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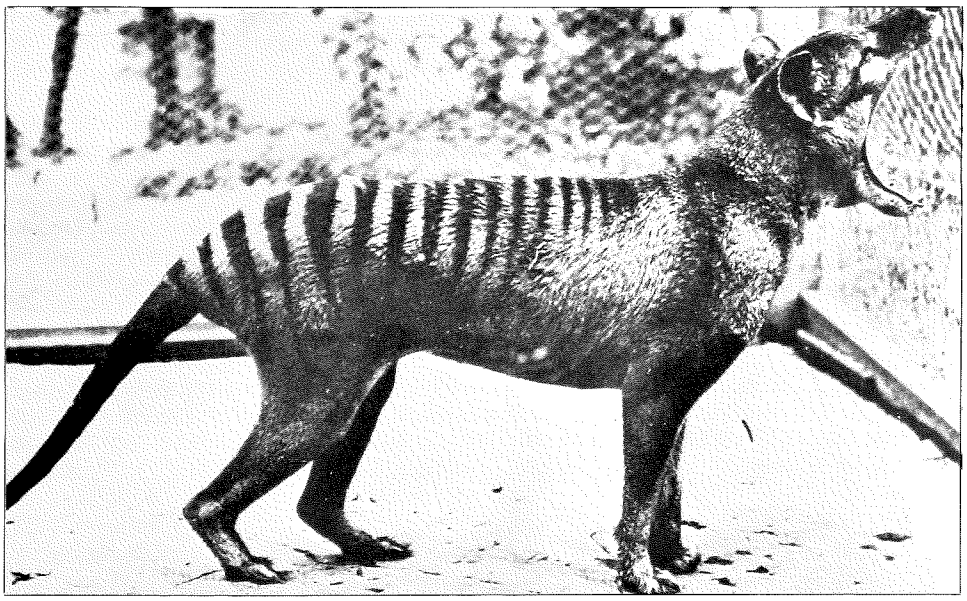

Photo: David Fleay

THE CASE OF THE TASMANIAN WOLF:

FOSSIL PROTEINS MAY REVEAL FAMILY SECRETS

By Jerold M. Lowenstein

We are all curious about our family backgrounds, as individuals and as members of the human species. It is perhaps putting it mildly to say that anthropologists disagree about human ancestry. On anatomical grounds, various investigators have proposed chimpanzees, gorillas, orangutans, gibbons, Old and New World monkeys, even tarsiers, as the ultimate human progenitor, and have estimated the length of time that the human lineage has been separate from that of the apes as somewhere between three and thirty million years. The relatively new field of molecular anthropology has placed severe constraints on these guesses by showing that 1) in the structure of their proteins and DNA, humans are much more closely related to the African apes – chimp and gorilla – than to any other primates; and 2) to judge by the rates of protein evolution in many other species, humans, chimps and gorillas probably diverged from a common ancestor about five million years ago.

These conclusions have been hotly contested, but a good scientific hypothesis makes predictions that can be confirmed or refuted, and the molecular data suggest that the oldest human ancestors will be found in Africa, resemble an African ape and be no more than about five million years old. The many hominid finds in East Africa are so far compatible with this

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DELVING INTO EARLY HUMAN BEHAVIOR: Life on the Koobi Fora Savanna

by J. W. K. Harris

Department of Anthropology, University of Pittsburgh

Over the last decade, the barren windswept landscape near the eastern shores of Lake Turkana at Koobi Fora in northern Kenya has been a major source of information about human origins. This and similar endeavors elsewhere in East Africa are simply not just the search for the oldest human remains (early hominids) or the earliest stone tool kits but are an interdisciplinary, paleoanthropological inquiry into the adaptations of early hominids and the dynamics and evolution of early human behavior.

All the East African early man localities are found in the floor or along the hilly flanks of the Rift Valley, which extends northward from Tanzania, bisecting the high plateau country of Kenya and Ethiopia before reaching the Red Sea near the Gulf of Aden.

There are good reasons why the Rift Valley has played a major part in our knowledge of early man. Millions of years ago during the Late Miocene and Pliocene periods of time, a broad trough was formed in the earth's crust by major earth movements together with volcanic eruptions. Many of the early hominid and archeological sites are found preserved in sediments associated with lake basins situated along the floor of the Rift Valley. A vacant primate ecological niche was thus created in the more open savanna grasslands found around the shores of these lakes and the

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PRESIDENT'S MEMO

"What does the Leakey Foundation do?" asked Professor Jerre Levy at a weekend symposium cosponsored by Caltech and your Foundation, and organized by our trustee, Professor Irven DeVore of Harvard. Her question was understandable because she is a psychobiologist and that subject has been beyond our purview.

We like to think of this Foundation, which supports research on organisms that live or have lived, as itself an evolving organism. The first weekend in February, we extended our reach to sociobiology by cosponsoring a symposium bringing together many of the brightest younger minds in that field. They talked to other scientists on the Caltech faculty and to visitors from the University of California at Los Angeles, Berkeley and San Diego, and from other academic institutions. Leakey Fellows and friends were in a sense eavesdroppers among the 350 avid listeners, and they met with the visiting scientists at luncheons and dinners.

The speakers were by no means dry academics. Their presentations often sparkled with wit, both in their words and in their slides. Among the conclusions of interest to lay listeners was the report by Dr. Alison Richard of Yale that in one baboon troop dominance was not, as previously thought, solely a function of the dominant male's size or fighting ability. One average size male maintained leadership over several years because when larger baboons from outside the troop would challenge him, he was supported by older females standing at both shoulders.

Dr. Levy's detailed argumentation that female brains differ significantly from male brains will be reported by her in our next issue. A skeptical audience listened as she explained her research at the University of Chicago, where she has been on the faculty since receiving her Ph.D. from Caltech. An ardent feminist, Dr. Levy presented her controversial finding in a rapid-fire deep Alabama accent that delighted the audience.

A simple answer to Jerre Levy's question is that the Leakey Foundation is what the Foundation does – with the caveat that we won't support any ***shabtsitvainiks*** (pronounced popsy rye wicks), to borrow a Yiddish expression for charlatans.

Trustees are repeatedly stimulated in their fundraising efforts by the high quality of funding requests. Most readers know my litany that we must raise grant funds afresh each year. But all funds go to support research. It may not be as titilating as the cry of the little girl in Hans Christian Anderson's 1836 adaptation of a Spanish fairy tale that "the Emperor has nothing on ***at all***," but our Emperor (office) deducts nothing ***at all***.

P.S. Mary Leakey has generously pointed out the need for an addendum to my last Memo. Andrew Hill did discover the first animal tracks at Laetoli. The man whom history will honor for the hominid discovery is Paul Abell, professor of chemistry at Rhode Island University.

Ned Munger

In Memory

Peggy A. Bartell, an active member of the Leakey Foundation, was killed December 31, 1980, in a terrorist bombing of the Norfolk Hotel in Nairobi, Kenya.

Peggy loved animals and was planning on returning to Kenya this spring for an extended period to work in wildlife conservation. She was active in many conservation projects and supported many groups including the Leakey Foundation, the Sierra Club, the National and World Wildlife Federation, and the African Wildlife Fund. She had also done volunteer work at Lion Country Safari, working with their tigers, lions, and primates.

Peggy's enthusiasm, love for all life, and infectious smile will be missed. In her memory, her friends have established a memorial fund through the Leakey Foundation to benefit Dian Fossey's work with the mountain gorillas.

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While this issue was at press, a great man, Dr. Max Delbrück, Nobel Laureate, died. He was a true friend to many of us in the Foundation.

N. M.

NEW FELLOWS

The Leakey Foundation is proud to welcome to its Fellows' roster:

Mrs. Jane Campbell, Los Angeles, California; Mrs. William E. Palmer, Los Angeles, California; and Dr. and Mrs. Roger Payne, Lincoln, Massachusetts.

Fellows of the Foundation now total 337.

CHINESE SCIENTISTS VISIT THE U.S.

Ten Chinese scientists from Peking visited the United States last summer for a rewarding, though whirlwind, tour of scientific institutions across the country.

It was widely agreed by the visitors and their hosts and colleagues that this trip represented a major advance in scientific and personal relations between American and Chinese paleontologists. All expressed a desire for continuation and extension of exchanges in the future, in teaching, laboratory and field work situations.

In the visiting group were four paleoanthropologists, including Prof. Wu Ju-kang, deputy director of the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP), Associate Prof. Wu Xin-zhi, director of the anthropology laboratory, and research associates Dong Xing-ren and Wu Mao-lin; four specialists in Early Cenozoic mammals, Prof. Chow Minchen, director of the IVPP, Associate Prof. Zhai Ren-jie, head of the Early Cenozoic working group, and research associates Qi Tao and Zheng Jia-jian; Hao Teng, director, Bureau of Foreign Affairs, Chinese Academy of Sciences; and Zhang Hong, senior preparator in the IVPP. Financial support for the group's visit, organized by Prof. Eric Delson of the American Museum of Natural History in New York, was provided by the Academia Sinica, the Wenner-Gren Foundation, the Foundation for Research into the Origin of Man, the L.S.B. Leakey Foundation and the institutions visited by the delegation.

In the summer of 1975, an American paleoanthropologic delegation sponsored by the China Committee of the U.S. National Academy of Sciences visited the People's Republic of China for a month. Several days in Peking were spent at the IVPP, after which Dr. Wu Xin-zhi accompanied the group throughout China. Members of that delegation continued contact and discussed the possibility of bringing a counterpart group to the United States. After American recognition of China in early 1979, plans for the IVPP trip were made firm.

Two of the areas of Chinese paleontology which have been the most active in recent years are recovery and study of new localities of Paleocene and Early Eocene age and advances in human evolution. Other than those in the western U.S., few localities in the world had produced large numbers of Early Cenozoic mammals until the Chinese finds. Some Eocene localities in China were also studied by expeditions from the American Museum of Natural History in the 1920s, and this material would be of interest to Chinese scholars, as would comparison with American fossils. In addition to continued study of the famous Peking Man locality at Choukoutien, the last decade has seen the recovery in China of jaws and teeth of

Left to right: Qi Tao, Zheng Jia-jian, Prof. Chow Minchen, Hao Teng, Prof. Wu Ju-Kang, Zhai Ren-jie, Wu Xin-zhi, Wu Mao-lin, Zhang Hong and Dong Xing-ren. *Photo by E. Delson.*

Ramapithecus and/or *Sivapithecus*, additional teeth of *Gigantopithecus*, some associated with early *Homo* or *Australopithecus*, and a number of later Middle or early Late Pleistocene *Homo* fossils, most importantly the nearly complete cranium from Dali. The chance for Chinese and American anthropologists to compare these new fossils with other remains, especially those from Europe and Africa under study in this country, was of great interest to both sides. On this basis, an American committee of active researchers was organized to include scholars at the AMNH (New York), Carnegie Museum of Natural History (Pittsburgh), Cleveland Museum of Natural History, University of Michigan (Ann Arbor), and the University of California (Berkeley and Los Angeles).

The Chinese group began their stay in the United States with a thirteen day visit to the New York area, based at the AMNH. They also visited such local institutions as Yale, Princeton, Columbia and New York universities, Lehman College and the graduate school at the City University of New York and the State University of New York (Stony Brook).

The group then divided into three units, with Chang Hong remaining in New York for a while to learn new techniques of casting and cleaning fossils at the AMNH. The anthropologists, with Hao Teng, spent five days at the Cleveland Museum of Natural History. The two units reunited at the University of Michigan and most of the following week was spent at the University of California (Berkeley). The anthropology group also visited the UC Davis campus and primate center and the UC campus and the Natural History Museum in Los Angeles. The paleontologists went to Los Angeles for one day only, followed by a quick tour of major Early Cenozoic localities in Wyoming. The groups again rejoined in Washington for a visit to the Smithsonian and then returned home. Prof. Chow Minchen, director of the IVPP, remained in Washington and New York for an additional two weeks.

The visitors brought a variety of casts for their hosts, who presented a number of casts of comparative material in return. Researchers concerned with Early Cenozoic mammals were able to discuss the faunal compositions of their respective sites, their relative ages and the question of intercontinental migrations. Despite a published report of an adapid in one Late Paleocene locality, identification of this specimen is uncertain, and no other primates are known in China before the Late Eocene. Proposals were made for joint research, including a paper on intercontinental correlation of Eocene mammal localities.

The anthropologists discussed several aspects of their recent work. From the later Middle Miocene site of Shihueba, Lufeng county, Yunnan, a large faunal assemblage with *Hipparion* has yielded two hominoid mandibles, published in 1979 as new species of *Ramapithecus* and *Siva-*

pithecus. In addition, some 200 isolated teeth have been recovered from the lignitic deposits, and a crushed but largely complete cranium of a similar hominoid is now being cleaned in Peking.

Since 1979, the fiftieth anniversary of the discovery of Peking Man, a major excavation program has been under way at Choukoutien, directed by Prof. Wu Xin-zhi. Over 100 scientists and technicians from seventeen institutions are participating in this work, employing the most advanced techniques. Two monographs are in the final stages of preparation, one about the geology, paleontology (no new human fossils have been recovered since 1966) and paleoenvironments, a second concerning the artifact assemblages. One major goal of the past few years' work was to determine the age of Choukoutien, and a variety of methods was applied. The result so far indicates that the upper layers are older than 200,000 years, while the base is younger than 600,000 years.

Additional remains of *Homo erectus* have been found at several sites, and teeth and skull fragments of *Homo sapiens* (broad sense) were recovered from Hsuchiayao (Xu Jia-yao) north of Peking and the previously known site of T'ing-tsun (Ding Cun). The most intriguing and probably most important recent find of fossil man, however, is the Dali skull. This cranium (no mandible or other remains so far) was discovered near Jeifang village, Dali district, Shaansi province, in March, 1978, by a geological team. A first report was published by scholars at Northwest (Xi-bei) University in Xian, and it is now being studied by Dr. Wu Xin-zhi. According to Wu, the cranial capacity is about 1120 cc (by sand volume measurement), among the smallest known for *Homo sapiens*. The skull presents a mosaic of archaic and relatively modern features. Most intriguing are the "Mongoloid racial" features. Wu has suggested that Dali offers strong support for a local-lineage view of human evolution, in which each major geographic region was relatively isolated and saw progression from *Homo erectus* to modern humans through intermediate stages (such as Dali or Neanderthals), with only minor gene flow between regions.

The major result of this visit is undoubtedly its effect on future exchanges between our two countries in the field of paleontology. At present, a few IVPP members are at American institutions for research or study, and there was much discussion of increasing this number and permitting more intensive study of IVPP materials by Americans, as well as the possibility of joint field research. Moreover, the National Science Foundation and the China Committee of the National Academy are each engaged in developing funded programs in paleontology/paleoanthropology, with presumably complementary objectives. Prof. Chow was able to discuss the role of the IVPP in relation to these programs while in Washington. □

ACROBATIC PYGMY CHIMPANZEES

by Randall Susman

(Abridged from an article in Natural History, September, 1980.)

Lofinda, one of our guides, whispered softly and motioned toward the high canopy of the trees. I tried to find the pygmy chimpanzee but saw only a mosaic of green leaves, broken by beams of bright sunlight. With his finger frozen on the point where the animal was, Lofinda turned to me and again whispered, "Edja." Frustrated, I moved close to him, put my chin on his shoulder, sighted along his extended arm to the tip of his index finger, and finally spotted a dark silhouette perched on the end of a bough some eighty feet from the ground. He was a magnificent animal, with a lustrous black coat. His pink lips contrasted with the coal black skin of his face, his nose was strikingly gorilla-like, and his brow was an unbroken, heavy shelf across his forehead. The black hair on his face formed sideburns; the hair on his head was parted at the midline.

It had been three hours since our party had left camp to search for pygmy chimpanzees. We had arrived at our study site earlier that morning following a fourteen-day journey from Kinshasa, the capital of Zaire. After seven years of studying apes in the laboratory, I was thrilled to see these animals under natural conditions. Four years earlier, my colleague Noel Badrian and his wife, Alison, had conducted a six-month study of the pygmy chimpanzee (*Pan paniscus*) in this area. The first primatologists to observe pygmy chimpanzees in the wild, they had gathered some ninety hours of observations on social behavior, feeding, and other aspects of pygmy chimpanzee ecology. Unfortunately, their study was cut short for lack of funds. I returned to the Lomako Forest with Noel to gather data on locomotor behavior and add to the Badrians' earlier work.

These animals, which we had come so far to observe, first captured the attention of anthropologists some fifty years ago, when the study of great ape behavior began to come into its own. Although captive pygmy chimpanzees were observed in the mid-1920s by Robert Yerkes and others, the animal was not recognized as a distinct species until Ernst Schwarz's work in 1929. Harold Coolidge published the first detailed paper on the biology of the pygmy chimpanzee in 1933. Using museum records of localities from which specimens were collected, Coolidge mapped out the range of the pygmy chimpanzee, as he called the animal. He noted that the pygmy chimpanzee was found on the left bank of the Zaire (formerly Congo) River, while the common chimpanzee occurred on the right bank to the north. Coolidge further reported the eastern extent of the range as the Lomami River, and roughly defined the southern boundary by a line connecting Lukolela in the west and Mondombe in the east. Although a number of different distribution maps for the pygmy chimpanzee have been published since Coolidge's, information collected during the past few years shows that his map provides the most accurate assessment of the species' range.

From the start, anthropologists and primatologists were intrigued by descriptions of a dwarf, or pygmy, chimpanzee. (No one now believes that the creature is a true pygmy version of the common chimpanzee, but the name is still in popular usage.) Many new thoughts and hypotheses quickly appeared. Few anatomical studies were actually conducted on the morphology of the animal, however, and no fieldwork was undertaken for the next thirty years. The remote, restricted range of the pygmy chimpanzee in the rain forest of Zaire no doubt accounted for the latter fact.

In recent years, discoveries of fossil apes and ancient humans have rekindled interest in the evolutionary biology of the pygmy chimpanzee. First, similarities in overall size and dental and facial proportions of *Ramapithecus* (possibly the earliest bona fide member of the hominid line) and the pygmy chimpanzee engaged the attention of primate paleontologists. Second, new finds of two to three million year old hominids in eastern Africa, as well as those found earlier in South Africa, revealed size differentials in early humans that recalled the differences between the pygmy chimpanzee and the common chimpanzee. Most important, however, was the lingering notion that the pygmy chimpanzee, smallest of the great apes, was less specialized adaptively than chimpanzees, gorillas, or orangutans, and that for this reason it might provide the best living analogy with the behavioral patterns of our earliest apelike human ancestor.

In the early 1970s extensive studies of the teeth and skulls of pygmy chimpanzees and preliminary investigations of their skeletons were carried out. Attempts to collect data on the behavior of free-ranging pygmy chimpanzees were also made and more formal studies of captive behavior were begun. From the information that was gathered, two poles of opinion emerged on the question of the phylogenetic affinities of the pygmy chimpanzee and its place in the family tree of African apes and humans.

Some scientists suggest that the pygmy chimpanzee closely represents the proto-

type from which humans and the African great apes have evolved. They suggest that the pygmy chimpanzee's smaller size and relatively small cranial, facial, and dental dimensions make it a better model of the prehominid ancestor than either the common chimpanzee or the gorilla. To underscore such similarities to humans these scientists further suggest – largely from observations of captive animals – that pygmy chimpanzees walk bipedally more often than common chimpanzees do and engage in more complex and variable sexual and copulatory interactions than other chimpanzees. Proponents of this school also emphasize the size similarities of early hominids and pygmy chimpanzees and the "generalized" hominoid morphology of the latter.

Other scientists, however, have pointed out that the similarities of the pygmy chimpanzee and early hominids such as *Australopithecus* or *Ramapithecus* are revealed only in a certain few morphological traits, many of which can be attributed to the overall effect of small size. In other words, these similarities in size may mask many important underlying adaptive differences. These workers feel that pygmy and common chimpanzees are equally good working models for the common ancestor of humans and African apes, and that acceptance of the pygmy chimpanzee as the prototype is not warranted by our limited knowledge of the species. Nevertheless, both schools agree that the pygmy chimpanzee is a highly significant, still untapped reservoir of information for interpreting the fossil record of human evolution.

The data on pygmy chimpanzees suggested that pygmy chimpanzees are more arboreal than common chimpanzees. But we were at a loss to confirm this interpretation of our anatomical observations. Noel Badrian and I designed a brief field study to try to determine how they moved about in their native habitat so that we could verify or deny the hypotheses developed in the laboratory about pygmy chimpanzee locomotion. We intended to eventually combine the behavioral and morphological observations and hoped the combination would help us infer the locomotor characteristics of selected fossil apes and humans, and especially, shed light on the critical question of how hominid bipedalism originally evolved.

The initial observations that Lofinda and I made were only the first of many sightings that our party made during the next four weeks. We logged nearly twelve hours of detailed observations on locomotion and feeding alone – more than anyone had previously collected. Most of the time we encountered small groups of five to eight animals feeding high in the crowns of fruit trees. Groups consisted of a large male (weighing 100 pounds or more), one or two smaller males, and two or three females – one or two of which might be carrying an infant. When we approached, the group members frequently spotted or heard us. Sometimes they continued to feed; at other times they hurriedly descended the trees and fled on the ground. In both situations a male would interpose himself between us and the group, attracting our attention with a noisy, bough-drumming, bipedal display (standing on his hind limbs, waving his arms, and vocalizing) or just moving toward us to build a nest or feed. Often, while the prominent male had our attention, the rest of the group would quietly move off.

From footprints, plant remains, and direct observations made by Lofinda and his son Ikwa, we learned that pygmy chimpanzees spend a large part of the day on the ground. Much of their diet consists of fruit, but they regularly eat a number of canes and herbs that are found on the forest floor. In addition, Noel and Alison had earlier observed and reported insect and small mammal remains in pygmy chimpanzee feces. Pygmy chimpanzees are basically quadrupedal knuckle walkers when on the ground, but they engage in other mixes of walking as well. Ikwa observed a large male pygmy chimpanzee walking bipedally on the ground. When he spotted the guide, the startled animal dropped the canes he was carrying, stomped, defecated, and then turned and fled on all fours.

In the trees, pygmy chimpanzees are highly skilled acrobats, and adults are

Agile black mangabey monkey, frequent feeding companion of the pigmy chimpanzees.

Natural History Magazine

reported to be more agile and daring than adult common chimpanzees. Large and small animals of both sexes, as well as pygmy chimpanzee mothers with infants, arm swing, leap, and dive in the high canopy. Juveniles engage in acrobatic play and are also adept arboreal bipeds. We observed several instances of bipedal walking along large boughs at heights of 100 feet and more, usually when the animals were carrying objects or when they engaged us with behavioral displays. The relative frequency of bipedal locomotion – it occurred in ten percent of our observations – was comparable to that reported for gibbons by C. R. Carpenter and later workers.

Our conclusion that pygmy chimpanzees are better than common chimpanzees at leaping, diving, arm swinging, and walking upright in trees rests on our quantitative assessment of the frequency and context of the various modes of pygmy chimpanzee locomotion. And it confirms our initial studies of pygmy chimpanzee and common chimpanzee anatomy, in particular the structure of the shoulder blade, arm and hand, which suggest that the pygmy chimpanzee is more arboreal than its relative. But these are not definitive conclusions, and our studies are continuing. We need more anatomical and field studies of both animals to nail down the differences we believe we see.

If our findings are confirmed, we will have a series of living apes, closely related to, but differing in locomotor behavior from, the human lineage, that can be used to explain the morphology of fossil apes and humans. As to how good a model the pygmy chimpanzee is for the common ancestor of humans and apes, I believe that it cannot be taken as the best model to the exclusion of the common chimpanzee.

Although the pygmy chimpanzee appears at first glance to be the ideal candidate for modeling the ancestral human condition, close inspection of selected elements of pygmy chimpanzee anatomy and recent discoveries of early human fossils cast doubt on how ideal it is. Recent fossil evidence, from various sites in Africa (Hadar in Ethiopia, and Laetoli in Tanzania), of hominids as old as 3.75 million years indicates that early human ancestors showed a much greater anatomical difference between the sexes than do pygmy chimpanzees. The common chimpanzee, other apes, and modern humans all exhibit greater differences between the sexes in body shape and size than do pygmy chimpanzees. Thus, it may be that the similarity of sexes in the pygmy chimpanzees is not an indication of its similarity to a generalized primate ancestor but a more recent adaptation.

Problems always arise in trying to read back from a living creature to an extinct one. An animal that lives today may have changed less than some other animal in terms of a common ancestor, but all have changed. And some aspects of each species have changed more than others. Chimpanzees or pygmy chimpanzees may be closer than human beings are to our common ancestor – that is, they may have changed less since divergence. But some aspects of the apes are recent and highly specialized adaptations. For example, both chimpanzees (pygmy and common) and gorillas engage in knuckle walking, an adaptation to a mixed life in the trees and on the ground that allows the apes to have long grasping fingers and still walk comfortably on all fours. No other apes exhibit this behavior, and there is no evidence of it occurring in any of the fossil primates we know.

To begin to do what we want to do – read into the fossil record behavioral interpretations bolstered by evidence gained from our investigations (behavioral and anatomical) of living apes – we need to learn more about the anatomy of humans and of apes other than the pygmy chimpanzee, and to avoid the pitfalls of comparisons. We have to determine which traits are conservative (common to all apes and humans) and which are derived (peculiar to a subgroup of apes, African apes, for instance, and humans).

Such distinctions are absolutely necessary in reaching conclusions about the special affinities of humans with any one ape species. And such distinctions are also a necessary prelude to using living apes to deduce the behavior of our fossil ancestors.

Dr. Susman, who is associated with the State University of New York at Stony Brook, has received funding from the Leakey Foundation. □

FIELD REPORTS

Excerpts from reports by Leakey Foundation grantees on their work in progress.

THE PYGMY CHIMPANZEE: LIVING MODEL FOR THE APE-HUMAN ANCESTOR?

Adrienne L. Zihlman,
Department of Anthropology,
University of California,
Santa Cruz

In drawing a portrait of the common ancestor of the apes and humans, we find clues in the fossil record, in the comparative anatomy of living species, and in the new field of evolutionary biochemistry. The oldest human fossils, over three million years old, reveal creatures of small stature, with brains little larger than chimp brains, who walked upright like us. From comparative anatomy, Darwin and Huxley deduced that we are most closely akin to the African apes, the chimpanzee and gorilla. Biochemical studies of DNA and proteins have shown the kinship to be even closer than anyone thought, for, based on the rate of evolution of proteins in many species, humans, chimpanzees and gorillas must have had a common ancestor about five million years ago. From these lines of evidence, the common ancestor should have been a small African ape that could have evolved into these three very different creatures.

To me it seemed that the pygmy chimpanzee matched that portrait. Somewhat smaller than the common chimp (but not a pygmy!), this species, *Pan paniscus*, is on average nearly identical in size to the early australopithecines, and its anatomy and behavior are sufficiently "generalized" that it could have evolved into the larger common chimp, the still larger gorilla, and the bipedal hominids. Pygmy chimpanzees resemble humans more than do the other apes in these respects: male-female differences are less marked, they are bipedal more often, they are more social and they copulate front to front.

My earliest studies, based only on the skeletons of the two chimpanzee species, showed that pygmy chimps have less sexual dimorphism (male-female size difference), somewhat shorter arms and a narrower chest rather than the "barrel chest" of common chimpanzees and gorillas. But the skeleton is only 20% of body weight, and I thought that the other 80% – skin, muscle and soft anatomy – would be critical too. As I have studied specimens that died in zoos of natural causes, I have found even more similarities of pygmy chimpanzees to humans. One particularly important study compared pygmy and common chimpanzee females of similar body weight. This eliminates a favorite anatomical fudge-factor known as "allometry," which attempts to explain all difference in proportion as mere differences in scale, due to one animal being larger. In these two females, though the lengths of the lower limb bones were nearly identical, the relative *weight* of the pygmy chimpanzee lower limb was 25% greater, which is more like the relatively heavy lower limb of humans and helps explain why pygmy chimps tend to be characterized as "more bipedal" than are common chimps. It would also help explain the transition to a fully upright hominid.

After doing these anatomical studies, I went to observe pygmy and common chimpanzee behavior at the Yerkes Primate Center, Atlanta, by invitation of Dr. Sue Savage-Rumbaugh. I wanted to observe their locomotor behavior, to see whether either species appeared more "arboreal" or "terrestrial" than the other. Pygmy chimps

have been reported by some observers to be more "arboreal," by others as more "terrestrial" than the common species – which would seem to be impossible.

My observations focused in particular upon a female pygmy chimpanzee, Matata, and a male common chimp, Sherman, of nearly equal weight, as they moved about a high cage with horizontal and vertical supports, and in trees and on the ground. I had the two of them perform the same task and filmed their movements under a range of conditions. And I concluded that there was some truth in seemingly conflicting reports – that the pygmy chimp is *both* more arboreal and more terrestrial, for Matata seemed more agile in the trees and on a spot where I saw nothing. She began digging furiously, sniffing at clots of dirt as she pulled them out; she had uncovered an animal's burrow. Only after her arm went into the hole up to her shoulder and she had removed a mound of dirt was she satisfied that no food was there. Japanese field researchers in Zaire have also reported that pygmy chimps dig for food, a very uncommon activity among other apes, though of course a favorite occupation among !Kung gatherer-hunters presumed to be the living humans most like our early ancestors.

It seemed that the two species climbed up and down differently, and films confirmed this. The pygmy chimp consistently

Dr. Adrienne Zihlman and Matata at Yerkes Primate Center.

yet more "at home" on the ground, than the common chimps. Once we provided four chimps (Matata and three common chimps) with six foot long pieces of sugar cane, which they adore. Matata managed to grab these treasures away from two of the others, and with the three unwieldy stalks moved so quickly around the cage – swinging, jumping, leaping, climbing and dropping down, that Sherman and Austin, two screaming and agile adolescents, were unable to retrieve their stolen sweets.

Another time we scattered raisins, bananas, carrots and other goodies on a flat surface and filmed the results. Matata foraged quadrupedally, standing on three limbs while her free hand picked up the tidbits. She acted very much like a baboon, one of the most "terrestrial" monkeys. The common chimps fed differently, either sitting down to pick up the food or taking a few pieces to sit with and eat. Once when we were outside in a grassy area, Matata suddenly stopped and fixed her attention climbed up on a table, for instance, foot first and jumped down feet first. Sherman, the common chimp, did it this way: he first placed his knuckles on the table and then pulled himself up; and, coming down, he usually leaned over and went knuckles first again. In the same situation, Matata used her legs, as we would do; Sherman used his arms. It is because of this type of behavior that pygmy chimps seem more bipedal than common chimps. They don't actually walk around much on two legs, but they assume a bipedal posture more often in climbing, jumping and standing.

After carefully studying their anatomy and their behavior, I'm even more convinced than before that pygmy chimps are one leg up on the other living apes as a model for the common ancestor of the African hominoids – the chimps, the gorillas, and that small-brained biped with footprints like our own.

THE BABOONS OF MIKUMI

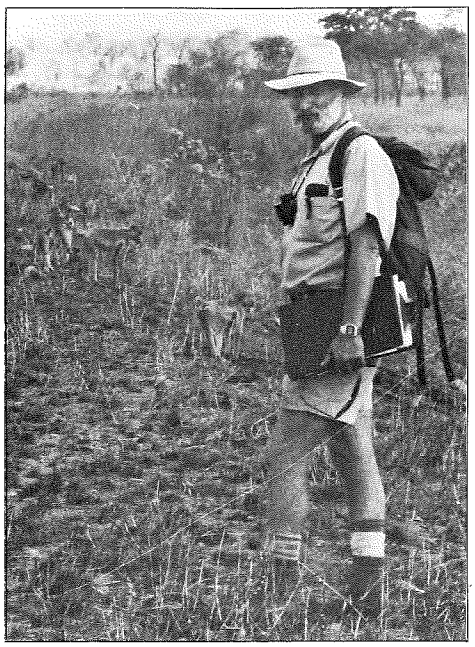
Ramon J. Rhine,
Department of Psychology,
University of California,
Riverside

The 1200 square miles of Mikumi National Park, Tanzania, together with the contiguous Selous Game Reserve, comprises one of the largest remaining unspoiled natural habitats of African wildlife. This area supports untold numbers of mammals, birds, and reptiles, including a large population of baboons, the subjects of our research, and more than 160,000 elephants, probably the largest single concentration in all of Africa. Only a small part of Mikumi is accessible by road, and in this area of wooded hills and savanna grasslands, relays of baboon researchers have kept a research camp in operation since late 1974.

Actually, Mikumi research goes back to 1970–71 when I spent the first part of a sabbatical year with Sherwood Washburn at Berkeley, and the latter part in Africa studying baboons at Gombe National Park, where I met David Hamburg and Jane Goodall. I came away from Berkeley reoriented toward human evolution, and away from Gombe convinced of the importance of long-term studies of advanced terrestrial primates which are subjected to many of the same evolutionary pressures impinging upon ancestral hominids. With the advice and support of Hamburg, Goodall, and Derek Bryceson, who was then director of Tanzania National Parks, and with the dedication and sacrifice of students from the University of California, Riverside, the initial Mikumi research was planned and eventually begun with shoestring financing. During more than six years, twenty first-rate young researchers from several institutions and programs have participated in a variety of Mikumi research projects of which two major ones are the study of movement patterns and the dynamics of long-term change.

Early studies of movement patterns focused on the socio-spatial organization of moving troops as they progressed from one location to another. Like human ancestors, baboons have adapted to a terrestrial existence among predators on the African savannas. It has been suggested that a protective socio-spatial organization of progressing troops is an element of this adaptation. The more self-sufficient troop members, especially the powerful adult males, were thought to take progression positions which tend to protect more vulnerable animals, especially the small juveniles and infants. Quantitative analysis of considerable amounts of Mikumi data indicates that adult males tend to be located in the exposed front and rear of progressions, whereas walking infants and small juveniles tend toward the comparative safety of the troop's center.

Recent Mikumi studies of movement



Dr. Ramon J. Rhine with baboons at Mikumi.

patterns have focused upon leadership. Use of a large range by ancestral hunter-gatherer groups must have involved at least rudimentary leadership mechanisms which allowed coordinated movement by hunters away from and back to a home base. When inferences about the coordination of such movement patterns are a concern, probably the best source of information among living nonhuman primates is the savanna baboon. In our current work on baboon leadership, we are attempting to discover the characteristics of those animals which are most important in determining the direction and timing of troop movements, and the cuing mechanisms involved in leading the troop from one major resource area to another.

Long-term primate study sites are needed to document the dynamics of change. Ignorance of behavioral variation is a major obstacle to the generality of conclusions about natural primate behavior. Long-term research allows continuous knowledge of well-habituated, individually-identified animals of known kin lines, living in a thoroughly mapped range where major resource areas are identified and located. Lacking such long-term information, a researcher who tried to characterize Mikumi baboons after a study of only one or two years would almost certainly draw an incomplete or distorted picture, as will be seen from a few examples. After several years, a large initial study troop, Viramba troop, split into three distinct parts, including one quite small troop. All of the current most dominant males transferred into the Viramba troops from surrounding ones, and all males who reached young adulthood in a Viramba troop transferred out. In some years the rainfall was double that of others, and foods often eaten in one year were almost excluded from the diet in others. The initial Viramba range greatly expanded before and during the split and has subsequently begun to contract toward the original. After one year, known groves of sleeping trees were numbered to nine, and now there are thirty-four. Recording troop behavior through these and other variations at a long-term site helps separate situation-dependent behaviors from those which are so fundamental they persist over time and under a wide variety of different conditions.

Without the help of the Leakey Foundation, site continuity, the cornerstone of successful long-term research, could not have been maintained, and several young researchers could not have completed their work. The Foundation helped establish the initial Mikumi research and on two subsequent occasions, when the need was desperate, helped save site continuity while more substantial requests from other sources were going through an evaluation process that can take over a year. Because Foundation support was well timed and precisely aimed, its impact, dollar for dollar, was considerably more significant than important and appreciated grants from other sources. If something worthwhile comes from Mikumi research, it will be due in no small degree to the L.S.B. Leakey Foundation.

PALEOANTHROPOLOGICAL RESEARCH AT KAO PAH NAM, NORTHERN THAILAND

Geoffrey Pope,
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University of California,
Berkeley

For decades, paleontologists and anthropologists have searched for the remains of early man in the Asian tropics. Many fossils assignable to an early species of *Homo* were recovered from Java in the first half of this century. More recently, other specimens of early *Homo* have also been recovered from Yunnan, southern China. In spite of the fact that multidisciplinary research efforts continue to be mounted in Asia, little work on early man sites has been conducted in the geographically intermediate area of mainland Southeast Asia. As a result, our understanding of human evolution in this part of the world has been severely constrained. Recent work by the Thai-America Expedition to northern Thailand has made significant progress toward remedying this situation.

Thanks in large part to the support of the Leakey Foundation our continuation of work in Thailand has resulted in the discovery of an important new paleolithic locality containing artifacts, indications of the use of fire, and fauna of Middle or Early Pleistocene age.

This locality is called Kao Pah Nam (Forest Thorn Hill) and is well named. It is

Geoffrey Pope and Thai helper.

a jagged and rocky limestone outcrop covered with tangles of giant thorn trees. Local Thai villagers have burned one flank of the hill back to expose the remains of a cave from which they mined phosphate for gun powder and fertilizer. One of our geologists at the University of Chiangmai had originally asked local villagers if any bones were found at the site. The answer was extremely encouraging, "yet yet yai," ("many and large").

Subsequent excavation at the locality has revealed this indeed to be the case. Not only had the cave been the last repository of hyaenids, tigers, giant bovids, hippos and cervids, but it had also been a probable campsite for early hominids in the Pleistocene. Tools and a hearth revealed that hominids had carried out at least some activities under the shelter of the now vanished roof. Geological and paleomagnetic studies on parts of the stratigraphically higher Lampang basalt flow as well as the composition of the fauna suggest that the fauna is of at least Middle Pleistocene and possibly Early Pleistocene age.

The fossils occur both in soil and in an extremely hard breccia, a kind of natural cement familiar to anyone who has followed the important early hominid finds from South Africa. While the hardness of this breccia accounts for the excellent preservation of the Kao Pah Nam fauna, it also makes excavation here a slow, back-breaking task that must be carried out with hammers and chisels in temperatures that are usually over 120 degrees Fahrenheit.

Initial excavations brought to light not only a wide range of mammalian species but also the discovery of large chopper-chopping tools associated with the fossils. A few associated cobbles which appear to have been fire cracked are also present at the locality. Whether or not hominids accounted for the accumulation of most of the Kao Pah Nam fauna is not certain at

this point in our research. It is likely that the carnivores which occur at the site were also responsible for some part of the accumulation. The alternate occupation of the cave by carnivores and hominids is a fairly common occurrence as exemplified by the famous early man sites as Choukoutien.

Previous work at Kao Pah Nam represents an appreciable advance in our understanding of human evolution in this part of the world. We feel that continued work at this important locality will result in further discoveries which will be instrumental in documenting the scope and timing of human evolution.

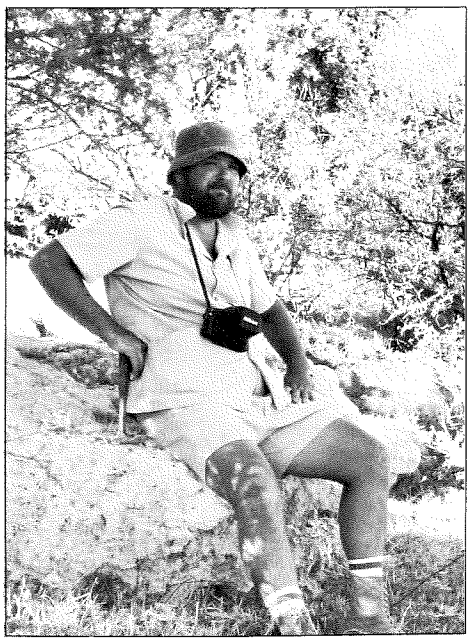
RESEARCH AT TOROMOJA, A LATE STONE AGE SITE, CENTRAL DISTRICT, BOTSWANA

David M. Helgren,
Department of Geography,
University of Miami,
Coral Gables, Florida

Leakey Foundation funds supported part of the field expenses for a multidisciplinary expedition to the northern Kalahari (Botswana) during June and July, 1980. The Kalahari is one of Africa's great sedimentary basins and contains extensive Late Tertiary and Quaternary deposits. However, exposures are rare, and archeological and paleo-environmental studies are only beginning.

The northern Kalahari is divided into three great depressions – the arid salt-flats of the Makgadikgadi pans and Lake Ngami as well as the lush forests of the inland Okavango Delta. Initial research indicates these depressions contained great freshwater lakes at several times during the Quaternary and these ancient lake shores attracted human settlement. Settlement along shores of the most recent, but now dry, great lake in the Makgadikgadi basin was the focus for this expedition. The archeology, geology and paleontology of a large Late Stone Age settlement near the modern village of Toromoja was investigated. More than 20,000 pieces of artifactual debris and more than 5000 pieces of identifiable bone were recovered. People living along this shore were taking an assortment of medium and large antelopes plus zebra and hippo. In addition they were fishing and fowling along the lakeshore. The expedition also excavated a Late Stone Age burial at nearby Gwi Pan. At this writing, dates for this lakeshore settlement are still pending, but a mid Holocene age seems likely.

Future research in the region will emphasize studies of settlement along still more ancient shorelines. In addition a search for more burials around Gwi Pan is anticipated. Further studies in the Kalahari are necessary as a paleoclimatic and paleocultural bridge between South Africa and East Africa, so that regional patterns in prehistory can emerge.



Dr. David Helgren

Leakey funds supported travel within Botswana by me, acting as the project's earth scientist. Other participants included Alan Mann, physical anthropologist (University of Pennsylvania), and archeologists Alison Brooks (George Washington University) and John Yellen (National Science Foundation).

THE MIDDLE STONE AGE IN BOTSWANA

Kathleen Rubin,
Franklin Mosher Baldwin Fellow,
Department of Anthropology,
University of Pennsylvania

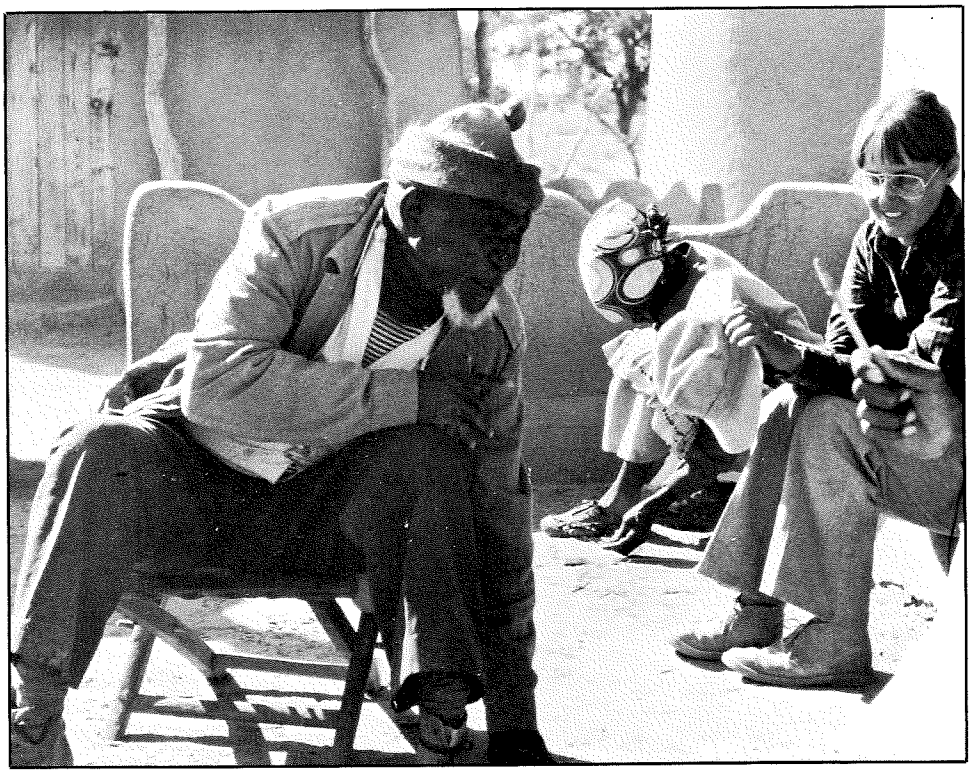
Botswana has for many years attracted anthropologists in large numbers who come to study some of the world's last remaining hunter-gatherers, the Bushmen, or the complicated patchwork of Black African settlement in the region. Intensive archeology is somewhat newer to Botswana. While most recent work has centered on the later sites of Bantu-speaking peoples in the Iron Age, the country was by no means a no-man's-land during the Stone Age. The most common sites are Late Stone Age, found especially around the shores of extinct lakes or the margins of seasonal pans. These places provided a focus for the activities of prehistoric people and so have become more archeologically visible. Sites are also known for the Middle Stone Age and even for the earlier Stone Age, although these latter are mostly surface finds of artifacts that have been transported by water from their original contexts.

A grant from the Leakey Foundation for the summer of 1980 made it possible for me to participate in a project sponsored by the National Geographic Society, several American universities, and the National Museum of Botswana to survey for Middle Stone Age sites. The study area is a parched grassland in the northeastern Kalahari desert at the southern margin of the Makarikari pans and Game Reserve. Here Tswana, Herero, Kalakgadi, Kalanga and other Bantu groups live in villages clustered near the country's main river and send their cattle into the pans to graze.

For some time the National Museum had been aware of this area's archeological richness and, in particular, of its excellent rate of fossilization which provides an opportunity to find stone tool industries with a rich fauna. During June and July, we surveyed the area, excavating test pits which yielded enough ostrich egg shell, bone, and charcoal to submit for an absolute date of the deposits. With excavation it soon became apparent that the finds were all from the Late Stone Age, in association with recent fauna. Middle Stone Age sites are in part identified by the presence of distinctive stone flake tools, usually associated with certain extinct species. Earlier surface surveys in the region had given the impression of large flake tool industries characteristic of the Middle Stone Age, but careful test excavations showed the resemblance was only superficial. Classic microlithic tools of the Late Stone Age turned up along with the larger unretouched flakes. No extinct species have been identified in a preliminary study of the fauna.

Because the Late Stone Age persisted in parts of Botswana until 100 to 300 years ago, we had a rare opportunity to do some ethno-archeological interviews with the Batete, the last remaining members of the original inhabitants of the area after whom the Botletle River was named. The Batete were hunter-gatherers belonging to the Khoisan linguistic group. Its speakers are an ancient people thought to have been widespread in southern Africa. Today they are represented by the San (Bushmen) and the Hottentots. Eventually, the Batete established close economic ties with Bantu people moving into the area. After generations of intermarriages, they adopted their agricultural practices and came to resemble the Bantu physically. However, the elders still speak a dialect of the click-language used by Khoisan groups which is distinct from Bantu languages.

The survey also discovered the first complete Late Stone Age burial to be found in Botswana, on the western edge of Gwi Pan. The body of an adult male was found in a flexed position in a shallow pit which had been dug in a hard calcrete-like deposit and which was slightly too small for the body. This seems to account for some crushing of the skull bones as the



Batete elder, Braai Osai, tells of how Batete once hunted hippo near the river by harpooning them with spears from a safe position in the trees. Mrs. Rubin sits on right.

body was forced into the crypt. One foot had also been removed and was placed on the chest for burial. Collagen from the rib bones is being dated at the Smithsonian radiocarbon lab, but the find seems to be either a larger than average Bushman with unusually thick cranial bones or an earlier form ancestral to the Bushmen. Ostrich egg shell and more numerous bone beads were found with the skeleton, forming a pattern typical of the beading which decorates the apron worn by Bushmen males.

The American directors of this summer's work were Alison Brooks, John Yellen, David Helgren, and Alan Mann. The National Museum investigators and discoverers of the site area are Jim Denbow and Alec Campbell. I was also able to use this opportunity in Botswana to work for a few weeks with the Middle Stone Age materials from another site previously excavated by Drs. Brooks and Yellen in the western Kalahari. This will add another dimension to my doctoral dissertation on this site since only the retouched tools have been brought to the Smithsonian for thorough study. For much of August, I travelled to museums and universities in South Africa and Zimbabwe to see the range of Middle Stone Age industries. I talked to local archeologists about evaluations of sites and the chronological positions of their industries and so learned valuable information which is not in print. The industries of Botswana show some close resemblances to those of Zimbabwe. The South African Middle Stone Age varies markedly from these, we believe largely because of important differences in the raw materials used. □

J.W.K. Harris

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adjacent plains which was eventually filled by early hominids. In contrast, our primate relatives, the apes and monkeys, occupy generally more densely vegetated bush and forest environments.

Quite apart from being attractive habitats, lake basins provided extraordinarily favorable conditions for the preservation of animals who died there over the last three to four million years. Their bones were fossilized because of rapid burial after death by sediments brought by rivers draining into the lakes and by rises and falls in the lake levels. More recent movements of the earth's crust have uplifted ancient land surfaces and, as a result of the natural forces of erosion, fossils and habitation sites have been exposed, providing a wealth of information for the reconstruction of the earliest stages of human existence.

Of equally crucial importance is the availability of material which can be accurately dated. Ash and lava, which can be dated by a complex geophysical process called the potassium-argon method, were deposited by volcanic activity in the past over many parts of the landscape in the Rift Valley region. These volcanic materials occur as dated "marker horizons" sandwiched within the sedimentary sequences where fossils and archeological sites are found.

The earliest dated finds attributed to the *hominidae*, the zoological family of man, are isolated fragments of bone from Lothagam and Kanapoi on the western side of Lake Turkana dated to five and four million years ago, respectively. However, for the most complete earliest dated hominid material and evidence for human-like behavior, one has to cross the borders of Kenya to Hadar in the Afar depression of eastern Ethiopia, and to Laetoli on the flanks of the Rift in northern Tanzania.

The exciting early hominid discoveries from both these localities are highly significant because they fill a crucial gap in human evolution between three and four million years ago. After several years of painstaking study, American researchers Johanson and White came to the conclusion that they were dealing with the earliest species yet belonging to the family of man, which they called *Australopithecus afarensis*.

This creature possessed a small brain the size of a modern chimpanzee's and other primitive ape-like features, but was fully erect and walked like modern man. Dramatic confirmation of this creature's capabilities was the excavation of trails of hominid footprints by Dr. Mary Leakey and her co-workers at Laetoli. These prints are the oldest evidence so far to show that a fully upright posture and a bipedal, free-striding gait had been achieved.

The Laetoli and Hadar discoveries have important implications for revising currently held ideas of human evolution. The primitive nature of *A. afarensis* appears to refute the traditional view that the human line diverged from the ape line as long as fifteen to twenty million years ago. In fact, Johanson and White's findings strongly support the more controversial theory, based upon molecular evidence of the close relationship between modern humans and apes, that the lines diverged as recently as five to six million years ago. Furthermore, these findings have clarified considerably the evolutionary relationships leading to later hominids.

From the basal stock, *A. afarensis*, early populations of hominids diverged and evolved in different directions. One line led to early *Homo* or *Homo habilis*. The other line was subjected to evolutionary change of a different nature leading to *Australopithecus africanus* and the hyper-robust *Australopithecus robustus* or *boisei*, and ultimately to evolutionary extinction.

Taken together, the evidence of the primitive nature of the fossil remains and the Laetoli footprints indicates that bipedalism preceded the expansion of the brain. More important from a behavioral point of view, this unique trait was the basis for life on the savanna. Hominids were able to range widely over more open terrain. With the hands free, food and raw materials for tool making could be transported back to campsites and fine manipulative skills like tool making and tool use could be achieved. In addition, a striking example of how perhaps early hominids congregated in social groups was the finding of at least thirteen individuals together, including infants, juveniles and adults, in one locality at Hadar.

In 1968, Richard Leakey, director of the National Museums of Kenya, mounted

a small expedition to explore the arid wastes by Lake Turkana at Koobi Fora in the search for early hominid fossils. The team found the first of many significant fossils which date between three and one million years ago. An enlarged research group has returned in successive years since then.

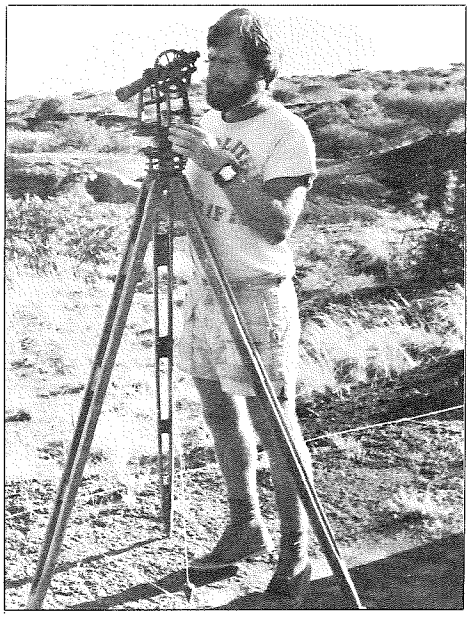
In the fossil record at Koobi Fora is the earliest specimen attributed to *Homo* or *H. habilis*, dated to a little over two million years ago. This specimen, known by its museum accession number, 1470, shows substantial expansion in the brain-case compared to the australopithecines. Living at the same time as early *Homo* was another hominid species, the hyper-robust australopithecine, *A. boisei*, and perhaps a third species, a more gracile australopithecine with similarities to the South African form, *A africanus*.

By 1.5 million years ago early *Homo* or *H. habilis* had advanced further and generated *H. erectus*. The gracile australopithecine species is no longer found. The robust australopithecine species continues in the fossil record before finally becoming extinct about one million years ago, thus leaving *H. erectus* as the sole survivor of early hominid differentiation. *H. erectus* later gave rise to *H. sapiens,* or modern man, about 100,000 years ago.

The discovery of numerous stone tool kits over the Koobi Fora landscape has documented some of the earliest traces of cultural manifestations which indicate truly human behavior. The ages of these occurrences range between 1.8 and 1.5 million years and are similar to the Oldowan tool kits found in the lowest strata at Olduvai Gorge. Two kinds of tools are commonly present. Fist-sized cobbles which have had chips or flakes removed to create one or more blunt edges were probably used as bashing or chopping tools. Sharp fragments of stone, produced by knocking two cobblestones together, were probably used for cutting, sharpening and piercing.

The discovery of the bones and stones of early man has been of major importance. In addition, emphasis in the Koobi Fora study has been placed on the reconstruction of the past environments: the landscape, the vegetation, and the animal communities. Armed with this knowledge together with the remains of hominid campsites and their distribution across the ancient landscape, it has been possible to reconstruct some aspects of the adaptive behavioral patterns of early hominids.

In time long past, Koobi Fora was a large sedimentary basin, the extent of which was subject to fluctuations in lake level. A low range of volcanic hills surrounded the broad plains adjacent to the lake. A large perennial river, whose headwaters extended far beyond into the hinterland, entered the basin through a gap in the volcanic hills. Within the basin, several streams and small rivers flowed seasonally across the open savanna grasslands. Close to the lakeshore the vegetation



J. W. K. Harris using surveying instrument on an archeological site at Koobi Fora.

became more lush, with swampy areas as well as bush and gallery forest along the streams.

Most of the precursors of animals found today on the grasslands and along the lakeshores of the savanna zone were present then: large species such as elephant, rhino and antelope as well as smaller creatures like tortoises and rodents. It was the availability and subsequent occupation by early hominids of more open savanna habitats that was a major stimulus to bring about changes in behavior.

The maintenance of a cohesive group of adults, children, and perhaps aged or non-productive members required cooperative subsistence strategies and food sharing. This could best be achieved by a division of labor with the males carrying out hunting and scavenging activities and the females gathering plant and vegetable foods – the same pattern of behavior as that of present-day hunters and gatherers.

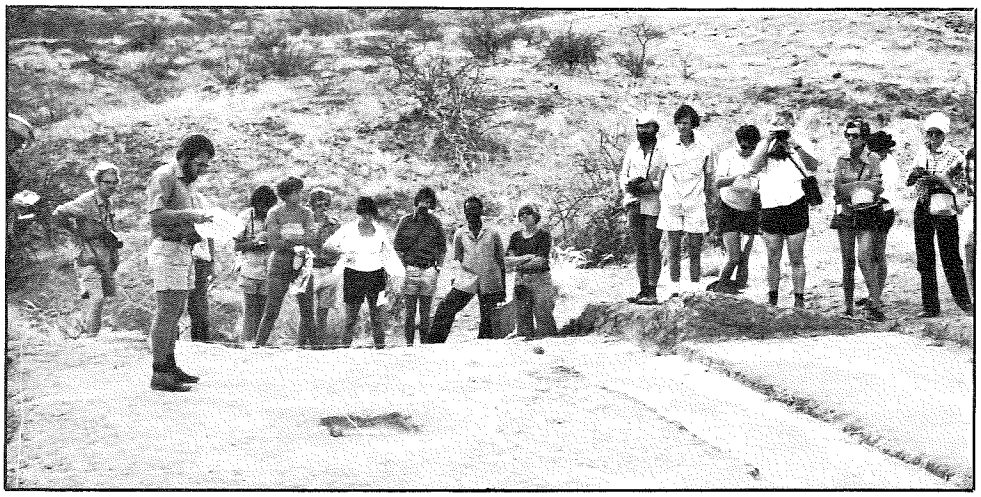
The excavation of a large number of early man campsites where the broken up bones of a variety of animals are found in association with stone artifacts demonstrates the concept of a home base where food products were carried for processing, sharing, and finally consumption. Moreover, wide-ranging scavenging, hunting, or gathering activities presumably lasted over several days which would out of necessity require a central location or home base.

The widespread distribution of campsites and hominid localities over the Koobi Fora landscape attests to the view that early hominids were nomadic hunters and gatherers who ranged freely and exploited a broad range of vegetable and meat resources. The butchered and broken up bones of animals at campsites indicate that meat protein had become a regular feature of their diet. Unfortunately, plant or vegetable residues do not preserve at sites of this antiquity. We can only infer from the behavior of present-day hunters and gatherers that plant and vegetable foods formed a substantial part of early hominid diet.

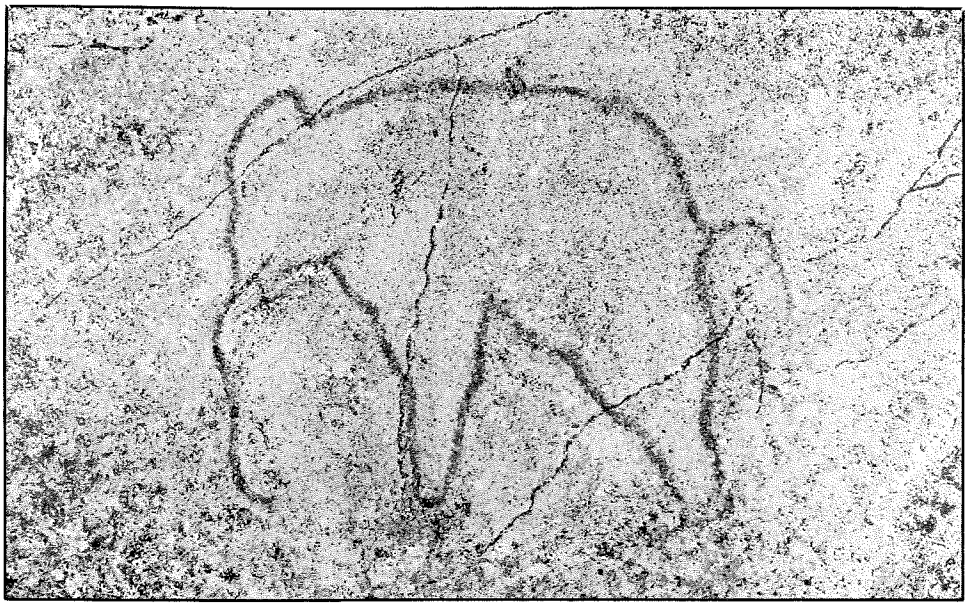
Stone tools indicate innovative adaptive behavior and signify changes in early hominids' subsistence strategies to perhaps include the acquisition and certainly the preparation of food requiring their use. In this respect, the beginning of stone tool manufacture and use is a threshold in human evolution. However, it should be thought of as one of a complex of adaptations to early hominid life on the savanna which also favored a shift toward a higher protein meat diet, food sharing, and other behaviors which became typical of later hominids.

Each year scientists of diverse nationalities visit Kenya to undertake paleoanthropological inquiries in the quest for human origins. Funding is provided by many organizations including the L.S.B. Leakey Foundation. This work could not be possible in Kenya without the government's assistance and the participation of National Museum personnel.

A shorter version of this article first appeared in ***The Guardian****, London. Dr. Harris is a member of the team which has been exploring at Koobi Fora.* □



J. W. K. Harris showing group of visiting scientists an archeological site at Koobi Fora.



Mammoth, El Castillo, Spain ©Douglas Mazonowicz

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hypothesis. The oldest undisputed hominids have been dated at about three million years; they have rather chimplike skulls and bodies, but they were bipedal and left footprints remarkably like ours.

The principle objection to the molecular evidence is the existence of the fossil genus *Ramapithecus*, which many anthropologists consider a hominid, though it lived eight to fifteen million years ago, in Africa, Asia and Europe. It has been considered hominid on the basis of its jaws and teeth, the only parts of the anatomy known. From the molecular point of view, *Ramapithecus* is much too old and much too widespread to be a true hominid. Therefore, at least one of these two theories of human origins must be wrong.

If one could do molecular studies on the fossils themselves, one might be able to show whether *Ramapithecus* is more closely related to humans than to African apes, as would be expected if it were hominid, or equally related to humans and African apes, as the molecular hypothesis predicts. It was to try to settle this sort of question that I began four years ago to develop a way of detecting species-specific proteins in fossils.

I use a method known as radioimmunoassay (RIA), which employs radioactive tracers and highly specific antibodies. With this technique, it is possible to measure almost unimaginably small amounts of proteins, in blood, in tissues, or, as I have shown, in fossils. I look for collagen, the main bone protein, and albumin, the main serum protein.

For well-preserved proteins, one can't do better than a Siberian mammoth. Where else could you find a fossil deep-frozen in the permafrost for 44,000 years? In 1977, the baby mammoth known as Dima was discovered near Magadan, U.S.S.R., and has subsequently become something of a celebrity, being displayed and written about all over the world. A piece of Dima's thigh muscle ended up in Berkeley, where the evolutionary biochemistry group attempted to identify albumin in it. When conventional methods failed, Vincent Sarich, a molecular anthropologist at Berkeley, asked me to join the effort. Using the RIA method, we were easily able to detect albumin, though the muscle contained only one-hundredth as much as fresh muscle. We were able to reconstruct the family tree of the mammoth by showing how similar its albumin is to the albumin of its closest living relatives, the African and the Indian elephants. We deduced that it is equally closely related to these two species, and that they all diverged from a common ancestor about three to five million years ago. Paleontologists, from studying the fossil record, had already come to the same conclusion. No arguments or surprises there, but it was the first time molecular identification had been made of a fossil species, and The New York Times carried the news on its front page, as well as making a comment about it in an editorial about the Republican convention!

Paleontologists often disagree about the genetic relations of a fossil species, and Sarich and I recently collaborated in helping to resolve just such a disputed ancestry – the case of the Tasmanian wolf. This Australian marsupial, remarkably similar to the dog family, was considered a pest by settlers and completely shot out about the turn of the century. Most mammalogists have considered it a member of the dasyurids, a varied group of Australian marsupials that also includes the notorious Tasmanian devil. But, as though one marsupial wolf was not enough, there exists a South American fossil genus, *Borhyaena*, with strong dental and skeletal similarities to the Tasmanian wolf; so much so that a number of experts has suggested that these two are more closely related to each other than either is to the dasyurids.

One specialist analyzed forty-five different characteristics of marsupial teeth and declared the Tasmanian wolf more similar to the *Borhyaena* than to any other species. Can forty-five different ways of looking at the teeth be wrong? If so, the entire structure of mammalian evolution, as read from the fossil record, must tremble, for as often as not teeth are all that we have. Yet convergent evolution can bring totally unrelated creatures to resemble each other, as the marsupial wolves resemble the canine one, or a whale resembles a fish. Using the RIA technique, we studied Tasmanian wolf albumin in three museum specimens provided by Australian zoologist Barry Richardson. The results were unequivocal. Tasmanian wolf albumin is very similar to albumins of the dasyurids and much less similar to that of South American marsupials. Biochemically, the Tasmanian wolf is a dasyurid, as the majority has believed.

Obviously, the case of the Tasmanian wolf is relevant to the *Ramapithecus* controversy, for it demonstrates how misleading dental similarities may be.

I have obtained a few tiny specimens of *Ramapithecus* bone and tested for proteins directly, with antibodies to collagen and serum proteins, and indirectly, by injecting ground up *Ramapithecus* bone into rabbits and testing the rabbit serum for antibodies. By direct test, I was unable to identify any proteins in the fossils, but the immunized rabbits produced antisera to some factor or factors in human and ape serum. The antibodies have been tested against human, chimpanzee, gorilla, orang and gibbon sera, as well as New and Old World monkey sera. Moderate reactions were observed with human and chimpanzee sera, strong reactions with gorilla, orang and gibbon sera, and no reactions with monkey sera. These reactions need to be further refined by separating and concentrating the reactive serum protein, and I am doing this by a variety of techniques. These preliminary results have important implications for research in primate evolution. First, they show that immunologically detectable serum components may survive in bones as old as eight million years. Second, *Ramapithecus* reacts like a hominoid, as would be expected, and not like a monkey. Most importantly, it does not react as though it were more closely related to humans than to the apes. With more adequate specimens and more refined techniques, I have hopes that these and other critical primate fossils may be forced to yield up their family secrets.

Dr. Lowenstein, of the School of Medicine, University of California, San Francisco, is a grantee of the Leakey Foundation.

On page 1 is a photograph, taken in 1933, of the last Tasmanian wolf in captivity. Clearly shown are the wide gape of its jaw, its oddly proportioned hind legs and its thick, drooping tail. Efforts to raise this rare carnivore in captivity were unsuccessful. Invariably the animal sulked, refused to eat, weakened and died. □

THE EVOLUTION OF ANIMAL LIFE

ERA	PERIOD	EPOCH	DURATION	
KAINOZOIC ERA (CENOZOIC)	QUATERNARY PERIOD (Pleistocene & recent epochs)		about 2 million years	Rise and dominance of modern man.
	TERTIARY 38 m.y.	Pliocene	about 5 million years	Man-apes were in Africa at the close of the epoch. Many larger mammals which were almost as abundant as in Miocene times, became extinct with the onset of colder conditions at the beginning of the Pleistocene.
		Miocene	19 million years	Acme of the mammals, notably the larger running forms. Unspecialized apes were abundant in Africa and in the tropical forests of the Old World. Supposed man-apes in India and Africa.
		Oligocene	12 million years	Rise of many modern mammals.
		Eocene	16 million years	Archaic mammals predominate but precursors of many modern groups appear. Rise of snakes. In the sea modern bivalves and gastropods appear and proliferate. Rise of new large Foraminifera.
	63–64 m.y.	Paleocene	10 million years	
MESOZOIC ERA	CRETACEOUS 136 m.y.	(Upper Cretaceous	35 million years)	At the close of the period a world-wide extinction of many large reptiles (dinosaurs, ichthyosaurs, plesiosaurs). The ammonites and belemnites (with one exception) also became extinct. Brachiopods were much reduced. Extreme specialization of the reptiles on land, in the sea and in the air. Beaked, or true birds appear. Mammals remained small throughout the period. Some were shrew-like and many probably nocturnal.
			71 million years	
		(Lower Cretaceous	36 million years)	
	JURASSIC 190–195 m.y.		about 57 million years	Ammonites and belemnites abundant. Brachiopods continue. Large reptiles, notably the dinosaurs, were dominant on the land and spread to the air (pterosaurs). Toothed birds (*Archaeopteryx*) evolved from reptiles in the middle of the period. Small primitive mammals were in existence, probably in restricted habitats.
	TRIASSIC 225 m.y.		about 33 million years	Acme of ammonites. First scleractinid corals. Many marine invertebrates increase in diversity and numbers following the world-wide Permian extinctions. First dinosaurs and large marine reptiles. On land reptiles flourished and gave rise to the first small primitive mammals.
	PERMIAN 280 m.y.		55 million years	Life in shallow seas much reduced in numbers and species, with many extinctions towards the end of the period following the reduction of shelf-sea environments. Last trilobites. Rise and spread of ceratitic ammonites. On land great spread of the reptiles with the beginning of mammal-like features in some groups as opportunities for migration on land increased. Many new orders of insects arose from which the chief groups of living insects evolved either during the Triassic or Jurassic periods. First appearance of larval and pupal stages of insect metamorphosis.
PALEOZOIC ERA	CARBONIFEROUS 345 m.y.	(Upper Carboniferous	about 45 million years)	Rise of reptiles before the close of the period. Spread of amphibians and ancient sharks. Insects were evolving rapidly with the production of many new orders.
			65 million years	
		(Lower Carboniferous	about 20 million years)	
	DEVONION about 410 m.y.		about 65 million years	Amphibians evolved from air-breathing fishes at the end of the period. Bony fishes, including air-breathing forms, were comparatively abundant. Goniatites evolved and spread. First known insects (wingless), spiders and mites. Graptolites became extinct soon after the beginning of the period.
	SILURIAN about 440 m.y.		about 30 million years	Armored jawless fishes became abundant toward the end of the period. Acme of eurypterids. Incoming of scorpions. Waning of graptolites. Bryozoans common.
	ORDOVICIAN about 530 m.y.		about 90 million years	Acme of graptolites. Appearance and increase of rugose and tabulate corals. Brachiopods abundant in shallow water facies, in which trilobites show a decline. Spread of molluscs, notably very large straight cephalopods, which reached their acme at this time. Rare cystid-like forms show possible links with primitive vertebrates. Occasional appearances of armored fish date from lower Ordovician times.
	CAMBRIAN about 570 m.y.		about 40 million years	First graptolites in late Cambrian times. Dominance of trilobites in shallow water faunas, brachiopods and molluscs small, primitive and thin-shelled. Crinoid-like cystids include rare forms in the Upper Cambrian having features which have been compared with those of primitive vertebrates. Appearance, burst and extinction of coral-like phylum, the archaeocyathids, in Lower and Middle Cambrian times. Sudden appearance in the fossil record of nearly all the invertebrate phyla.
	PRE-CAMBRIAN ERAS (CRYPTOZOIC)			Traces of life rare, except in very late Pre-Cambrian times, when exceptional conditions have very occasionally permitted the preservation of soft-bodied animals. Supposed representatives of the annelids, possible fore-runners of the trilobites, "worms" and medusoid and colonial coelenterates ("jelly-fish" and "sea-pens"). Sponge spicules have been claimed present in late Pre-Cambrian beds. It is reasonable to assume that animal life followed plant life in comparatively late Pre-Cambrian times when sufficient oxygen became available from the respiration of photosynthesizing plants; that animal life was at first soft-bodied and that a great burst of evolution occurred shortly before Cambrian times when abundant plant food and living space was then available.

The duration of the interval between the Earth's formation and the beginning of Cambrian times was about 4,000 million years. The Moon and the meteorites have an age of 4,600 M.Y. and there is much indirect evidence that the Earth is also of this age.

(Adapted from The Geological Column, Manchester Museum, England)

CALENDAR

DR. SLYVIA EARLE
April 23 – Shawnee Mission Schools, Shawnee County, Missouri
May 19 – Denver Museum of Natural History, Colorado

DR. DIAN FOSSEY
April 28 – Sweet Briar College, Virginia (special lecture/panel presentation)
April 30 – School of American Research, Santa Fe, New Mexico
May 2 – California Institute of Technology, Pasadena (special lecture/panel presentation)
May 4 – California State University, Northridge
May 12 – Minnesota Science Museum, St. Paul, Minnesota

DR. BIRUTÉ GALDIKAS
April 28 – Sweet Briar College, Virginia (special lecture/panel presentation)
May 2 – California Institute of Technology, Pasadena, California (special lecture/panel presentation)

DR. JANE GOODALL
April 28 & 29 – Sweet Briar College, Virginia (special lecture/panel presentation)
May 2 – California Institute of Technology (special lecture/panel presentation)
May 3 – University of California, Los Angeles, California
May 4 & 5 – University of California, San Jose, California
May 6 – University of California, Berkeley, California
May 10 – University of California, Davis, California
May 11 – Santa Catalina School, Monterey, California
May 12 & 13 – American Museum of Natural History, New York

DR. DONALD JOHANSON
April 14 – California Institute of Technology, Pasadena, California
May 31 – Keynote Speaker, Mental Health Association Conference, Marin County, California (Conference May 31 – June 6)

DR. MARY D. LEAKEY
April 6 – University of California, Berkeley, California
April 9 – Minnesota Science Museum, St. Paul, Minnesota
April 10 – University of Arkansas Medical School, Little Rock, Arkansas
April 13 – William and Mary College, Newport News, Virginia
April 15 & 16 – Philadelphia Academy of Natural Sciences, Pennsylvania

MR. ALEXANDER MARSHACK
April 23 – Fermi Laboratories, Batavia, Illinois

DR. ROGER PAYNE
April 23 – San Francisco Zoological Society, California
April 26 – British Columbia Provincial Museum, Canada
April 28 – Minnesota Science Museum, St. Paul, Minnesota
May 1 – Bell Laboratories, Murray Hill, New York
May 8 – Philadelphia Zoological Society, Pennsylvania
May 26 – California Institute of Technology, Pasadena, California

PLEASE NOTE: Dr. Johanson's March 27 lecture date at San Francisco Zoological Society announced in the previous issue was an error. He will not speak at that location.

MAN & APE: SYMPOSIUM AT CALTECH

May 2 from 3:30 to 5:30 and continuing after dinner recess from 8:00 to 10:00.

A special afternoon and evening series of public lectures in Caltech's Beckman Auditorium, Saturday, May 2, will feature three primatologists famed for their long-term studies of the Great Apes, Jane Goodall, Dian Fossey and Biruté Galdikas. Protegees of the late Dr. Louis Leakey, who long dreamed of studying these primates in depth, each of these enterprising scientists' careers has involved her not only in research and scholarship but also in danger, privation and loneliness.

Dr. Jane Goodall has been observing wild chimpanzees for the past twenty years; Dr. Dian Fossey has tracked the mountain gorilla for thirteen years; Dr. Biruté Galdikas has followed the elusive orangutan in North Borneo for nearly ten years. These three internationally acclaimed experts will share their findings at Caltech beginning at 3:30 p.m. Saturday afternoon and continuing in the evening after a dinner break. Among the topics to be discussed are the influence of environment on chimpanzee behavior, the use of tools by orangutans, the presence of internal conflict and cannabalism among all three types of apes, and the implications of Great Ape studies for further understanding of human evolution.

Moderating this unique program will be Dr. Donald Johanson, discoverer of the "Lucy" skeleton and author of the current best seller about his extraordinary fossil finds in East Africa, *"Lucy: the Beginnings of Humankind."*

Lecture tickets, $12.50 for general and $10.00 for students, are available through the Caltech ticket office, (213) 356-4652, as well as the Foundation office, (213) 449-0507. Fellows and members of the Foundation are invited to attend a dinner honoring the speakers which will be held at the Caltech Athenaem. Cocktails will be at 6:00 p.m.; dinner at 6:30 p.m. The cost is $20.00 per person. Because of limited seating, early reservations are advised. For further information about dinner reservations and this special program, call the Foundation office.

*A limited edition art poster, suitable for framing, designed to commemorate the panel presentation, **Man and Ape**, by Jane Goodall, Dian Fossey and Biruté Galdikas, is offered at the introductory price of $10. The poster measures 16" x 20", is lithographed in six colors and will fit a standard frame. The first 100 will be autographed by the three scientists and are now offered for $35. each. Posters are available from the Foundation; handling and mailing charges, $1.50.* □

ANNUAL MEETING

The 1981 Annual Meeting of the L. S. B. Leakey Foundation Trustees will be held September 16–20 in Napa, California. Highlighting these meetings will be a special afternoon study program at the Auberge de Soleil in St. Helena where several Science and Grants Trustees will discuss current research projects funded by the Foundation. □

PREMIUM

Some String Figures From North East Angola, by M.D. and L.S.B. Leakey, is among the least known of their writings. First printed in 1949, this fascinating booklet has been very difficult to get for some time. Now reprinted, it is available through the Leakey Foundation office in Pasadena.

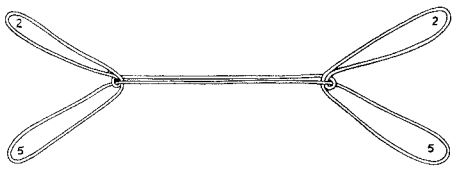
In an interesting foreword, Dr. Ned Munger, president of the Foundation, reminds us of some of the highlights in the colorful lives of the Leakeys. Louis Leakey then gives a brief history of string figures. They are supposed to have originated in the Orient and spread out north, south and west from there all over the world. They appear in almost all primitive cultures. In England and the United States we call this game Cat's Cradle and there is similarity between several of the Angolan figures shown in this booklet and ours.

When Mary and Louis Leakey visited Angola, the Portuguese there insisted that their people knew nothing about string figures. Louis Leakey soon proved them wrong. Twenty-two intricate string figures are herein described, all meticulously drawn by Mary Leakey and accompanied by detailed instructions by Louis Leakey for the different steps used to make them. All these figures come from northeast Angola.

Louis Leakey also entertains us with some reminiscences of when his ability to produce string figures proved vital to his life. He always kept a length of string in his pocket because, he says, in Africa the skill of making string figures was as good as carrying a talisman, enabling him to change a potentially sticky situation into one of good fellowship and assistance.

This booklet makes a valuable addition to the scant literature now existing on this fascinating subject. It will be offered to friends of the Leakey Foundation who become members of the Foundation; members who upgrade or renew their membership or who give gift memberships before June 30, 1981. After that date, the remaining copies will be offered for sale at $3.95 each. Become a member or renew your membership today – there are only a limited number of copies of this charming edition available and they will make a most welcome addition to your or your child's library!

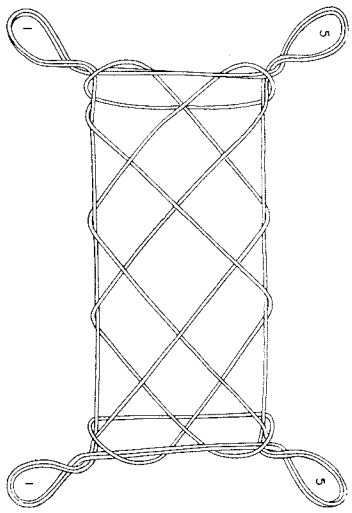
MATEMO
The Hoes



Place the string over both feet, then, keeping feet apart so that string is taut, hook the little fingers over the proximal string. Pass the indices proximal to this string and distal to the far string pulling it towards the body.

Insert the thumbs from the proximal side into the closed loop in the centre of the figure, withdraw indices and insert them again from the proximal side. Release thumbs. Hook indices into the foot loops from above and draw out the ulnar string releasing feet. Extend.

MUHELA
The Bed



Opening A. Insert middle, ring and little fingers proximally into index loops and let the ulnar index strings slip over on to the backs of the hands. Then insert thumbs proximally into the index loops and let the radial index strings slip over their backs, so that the original index loops become wrist strings.

Insert thumbs proximally into little finger loops, pick up radial strings and return.

Insert little fingers proximally into the thumb loops, pick up ulnar strings and return.

With right thumb and index finger grasp all the strings which cross the centre of the figure and pass them anti-clockwise, from the palmar to the dorsal side, between the left thumb and index finger. Pick up the double loop on the left thumb, withdraw thumb (retaining the wrist loop), and replace the double loop without twisting it and allowing the strings which were between the thumb and index finger to slip off on to the palm. Repeat with opposite hand.

Then bring the wrist loops over the tips of the fingers, clap the hands and extend. □

Without the opportunity to seek, there is no opportunity to discover. To stimulate and to provide the means for scientific discovery are major goals of the Leakey Foundation.

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GLOSSARY

ADAPID: An extinct lemuroid mammal, about the size of a rabbit, from the Eocene or Lower Tertiary periods.

COLLAGEN: A gelatin-like protein occurring extensively in vertebrates. It is the chief constituent of the fibrils of connective tissue and of the organic substance of the bones, also occurring in cartilage.

HIPPARION: An extinct genus of Miocene and Pliocene mammals allied to the horse. These animals were smaller than horses and three toed.

LIGNITIC: Containing lignite, a variety of coal intermediate between peat and bituminous coal, especially one in which the texture of the original wood is distinct.

IN BRIEF

Dr. Colin Turnbull will return to Southern California in May to present a one day workshop on *Adolescence*, sponsored by the Associates for Interdisciplinary Studies. The Associates consist of clinical and academic workers who have undertaken an on-going, multidisciplinary study of human personality in relationships.

The workshop will be held on Saturday, April 25. For further information, call Frederick Kurth, M.D., at (213) 276-0113.

•••

At a ceremony held in Jakarta on September 17, 1980, Dr. Biruté M. F. Galdikas was appointed Professor Extraordinaire of Anthropology and Animal Behavior in the biology faculty, Universitas Nasional, Jakarta, Indonesia, by Dr. S. T. Alisjahbana, the university's rector and one of Indonesia's leading literary figures and philosophers. The keynote address was given by Dr. Sumitro Djojohadikusumo, former Minister of Finance and more recently, former Minister of Research in the Indonesian government.

Dr. Galdikas is currently visiting professor in the department of archeology at Simon Fraser University, Burnaby, British Columbia, where she is teaching courses in human origins and primate behavior and evolution. She will be returning to Indonesia following the "Man and Ape" program with Dr. Jane Goodall and Dr. Dian Fossey at Caltech May 2.

•••

A national volunteer organization, Earthwatch, is cooperating with The Center for Field Research in providing volunteer staff and private funds to scientists and humanists conducting field research, and to improve the public's understanding of science. Both basic and applied research projects are considered by the Center, providing there is space available on the field team for participating Earthwatch volunteers, a stipulation that is demanded for grant eligibility. Volunteers are generally available for periods of two to four weeks, and have been used to excavate, map, photograph, observe animal behavior, survey flora and fauna, and share all the other field chores associated with expedition research. For information, contact The Center for Field Research, 10 Juniper Road, Box 127-N, Belmont, Mass. 02178. □

CIRCLE & SAVE

the evening of July 1, 1981, for the L. S. B. Leakey Foundation gala preview showing of

THE ARTIFACTS OF COLUMBIA
SWEAT OF THE SUN
TEARS OF THE MOON

at the Los Angeles Museum of Natural History in Exposition Park.

Many of the ancient gold working areas of Columbia will be represented, each with its distinctive technique and style, as well as some of the world's largest emerald crystals. These artifacts, from the Museo de Oro and the vaults of the Banco de la República in Bogotá, have never before been shown outside of Columbia.

An added attraction for members and guests of the Leakey Foundation will be a special lecture given by Dr. Gerardo Reichel Dolnatoff, the "Father of Columbian Archeology." This exhibition is an exclusive for Los Angeles and returns directly to Columbia when it closes here.

Tickets are $35 each. Seats in the museum auditorium are limited. For reservations please write to the Leakey Foundation, Foundation Center 13–83, Pasadena, California 91125, or phone (213) 449-0507. □

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