as dangerous. This energy required ritual release through killing, for example by mutilating the left eye and nose of a face, removing color from the surface, or marring the design, among other methods. And that energy

Green stone “bib-head” figure. This example, recovered from the Cenote at Chichén Itzá, was probably an heirloom from a Late Preclassic cache like those found in Belize, referred to as shamanic paraphernalia by Schele. P.M. Cat. # 10-56-20/5976.

was also shown in the images of power objects as the ubiquitous long-nosed god, a symbol, it turns out, of the animate power associated with all kinds of power objects and supernatural beings.

David Freidel has associated the shamanistic beginnings of Maya kingship with the bibbed heads, a complex of carved jades found in Late Preclassic caches and burials. Carved with the faces of supernaturals, these stones are found cached in directional patterns and with other materials associated ethnohistorically with the divinatory practices of the Maya and with the imagery of kingship. They were equivalent to the precious stones called am, used in healing and divinatory rites until well after the Conquest. Writing appears in the Lowlands directly in association with this type of object or with similar small objects, usually made of stone, bone, or shell, used in rulers’ costumes or in ritual. The earliest texts name the supernaturals addressed by the object in ritual context. And significantly, the Late Preclassic Maya also included Olmec objects in this shamanistic category — actively collecting them and marking them for new ownership or function by writing on them.

The shamanistic function of Maya kingship was more complex than we are likely ever to recover from the archaeological record, but the inscriptional and symbolic images the Maya themselves used to define rulership publicly give us some hints. We know that the earliest monumental images now known from the Lowlands depict bloodletting/vision rites or are found in contexts associated with them. The function of this public art at this early time and throughout subsequent Maya history was not to depict portrait likenesses of rulers, but to record the rituals in which they engaged. Writing apparently developed with two great social functions — to mark objects for their ritual and symbolic function, especially in light of the transformational function of Maya symbolism, and to fix ephemeral ritual in time and place with identified actor. Imagery both on objects and public monuments either creates the ritual environment, transforms mundane objects into power tools, or freezes the progress of ritual in an eternal present.

Tatiana Proskouriakoff long ago speculated that the beings manifested in the Vision Serpents “represents a person once living and real, a hero of the past or an ancestor of note, sanctified and invoked in the ceremony depicted.” The warrior on Yaxchilán Lintel 25 is named by a title that normally appears in the name phrases of

Continued on page 16
Temples 2, 3 and 4 of Tikal, rising above the jungle, as seen by Teobert Maler when exploring for the Peabody Museum in 1895. The pyramids with temples atop them are likened to the sacred mountain with cave entry to the underworld. Peabody Museum Cat. # H7661.

Photograph of model of Uaxactun E-VII-Sub. This model shows the Late Preclassic stage of this pyramid, with large stucco masks of supernatural beings. Similar masked buildings were common throughout the Maya Lowlands at this time. P.M. Cat. # C/13781.
lineage founders. Shield-Jaguar’s wife evokes the founder of her husband’s lineage to participate in his accession ritual. On other monuments, the beings evoked are shown in the mouths of the Double-headed Serpent Bar, one of the preeminent symbols of Maya kingship, and one of the images that symbolize the path communicating between the worlds of supernatural and everyday experience.

Like the Chinese, the Maya symbolized this path between the levels of the Cosmos as a great tree, located at the center of the world, but also in the mouth of every witz’, “sacred mountain” symbolized by the Maya pyramid. This World Tree is the path of the Vision Serpent and the Double-headed Serpent path. In his most standard costume, the king wore this tree as a loin cloth and carried the vision path in his arms in one of its many manifestations — the Double-Headed Serpent Bar, the Vision Serpent, and the Cosmic Monster. Maya kings were then the incarnation of the Vision Path and the central axis of the cosmos.

Chang described the key to the workings of Ancient Chinese civilization as “the monopoly of high shamanism, which enabled the rulers to gain critical access to divine and ancestral wisdom, the bases of their political authority.” With no change, his description is applicable to the Maya case, but in Mesoamerica the central rite was bloodletting and the birthing of ancestors and gods through ritual. Archaeological and inscriptional evidence for the Maya suggests these rituals were frequently conducted and that they were often enacted with huge audience participation. The scale and frequency of these rituals suggest they were central to Maya identity and the cohesiveness of their society.

The shamanistic basis of kingship and political power was very likely inherited by the Maya from their predecessors, the Olmec. Peter Furst has long argued for shamanistic kingship for the Olmec, identifying their transformational figurines with hallucinogenic rites enabling communication between the supernatural and natural worlds. Rosemary Joyce, David Grove, and Kent Reilly are among the Olmec specialists now arguing bloodletting as a major Olmec rite, and most critical Olmec royal iconography displays the ruler controlling the cave portal between the two worlds. Olmec royal iconography explains the ruler’s power in terms of the control of this portal. Since all life and abundance, as well death and disease, come from the supernatural world, control of that portal was the most critical and important power in Precolumbian Mesoamerica.
The Biological Anthropology Laboratories at Harvard

Katherine Hiebert is a Research Assistant in the Bone Chemistry Laboratory. A 1978 graduate of Washington Univ. in St. Louis, she received her M.A. (1981) and will receive the Ph.D. in Anthropology (1987) from the Univ. of Michigan. Her dissertation is on Domestication of Animals in South America.

Dr. David Marks is a Research Assistant in the Nutritional Biochemistry Laboratory. He received his undergraduate degree from Boston Univ. in 1977 and a Ph.D. in Biology, also from Boston Univ., in 1985. His dissertation was on the Chemistry of Primate Food Choice.

Mary O’Rourke is a graduate student in Biological Anthropology at Harvard. She received a B.S. in Biology and Anthropology from Tufts Univ. in 1984. Her research interests include human reproduction and reproductive ecology.

The Biological Anthropologists at Harvard are extremely fortunate in having access to well-equipped laboratories which carry a variety of scientific instrumentation, permitting a broad range of analytical techniques to be applied. The laboratories were constructed and instrumented with funds from the Peabody Museum and the Faculty of Arts and Sciences. FAS also supplies funds for teaching along with some support for student research projects. Faculty and most student research is funded through external sources. The laboratories are used for course teaching, for individual student research projects, and for faculty research.

Professor David Pilbeam is the Director of the Biological Anthropology Laboratories.

Bone Chemistry Laboratory

by Katherine M. Hiebert

Research in the Bone Chemistry Laboratory is designed to reconstruct the diet of prehistoric populations. The chemical composition of a human bone reflects the type and proportion of certain foods in the diet of that individual. This information, applied to prehistoric populations, can be used to trace the introduction and use of plants like maize in prehistoric North and Central America, the shifting importance of fish and shellfish in the diet of many coastal peoples, and the differential access to high quality protein from meat that different groups may have had within a society.

Two techniques are used in this research program to quantify diet; one, which measures trace metal elements in the mineral portion of bone, and another, which measures the ratio of stable isotopes of nitrogen and carbon in bone collagen, the organic portion of bone. Both modern and prehistoric samples of plants and animals are also analyzed to provide a baseline for our findings about human populations.

Major projects in the laboratory include the Koobi Fora project, a modern ecosystem study of a lake basin in northern Kenya, and several large archaeological populations. Samples from Koobi Fora range from mice to lions and hippos, in addition to the important forage plants of the area. The results provide insights into the complex relationships of plants and animals within terrestrial systems that can be applied elsewhere, and are a first step to applications to the prehistory of humans in this important region.

Archaeological samples from four areas span the cultural and ecological diversity of prehistoric North America. St. Catherine’s Island, off the coast of Georgia, provides skeletal populations from time periods before the disruption of traditional lifeways by Spanish missionaries. At Moundville, in Alabama, skeletons from several social groups are being compared to see the degree of nutritional and health differences between different status groups in this early chiefdom and to determine whether the village’s abandonment is associated with increased dietary dependence on a nutritionally marginal staple, i.e. maize. Pecos Pueblo, in New Mexico, is the core site in a regional study which seeks to trace exchange of agricultural foods, especially maize, for bison meat which would have been provided by nomadic hunters on the plains. A series of sites from late prehistoric South Dakota will provide further perspective on economic differences between hunters and farmers on the plains. In each study, information from other archaeological and physical anthropological research at these sites is integrated to create as complete a dietary reconstruction as possible.

Student training and research is ongoing in the Bone Chemistry Laboratory, as both undergraduates and graduate students pursue their interests in prehistoric diets and environments. Prehistoric skeletal material from Texas, Alaska, Yugoslavia, and Peru has been analyzed as part of student projects, with results that complement and extend the findings of the larger projects.

Continued on next page
18 responses to temporary or moderate nutritional stress. Results indicate that progesterone levels are indeed depressed by modest weight reduction. Progesterone secretion into circulation during the luteal (post-ovulatory) phase of the menstrual cycle occurs in discrete episodes. Specific characteristics of these episodes — frequency, duration, and amplitude — can be discerned and measured in saliva; these vary separately and in consistent patterns across the luteal phase in normal women. Future investigations will examine these same characteristics in groups of women known to have low progesterone levels.

In a Psychology Department project, children identified at age 2 or 3 as extremely shy or extremely outgoing have been followed through age 7½. The personality trait has been maintained, and of physiological variables studied, cortisol levels have been among the best discriminators between the two groups. A new study focuses on personality and physiology in adults.

Comparative Neuroanatomy Laboratory by Terrence W. Deacon

Within the Biological Anthropology Laboratory complex the Comparative Neuroanatomy Laboratory has recently grown along with the creation of a new Assistant Professor position now filled by Dr. Terrence W. Deacon. The purpose of research carried out in this laboratory is to investigate problems of brain evolution, particularly as they pertain to human evolution and human language. Research is proceeding in a number of directions. Of major interest is the application of techniques that enable one to trace out the microscopic connections that link one neuron to another within the brains of laboratory animals. Using this technique it is possible to begin inferring the evolution of various brain “circuits” by comparing their similarities and differences in different species. Some of the circuits under investigation include neural connections in primate brains that (1) correspond to those specialized for language in humans; (2) underlie emotional processes and social behaviors; and (3) control motor functions important in language and locomotion. Also a number of new computer techniques are being developed for enhancing microscopic images of brain tissue and for reconstructing three-dimensional models of brain structures and circuits.

Nutritional Biochemistry Laboratory by David Marks

The Nutritional Biochemistry Laboratory is a facility set up by Asst. Prof. Mark Leighton and Dr. David Marks to perform nutritional and toxin analyses of foods. The lab is used to analyze food samples collected during field studies of monkeys, apes and hunter-gatherer human groups. Through a combination of field and laboratory research we hope to answer some important ecological and evolutionary questions.

First, by what criteria do animals (or people) choose their food? We typically analyze food items for protein, fat, sugars, starch and fiber and a class of chemicals called tannins (so named because they are used to tan animal skin to leather). Tannins are present in many plant materials and decrease the nutritional quality of foods by decreasing nutrient absorption. They also impart a ‘puckery’ or astringent taste to foods such as we experience in dry wine, strong tea and some unripe fruits (bananas, persimmons, plums, etc.). We have analyzed materials collected from field studies of primates in Brazil, Peru, Pakistan and Indonesia. Animals do appear to sometimes select food items high in nutrients but even more consistently they prefer foods low in tannins and fiber.

We have analyzed some food items of the Efe pygmies in the Ituri Forest, Zaire and the Hadza of Tanzania. In both cases, most preferred foods that were high in one or more nutrients (protein, fat, or starch) and most were low in tannins. The Hadza and Efe also eat meat and honey when these are available. The diets of these two groups of hunter-gatherers appears to be as rich in nutrients as typical western diets (although higher in fiber). This indicates that the human taste for (and ability to pro-
cure) high quality foods is not just a product of agriculture or modern technology.

We are also interested in the interactions between plants and animals in natural ecosystems. Prof. Leighton has set up a long-term study of animals and plants in a rainforest in East Kalimantan (Borneo), Indonesia. There, we monitor the fruiting patterns of plants and the consumption of fruits and seeds by animals (gibbons, orangutans, macaques, squirrels, birds, bats and others). We chemically analyze fruits and seeds to determine how plants use chemical and physical characteristics of their fruits to encourage consumption by animals that will disperse their seeds well and to discourage poor seed dispersers. Also of interest is how the animals of the forest differ in their abilities to exploit different foods. We are finding that plant chemistry (and the abilities of animals to tolerate plant toxins) definitely plays a role in determining the feeding niches of these animals. For example, squirrels eat acorns which are high in tannins and not used by other animals. Similarly, macaques are able to utilize fruits which contain large amounts of volatile oils whereas most other primates avoid these fruits.

Another important function of the lab is as a teaching facility for the course 'Diet, Digestion and Food Chemistry' which we offer each year. In this class, students are taught to perform nutritional analyses and they then carry out independent projects related to food. Examples of some notable projects are; measurements of blood sugar in humans in response to various meals and exercise, a comparison of fiber digestion among three primate species and nutrient analyses of vegetarian foods offered in Harvard's dormitory cafeterias.

Martha Lamberg-Karlovsky is the Editor of Symbols

Asst. Prof. Margaret Schoeninger is head of the Bone Chemistry Laboratory.

Graduate student Michele Morgan in Casting Laboratory.

Asst. Prof. Peter Ellison is head of the Endocrinology Laboratory.
Hopi exhibition opens

Qahin is a Hopi word used to describe a vessel when it has been carefully crafted; it implies that the pot has been well executed and is finely made. Such a description indicates that a potter has spent considerable time and a great deal of effort on her work. The term does not refer to the design or style of the pot, but rather to the overall effect of the finished piece.

This exhibit focuses primarily on the historic pottery traditions of the Hopi Indians of northeastern Arizona. Some prehistoric pieces have also been included to illustrate the antiquity of pottery-making, antecedents of historic traditions, and range of style. Nearly 100 ceramics from the Peabody Museum's Thomas V. Kearn Collection of Hopi Material Culture have been selected to illustrate the diversity and excellence of this artistic tradition over a 500-year period. In addition, some twentieth-century pieces have been included to show the continuity of ceramic traditions at Hopi.

"Collection made by T.V. Keam and now exhibited at the Peabody Museum. Hemenway Collection" is the caption that appears on the historic board under this photograph. It is likely an interior view of Keam's post in Arizona. The "Thomas V. Keam Collection of Hopi Material Culture" was purchased by Jesse Walter Fewkes, director of the Second Hemenway Expedition, for $10,000 in 1892 and given to the Peabody Museum on the death of Mary Hemenway in 1894.