ANTHROQUEST
news of human origins, behavior, and survival

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HOW THE SKY HAS CHANGED OUR MINDS

CONNECTIONS

James Burke
London, England

If what seems to be happening in neurophysiology is right, it looks as if the process of file-and-retrieve in the brain — the thinking process - might operate in a very associative way. The cerebral cortex would act in small autonomous clusters of neurons, each holding a core concept a bit like a trickle charge in a battery. Each of these core-concept clusters would be connected directly or indirectly to all other core-concept clusters. And the links — or example in terms, say, of language — might connect up like a string of concepts: bird, tail, plane, simple, complex, neurosis, psychologist, shrink, expand, balloon, hot-air, and so on . . . The beauty of this associative system is its efficiency, which is good for evolutionary survival. You don't have to head straight for the target — what you're trying to access and retrieve — immediately. You can come in, so to speak, anywhere on the net and get there along the lines of association.

A sixteenth century illustration of Ptolemy using a quadrant to measure angles of star altitude. Urania, the Muse of Astronomy, stands behind him.

Originality, then, might be the juxtaposition of two or more concepts that haven't been juxtaposed before. In other words, associative accessing sometimes makes unexpected cerebral bedfellows. And fun. It's also why jokes work. The punch line is a novel juxtaposition; you laugh because you weren't ready for it, which is bad for survival, and at the pleasure of knowing you did survive. It seems that the essence of intellectual progress is like a joke, making relationships where there were few or none before.

One of the reasons new juxtapositions are possible at all is that we humans like to get an answer and stick to it. The fancy word for this is a "paradigm," a cognitive, mental model in your head of how you think things are at every level of reality from the galactic to the subatomic. The switching of views when a new model offers itself is what makes change happen. You see the same but you see it different. And every model

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THE L.S.B. LEAKEY FOUNDATION

The L.S.B. Leakey Foundation was established in 1968 by a group of eminent scientists and informed lay people who recognized a critical need to strengthen financial support for new multi-disciplined research into human origins, our evolving nature and environmental future. it was named in honor of the man who had become known as "the Darwin of pre-history," Dr. Louis S.B. Leakey.

The Foundation sponsors:

International research programs related to the biological and cultural development of humankind.

Long-term primate research projects which may help us to understand how we evolved as a species.

The training and education of students in these fields.

Conferences, publications of scientific papers, and educational programs designed to disseminate knowledge relevant to our changing view of humanity's place in nature.

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THE L.S.B. LEAKEY FOUNDATION NEWS

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PRESIDENT'S MEMO

Your Foundation has many facets. In this issue I call your attention to our role in encouraging science writers. It is part and parcel of our educational thrust reflected in our lectures, symposia, workshops, and the widely acclaimed paleoproject, "Stones and Bones." The latter started in the Los Angeles public high schools, using reproductions of early human skulls, spread through the state of California and now has become national.

Our ties with science writers include a frequent observer at our events, Robert Cooke of the *Boston Globe*. Boyce Rensberger, while a science writer on *The New York Times*, was given a grant to extend his travels in eastern Africa. He is now Senior Editor of *Science '84*. Pam King of the Los Angeles *Herald Examiner* attended our symposium in Santa Fe, and Elaine Warren of the same paper reported on our Pasadena symposium at which Prince Philip spoke. Among Bay Area writers who have been interested in Leakey Foundation events are Carolyn Drews and Richard Saltus of the *San Francisco Examiner*, and Erica Goode of the *Chronicle*.

Bettyann Kevles, with assistance from the Foundation, published a Dutton book for juveniles on the Trimates: Jane Goodall, Dian Fossey and Biruté Galdikas. It is always better to show than to tell, so please see her piece on page 14, most of which was printed in one of her weekly columns in the *Los Angeles Times*. Professor Mark Konishi of Caltech deserves credit for inviting such exciting speakers for this symposium on the human brain. Our Trustee George Jagels and the Gordon Ross Medical Foundation made it all possible with their generous gifts to underwrite the two days.

In adumbrating science writers who have helped the Foundation in its heuristic endeavors, we have a special affection for Harold Hubbard who, at 84, is as spritely as he is shrewd and entertaining in his many columns on Leakey speakers in the Pasadena *Star News*.

These science writers and the Foundation share a reciprocity for which we are all grateful.

Ned Munger

WINTER WEDNESDAYS

Leakey Foundation Trustee Diana Callery has arranged for a splendid series of four lectures, called Winter Wednesdays, to take place during the first few months of 1984 in the Los Angeles area. Attendance at these talks is a special privilege of Annual Fellows of the Foundation, who have greatly appreciated them in the past. On each evening, an outstanding young scientist brings back to his audience the latest news of paleoanthropological studies from around the world. This year's speakers are Drs. Russell Ciochon, James Sackett, Donald Johanson and Richard Wrangham, whose work has taken them to India, China, Zaire, France and Ethiopia.

CALENDAR

SYMPOSIA

Saturday, August 18

SIGNIFICANCE OF EAST AFRICA SAVANNA ECOSYSTEMS TO HOMINOID AND LARGE MAMMAL EVOLUTION IN THE PLEISTOCENE

National Museums of Kenya, Nairobi. Participants scheduled to participate in this symposium honoring Dr. Mary Leakey include Drs. Irven DeVore, F. Clark Howell, Glynn Isaac, Richard Leakey, David Pilbeam, Shirley Strum and David Western.

Saturday, November 10

HUMAN DIET, BEHAVIOR AND ADAPTATION

Palace of Fine Arts, San Francisco, California.

THOUGHTS ON THE LEAKEY FOUNDATION

Nothing touches so deeply people's instincts and emotions as serious thinking about man's origins and man's future. Many cultures are able to avoid the problem of origin by accepting supernatural creation of a universe for the sole benefit of man. The problem of the long-term future has for such cultures a corollary in some sort of everlasting Valhalla or Elysian Fields. For those able to embrace such beliefs, the evidence of the physical world as to man's origins is not to be trusted, and they see no point in trying to use the scientific method to deduce from whence we come, what we are, and where we and the universe are going.

The more I hear about the first seconds of the BIG BANG, about quasars and the black holes that spawn them, the more attractive it seems to search for comfort in the supernatural. Especially today, when man's fate seems very immediately precarious. Not from earthquakes, not from volcanic eruptions, nor from collisions with asteroids, and not even from the long-term dwindling of the energy of the sun, but from basic defects in the nature of mankind which somehow prevent creation of a world of love, cooperation and trust that all of us aver is what we want.

The problem of the short-range future is grim and often seems out of any control. The past is a different matter. It is behind us and provided we are willing to accept what our senses tell us and use the remarkable powers of memory and analysis that we, alone of the living creatures on this planet, seem to possess, much has been and much will be deduced about our origins.

Unfortunately, the record is often pretty thin. Part of a skull and some teeth here, some leg bones there, a scattering of stone tools, cinders from ancient fires, footprints in volcanic ash, paintings in caves. These are the kinds of evidence which are combined now with the results of super high-technology instrumentation in sort of a Sherlock Holmes style to tell us in amazing detail what prehistoric men and women looked like and how they lived. Unquestionably, these prehistoric people did not look very much like us and we have little to go on as to the way they communicated with one another and what they thought about. Nonetheless, following the inspired leadership of Louis Leakey, we are deducing much about some of these latter things by studying the behavior of living primates — chimps, orangutans, and gorillas. These species provide the best models we have for how evolution may have led to what we think of (for better or worse) as human behavior.

This kind of science and its wonderful intellectual challenge has immense appeal for the lay public. As an organic chemist, I can say that I envy anthropologists for the interest and general understanding that a broad social spectrum has in their work. Even though organic chemistry is the very chemistry of life itself, there are no comparable eager lay audiences that wish to find out what we organic chemists think about. Certainly, there are no gung-ho lay people ready to ask searching questions about the validity of our results, or willing to listen to our disagreements over their interpretation.

But then chemistry and indeed most other physical and biological sciences are commonly inferred to contribute so importantly to the nation's industrial, medical and technical interests that they are relatively well supported by our society. This despite the fact that the specific reasons for such support are not always well or easily appreciated by the general public. On the other hand, the advancement of prehistory, however enriching to the soul, does not seem to be perceived by Congress or the Administration as an urgent national goal. One can well argue that this is wrong, that better understanding of history, of prehistory and of evolution, could well lead to better understanding of ourselves, to greater and badly needed efforts to avoid the mistakes of the past, to forging new directions to make the world safe for our children, their children and for all of the possible generations to come.

The L.S.B. Leakey Foundation is dedicated to such ideals. It aims to advance understanding of man's origins through research. But, even more, the Foundation has a mission to involve and inform influential people as to the nature and significance of that research. There is almost no other area of science where such involvement and interest is at once possible, necessary and important. Those of us fortunate enough to have known Louis Leakey found it easy to recognize that, beyond the rather combative facade of a scientist who clearly had to fight for the acceptance of his novel ideas, there was a man with a deep appreciation of the importance of helping to understand ourselves, by learning all we can about our origins in the broadest possible sense.

Translation and amplification of Louis Leakey's ideals and ambitions through the L.S.B. Leakey Foundation has been so successful that quite a few other ventures have been set up for similar, but rather narrower, purposes. It is indeed true that my cousin Allen O'Brien started the Leakey Foundation with the simple and direct idea of supporting the research of Louis and Mary Leakey. It was a great idea, but somehow — I suspect through Louis Leakey's character — a much broader purpose, a broader dedication, emerged. Not just the support of Louis and Mary's work, but support of the full range of the Leakey interests and purposes for the benefit of all who live on this planet.

I have an intense personal interest in the L.S.B. Leakey Foundation. The reason is that my cousin, the late Allen O'Brien, was its founding father, and first president. Allen's aims for the Foundation were simple and direct. He was enormously impressed with Louis Leakey and wanted to relieve Louis of the necessity of spending so much of his time on the lecture circuit to obtain funding for his work. Allen hoped to get more time for Louis and Mary Leakey to carry on their research at Olduvai and elsewhere on man's origins.

It is possible that Allen misjudged Louis — instead of begrudging the lecture circuit, I think Louis actually reveled in it. It enabled him to popularize and proselyte for his chosen research field. It allowed him to demonstrate the opportunities for people like Jane Goodall and Dian Fossey to help fill the gaps in our knowledge of primate behavior. And very especially in the later years of his life, it offered him a forum to deliver, as he did in a most effective way, the increasingly relevant message of how modern man is endangering the very existence of life on our planet.

The Foundation today strongly reflects Louis Leakey's ambitions and ideals. It is heavily oriented towards the support of young people starting in research. Research which reflects on man's origins through studies based on excavations, primate behavior, anatomy, psychology, dating procedures and so on. At the same time, the Foundation is very involved in popularizing the field and even more helping to bridge the gap between scientists and the public. Bridging this gap is obviously important to obtaining the funds necessary to carry out the Foundation's mission. We trust that those of you who find the general aims of the Foundation appealing consider support of its work, if you do not already. —*John D. Roberts*

Dr. Roberts, a trustee of the Foundation and Institute Professor of Chemistry at Caltech, made these remarks when he opened the Members' Workshop on October 31, 1983, at the Caltech Athenaeum. □

THE STATUS OF WILDMAN RESEARCH IN CHINA

ZHOU GUOXING
Beijing Natural History Museum
Beijing, People's Republic of China

Chinese historical documents, and many city and town annals, contain abundant records of Wildman, a supposed large unknown primate to which many names are given, such as "man-bear," "hairy man," "shangui" (mountain monster), "xingxing" (orangutan), and "feifei."

During the Ming Dynasty (1368–1644 A.D.), the great pharmacologist Li Shizhen mentioned several kinds of Wildman in the 51st volume of his monumental work *Compendium of Materia Medica.* One of them was called "feifei," an account of which is quoted as follows:

> "Feifei," which are called "man-bear," are also found in the mountainous areas in west Shu [part of Sichuan Province today] and Chu division, where people skin them and eat their palms. The You mountain of Sha country, Fujian Province, sees the same ones, standing about one zhang [equal to 3.1 meters] in height and are called "shandaren" [men as big as mountains], "wildmen" or "shanxiao."

Even today, in the area of Fang County, Hubei Province, there are still legends about "maoren" (hairy men) or "wildmen." A local chronicle, about 200 years old, says that "the Fang mountain . . . is precipitous and full of holes, where live many maoren, about one zhang high and hair-coated. They often come down to eat human beings and chickens and dogs, and seize those who fight them."

There are fairly widespread folk tales about Wildman among the peoples of China. One of the most well-known says that there was a kind of long-haired Wildman in the depths of a forest. When it saw people, it would smile, grab their two arms tightly, and then faint with laughter. Once recovered, it would kill and eat them. Thereafter, when people entered the mountains, they took a pair of hollow bamboo poles with them. If by chance they met a Wildman, they would put their arms into the poles, and when the Wildman fainted with laughter, they would break away from it by slipping the poles off their arms — and would then either run away or kill it. Stories like this are heard in many parts of China.

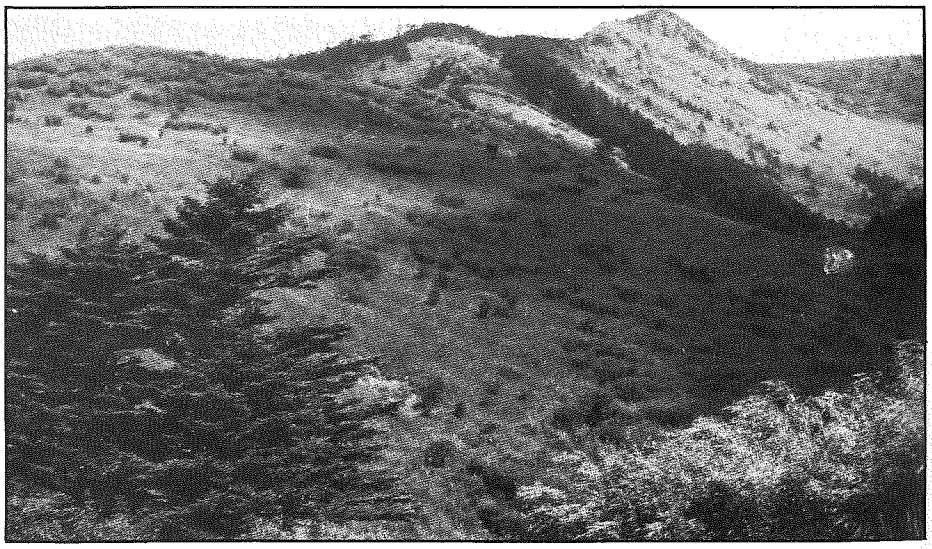
In modern times, many incidents of people encountering Wildman have been reported. Among these, there are two worthy of note because the witnesses were scientific workers and had a good knowledge of natural science. One is Wang Tselin, a biologist, who saw a Wildman killed in the Gansu area in 1940; it was a female with very big breasts, was covered with greyish-brown hair, was about two meters in height, and the configuration of its face looked very much like the famous Peking Man. The other is Fan Jingquan, a geologist. With the help of local guides, he watched, at a safe distance, two such creatures in the mountain forest near Baoji County, Shanxi Province, in the spring of 1950. They were mother and son, the smaller one being 1.6 meters in height. Both looked human.

There have been an increasing number of eyewitness reports of Wildman in recent years, and Chinese scientists are being urged to make on-the-spot investigations. By the end of the 1950s, the "Abominable Snowman" (Yeti) craze had spread throughout the world, and many private investigation teams from various countries went to the southern foot of the Himalayas to search for it. Numerous people, including participants in the current investigation, do not believe in the existence of Snowman. But Professor Wu Dingliang, an anthropologist and director of the Division of Anthropological Teaching and Research at Shanghai Fudan University, and the present author both conclude that the Snowman is probably a large, unknown species of primate.

In 1961, it was reported that road builders had encountered and killed a female Wildman in the primeval thick forest of the Xishuang Banna area. The concerned departments of the Chinese Academy of Sciences conducted an on-the-spot investigation. They failed to obtain any direct evidence. The present author recently visited a newsman who took part in that investigation. He stated that the creature which had been killed was an unknown animal of human shape.

There have been legends about giant-sized "hairy men" existing in the forests of Fang County and the Shennongjia area of Hubei Province since the earliest historical times. Resembling both man and ape, walking upright and leaving huge footprints, these creatures are said to be covered with red hair, and their head hair is long. In recent years, witnesses have reportedly encountered Wildman on a number of occasions, and this has aroused interest in Chinese scientific circles.

A large-scale scientific investigation sponsored by the Chinese Academy of Sciences was carried out in these areas in 1977. More than 100 people participated in it for nearly a year, and the



Lower parts of the forested Shennongjia Mountain Range, where the Wildman has been investigated by Chinese Academy of Sciences expeditions.

The author, Zhou, and AnthroQuest editor, Elizabeth Brady, in Beijing airport, 1980.

author took part as head of both the "deep-thrust" team and the scientific research group. As head of the "deep-thrust" team, I directed the investigation of the whole area around the highest peaks of the greater and lesser Shennongjia Mountain Range, which is covered with thick, ancient forests, and as head of the research group, I was responsible for the summary work based on all the scientific evidence obtained during the investigation. Although the investigation was unusual in its scale, number of participants, and duration, no direct proof was found of the existence of Wildman.

"Manbears" in the Jiolong Mountain Natural Reserve Area were recorded long ago in local chronicles. Preserved hands and feet (two of each) from the area were recently obtained from a middle-school teacher of biology. He got them in 1957, when local peasants reportedly killed a "manbear." These remains represent the first instance of physical evidence obtained during investigations of Wildman in China.

In December, 1980, I went to Sui Chang to study these hand and foot specimens. I concluded, beyond any doubt, that they belong to a higher primate, and have morphological traits of both ape and monkey. After examining the specimens, I determined that they were not the hands and feet of a Wildman. They might possibly belong to an enormous monkey (perhaps a species of macaque not previously recorded in this area).

Since the end of the 1950s, China has organized a series of on-the-spot investigations of Wildman in Tibet and the provinces of Yunnan, Hubei, Shanxi and Zhejiang. Among the participants in these investigations have been a number of professional scientists, such as anthropologists, geologists, zoologists, and botanists, as well as personnel in specific fields of zoological parks and natural history museums. Up to the present time, apart from the above-mentioned hand and foot samples, no direct physical evidence has been found to support the existence of Wildman. That is to say, all we know about Wildman is based on indirect evidence, such as folklore, eyewitness accounts, footprints, hair samples, and feces samples. Legends about Wildman have a long history, however, and there are numerous eyewitnesses. More significantly, the ecological and morphological aspects of Wildman are consistently reported. Thus, it can be inferred that these unknown animals are not mere creatures of fiction. What Chinese scientific workers seek on thickly forested mountains may actually be unknown animals, yet to be scientifically described.

Based on the evidence obtained in recent years, the legendary Wildman of China has the following morphological characteristics:

(1) Its height varies between 1.2 and 2.5 meters. It can, therefore, perhaps be subdivided into two types.

(2) It can walk upright, but four limbs are used when running fast or climbing slopes.

(3) It resembles both man and ape, with faces, in particular, having mixed features of both.

(4) Its head hair consists of interspersed short and long hairs, the former 3-4 cm in length, the latter trailing down the shoulders. The hair, reddish-brown, grey, brownish-yellow, black, or occasionally white in color, covers the whole body.

(5) Its hands, ears, and male external genitalia are similar to those of humans.

(6) The female has a pair of prominent breasts.

(7) There are two types of footprints. One is large, 30-40 cm, remarkably similar to that of man, with the four small toes held together and the largest one pointing slightly outwards. The other is smaller, about 20 cm, and more similar to the footprint of an ape or monkey, with the largest toe evidently pointing outwards.

(8) It has no syllabic language, but yells monotonously.

Their ecological characteristics are as follows:

(1) They are usually observed as isolates. Only on rare occasions are they seen in pairs (one male and one female, or one female and an infant).

(2) They can move about in winter and do not seem to hibernate.

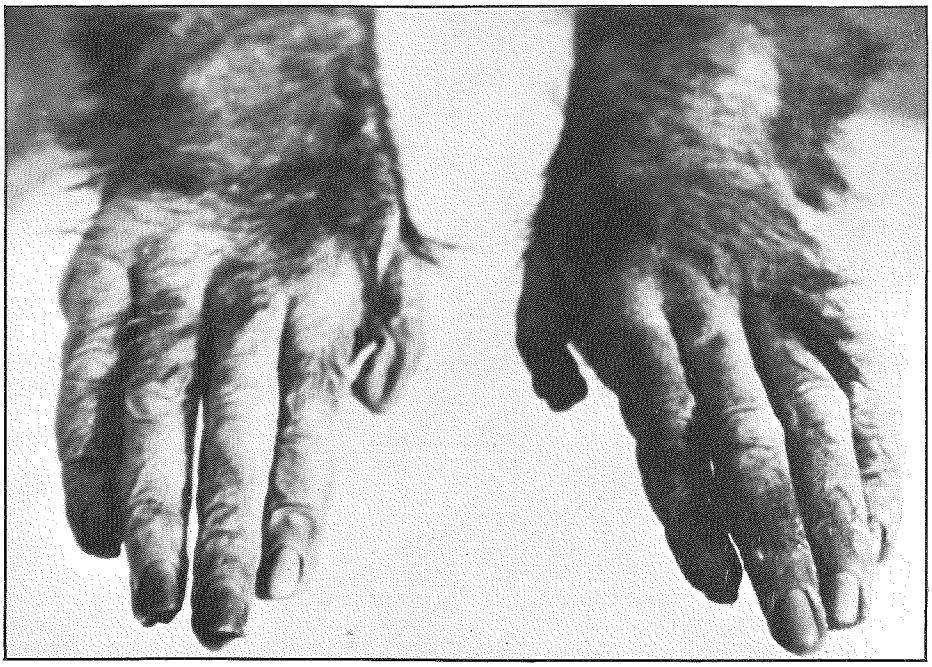
(3) They consume berries, nuts, tender stems, saplings and roots, but eat insects on occasion.

(4) They have not been observed using tools.

(5) They can move about at night, but their eyes do not reflect light, a characteristic that nocturnal animals usually have.

(6) They live mainly in thick primeval forests which are sparsely populated by humans. If they encounter a human, they make no aggressive moves.

Investigative activity and research work on Wildman continue at various levels. It should be emphasized that there are two completely different views on Wildman in Chinese scientific circles. The majority of scientific workers reject the existence of animals in human shape. They argue that the legendary Wildman merely represents some known



The preserved hands from the Jiolong Mountain "manbear" killed in 1957. The author's analysis indicated that they had belonged to a large, unknown monkey species.

animal, such as bear, monkey or gibbon ape, or that reports of Wildman might be due to hallucinations or even deliberate fabrications. A smaller number of scholars are of the opinion that the existence of Wildman should not be rejected and that it might be a living species yet to be identified by science.

Even among the latter there are different views on the classification of the unknown creatures in systematic zoology. Some think they are surviving descendants of *Ramapithecus* or *Australopithecus* (especially *A. robustus*), both remote relatives of modern man. Others assume that Wildman belongs to the ape family and is possibly a living descendant of *Gigantopithecus* or the orangutan which thrived in southern China in the Pleistocene.

It is my view that these human-like animals are not of human type, or at least that the possibility is very small that they are. Judging from the available evidence, there is no indication that they live in groups nor that they have simple syllable language nor that they make or use tools — the prerogatives of the pre-humans. It should also be pointed out that no fossil remains which can definitely be associated with *Australopithecus* have been found in China.

If the legendary Wildman exists, I am of the opinion that it is quite possibly the descendant of *Gigantopithecus*. Up to now, only fossil lower jawbones and teeth of *Gigantopithecus* have been unearthed and it is therefore difficult to infer its height and mode of locomotion. Nevertheless, quite a few scholars estimate its height to be about two meters and some of them even infer that it could walk erect. Many eyewitness reports of the Chinese Wildman indicate these characteristics.

However, *Gigantopithecus* is a topic of contention in the field of paleontology. Some scholars maintain that it belongs to the ape lineage while others believe it should be included in the human lineage. Consequently, there are different opinions as to its morphological features and ecological and behavioral characteristics. If we could capture a Wildman, this would, in turn, help classify the fossil *Gigantopithecus*. If a specimen were obtained, it would not only be an important scientific discovery, but it would also be of great significance to the research on the origin and evolution of all mankind.

This article is a condensed version of one first published in **Cryptozoology**, *1, 1982, and is reprinted by permission.* **Cryptozoology** *is the journal of the International Society of Cryptozoology, an open-membership society which studies reports of unknown animals. Its address is P.O. Box 43070, Tucson, Arizona 85733.* □

L.S.B. LEAKEY FOUNDATION RESEARCH FELLOWSHIP

Field Studies of the Great Apes

Applications are invited from individuals intending to establish or advance studies of the great apes in their natural environments. Preference will be given to studies with significance for understanding human origins, and to those which seek to explore the diversity of ape behavior in different habitats. The fellowship will be worth up to $20,000 and will begin October 1, 1984.

This offer of a new Leakey Foundation Fellowship for great ape field studies was made earlier this year.

Louis S. B. Leakey believed that intensive long-term studies of great apes in their natural surroundings would provide vital clues to understanding how human ancestors behaved, evolved and survived. As a result of his influence and encouragement, Jane Goodall has studied the wild chimpanzee in Tanzania for 23 years, Dian Fossey the mountain gorilla in Rwanda for 16 years, and Biruté Galdikas the orangutan in Indonesia for 12 years. All three continue to conduct field research today.

In light of this tradition of boundary-breaking research, the new fellowship will help to establish yet another and equally exciting long-term research project on a wild population of great apes (for example, the lowland gorilla) in a new, unstudied habitat. Due to the extremely rapid rate of habitat loss, there is real urgency in getting these field studies underway.

This fellowship was proposed to the Foundation by Dr. Richard Wrangham, a member of the Science and Grants Committee and a primatologist presently with The Center for Advanced Study in the Behavioral Sciences in Stanford, California. In his proposal he said:

"We are learning more about the importance of variation between study sites. It is easy to think that the superb long-term studies of Goodall, Fossey and Galdikas have told us all that there is to know about the great apes. In fact, however, surprises emerge whenever apes are studied at different sites, and there are still huge gaps in the most basic descriptive material. This is because it is so difficult to habituate wild apes to the presence of observers. Thus there are no behavioral studies of the 'band-living' chimpanzees of the eastern or western savannas, nor of chimpanzees or gorillas living in the same habitat, nor of any true forest chimpanzee, nor of any lowland gorilla. We don't know if chimpanzee 'warfare' is common or an aberration, whether male gorillas are provisioned by their mates (as they are supposed to be), why forced copulations are common or rare among orangutans. We don't understand the role of predation in encouraging group living, or whether infanticide is widespread, or the significance of meat as food. We know little about the dynamics of social relationships. We know that chimpanzees have rudimentary cultures, but not how they spread, or why. The field of ape research, in sum, is in a primitive phase. There is an exciting era waiting, when population variation is explored and explained, and details of behavior learned at several long-term sites. There will be much of significance here for human origins, not least the idea that prehominids also lived in a variety of types of society.

"There is an urgency to great ape field research, just as there is for many tropical forest species. The National Academy of Sciences Committee on Conversion of Tropical Moist Forests expects all forest to be lost within the range of the orangutan by 1990-2000, of the western chimpanzees by 1990, and of central chimpanzees and gorillas by some time in the 21st century. Establishing a field site, incidentally, often does more than allow the present fauna and flora to be documented. In many cases, such as at Gombe and in the Virungas, it has stimulated protection of the habitat and animals, allowing research to continue for years to come.

"In the field of human origins great ape research has been a comparatively neglected area. No funding organization other than the Leakey Foundation systematically favors work on the great apes. Many, indeed, appear to do the opposite, apparently because of the large logistic problems in setting up ape fieldwork and the long wait (often two years or more) before results look interesting.

"Many funding organizations treat the great apes as scientifically equivalent to other animals. For some purposes such detached anti-anthropo-centrism is fair. But for those of us interested in human origins it is not. The great apes are undoubtedly uniquely important to an understanding of human evolution, and they therefore deserve special study." □

Photo: Kathy Schick

The author with an Olympus bright-field metallurgical microscope, provided by a grant from the L.S.B. Leakey Foundation.

ARCHEOLOGICAL FORENSICS:
MICROWEAR ANALYSIS ON PALEOLITHIC STONE TOOLS

Nicholas Toth

Department of Anthropology
University of California, Berkeley
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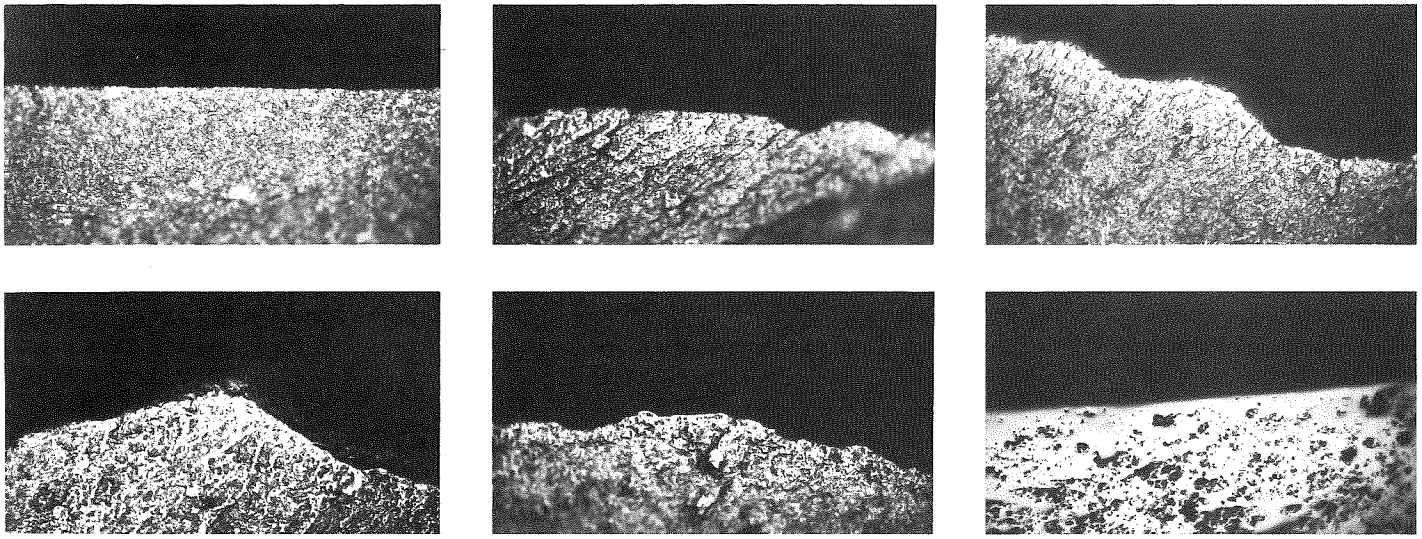


Six photomicrographs (200x), illustrating unpolished and polished flint edges from a range of functions. It should be noted that one important attribute, polish luster, shows up rather poorly in black and white photos. From top left: unused flint edge; polish from butchering horse (hide slitting, meat cutting); polish from scraping fresh, sun-dried hide; polish from sawing through fresh bone; moderately developed polish from scraping wood; polish from cutting grasses (silica gloss).

In order to gain a realistic understanding of the nature of human adaptation throughout the course of hominid evolution it is necessary to determine the functions of stone tools from archeological sites. This has long been a major obstacle for Paleolithic archeologists. Recent methodological breakthroughs have made it possible to identify characteristic wear traces on stone artifacts using similar techniques to those employed by forensic scientists.

Historically, a number of lines of evidence were used in speculating about the functions of stone tools. These included:

1. Ethnographic analogy: comparing prehistoric stone tools to those of similar morphology of recent ethnographic groups (such as Australian aborigines and American Indians) gave clues to their possible uses;

2. Contextual evidence: the context of physical remains from archeological sites could occasionally suggest function — for example, a Paleo-Indian Folsom point being found between the ribs of an extinct species of bison;

3. Feasibility experiments: experiments designed to test the functional capabilities of stone tools for a range of tasks were undertaken in order to determine the likelihood of a given tool form for a given function. For example, we recently butchered an African elephant with Early Stone Age tools to determine which were best suited for this purpose;

4. Macroscopic use-wear evidence: certain features on stone tools visible to the naked eye can sometimes suggest function, such as the "silica gloss" on the edge of Neolithic flint sickles.

In the last several decades a great deal of attention has been paid to the use of the microscope for analyzing stone tools. The major pioneer in this field was the Russian archeologist Sergei Semenov, whose work is best exemplified by the book *Prehistoric Technology*. Prehistoric archeologists used his research as a foundation to build upon, usually following one of three major lines of inquiry using different analytical techniques:

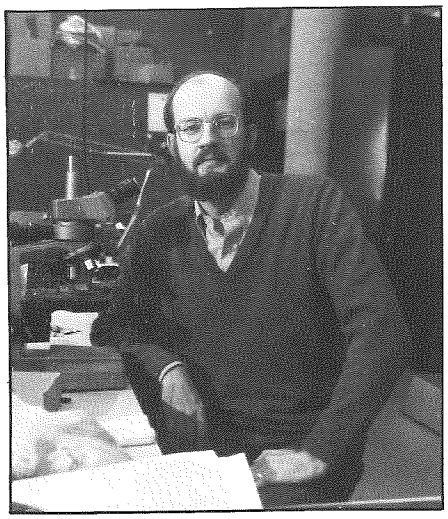
1. Studies of edge damage (microchipping) with a low-powered optical microscope (usually below 100x).

2. Studies of polish (and other phenomena) with a high-powered optical microscope (usually between 100-400x).

3. Studies of the alteration of stone surfaces at very high magnifications with a scanning electron microscope.

The techniques developed by Lawrence Keeley to study polish were a major breakthrough in this field of research. He presented a methodology whose results could be replicated by other researchers and demonstrated through blind tests as having a high degree of reliability. Keeley developed this methodology as a graduate student at Oxford University (and is presently at the University of Illinois, Chicago). After an intensive experimental program he was able to discriminate between polishes on experimental tools used on meat, bone, hide, antler, wood, and soft plant material. He then analyzed polishes and other wear traces on Early Stone Age artifacts from British Acheulian and Clactonian sites.

The type of microscope used in this



Dr. Lawrence Keeley in his Chicago laboratory.

approach is an optical, metallurgical microscope with a bright field illuminator. With this system a beam of light is directed down the viewing tube of the microscope, striking the specimen at 90 degrees. Magnifications used range from 50 to 400x, 200x being the most common magnification for identification and photography.

At the present state of knowledge, materials suitable for this microwear analysis are flaked stone artifacts of fine-grained silicious rocks (flint, chert, chalcedony, etc.), although other fine-grained rocks, such as indurated shales, ignimbrites, and fine quartzites may also retain characteristic polishes. Artifacts must be in "mint-fresh" condition (not physically or chemically altered) and have to be carefully cleaned with a weak solution of hydrochloric acid to remove any traces of mineral deposits (from archeological specimens) and potassium hydroxide to remove any organic residues (from experimental specimens).

The criteria used in determining the functions of prehistoric stone tools include:

1. Brightness of polish: the amount of light reflected back at the observer (in a black and white photomicrograph, a very bright area looks completely white).

2. Luster of polish: the reflective qualities of a stone surface, qualified in terms of "fluid," "greasy," "matte," etc.

3. Smoothness of polish: the micro-topography of a stone surface, described in terms of "smooth", "rough," etc.

4. Location of polish: the way a polish spreads over a tool surface. For example, is it sporadic or continuous along an edge? Is it restricted to the very edge or invasive?

5. Striations: micro-scratches on the stone surface which can be indicative of the *direction* of use. For example, striations parallel to a tool edge suggest a cutting or sawing motion, while those perpendicular to an edge can suggest a scraping, planing, or chopping motion.

6. Pits: some types of polishes exhibit characteristic pitting, such as hide and bone polishes.

7. Edge damage: the location, type, and amount of micro-chipping of tool edges can suggest the direction of use as well as the relative hardness of the material worked.

It should be noted that the first two (and most important) criteria for polish identification are brightness and luster, which are both *optical* phenomena, which explains why an optical light microscope is at present superior to the scanning electron microscope (which uses a beam of electrons to show topography).

Using these criteria, with enough experience, one can accurately infer functions on artifacts with developed polishes. When stone artifact assemblages are considered as a whole, it is possible to examine the relationships of artifact form to function, as well as document the probable range of activities that occurred at an archeological site.

The L.S.B. Leakey Foundation has been instrumental (no pun intended)in providing researchers with the necessary equipment to carry out such investigations. Keeley's present microscope at the University of Illinois, as well as mine at Berkeley (both Olympus BHM models), were purchased thanks to grants from the Leakey Foundation. (At Berkeley, the University of California was impressed enough to provide matching funds for additional equipment to Dr. Desmond Clark and myself once the Leakey Foundation grant was awarded.)

Keeley and I recently published an article on microwear polishes from sites 1.5 million years old from Koobi Fora, Kenya, documenting animal butchery, wood working, and cutting of soft plant material by our early hominid ancestors. More recently I have been working with F. Clark Howell and analyzing stone artifacts from the upper levels of the Acheulian site of Ambrona, Spain. Among other findings, it appears that "handaxes" (as argued by Keeley for British Acheulian sites) were used for animal butchery as meat knives. I am also examining artifacts from a Clovis (Paleo-Indian) site in Montana.

At Berkeley we have incorporated microwear analysis into the Paleolithic archeology curriculum. Students study our comparative collections of experimental microwear polishes, and then go on to construct an experimental program of their own on a chosen topic of microwear analysis, which includes an ethnographic survey of modern stone tool-using people. Photography of experimental pieces is made possible with the attachment of a 35 mm camera.

Students' projects have included such topics as animal and fish butchery, cutting of grasses, wood working (fresh and charred), hide working, bone working, feather working (for arrow fletching) and shell working, and the effects of "heat treatment" of flint on polish formation.

A number of students have then gone on to analyze prehistoric archeological assemblages, including examples from California, India, and Kenya. One of our graduate students, Carole Sussman, is carrying out her dissertation work on vein quartz (a very common raw material in Africa and elsewhere), and hoping to replicate Keeley's results in flint.

The future of microwear research appears to be very promising. First of all, our sample of carefully analyzed prehistoric assemblages will lead to a better understanding of prehistoric lifeways. More experimental research will help sharpen our analytical techniques, making functional interpretations more accurate. We hope that it will be possible in the future to combine microwear analysis with the study of organic residues on prehistoric stone artifacts (an approach still in its infancy). For example, promising results have recently been claimed for identifying hemoglobin blood traces on recent prehistoric stone tools and determining what species of animal the blood belonged to. Dr. Vince Sarich of Berkeley and I are also presently planning a long-range study of detecting protein residues on stone artifacts.

Microwear analysis of stone tools has proven to be one of the biggest breakthroughs in the field of Paleolithic studies. Answers to the century-old question "what were they used for?" are now forthcoming thanks to archeological detective work in the laboratory, and we can hope for more of such promising techniques in the future. □

Dr. Nicholas Toth giving an expert demonstration of tool-making from obsidian, at the Members' Workshop, Oct. 31, 1983, in the Caltech Athenaeum.

EARLY HOMINID LIFESTYLE: THE SCAVENGING HYPOTHESIS

Pat Shipman
Johns Hopkins University School of Medicine
Baltimore, Maryland

Fascinating as it is to ponder the bones and stone tools of our ancestors, people have always sought to know more than what these fragments of past lives look like. What can these scrappy bits of bone and stone tell us about how early hominids lived? How close can we come to understanding the biology and behavior of these extinct creatures?

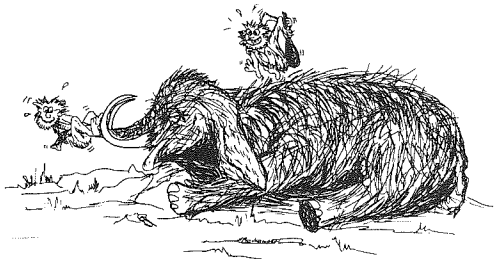
Until recently, the hard evidence of early hominid lifestyles was limited. Until the mid-20th century, the prevailing image was that early hominids were stupid savages struggling through a vicious existence. No scientist ever portrayed this view of "Man the Killer Ape" more vividly than Raymond Dart, who wrote:

> ". . .man's predecessors differed from living apes in being confirmed killers: carnivorous creatures, that seized living quarries by violence, battered them to death, tore apart their broken bodies, dismembering them limb from limb, slaking their ravenous thirst with the hot blood of victims and greedily devouring livid writhing flesh."

His evidence? The broken, smashed bones of animals (and other hominids) found in association with hominid remains. Little did Dart – or anyone else at the time – know that fossils are almost invariably broken and smashed, because of the many different events that occur between the death of an animal and the fossilization of its bones.

Later, the "noble savage" image of man the hunter – living in simple harmony with his fellow humans and animals alike – became popular. Like the Killer Ape, the Noble Hunter is an oversimplification based on incomplete or poorly understood evidence. The Noble Hunter idea arose at a time when anthropologists had turned to two rich sources of information: studies of living primates and modern hunter-gatherers like the San Bushmen of the Kalahari. Early hominids were seen as lying along a behavioral continuum between, say, chimps or baboons and technologically simple hunter-gatherers.

A remarkably consistent image of early hominid behavior resulted that can be summarized as follows: early hominids were savanna-dwellers; they began walking upright some three to four million years ago; they began making stone tools, largely for hunting and obtaining meat, by at least two million years ago; at that time, they changed from eating mostly plant foods to incorporating increasing amounts of meat in their diet; they shared meat with members of their family or social group, the men doing most of the hunting and the women gathering vegetable foods; they lived in temporary or semi-permanent base camps, to which various types of food



TRANSPORT

were carried and at which food-sharing and different social functions occurred. What aspects of this lifestyle will show up in the fossil record?

As a first step, stone tools might co-occur with bones of prey animals. Unfortunately, stone tools are much more indestructible than bones, so that bones deposited long after the hominids have left may be accidentally associated with stone tools. The critical question is: how can bones processed by hominids be distinguished from those damaged by hyenas, weathering, transport in rivers, or a dozen other causes? In 1980, Rick Potts, Henry Bunn and I stumbled upon an important key to this problem: we found what looked like cutmarks on fossils from Olduvai Gorge and Koobi Fora.

But how could we tell if these were cutmarks? Working with Rick Potts, I found that experimentally-made cutmarks are always different in microscopic appearance from carnivore tooth scratches and other types of damage. When detailed replicas of the marks on the fossils were inspected under the scanning electron microscope, some were clearly cutmarks and others were carnivore tooth marks. For the first time, we could prove that at least these particular bones had been damaged by hominids.

The next step was to generate three testable predictions, based on the hunter-gatherer model of early hominid lifestyle. These were:

1) Meat-eating would be indicated by the presence of cutmarks on the meat-bearing bones (upper forelimb and hindlimb bones) of prey animals; very few cutmarks would be present on non-meat-bearing bones, like those of the feet.

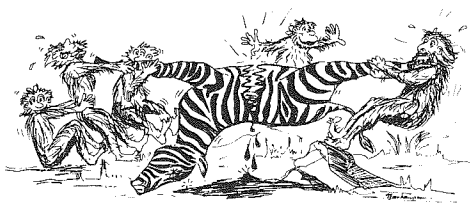
2) Carrying food and sharing it with other members of the social group would be indicated by the disarticulation and systematic butchery of prey.

3) Evidence of both meat and vegetable foods would be present at the base camps.

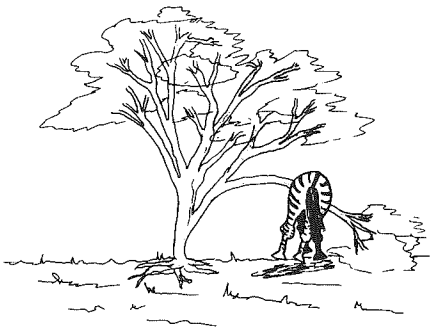
To test the first prediction, I surveyed more than 2,500 antelope limb bones from Bed I at Olduvai for cutmarks. The result was surprising. More than half of the cutmarks occurred on non-meat-bearing bones! Trying to explain this result, I compared the cutmark locations to the carnivore toothmark locations on the same bones and to cutmarks at a Stone Age site called Prolonged Drift. Prolonged Drift was inhabited by human hunter-gatherers who left over 20,000 bones from the animals they butchered. The cutmarks and toothmarks on the Olduvai bones occurred in similar locations. However, the distribution of cutmarks at Prolonged Drift differed dramatically – over 75% of the marks were on non-meat-bearing bones. Many of these marks must have resulted from skinning and tendon removal as well as butchery. This evidence suggests that early hominids were removing meat from carcasses, but not in the systematic, regular way that human hunter-gatherers at Prolonged Drift did.

The test of the second prediction produced equally startling results. One of the clearest types of evidence of carrying and sharing food would be patterns of marks related to disarticula-

tion. Why do hominids disarticulate animals? There are four main reasons. First, animals may be too heavy to carry without cutting them up into convenient hunks. Second, it is nearly impossible to share food if it isn't cut up into pieces. Third, it is difficult to store food, even in a simple manner, if it isn't cut up. Finally, animals may be too big



SHARING



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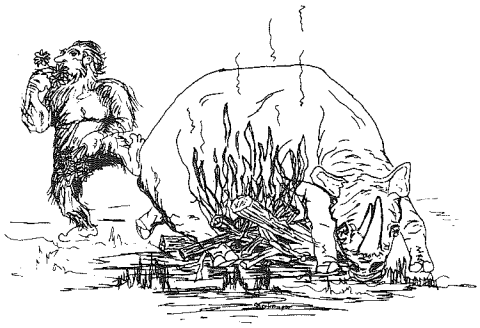


COOKING

to cook (probably not a concern of early hominids, who didn't have fire) without cutting them up.

The cutmark data from Olduvai were also used to test the second prediction. The results showed that disarticulation rarely, if ever, occurred in the early record. Roughly half of the cutmarks at Olduvai occur near joints — about the same proportion as carnivore toothmarks. This pattern is very different from the systematic disarticulation of antelopes at Prolonged Drift, which left about 90% of the cutmarks near the joints.

The last prediction was neatly confirmed by Nick Toth and Lawrence Keeley. They showed that some of the tools from Koobi Fora were used for cutting meat and others were used for processing plant foods, by studying the microscopic wear on the tools. Thus, both plant and animal substances were used in some way by early hominids. To find out what was actually *eaten* required study of the microscopic wear on hominid teeth. (Different diets leave different patterns of microwear on teeth.) Alan Walker found that the microwear of early hominid teeth most closely resembles that of living chimps — which eat mostly fruit, and only a small proportion of meat. Despite the tendency to think of early hominids as killer apes or noble hunters, most of their diet apparently wasn't meat.

If early hominids aren't eating lots of meat — and aren't disarticulating, transporting and sharing it when they get it — why are they processing carcasses? What sort of lifestyle fits the evidence? I am now exploring the idea that our early ancestors lived as part-time fruit-eaters and part-time scavengers, somewhat like striped hyenas today.

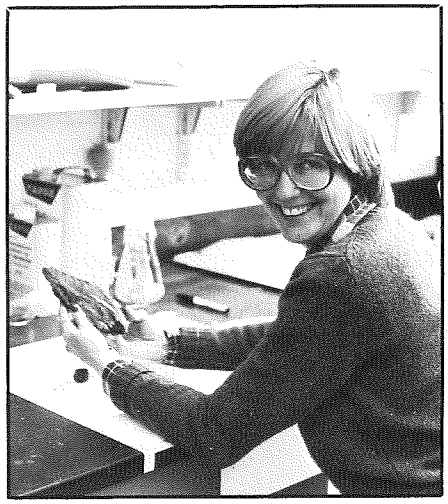
Scavengers are often small in body size, as were early hominids, because it is a difficult way to make a living. As a consequence, they are usually subordinate to the primary predators from which they steal food. Successful scavengers face other constraints, too. They must have reliable, alternative food sources, because scavenging is a risky and uncertain business. They can't expect to get the most nutritious portion of the carcass, so they have to take what they can get. Finally, they can't retain possession of the carcass for long before a dominant predator drives them off.

What we know about early hominids fits this pattern quite well. Fruit is a safe, reliably-obtained staple to pair with scavenged meat. The fact that cutmarks occur on all parts of prey skeletons, regardless of the location of meat, suggests an opportunistic use of carcasses ("take what you can get"). Finally, the cutmark evidence shows that early hominids didn't process carcasses systematically, as if they didn't have time to disarticulate and butcher them.

Of course, the scavenging hypothesis has to be tested and studied further before it can be widely accepted. It is not a flattering image of our earliest ancestors — how much easier it is to view ourselves either as noble hunters or even killer apes! Even if the hypothesis proves to be false, it will have reminded us of one important fact: the past is full of undiscovered surprises. Ultimately, our ancestors were neither ourselves nor apes, but something different and unexpected.

Dr. Shipman wrote this article for Interim Evidence, *the publication of the Foundation for Research into the Origins of Man (FROM), which regrettably is suspending publication.*

Cartoons by George Bierkamper, after the style of Larry Gonick. □



Pat Shipman, of Johns Hopkins University School of Medicine, examines a bifacially-flaked bone from Olduvai Gorge.

PRIMATE CONGRESS

The Tenth Congress of the International Primatological Society will be hosted by the Institute of Primate Research, National Museums of Kenya, July 22–27, 1984, in Nairobi. The theme of the Congress is "Primates at their Source: Past, Present and Future." The scientific program, which will include symposia and paper and poster sessions, has been structured to transcend traditional categories in order to promote exchange among scientists of diverse disciplines. Additional information is available from: IPS Congress Office, P.O. Box 34505, Nairobi, Kenya. □

SERVICE OFFERED

Young physician, internist and Fellow of the Leakey Foundation. Keen to join archeological expedition for expenses only. Strong back — good digger — can make coffee — contribute medical skills. Inquiries to editor.

FIELD REPORTS

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

SCAVENGING IN THE SERENGETI

Robert J. Blumenschine
University of California, Berkeley

August, 1983

We arrived in Seronera, Tanzania, a month and a day after I left California. It's great to finally be here after a lifetime of desire and months of planning. Logistically, things have gone about as smoothly as I could have hoped for except for one important exception – petrol. Tanzania is in the midst of a big shortage, such that there are rationing and gas lines in Arusha and few if any stations pumping petrol between there and Seronera. We are based in a fully-furnished three bedroom house built by the Ford Foundation in the late '60s. It's equipped for electrical appliances (yet there is no diesel to run the generator), and a refrigerator and stove (but no gas). All in all, though, it provides fantastic, unbelievable accommodations considering we're in the middle of the Serengeti.

So far we've been out twice looking for carcasses, both times with Moula Bruno, who is Acting Director of the Serengeti Wildlife Research Institute and very helpful and knowledgeable. We saw thousands of migratory zebra, huge herds of buffalo, a wide variety and abundance of other animals, but none of which were dead. For our efforts, though, I got a very good introduction to the Serengeti woodlands, a very good idea of how I should proceed hereon, and one ostrich egg, which yielded 1314.5 grams of food, or about eight jumbo omelets. Clearly, however, this is not the time of year or place for a diurnal scavenger.

My plans are to stay around Seronera for about two more weeks and reproduce the maps I'll be using. The chances of finding a carcass are slim but I hope to find at least one relatively intact one so that I can practice techniques of weighing flesh and marrow and determining marrow fat content. For the latter, the SRI has a beautiful drying oven, but alas, no power for it. In fact, the SRI is extremely well-equipped, but this is largely an illusion as many things are out of service. So I have to get used to using a charcoal oven.

All in all, things are just fine. I can't wait to find, observe and process the first carcass. This evening I will climb atop the *kopje* near our house to search some more.

September, 1983

I have been in the Serengeti for a month now and I couldn't be more pleased with the progress of the research. After the first 10 days, data started pouring in in the form of 17 carcasses. I've never been so consistently busy, and despite the grizzly nature of the work which offends all senses save the intellectual, I'm having a good and rewarding time. Below is a brief summary of progress on various fronts and some incidental and preliminary results:

Carcass density distributions: this aspect of the research is least developed as there are simply not very many animals dying now. Even the vultures seem to be having a hard time. Most deaths and scavenging opportunity result from nocturnal predation, so that in early a.m. one sees satiated lions and hyenas but few if any carcasses. The Seronera area is not a promising one now for a diurnal scavenger. Most of the animals are up north in the woodlands. Many have not gone too far because of heavy and frequent rains, so that we were able to monitor the action about 20 km north of here, safely away from poacher-infested areas further north. At Banagi, with 7000 wildebeest and many other animals currently, we found three wildebeest carcasses in one day. At least two were lion kills of the previous night.

Longitudinal observations of carcasses: I've observed competitive interactions, rates, sequences and completeness of consumption of several carcasses. The action is usually fast and furious. I'll never forget the total frenzied feeding of some 100 plus vultures on an impala caught in a poacher's snare. That animal was completely consumed within an hour by vultures alone. If hyenas don't get involved, one can always get marrow and brains from medium to large size lion kills. Lions seem to leave a very predictable pattern of remains. I have data on marrow quantity and quality from wildebeest, impala, Grant's and Thompson's, baking marrow samples in a cinder block and flagstone coal-fired oven I built. It's amazingly efficient, though I get quite a workout supplying it with hard firewood.

This past Sunday, a Britisher working near here and I shot 10 animals including two Grant's and an impala and a wildebeest. We butchered them all the same day (very gory but we had a lot of help from the meat-starved SRI staff), obtaining flesh yields from individual bones, organ weights, etc. I've spent the last two and a half days preserving the marrow from five of the animals. We both disliked the idea of shooting animals for "cheap data," but we plan to do it again as we got very good and complete data out of it. Among other things, Binford's "General Utility Index" is going to be put to a good test.

October, 1983

Since I last wrote, things morbid have really picked up here; I'm finding an average of two carcasses a day or fresh remains thereof, such that the total is now 53. After finishing processing the flesh, marrow and bone of the 10 animals we shot, it was clearly time to go out and experience the scavenging scene, now that I had a good idea of what various parts of animals are worth. (Besides, my senses demanded a respite from the gory task of butchery and marrow extraction.) Fortunately, the environment and animals obliged me well, so that patterns are now starting to emerge on the ins and outs of scavenging opportunity and on the manner in which modification to and presence or absence of bone relates to this.

An obvious pattern is emerging with regard to the location and cause of death and the scavenging opportunity that results. I've concentrated effort in the Seronera area and most of the carcasses found so far were on short grass plains or open woodland away from the vicinity of riverine habitats. Most were hyena kills which are almost always either completely consumed or transported for final consumption, presumably at a den. These, needless to say, would provide no scavenging opportunity for anything but an army of well-equiped hominids. Only once have hyenas left some limb bones unbroken and not completely defleshed and this by a group which had obviously fed well before seeking dessert. So the best opportunity presented in areas away from rivers is afforded by natural deaths (I have two of these) where vultures target the carcass and from which at least the marrow can be scavenged, and by cheetah kills (I have one of these) where marrow bones and some flesh remain. But the bones remain unscavenged for a very short time – certainly not more than a day and a night, as hyenas are quick to find them.

Scavenging in riverine woodlands is much more profitable though possibly more dangerous. I have found 12 carcasses in this setting, all lion kills. (I have seen no lion kills away from riverine woodland.) Lions only very rarely crack a long bone so that all limb bone marrow remains and often substantial tidbits of flesh. Moreover, remains from

Lion and kill in the Serengeti.

lion kills persist longer than they would away from rivers, as hyenas apparently don't frequent rivers very regularly. Hence, it's not uncommon for marrow bones to remain at a lion kill for two days and even more. The only problem with lion kills is that they are difficult to locate and dangerous, at least for a scientist, to deal with, because the vegetation is thick and lions, non-arboreally inclined, usually remain near the kill after feeding. But scavenging from lion kills in riverine habitats is clearly the best way to get fat and some protein in one's diet. I should emphasize the fat, because most calories from scavenging would derive from marrow. The brain is also a usual leftover. It's rare to find much flesh on a lion kill, and I've found only one full-fleshed bone at an abandoned one and that was a wildebeest radius-ulna, yielding 800 grams of flesh.

I am excited to report that I saw two baboons feeding on a Thompson's gazelle fawn yesterday. As I approached, one baboon fled with its prize, quadrupedaly, forepedaly, and, for about ten meters, bipedaly, into a tree to eat in relative peace. Then the baboon, feeling too pressed by me, dropped the carcass and bolted for refuge before I could observe very much. Although my memory of the episode will always be scarred by my disruptive action, it will nevertheless always provoke very vivid images of some of the ways our very ancient ancestors might have behaved.

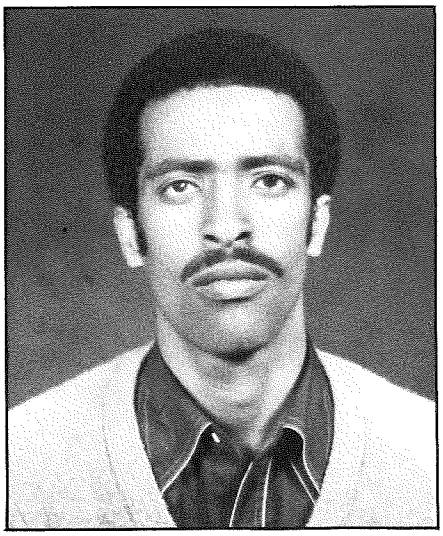
MY EXPERIENCES AND PROGRESS IN BERKELEY

Alemseged Abbay
Franklin Mosher Baldwin Fellow

In the middle of August, 1983, I flew from Addis Ababa, Ethiopia, to Berkeley with the plane ticket that was sent to me by the L.S.B. Leakey Foundation. With the money the Foundation gave me I started to live in the International House, where students and scholars from all corners of the world reside. Life in this atmosphere is very educational. I have learned a lot from the conversations with both Americans and foreigners who have different social backgrounds as well as varieties of psychological make-up.

Not very long after my arrival at Berkeley, school began. I registered for four courses and got started. The knowledge one gets from every course is immense. No sooner had I started attending classes then I approved of the high reputation of U.C. Berkeley. There are adequate facilities in terms of laboratories and libraries. It gives me maximum pleasure to have the opportunity to study here. I am also most delighted to share the immense knowledge and experiences of my renowned professors who are leading scholars in their respective fields in the whole world. I benefit a lot from the advice and guidance I get from my professors, particularly Professor Desmond Clark, without whose attention I would have found it difficult to be on the right track. Indeed, I have found him very helpful. Now I have a clearer idea about the course of my studies. Following my exposure to prehistory in general in the first semester, I have found the earlier part of African prehistory much more fascinating. Consequently, I am hoping to go back to my country and undertake the necessary research on the Early Stone Age as soon as I am ready.

When I came here I was shocked at the tuition fees, prices of books and living expenses in Berkeley. Had it not been for the fellowship I have from the Leakey Foundation, I could never have met these expenses. Therefore, my heartfelt thanks go to the Foundation. □



Alemseged Abbay.

Photo: Jodi Cobb, National Geographic Society, 1983.

Alan Walker, professor at Johns Hopkins University School of Medicine, holds a cast of a jaw from an apelike creature about 17 million years old. The jaw, found in Kenya in an expedition headed by Walker, may be that of the common ancestor of humans and all the great apes. The original fossil jaw is in the National Museums of Kenya, whose director, Richard Leakey, participated in the scientific expedition.

COMMON ANCESTOR?

The remains of an apelike creature about 17 million years old were discovered in Kenya late last summer. Some scientists believe that it may be the common ancestor of humans and all the great apes.

The discovery team, headed by Richard Leakey, director of the National Museums of Kenya, and Alan Walker, a professor at the Johns Hopkins University School of Medicine, found several bones of this creature, including an upper jaw, in a weathered-out river channel in an arid, desolate region known as Buluk in northern Kenya.

The specimen is markedly similar to *Sivapithecus*, one of a group of apelike creatures known as ramapithecines, according to Dr. Walker. The animal was probably about the size of a male chimpanzee or a female orangutan, weighing about 120 to 150 pounds. It had a very short face, like that of an orangutan. Preliminary potassium-argon dating puts the age of the new find at between 16 and 18 million years.

This discovery may add further complexity to the question of the evolution of apes and humans.

The expedition was funded in part by the National Geographic Society. □

LABYRINTHS

Misia Landau
Department of Archeology
Boston University

Impossible encounters with historical figures happen regularly in fiction. Freud treats Sherlock Holmes in "The Seven Percent Solution." Tom Paine shares a carriage with Casanova in the recent Italian film "La Nuit de Varennes." One hundred years separate Charles Darwin from the contemporary Latin American writer Jorge Luis Borges. What could possibly link these two, a 19th century naturalist and a 20th century avant garde surrealist, to occupy a nonfictional essay?

On the face of it, very little. Borges writes short, almost mathematically tight stories and essays; Darwin wrote lengthy treatises. Borges is often supernatural; Darwin is much closer to reality.

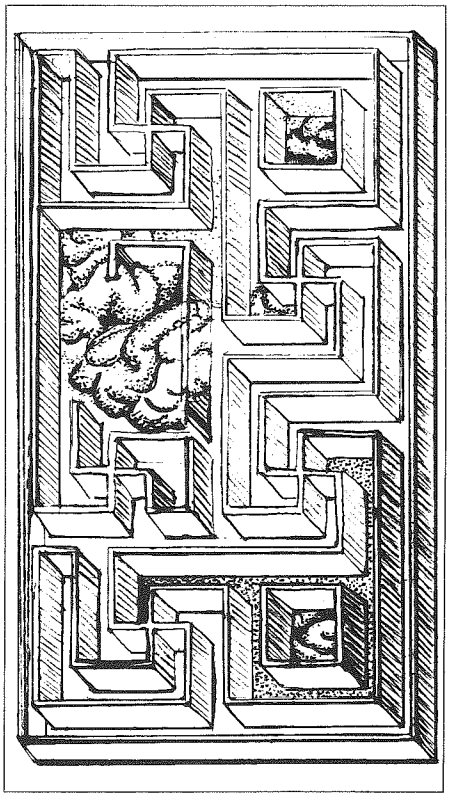
Yet it seems to me they have quite a lot in common. Whether reading the *Descent of Man* or *Labyrinths*, a collection of Borges' stories and essays, I am amazed by their richness of detail and sources. Kafka collides with Kant in a Borges story. Famous scientists and obscure amateurs together gain immortality in the *Descent of Man*. When it comes to seeing connections, Darwin and Borges are as gifted as Freud and Holmes.

Interestingly, Borges' stories often appear to be mysteries, complete with murders, detectives and surprise twists. Unlike most mysteries, however, these must be read again and again. To begin a Borges' story you must finish it: only then do you discover what the real mystery has been. So finishing, you have begun.

In this sense, a Borges story is itself a surprise twist. It subverts our expectations about what mysteries are. Murders do not have single solutions, they have many. Clues point conclusively to several suspects, not one. All of this becomes intelligible when you recognize a simple fact about Borges: that behind the apparently familiar elements, the suspects and clues, lies an unfamiliar world governed by a whole new set of principles.

But what has all this to do with Darwin? Like Borges, Darwin took the familiar, if ambiguous, clues of reality and out of them shaped a new world order. Though it was an order based on natural principles, it must have appeared fantastic to some of Darwin's early readers. Certainly, to be descended from an ape was an idea as absurd, initially, as it was frightening.

Yet Darwin was not the first to write about human evolution. In 1863, almost a decade before the *Descent*, Thomas Henry Huxley addressed the problem in his classic *Man's Place in Nature*. As though anticipating his reader's shock, Huxley begins with the imagery of surrealism. "Ancient traditions often fade into dreams," he writes "but it is singular how often the dream turns out to have been a half-waking one." Huxley's mission is to convince us of the reality of our ape ancestry for, according to Huxley, believing in evolution would further the cause of truth and, thus,



humanity's evolutionary progress. Reading Huxley on human evolution is not unlike reading Paine on democracy.

Ernst Haeckel, the great German zoologist, was also a great believer in the revolutionary power of Darwin's theory. For Haeckel, "it was the magic key which would unlock the riddle of the world." But it would not turn people's minds easily, because more than all other theories "it most strongly contradicts the traditional and mythological prejudices which have been held sacred for thousands of years." Nevertheless, like Huxley, Haeckel's mission is to show the reader his place in the new Darwinian universe; to transform him by means of the Darwinian key into a new, more intelligent form of human.

But it was Darwin who did most to accomplish this. Only Darwin had mastered the principle of natural selection well enough to apply it to humans. Coming to the *Descent* after reading its predecessors, I was truly amazed by Darwin's control over his subject, and by his creativity. I still am. *The Descent of Man* reveals something new with each rereading. Like Borges, Darwin seems to tell more than one story. Indeed, he has been cited as the original source for contradictory theories of human origins.

"Any great and lasting book must be ambiguous," Borges says, "for only then will it approach life." Typically, it is through irony that Borges makes us aware of the paradoxical nature of reality. By constructing totally rational worlds, Borges makes us aware of the irrationality of existence. For example, in one of his stories, a secret society of scientists invents a new world, Tlon. This world which they have created is a completely orderly place. The international press discovers Tlon and soon it obliterates our own world. A new past takes the place of the old. A group of scientists has transformed the universe. "How could one do other than to submit to Tlon," Borges asks,

> "to the minute and vast evidence of an orderly planet? It is useless to answer that reality is also orderly. Perhaps it is, but in accordance with inhuman laws which we never quite grasp. Tlon is surely a labyrinth devised by men, a labyrinth destined to be deciphered by men."

Over a century ago, Darwin devised such a labyrinth. That we are still wandering through his maze attests to the brilliance of Darwin's conception.

This article was written for Interim Evidence, *the publication of the Foundation for Research into the Origins of Man (FROM), which regrettably is suspending publication.* □

GORDON

Robert J. Gordon of the Department of Anthropology at the University of Vermont wishes us to make it abundantly clear that he has withdrawn from the Himba oral tradition project reported upon in *AnthroQuest* No.27. He states that he has never accompanied the TUCSIN group to the Kaokoveld. □

THE BRAIN:
SOMETHING TO THINK ABOUT

Bettyann Kevles

Different versions of the map flashed on the lecture hall screen throughout the weekend. Brightly colored or black and white, the interior still sketchy, the terrain was the human brain.

It's hard to think objectively about the brain. Mention laterality (handedness) and I look to the fingers clutching my ball point pen, remember the left-handed child at home and puzzle over his strange ability to instantaneously count and alphabetize the letters in a word. He has allergies, as lefties often do, according to Norman Geschwind of Harvard, who adds that statistics indicate that these lefties also have a good chance of avoiding cancer.

Geschwind was one of nine physicians in a symposium, "The Human Brain and Its Human Disorders," sponsored jointly by the L.S.B. Leakey Foundation and the biology division at Caltech. Each has extensive experience of patients suffering brain abnormalities from tumors (less threatening now because of the success of brain scans) to epilepsy, schizophrenia, manic depression, Parkinson's and Alzheimer's diseases.

A successful symposium is an interesting part of the scientific process. At Caltech researchers from as far as Norway presented reports of their work in progress. Some illustrated new technology: Nils Lassen explained his process of imaging blood flow and metabolism that has enabled him to film the motor area of the cortex as it thinks a thought to direct an action; Frank Duffy from Boston showed a computerized portrait of the electroencephalogram of a newborn's brain. The symposium provided a place to present and get feedback from those doing related research.

Brain research is a "hot" subject. The last three decades have seen an enormous advance in the technology that allows us to peer inside the brain. This includes PET scans (enabling viewers to trace positron emissions), more sophisticated EEGs (electoencephalography), and NMR (a method of mapping the position of individual elements). No single method reveals a complete picture, but a composite can pinpoint areas of disturbance.

These tools are being honed now just as, for the first time in history, brain diseases are becoming one of the Western world's major health problems. This is largely because people are living longer and diseases such as stroke and Alzheimer's, which causes acute dementia (progressive intellectual deterioration), account for about half the residents of skilled nursing facilities in the United States.

Alzheimer's is not a new disease. It is a condition that has been differentiated from what used to be considered an inevitable part of aging, severe mental decline. In fact, Robert Katzman from the Albert Einstein School of Medicine in New York pointed out that in normal aging most individuals retain their ability to understand abstract ideas and slow down slightly only when doing certain rote tasks like arithmetic. At least 20% of the population that survives past the age of 90 maintain normal brain function.

Alzheimer's victims suffer deterioration of certain brain cells, and at death their brains are on average smaller, the cortex thinner, than that of normal people. Recent research has shown an aberration in the cells of Alzheimer's victims similar to that in the brains of individuals with Down's syndrome, a genetic disorder. Both Alzheimer's and Down's victims have a reduced level of a substance called somatostatin, a peptide, from that found in normal brains.

The exploration of the nature and causes of Alzheimer's disease is typical of the way researchers are probing the nature of brain dysfunction. A major area of research is chemistry, reflecting the recent discovery of the chemical nature of the synapses that transmit messages from nerve cell to nerve cell. Another avenue explores the possible influence of external factors such as the ingestion of aluminum, excess amounts of which have been found in the brains of some Alzheimer's victims. Scientists are also investigating the possibility of a viral agent, or a genetic component to the disease.

The last path is promising. Up to 10% of Alzheimer's victims have had relatives with the disease. Yet in identical twins, there is only a 50% chance of simultaneous infection, which means that something in the healthy twin has postponed its onset.

What about its occurrence worldwide? Katzman reports that Alzheimer's appears with the same regularity in Japan as in the United States, but recent reports from Israel indicate that it is far more frequent in Jews from Europe than in those from North Africa and the Middle East.

What does this mean? And what about other odd facts that participants mentioned during the symposium: the discovery of aluminum deposits in some Alzheimer victims' brains, but in none of the brains of victims from Kentucky. Or what about the excessive numbers of schizophrenics born in the winter months in the northern hemisphere, and in the summer on the other side of the globe? Could it have something to do with the pineal gland that responds chemically to length of daylight?

No skeptics at the symposium rejected out of hand any of the conjectures, the mention of apparently unexplained, unrelated phenomena. The human brain is a great puzzle, and one of these random observations or unexplained statistics may some day supply the missing piece that fills in the map. □

BOOKS

PRIMATE BRAIN EVOLUTION, edited by Este Armstrong and Dean Falk. Plenum, New York, 1982. 346 pp. $39.50.

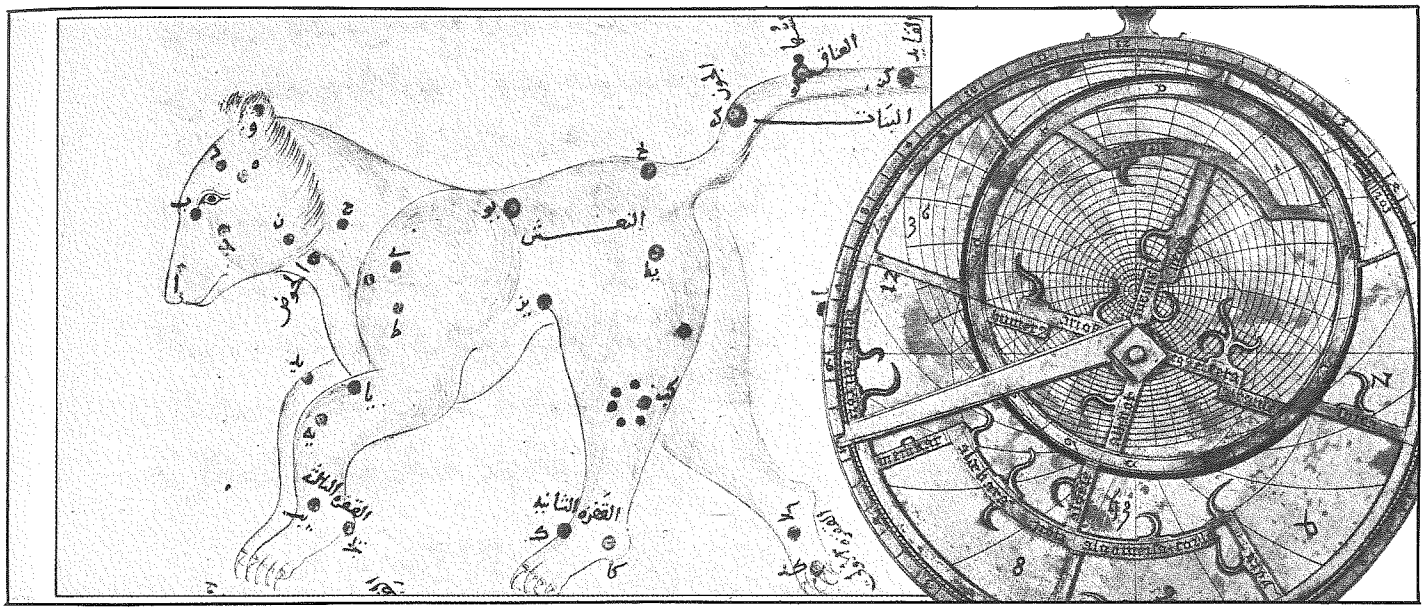
Summarizes and assesses major themes in ongoing research into primate brain evolution. The scope is wide-ranging and includes a synthesis of information from specialized fields coupled with evolutionary interpretation. The contributors include C.B.G. Campbell and P.D. MacLean.

THE GROWTH OF BIOLOGICAL THOUGHT by Ernst Mayr. Harvard, 1984. 974 pp. $30.

A course in evolution, taught historically, by the Alexander Agassiz Professor of Zoology, Emeritus, at Harvard. One reviewer says, "For a reader who is willing to make the effort, this book provides one of the best and most nearly complete discussions of these ideas to be found anywhere. It is an example of those rare books in popular science which can teach scientists as well as laymen."

HUMAN DIVERSITY by Richard Lewontin. Scientific American Books, New York, 1984. 179 pp. $27.95.

Geneticist Richard Lewontin of Harvard University here examines the infinite and psychic variation in humans. He demonstrates that each of us differs from all others because of the interaction of genetic and environmental differences coupled with chance events occurring during our development. More than 200 photos and drawings illustrate the individuals and species differences. □



The constellation of the Great Bear, shown in one of the earliest Islamic manuals of astronomy (A.D. 1009), based on Ptolemy's Mathematike Syntaxis. Next to it, a brass astrolabe, the instrument developed by the Arab astronomers. Each astrolabe was designed to be used at a particular latitude. By rotating the metal network mounted on the back plate so that the points of the tiny spurs came to rest on the positions of the stars as the observer saw them in the sky, dates and times could be read off the star tables.

continued from page 1

throughout history is internally valid; it has to be by definition. Everybody at every time has to have a valid version of reality. All that can be logically and accurately said about someone who thinks he's a poached egg is that he's in the minority. The Egyptians had a myth that the universe hatched. As far as I know, nothing came of it.

One of the things the Egyptians were looking for up there in the sky did move things along a bit. They needed to know one thing — when the Nile was going to flood, so they could keep out of the way and trap the waters for later irrigation. They found out how to do that from the sky, by watching the dog star, Sirius. Then they had a calendar. The priests had the magic knowledge of Sirius and made sure that nobody got their hands on the facts, so things stayed just as they were for 3,000 years. But thanks to Sirius, Egypt was a functioning, urban civilization that set the model for all that followed.

What the Egyptians and the Babylonians left the Greeks in terms of sky lore wasn't much use. But for the sailing Greek entrepreneur, the sky was the best road map ever. He found that certain stars at certain times were in certain places, depending on where he was looking from. Working backward he could see, from the angle and altitude of the star, where he was seeing from. Soon he had star tables that told him where the big stars were all the time so he was never lost.

After a bit, with all this gazing upward, the more man saw how different it is up there from the way it is down here. Everything in the sky goes in circles, never straight lines. Up there, it's the same show every night for as long as anybody can remember. Is the sky perfect, unchanging, immortal and the rest of us a temporary ball of mud? So man put the gods in heaven for a start, to run things. And the simplest fool could see, by looking up, that things run circularly, east to west, and that, also, we are at the center.

However, one can also see five objects, bright and moving and closer than the fixed stars that don't seem to move at all except for the regular wheeling around. These five movers go on wobbly but basically circular trips around the sky. They wander, so that's the name they got: wanderers, or in Greek, *planetes*.

The very eternal regularity of this immense, blazing spectacle up there is bound to get through to even the dumbest human. It's crying out for somebody to recognize that this kind of repetition night after night must have some kind of point. After a few hundred years the dummy who got the point was a fellow called Aristotle. He worked out a system that, modestly, explained everything. In the sky, he said, are seven concentric spheres, circling, and carrying five planets plus the sun and moon, with an eighth sphere carrying the stars. With a system like Aristotle's, everything down here, as well as everything up there, has its place. Life gets very hierarchical, reaching from the perfection of the Prime Mover right down to the simplest blob. The Great Chain of Being.

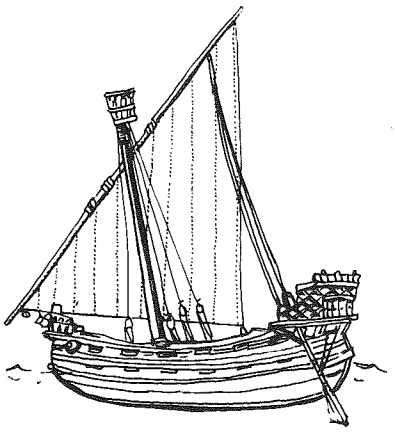
For the moment let's leave Aristotle there. He gets two thousand years unchallenged and he's the backbone of Western culture. And, as part of having worked out his cosmology, he produced a kind of kit for investigating nature systematically, called logic. He was also the high point of what ancient Greeks called curiosity, born of looking up. Their word for curiosity was "philosophia."

Meanwhile, a few wrinkles. In the first century B.C. in the city of Alexandria at the mouth of the Nile (a sad, delapidated place today), we meet Claudius Ptolemy, astronomer and general whiz, at the great university. He brings the star tables up to date and designs a thing for reading the sky called an astrolabe. A kind of heavenly computer, it has a circular base plate with a metal network of all the main stars swiveling on top. Move it around so that the metal stars are in the same position that they are in the sky at that time and read the figures around the edge of the base plate which give the time, the date and so on. The astrolabe made stargazing extremely accurate.

At about this time, apparently, the old Egyptian sail, the triangular one we mistakenly call the lateen (it wasn't Latin at all), moved off the Nile and out into the Mediterranean. And there was a great combination — a sail that you could use to go even against the wind and an astrolabe to navigate by. With those two things the Arabs ended by running the known world and, incidentally, probably burning all the books in Alexandria, where the astrolabe had come from. These books contained

pretty much the sum of all knowledge at the time.

Earlier, in the seventh century, when the Arabs settled down in Bagdad, they had at least two reasons for being interested in what went on above their



heads. They had to know where Mecca was if their prayers in that direction were to be effective. Navigation again. The other reason was that they were keen on astrology. Fate was written in the sky.

This interest took a vital turn for Western culture with the second Caliph in Bagdad, Al Mansur, who was prone to stomach trouble. His doctors couldn't cure him but the local Christian monks at the monastery of Jundishapur could because of their use of astrology. At the monastery Al Mansur found scads of moldy Greek manuscripts, long since lost to the West, which he promptly had translated because so much of them dealt with how to use the heavens to cure oneself.

By the eleventh century, the first Western medical school was operating in Salerno under half astrology, half common sense. It was working like a kind of medieval M*A*S*H for the Crusaders coming back from the Holy Land. Modern medicine was on the way.

One other bit of good luck; some of the manuscripts Al Mansur and subsequent Caliphs had translated from the monastery at Jundishapur included Aristotle's logic.

One of the early Arabs, fired by the Greek stuff he was reading, was Ibn al Hazan who lived in Cairo in the eleventh century. His problem was the way the stars, the moon and the sun got bigger the nearer they got to the horizon. He studied the idea of light rays coming in from the stars, or any other object, in an ordered way, in a kind of visual pyramid with the apex in the retina. That would account for the curious way distant trees were smaller than closeup thumbs, for instance.

By the thirteenth century Al Hazan's theory was being taught all over Europe. In Padua, a certain Paolo Toscanelli became excited. Toscanelli, son of a spice trader from Florence, a mathematician and astronomer, told a friend of his called Fillippo Brunelleschi, an architect also living in Florence, all about the new heavenly optics. Brunelleschi promptly turned the idea, in crude terms, into what we call "perspective."

A few years later the Florentine humanist Alberti wrote about it in scholarly terminology and gave the world the *eurythmia* (the sense of balance and harmony) that the Florentines were crazy about, having read about it in the recently discovered classical manuscripts. One of the most impressive results is the facade of the church of Santa Maria Novella just around the corner from the railway station in Florence. Every section of it relates to every other in a ratio of either two or three to one. Thanks to heavenly optics, Renaissance architecture was all balance and perspective. And let's not forget the other side of the coin, too — all the planning that became possible with the blueprint approach, the ideal cities that were drawn, like Sforzinda, and the starforts that would dominate the world militarily for two hundred years.

Al Hazan's optics changed the way painting looked, too. Think of Giotto's attempts at three dimensionality before perspective, and then of Masaccio's after it, and you see the hand of the Arab astronomer at work in the way, with Masaccio, perspective creates the illusion of looking out through a window at the real world. When you can do that you start to paint figures in their real relative sizes and not, for example, for their theological significance.

Giotto. Madonna and Child Enthroned. Uffizi Gallery, Florence. 1310.

The implications can be seen in the increasing secularity of culture and in its tremendous, arrogant self-confidence. With an accurate handle like perspective geometry to use on distant objects, which you could now measure without having to handle them, man was indeed "the measure of all" — the catchphrase of the Renaissance. You could now pin-point with accuracy an unknown spot on Earth, which is what Toscannelli did. He sent a copy to a certain Italian ship's captain who was looking for a quick way to Japan. The initial idea of the gridding system incidentally came from Claudius Ptolemy, brought back to Florence from an early fifteenth century tour to Greece, when a bunch of Florentine tourists found Ptolemy's *Geographica*. Using the perspective gridding system, Toscanelli had worked out that it was quicker for this sea captain to go west rather than east. Of course the captain never made it to Japan. He bumped into America on the way.

The study of angles, with instruments like astrolabes, became suddenly acute sometime after 1327. That's the date of a manuscript in Christchurch, Oxford, showing a couple of military men looking at a thing like a bulbous pot with a narrow neck, out of which sticks an arrow-shaped object. The significant thing about it is that it's smoking. What they called "Chinese snow" had arrived. Our name for it is "gunpowder." and the princes of Europe took to it and the cannon with all the abandon of an alcoholic in a brewery. All they had to do was find ways of firing the thing accurately enough. This they were able to do thanks to more skywatchers. Obscure Italian math teachers like Niccolo Tartaglia got on with the practical business of firing guns over and over again to find out maximum range and elevation figures. But astronomer-mathematicians like Giovanni Benedetti, a man unsung in history's hall of fame, made the problem a more general one.

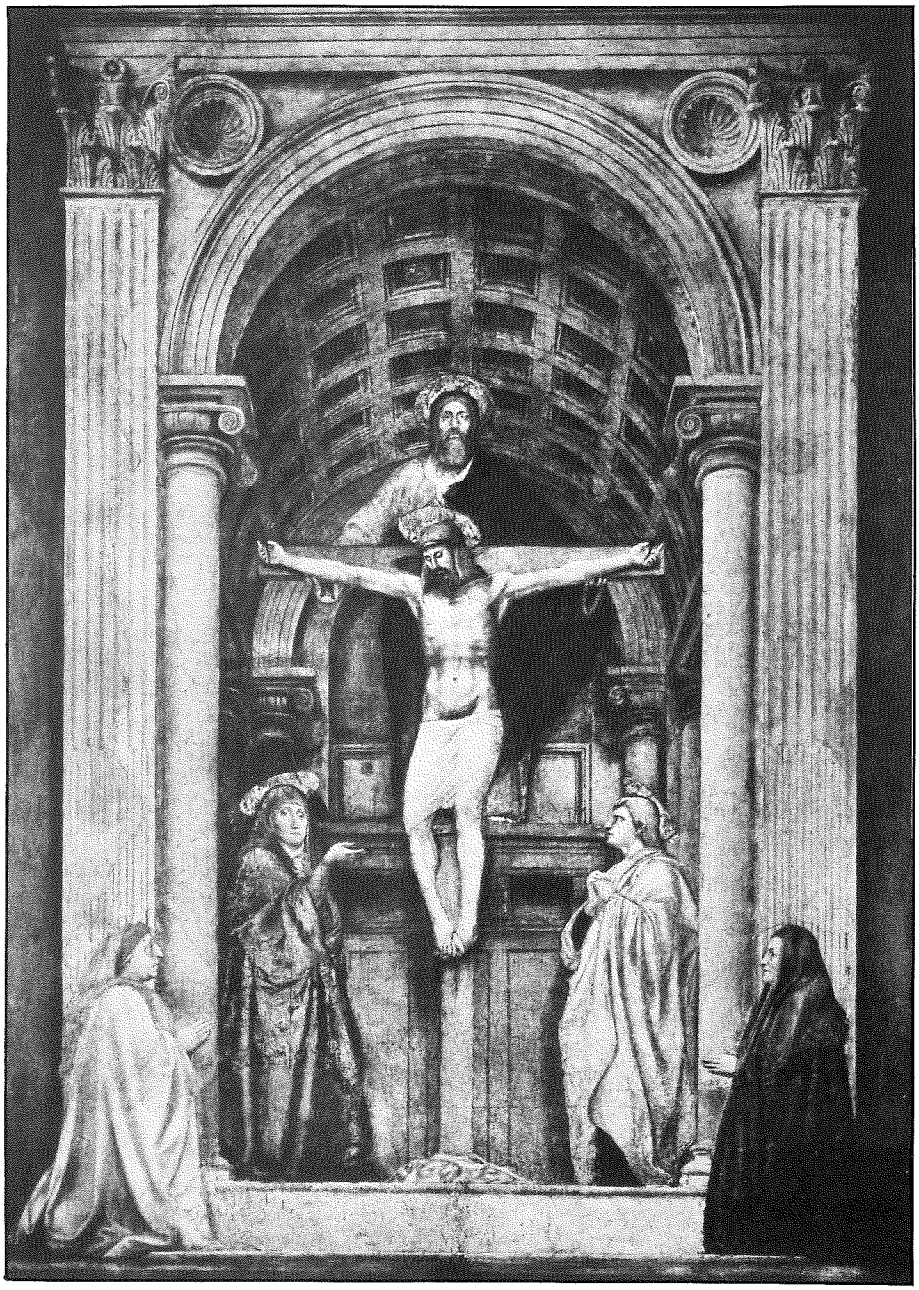
Benedetti spent most of his life in the small Piedmont town of Mondovi amid good food and better wine. He was fascinated by how the planets stayed in the heavens, as indeed were a lot of people. He was able to think about physics and other matters in a new manner, thanks to the word that a Pole had come up with an entirely different theory of the polar system. His name was Copernicus and he had worked out that the only way to explain the wandering planets that sometimes appear to go backward is to put the sun in the

center and let the Earth go around it just like the other planets. For Benedetti and others, if the Earth was in orbit, then everything was up for grabs. And in 1572 something happened to make them all swallow hard. A nova blazed in the night sky, a sky that was supposed to be perfect and unchanging. An then in 1577 another one, this time a great comet.

Things were about to get even worse. In Holland a spectacle maker called Hans Lippershay was turned down when he offered a telescope to his Prince Commander for use on the battlefield. Galileo heard of it. He looked through it and saw satellites circling Jupiter — the Earth wasn't the center of everything and there were more bits out there than there were supposed to be.

Galileo arrived at the extraordinary idea that nature might work according to a set of rules. He worked out the law of acceleration and why the tides occur. What he left us was the Scientific Revolution, the beginning of a new way of looking at all phenomena. "Observe, work out a theory, experiment to see if the theory holds good every time. Deduce from that some general statement." The basic rules of modern science.

At about the same time, that business of Benedetti's about what was holding the planets up was bothering another, an English dilettante and physician called William Gilbert, a member of the upper classes and doctor to Queen Elizabeth. He was fascinated by something else that had been worrying the navigators — the compass. When you floated one in a bowl of water it didn't head toward the North Star as you would expect. Gilbert built some little earths of lodestone and moved his compass needle all around them, marking what the needle did all the time. He decided that the earth was a giant magnet spinning in space and that was why we did not fly off into the void. If that was so, then perhaps some kind of magnetism from the sun kept all the planets in solar orbit.



Masaccio. The Holy Trinity with St. John, St. Mary, and Two Donors. Santa Maria Novella, Florence. 1425. Note how the artist has adjusted the perspective to a beholder whose eyes are on a level with the bottom edge of the fresco, about five feet above the floor of the church.

The next event concerns the only famous astronomer I know of who was too shortsighted actually to observe. Fortunately he had all the paperwork Tycho Brahe left behind. His name was John Kepler, and in 1605 he pushed the uncertainty about perfect circles in the sky to its limits. The circles up there — the planetary orbits — were really elipses. What's more, with his three laws — that the circles were elipses, that the planets sped up near the sun and slowed down far from it, and that their speed related to the distance they were from the sun — Kepler made it essential for the first time to work out some way of handling the mathematics of things moving in curves through space at velocities that were changing, and changing at rates that themselves changed.

Kepler cracked the problem during his honeymoon in 1613, a year that was a bumper harvest for the winemakers of his home town of Graz, in Austria, when he realized that there was a way of gauging how much wine there was in a barrel. The "infinitesimal calculus" he used (that's the modern term for it) enabled you to measure infinitely small parts of a curve, which of course you need to do with planetary orbit dynamics.

The French freethinker and permanent exile, René Descartes, put all the heavenly things together one winter, he said, when he shut himself in a well-heated small room (or inside an iron stove, depending on how you translate the word *poele*). His efforts were bent toward coming up with a universe that would agree with Copernicus but would still keep the church happy. His became a solar system of great whirpools of matter, each carrying a planet at its center, so although each orbited the sun, each was unmoving at the center of its vortex.

However, while at this monumental task, Descartes found that the old way of thinking things out wasn't up to the new mathematics. So he wrote his great *Discourse on Method*. It was basically a lesson in how to think and it changed the style of thinking for good. Before Descartes, we all said, *Credo ut intelligam* (I believe, and through belief I come to understand). After Descartes,

we said, *Intelligo ut credam* (give me the facts and I'll let you know).

The third major contribution of Descartes was what he did to heavenly curves. The story is that he saw a fly buzzing around one day and realized that its position in space could always be shown as the intersecting point of two straight lines at right angles to each other – one vertical, one horizontal. All you had to do to plot the fly's path was give coordinates on both of the lines. We call that a graph, and by making the dynamics of motion available to algebra, Descartes opened up the business of planetary dynamics to even more exact analysis. And a great deal more besides; analytical geometry essentially made Newton's and Leibnitz's lives easier.

There's almost no need to talk about Newton. With the *Principia* and the law of gravity, he paralyzed scientific investigation of the sky for perhaps a hundred years. What he did provide, though, was a view of the universe that radically altered the cultural life of the West. If the sky operated to exact laws like the ones he showed, it ran like clockwork. And if it ran like clockwork, where was the need for God to intervene in human life? Religion, in spite of the fact that Newton himself was a believer, took a knock from which it never fully recovered. And there were other effects. Newton's was essentially the view that gave us our modern optimism, the basic belief in progress in the long run. If the universe operates according to rational laws, then the rational mind of humankind is capable of understanding it all.

The stimulus that this gave to the belief in the value of education was extreme. Throughout the Enlightenment – the name we give the period that followed Newton – philosophy was as much interested in education as it was in anything else.

At about the same time as Newton, the German polymath and crafty businessman Gottfried Leibnitz was turning the kind of math that deals in infinitesimally different states of motion into a kind of philosophical metalanguage that he hoped would provide ways of understanding the infinitesimal difference in the basic unity of all things – a kind of astronomical calculus applied to everything in existence.

One of the more unexpected ways in which this calculus affected life was through another German, von Schelling, professor of mathematics at Wurtzburg at the end of the eighteenth century. He felt that it meant that you had to go looking for the irreducible minima in life because it would be there that you would find the common, simplest measurable units of all existence.

A French surgeon, Xavier Bichat, took up the Schelling-Leibnitz idea and looked for the smallest thing in the body. At the time, that turned out to be tissue, of which Bichat identified twenty different types. He saw that things happened to this tissue when you got sick that showed up in your unfortunate corpse. Disease could be correlated with *post mortem* findings. That was how pathological medicine and the localized view of disease began that would one day make it possible to hunt for and find bacteria.

The orbital-dynamics-calculus-inspired *naturphilosophe* idea of "oneness in all" also interested other people, like Christian Oersted, a Dane who went looking for unity between magnetism and electricity. He found that a current running down a wire made a nearby compass needle twitch. The direct result was the converse – spinning magnets induced current in the wire. Faraday, following up on Oersted, made electric motors and dynamos possible.

Not long after the beginning of the last century, Frauenhofer, a German optician making telescope lenses, noticed that when the light from the sun was refracted through glass the spectrum rainbow was interrupted by dark lines. However, he didn't know what his amazing discovery meant (a common feature throughout history). But in 1855 another German called Kirchoff burnt salt in a flame and looked at the sun through the flame and realized that the sodium atoms in the flame were absorbing some of the light coming from the sun, and that was why the lines were appearing.

That could only have been caused if the sunlight contained sodium frequencies; there had to be sodium in the sun. Spectroscopy was born and with it astrophysics. For the first time man was able to identify the actual materials from which the celestial bodies were made because of clues contained in the light they gave off. Everything from forensic medicine to pollution watchers benefits from that today.

In the third quarter of the nineteenth century, people like Huggins in England used the new photographic plates to superimpose views of the sky and show that it was a seething mass of movement in all directions. Newton's absolute universe was no more. Now you really couldn't say which way was up.

In Vienna, Ernst Mach (who came up with the speed of sound defined as Mach 1) led a group of physicists and philosophers who worried about the lack of stability and center to everything. The Positivists, as they called themselves, attracted a great deal of interest. Their message was that if there was no absolute, the best you could do was to look for constant ways in which things related to each other; you could never be sure that things were what you thought they were or were in any way absolute.

I suppose it was with the Positivists that the present day view began – that scientists do what they do for its own sake and not for the chance that they will find any ultimate reality. Unfortunately, the very relativistic nature of that attitude abstracts the scientist from the old-fashioned goal of telling the rest of us the final truths. No one expects that any more, but one wonders if perhaps it renders scientific work that shade less humanistic.

Perhaps a little less man-centered, gods-of-the-planet, changers-of-nature stuff wouldn't do us any harm. Astronomy, the oldest science, has finally brought us to realize that we are not the center of the universe and that there can be no final certainty in anything, because we alter reality in the very act of observing it. If it does nothing, however, but make us more careful, that will be fine. Astronomy has, above all the things it has done, revealed us as just a speck in the cosmos. All the more reason, then, to take better care of the speck.

James Burke, an educator, writer, chief reporter for the Apollo missions to the moon, spoke on this subject at greater length last spring at a Leakey lecture at Caltech. Mr. Burke, producer of the television series, Connections, *for the BBC, is the creator of a new series,* The Real Thing, *an exploration of the human brain, presented by PBS this spring.* □

NEW FELLOWS

The L.S.B. Leakey Foundation is pleased to welcome as new Fellows: Gloria S. Browning, Palo Alto, California, Dr. and Mrs. Harry N. Barnet, La Jolla, California, Caroline M. Getty, Irvine, California, Maryon Davies Lewis, San Francisco, California, and Katy Jo Sebastian, Ross, California.

OPPORTUNITIES

OPERATION CROSSROADS AFRICA

Operation Crossroads Africa is once again recruiting students and other interested volunteers for its summer, 1984, archeological projects in Africa.

Over the past several years the organization has sponsored a variety of archeology and museum projects in both East and West Africa. Teams of volunteers have participated in projects involving the excavation and preservation of artifacts and historical monuments in Mali, the Ivory Coast and Sudan.

The Crossroads experience allows students of anthropology, archeology and the arts to work on projects organized by members of the national museums of the host countries. Crossroaders have the opportunity to participate in field work, gathering surface materials from historical sites. Items are photographed, inventoried and catalogued for use by the museums.

Teams are made up of photographers, archeologists, anthropologists, topographers and oral historians from the host country and America. Students photograph and survey archeological sites such as Timbuktu, gather oral histories and map out areas to be studied.

Participants in the anthropology and archeology projects must have previously studied in one of these fields. Further information may be obtained from: Operation Crossroads Africa, 150 Fifth Ave., New York, N.Y. 10011, telephone (212) 242-8550.

BONE MODIFICATION CONFERENCE

The Center for the Study of Early Man, University of Maine at Orono, and the Nevada State Museum are sponsoring the First International Conference and Workshop on Human vs. Natural Bone Modification. Invited specialists will present papers at Carson City, Nevada, August 17 to 19, 1984. Other professionals and the public are welcome. Registration materials can be obtained by writing Donald R. Tuohy, Nevada State Museum, Capitol City Complex, Carson City, Nevada 89701.

The Center for the Study of Early Man, which is a sub-unit of the Institute for Quaternary Studies at the University of Maine, is also introducing a new publication series called CURRENT RESEARCH. The Center's goals are to encourage research about Pleistocene peoples of the Americas and their environments and to make this new knowledge available to both the scientific community and the interested public.

As part of the peopling of the Americas publication program, the CURRENT RESEARCH series will be introduced in May, 1984. It will appear annually with state-of-the-art note length summaries prepared by specialists and is planned to serve as a clearinghouse of multidisciplinary information relevant to the peopling of the western hemisphere.

Subsequently, the submission date for manuscripts will be January 31.

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THE NINTH PAN-AFRICAN CONGRESS ON PREHISTORY AND RELATED STUDIES
Jos, Nigeria, Dec. 11–17, 1983

The Pan-African Congresses have been a quite invaluable means of bringing together all those actively working and interested in the past human societies of the African continent. Ever since the First Congress, held in Nairobi in 1947 on the initiative of the late Louis Leakey, these have met approximately every four years and have done much to encourage mutual trust and understanding, sound, objective scholarship, free exchange of information, discoveries and hypotheses.

The Ninth Congress met in the relatively cool climate of Jos last December, by the arrangement and organization of Dr. Ekpo Eyo, the Director General of Antiquities for Nigeria. As might be expected, the largest number of participants came from Nigeria but delegates attended also from Niger, Kenya, Ivory Coast, Botswana, Tanzania, Mozambique and Togo as well as from Belgium, Britain, Canada and the United States.

One of the successes of the congress was that it was unnecessary to hold concurrent sessions and everyone was able to hear every paper during the sessions on the opening and following four days. As might be expected for a conference held in West Africa where remains of earlier prehistoric periods are still inadequately known but where there is a particularly rich Iron Age record, most of the papers were concerned with research into the later (Later Stone Age and Iron Age) periods. Not a few of these described discoveries of mines, smelting sites, the nature of the smelters themselves and the analysis of slags. Only two papers were concerned with paleo-environment, both in relation to Nigeria.

In the session on the growth and nature of urban societies in West Africa, Roderick and Susan McIntosh summarized their results at Jenne-jeno and other regional mound sites in the inland Niger delta and showed that the complex exchange network on which these centers were based existed between the 2nd century B.C. and the 14th century A.D. and owed nothing to the advent of Islam into North Africa. Investigations at other towns in the inland delta region, e.g., Gao, and in the Senegal valley are likely to produce complementary evidence to show how and why early West African urban centers developed.

The manner in which trading networks for salt developed in West Africa was described by John Alexander and might serve as a more general pattern for the course of urban growth in that part of the continent. Limited local distribution centers in the north and on the Guinea coast supplying the savanna and forest zones before 1000 A.D. were superseded after that date until 1800 A.D. by the advent of the camel, which made available the rich rock salt deposits of the Sahara in northern Mali, Niger and southern Algeria. Not until the beginning of the 19th century was the trade superseded in importance by cheaply produced salt from Europe introduced by the trading centers on the Guinea coast.

In connection with food production, a most interesting and novel study was reported by V. E. Chikwendu and C.E.A. Okezie from the University of Nsukka. Since 1977 they have been experimenting with the cultivation of five wild yam species which were planted in open ground and in forest. Some were cultivated on flat ground and were weeded; others were planted on mounds or in holes. Visual observations over the past six years show significant changes in the vines. If substantiated by further experiment, this is a significant discovery in the light of the current belief that the genetic changes that resulted in the domestic yam would have taken many hundreds of years to come about.

Reports on early hominid sites were presented by Francis van Noten for Kapthurin in northern Kenya, for Hadar in the Afar Rift by J.W.K. Harris who also combined with J.D. Clark to present papers on the archeology of the Middle Awash, Ethiopia, and early traces of hominid use of fire, by B. Vandermeersch on the 33,000 year old Upper Paleolithic chert-mining site in upper Egypt, by David Lubell on continuities in the Maghreb Epi-Paleolithic, and by J.C. Onyango-Abuje on Neolithic populations in East Africa.

The Ninth Congress enabled those attending to form a much clearer view of the progress of archeology in West Africa. It showed that there is no lack of enthusiasm and interest, in particular among young archeologists. Undoubtedly great discoveries lie ahead — the origins of the West African crop plants, the nature of the settlement of the earliest Neolithic food producers and of the Early Iron Age Nok culture, the incentives that lie behind the early growth of towns and kingdoms in the Sahel and the forest, and the social and economic implications of the unique terracottas and bronzes of Nigeria — to mention but a few. The answers can come only from archeology and only as a result of systematic, planned fieldwork, analysis and subsequent publication in collaboration with colleagues in related disciplines.

–J. Desmond Clark
Dept. of Anthropology
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