ANTHROQUEST
news of human origins, behavior and survival
™

Number 41 | The Leakey Foundation News | Spring 1990

THE YORA OF PERU

Kim Hill
Department of Anthropology,
University of Michigan

Hillard Kaplan
Department of Anthropology,
University of New Mexico

Abstract. *The Panoan speaking Yora of Manu National Park, Peru made first peaceful contact in 1984. A quantitative ecological study of subsistence patterns in the Yora village during the dry season of 1986 shows that: 1) The Yora subsisted entirely from wild resources during the study period; 2) Wild plantains and fish accounted for the vast majority of the diet; 3) Yora men provided almost all the food eaten by the group; 4) Yora expended very little time in subsistence activities; 5) Riverine resources were clearly depleted near the current village site; and 6) Yora sharing patterns favor close kin in the village settlement, but are more generalized when on overnight foraging trips. Data also suggest that the recent and current Yora commitment to agriculture is minimal but varies from year to year. The Yora were in poor health during the field period due to newly introduced diseases, and the devastating effects of contact related mortality were evident in the current population demographic and social structure.*

continued inside

THE L.S.B. LEAKEY FOUNDATION NEWS

Editor, Ted Poyser
Art/Production, Ruth Navarro

AnthroQuest is published by the Foundation as a service to its members.
L.S.B. Leakey Foundation, Foundation Center 1-7, Pasadena, CA 91125.

Telephone (818) 449-0507

PRESIDENT'S MESSAGE

Dear Fellows and Members of the Leakey Foundation:

Will you ever forget the person who gave you your first break?

Of course not! And the same goes for others along the way who had trust in you and gave a helping hand over the rough spots of your career.

Louis Leakey knew all about the difficulties of getting support for new ventures in areas where there was little public, or insufficient academic interest. But that didn't stop him from probing into the past and taking chances where there were no guarantees of success. His determination paid off and opened up new chapters in prehistory, the pages of which are being written and rewritten even today. Further, he always gave credit to those whose generosity made his pioneering discoveries, and those of his wife, Mary, possible. That he became a beacon of enthusiasm and encouragement to others is well known. That is a quality we shall try to emulate.

One prime purpose of the Leakey Foundation is to provide seed money that makes it possible for grantees to pursue a main-line study, or an obscure channel embracing a variety of disciplines, any or all of which deal with the mysteries of man's origins and shed some light on how we might better plan our future.

As you might expect, the pathways of our grantees' work often cross. One bright idea sparks another and fresh concepts ripple through the fabric of shared scholarship. Then, through publication and exposure, the discoveries and speculations can be debated, confirmed or contended. It's a playing field full of hard knocks; firm answers are mostly earned the hard way, by hands-on action and data checked under rigorous conditions. Achievement is a hard won prize.

Your Foundation picks up the tab by funding for new lessons to be learned from a fossil-past, primate studies and multi-disciplined research related to our origins. It's venture capital well spent and the kind that pays the sort of dividends of which every member and fellow can be proud.

The Leakey Foundation is one of the few that applies every penny of allotted funding to the pursuit and encouragement of both young and established explorers, researchers, and writers. The Science and Grants committee do their job extremely well. They must select from many applications and choose those that will be supported by funds essential to making new thrusts, new ventures toward discoveries in a broad range of fields. Sponsorship for those first steps can mean the beginning of a long and fruitful career. Initial projects often become full scale programs in their own right. Once recognized, a grantee's work may deserve full scale or additional support from other national and international groups. But acclaim does not come to the untried rookie, someone has to have faith in the try-out: simply put, talent must have its chance to show what it can do. Here, the Foundation has a fine track record. Scores of distinguished specialists, many of worldwide renown, can look back at an opportunity that was underwritten and put them "on track" for bigger and bolder ventures.

For many, the Leakey Foundation made possible that first break which they will never forget.

Mason Phelps

POPULATION DESCRIPTION AND DRY SEASON SUBSISTENCE AMONG THE NEWLY CONTACTED YORA (YAMINAHUA) OF MANU NATIONAL PARK, PERU

Introduction. The Panoan speaking Yora (or, Yaminahua) live in the headwaters region of the Madre de Dios, Urubamba, and Purus river systems in southeastern Peru. This region is one of the most remote and least explored areas of the Amazon basin. Probably for this reason, the Yora only made first peaceful contact with outsiders in 1984. We report here the results of research conducted in June and July of 1986 in a Yora village located along the headwaters of the Manu river in Manu National Park.

The Yora are of special scientific interest because of their unusual mix of hunting, gathering and horticulture. We present some qualitative and quantitative data on Yora subsistence adaptations, including information on diet, time allocation to food acquisition, and food sharing. These data also allow us to assess the extent of riverine resource depletion through time. Since many theoretical treatments of subsistence and settlement in Amazonia assume that riverine resources are not depleted by native harvesting, this information has important implications.

Yora men frequently used red body paint and tied sweet smelling plants to their arms to enhance their attractiveness.

Included is a description of health and recent mortality among the Yora, and the devastating effects caused by contact with westerners as well as some possible means by which population decimation can be avoided.

Environment. Manu National Park in southeastern Peru is one of the largest national parks in the world, comprising more than 1.5 million hectares, with nearly another half million hectares of protected area along the southern boundary of the Park. Along its western border, the Park reaches elevations of almost 4,000 meters along the steep eastern slopes of the Andes and then drops precipitously to about 2,000 meters in only a few kilometers. From this point one slowly descends from upland humid forest to lowland tropical forest at elevations under 500 meters near the Manu river. To the north and east near the headwaters of the Piedras river lay vast tracts of virtually unexplored lowland tropical forest. The climate near the Manu river is similar to that found in much of tropical South America with seasonal wet and dry periods.

Although most of Manu Park remains unstudied to date, the area around the Cocha Cashu biological station has been the site of extensive ecological studies by Peruvian scientists, and a variety of international research teams. As a result, the Cocha Cashu area is one of the best described patches of tropical forest in the world. The high ground forest which covers most of the Park interior is classified as tropical moist forest and, despite its apparent uniformity, has varied patches of unique forest types. Drainage, soil composition, slope, light exposure, and other factors combine to produce a mosaic of plant communities, a diversity which is extremely relevant to the animal and human inhabitants.

The rich faunal diversity near Cocha Cashu has also been extensively studied. In addition to the common presence of tapirs, peccaries, jaguars, deer, large rodents and other typical South American animals, the Park has 13 species of primates, over 500 species of birds, and is home to some of the rarest animals in the world, such as the giant otter. All this suggests that the Manu region may be exceptionally favorable for hunting, and that protein sources may be more abundant than in many other regions of Amazonia.

There is virtually no information about the prehistory of native peoples in the Manu Park region. Inhabitants were living on the upper Ucayali drainage at least 3,000 years ago and it is likely that the same is true for the Manu area. Historical information on the native inhabitants of the Park is also sparse and almost always of questionable accuracy.

By the time of the 19th century rubber boom in the area, a major population transition had taken place in Manu Park. Then, after the collapse of the trade, the population of Peruvian nationals and Europeans in the Manu Park area decreased rapidly.

In the second half of the twentieth century, the Manu Park area was temporarily inhabited by a small number of non-native inhabitants who were primarily involved in the extraction of wood, selling of skins, or missionary work (or some combination of all three). Until the Park was established in 1973, Machiguenga and Piro Indians (along with some Peruvians) earned cash income by extracting lumber, animal skins, and other animal products from the forest, and by working as boatmen, guides, and day laborers for various employers in the area. After 1973, all commercial activities within the Park boundaries were prohibited, as were firearms. All non-native settlers were evicted from the area, and native inhabitants who had previously been involved in the

cash economy returned to fishing, hunting, and gardening for a living. The other native populations were protected and isolated from outside incursions into their traditional home ranges.

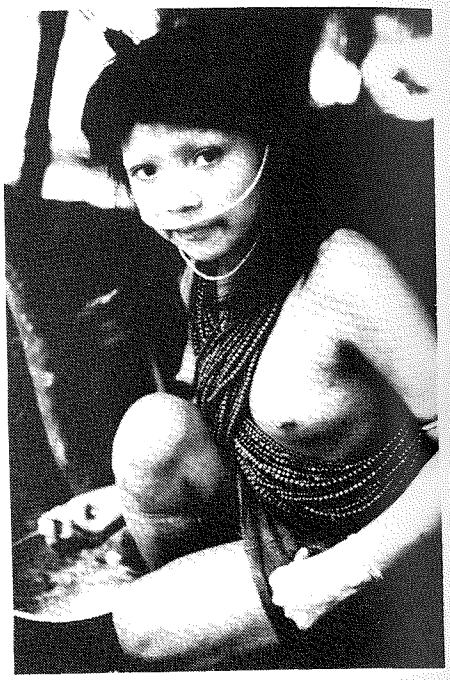
Background and recent history. There are two groups which call themselves "Yora" located in the northern extreme of Manu Park; they also say that they are Yaminahua (or, more specifically, "Yaminahua Shara") to distinguish themselves from other Nahua ethnic groups. "Nahua" is the term which refers collectively to the autonomous Panoan speaking tribes of the upper Yurua and Purus basins. The Yaminahua (a term which means "iron people") are currently the most numerous and widespread of the Nahua groups. According to Robert Carneiro, the various Yaminahua groups are all culturally and linguistically similar and can be easily distinguished from other Nahua groups because they alone shave their foreheads.

The term "Yora" apparently applies to all those Yaminahua living in settlements along the tributaries of both the upper Mishagua and upper Manu who recognize each other as related rather than as enemies. The different Yora groups maintain frequent visitation and appear to intermarry. These groups have been extremely hostile to outsiders, conducting lethal raids on woodcutters, oilmen, and neighboring Machiguenga until recently when they were contacted and "pacified." The Yora are a highly mobile population and informants state that although they have dominated the upper Manu for the past 40 or so years, they originally had to drive Machiguenga from the area with frequent raids. Machiguenga living downstream tell tales of wholesale massacres from which the few remaining survivors fled.

We estimate that just prior to 1984 when first peaceful contact was made, the Yora population in and around the Park consisted of 300-400 individuals. Contact, however, decimated the population. According to informant reports and some written accounts, several Yora raided a woodcutters' camp on the upper Mishagua river and stole a canoe in April or May of 1984. The group of woodcutters included Peruvian nationals and Machiguenga, Piro and Yaminahua Indians from the Sepahua mission. On the morning following the raid, the woodcutters found the Yora on a beach on the Mishagua river. A short battle ensued during which three or four Yora were either captured or convinced to put down their arms and remain with the woodcutting party. Transported to the Sepahua mission, and later released, they were given a variety of gifts. Soon after this initial contact, several small groups of Yora visited the Sepahua mission to receive gifts. Unfortunately, many became sick, presumably because they had no prior immunity to the diseases to which they were exposed in Sepahua. When they returned to their native communities, an epidemic of respiratory disease quickly spread to all the Yora groups remaining in the forest.

In August and September 1984, missionaries and medical personnel treated approximately 200 Yora who were gravely ill from pneumonia at a site near the headwaters of the Mishagua. Vaccination for polio, measles, diphtheria and tetanus followed. According to our estimates from informant reports, the number that died of epidemics at this time is probably between 50 and 150. More Yora continued to die of illnesses throughout 1985. Almost all of them died on the Manu, Cashpajali, and Condeja rivers. In November 1984, the missionaries set up a permanent base of operations at Putaya on the Mishagua river. A year later in December 1985, a medical team visited a Yora settlement for the first time on the Manu side of the watershed at the mouth of the Condeja, and treated severe cases of pneumonia. Sadly, on both sides of the drainage, many Yora continued to die well after their plight was known, because they did not have access to full-time medical treatment, and no way to communicate to the outside world when another epidemic struck.

Although the original size of the Yora population and the number that died are still unclear, the size of the surviving population is easier to determine. Based on our own data, and information supplied by persons located in Sepahua and Putaya during July 1986, we estimate that there were then about 180 Yora.



Boiled fish and green bananas were a favorite food during the dry season.

The study population. We lived with the Yora in Manu Park for 26 whole days between June 12 and July 18 of 1986. The community we studied was located on a small hill about thirty meters above the river, on the north bank of the Manu about 1.8km upstream from the mouth of the Cashpajali tributary. The river is about 60 meters wide at this point with a rocky bottom, steep banks, no oxbow lakes, and only very small beaches. They had apparently lived on, or very near, that same spot in times past. However, this occupation was relatively recent, and we estimate that when we arrived, it had probably been inhabited for only about 3 months. When the medical team visited in December of 1985, the Yora were living at the mouth of the Condeja 4km downstream, at a site that they visited occasionally during our stay in order to bring manioc cuttings to plant. Both settlements were cleared in old alluvial floodplain forest which was quite hilly, with soils high in clay content which are quickly depleted of nutrients when farmed.

The Yora settlement above the Cashpajali consisted of six occupied houses when we arrived. One had been abandoned, and two were built during our presence. The house roofing was of palm thatch, and none of the shelters had walls. The popula-

tion was clearly divided into a downstream cluster and an upstream cluster about 400 meters apart. At Mid-June our census showed 37 Yora residents; the village population fluctuated between 33 and 41 persons due to intervillage visiting. We noted that the old Condeja settlement consisted of six houses which were also separated into two clusters, suggesting that settlement size and organization have remained similar for the past year.

The residence pattern among the Yora was primarily based upon kinship and tended to be patrilocal, although it also appeared to be somewhat in flux as a result of the large number of contact-related deaths. The Yora, like many other South American groups, do not wish to reveal their traditional names, possibly because they fear their use in witchcraft. They did, however, desire Spanish names which they felt no compunction about using in public. Some already had Spanish names when we arrived.

The downstream section of the community was composed of an old man, Cesar, and his sons and their children, and two children of one of his daughters. Cesar is the leader of the section and the second most influential Yora in the community. The upstream section is composed of interlocking familial relationships with Pandiko and Curaca forming the core. Pandiko is the leader of this section, and also the most influential person in the Yora community. While these section "headmen" are well respected and play a major role in decision making, they have no formal authority. Pandiko seemed to gain his influence through his personal magnetism and charisma, and through energetic labor.

The age-sex breakdown of the community was skewed. The community consisted of 12 adult males, 6 adult females, 15 male children and 4 female children. It is not yet clear why the sex ratio was so skewed toward males, however several possibilities may be considered. The Yora report that more females than males died in the epidemics at first contact. It was also our impression that female children were treated worse and given less to eat than were males. This may have resulted in higher mortality of female children. Another possibility is that the Yora practiced selective female infanticide. Only further research will allow us to evaluate each of these possibilities.

An examination of the recent marriage and reproductive patterns of the members of the community shows the devastating effects of first contact. Of the twelve adult men in the community, five were recently widowed having lost their wives in the epidemic, and one lost his wife to an acculturated Yaminahua. Of the remaining six men four were currently married, and two were bachelors. Among the six adult women, three were married, two were widowed from the contact epidemic (one of these remarried), and one was an orphan (her parents died in the contact epidemic) who remained unmarried. According to informants, there were unrelated potential male partners for both unmarried women in the community, but neither seemed willing to marry. More impressive still, of the nineteen children in the community, only four had both parents still living, and fifteen have had one or both parents die recently from illness.

Plantains were often carried in disposable baskets made for that purpose.

Intervillage visiting appears to be an important part of Yora social life. On several occasions during our stay, small groups of visitors spent a few days at the settlement. They arrived with their bodies covered in red achiote dye, and wearing flowers, feathers, and sweet-smelling plants tied to their arms and legs. Proper etiquette seemed to require that the visitors be provided with a comfortable hammock to rest in, plenty of plantains and fish, and a good wad of tobacco to chew. Visitors generally requested, and were given, gifts by their hosts. They departed a few days later. This web of intervisitation maintains ties between communities, but is unfortunately also the means by which epidemics spread through the population. One group of visitors arrived quite sick. Within a few days after their departure, the entire community became very ill with respiratory infections and developed very high fevers. Although we were able to save the lives of even the most gravely ill through antibiotic administration, the visitors were not so fortunate. We later learned that one and perhaps two of the three visitors died in the forest, after leaving the Cashpajali settlement.

Anthropometry and health. Weights and heights for most of the population were collected on three occasions and triceps skinfold thicknesses were recorded once. When we first arrived, the Yora were undoubtedly one of the shortest and fattest Amazonian populations reported. The mean height for adult men was 154.1cm with a mean weight of 63.9kg. The mean height for adult women was 137cm with a mean weight of 49.5kg. This is 7 percent shorter but 9 percent heavier than the two Machiguenga populations we studied in Manu Park. Triceps skinfold thickness showed a mean of 7mm for men and 13.3mm for women. Weight data through time show that men lost a mean of 1.6kg, women lost 1.0kg, and children lost 0.2kg between June 14 and July 14. Part of this weight loss was certainly due to the illnesses that swept through the population, but the loss may also have been due, in part, to the increasing scarcity of plantains as the dry season progressed.

Our general impression of the Yora was one of a rather unhealthy population. Complaints of malaria ("saki") were almost universal, although these reports have yet to be confirmed by clinical analyses of blood. They also seemed somewhat listless and lacking in energy. As mentioned above, a severe epidemic of pneumonia affected almost every member of the population (with the exception of the headman and his

family). We administered aspirin and antibiotics throughout much of our stay.

Not only were the Yora suffering from contact-related health problems, but they also showed a variety of problems due to the characteristics of the environment in which they live. We conducted two systematic but rudimentary health checks on all children in the population on June 23 and July 12. The results are that 14 percent of the children seemed to be severely anemic (as determined by the color of tissue on the inner eyelid), 28 percent had skin infections (3 had very severe cases), 41 percent had open sores on the head, 100 percent had lice (21 percent had severe cases), 45 percent had coughs, 45 percent had fevers, and 7 percent had diarrhea. In addition, during our field session we observed at least 20 large ant and wasp stings, 1 poisonous snake bite, 1 burn, and 1 large accidental wound.

Yora subsistence ecology. Several methods of data collection were employed to monitor time allocated to subsistence and to other activities, productive efficiency, and techniques of food acquisition. Instantaneous scan samples were used to measure time allocation. This method involved a tour of the community with visits to each household. The scan would begin at randomly chosen hours (without replacement) so that all daylight hours were represented. An attempt was made to locate all individuals within the vicinity of the settlement and to determine the activity in which they were engaged. We also recorded the activities of individuals that left the settlement to forage.

In order to calculate Yora productive efficiency and to observe behavior away from the settlement, we collected two additional kinds of data. First, for one subsection of the population being monitored (usually either the upstream or downstream cluster) we clocked all individuals out of, and back into, the camp anytime they left the residence areas (on 22 days). Again, we also asked them what they were going to do, or inferred this based on tools taken, and resources brought back. When they returned, we weighed all resources acquired. The caloric equivalents of these resources being known from

The water is often so shallow in the dry season that canoes must be pulled and pushed over the rocks.

published sources, this allowed us to determine the total food consumed by the sector and the return rates for subsistence effort (i.e., calories acquired per hour of work effort).

These data were complemented by focal individual follows in order to observe behavior away from the settlement. Each day a member of the community was accompanied when he left the settlement. (We focused upon males because females rarely left the settlement to forage, and were always accompanied by men when they did. We were thus able to monitor their behavior during the follows of men.) We recorded time allocation for the focal individual and all people who accompanied him.

Finally, in addition to studies of time allocation and foraging productivity, we mapped the Yora settlement in some detail and updated the map weekly as men continued to clear more land for gardening.

The principal shortcoming of this study is the brief field period and the size of our sample. We were only able to observe dry season subsistence behavior, and our information on other times of the year is derived only from interviews which were limited by our rudimentary linguistic competence. Given the year to year variability which probably characterizes Yora subsistence patterns data on several complete seasonal rounds are necessary to fully describe their economy. This problem is further exacerbated by the fact that some features of Yora subsistence behavior are in the process of change.

Gardening. Although the Yora were in the process of clearing small gardens when we arrived, they had not planted gardens for at least a year and had no garden produce to eat. During our field session, they were entirely dependent upon fishing, hunting, and collecting plantains growing wild along the river to meet daily food needs.

When we left in late July, the Yora had planted about 1.5 hectares of manioc and corn (intercropped), with a few plantains, pineapples, and papayas near their houses. They also had cleared and burned about .25 hectares which had not yet been planted when we left. The apparent enthusiam for garden work by some of the men was curious in light of the fact that they had totally abandoned gardening the previous year at Condeja, and did not even have enough manioc stalks left to use for seed cuttings in their own fields (they traveled to Tayakome to bring back cuttings). Men did some agricultural labor on 14 percent of all days we monitored, whereas women only worked at horticultural tasks on 2 percent of days in our sample period.

Presumably, this pattern of intermittent gardening with years of total reliance on foraged foods is traditional, at least in the recent past. The Yora report that before contact, they had only one old machete and one axe in their village. Clearing gardens was difficult, and they therefore had very small gardens. They did not use stone axes, but instead used a sharpened hardwood club to clear the thick bamboo forests.

Thus, even these garden plots may have been large by Yora standards (their old gardens at Condeja totalled less than 1 hectare). Nevertheless, at their present size the Yora gardens could not provide sufficient agricultural food to support the population year round.

Yora horticulture was interesting in several ways. First, the primary crop planted in the fields was maize. This is in sharp contrast to the sweet manioc-based economies of their Machiguenga neighbors, or the large plantain gardens that must have existed along the river before the Yora drove out the previous inhabitants. We do not know whether this difference is due to preference or to a shortage of manioc cuttings. Second,

Yora did not appear to be skilled at tropical gardening. In order to examine the agricultural efficiency of the Yora we measured the time that it took them to plant their fields. Although we lack the data on clearing, weeding, harvesting, and food processing times necessary for a complete picture of agricultural efficiency, it is instructive to compare Yora with Machiguenga planting efficiency. Yora data show that on average, men planted 1 yucca hole every 2.1 minutes. We observed the Machiguenga at Quebrada Fierro to plant 1 yucca hole every 0.6 minutes. The Yora planted about 2700 holes per hectare and the Machiguenga about 2100 holes per hectare. The efficiency differences between the two groups are quite striking, especially considering that the Yora plant only two cuttings per hole whereas the Machiguenga plant three. If both planted about 2500 holes per hectare, it would take the Machiguenga only 24.6 man hours (about 4 working days) to plant a one hectare manioc field, but the Yora would spend 87.5 man hours (about 14.5 working days) to plant the field, more than three times as long. These data again suggest that gardening may be a relatively new and unimportant activity for the Yora, although part of this difference may be due to the Yora's apparent ill-health and general lack of energy.

Foraging. During our stay with the Yora we collected quantitative data on the diet in one or both subsections of the community on 23 days. Caloricially, the most important resource acquired was wild plantains which grow in patches along the Manu river. We observed the Yora to collect 1319kg of wild plantains. Almost all of these were sweet, eating plantains (species unknown) and not green, cooking plantains. The plantains were almost certainly the descendants of cultigens planted earlier in this century or in previous centuries by the Machiguenga. Apparently, during the yearly floods plantain root stalks are washed downstream and deposited in areas that favor their propagation. Plantains were collected every few days when men went out to fish, and they accounted for 79 percent of the calories in the Yora diet during our dry-season field period.

Fish were the most important protein resource in the diet, and the second most important food category in terms of energy, accounting for 14 percent of the calories in our sample. Of the 274kg of fish we saw taken, almost half of the total (133kg) was due to the capture of 16 very large fish (13 zungaro and 3 paco-species unknown) whereas the remainder was made up of over 60 small fish. Importantly, of the fish we actually saw acquired, 60 percent by weight was caught with hook and line, 32 percent shot with bow and arrow, and 8 percent was speared. This means that it is somewhat difficult to predict exactly how much fish the Yora were eating before 1984 when they first acquired hook and line.

A variety of other wild resources made up the remainder of the Yora diet during our field stay. These included 7 caimans, 2 turtles, 3 sting rays, 1 woolly monkey, and a good number of turtle eggs. Wild honey was also taken on one occasion. Interestingly, there appear to be no wild fruits or nuts that the Yora exploit during this time of the year, although we did see them eat small quantities of insects and palm hearts and starch. We also saw them acquire non-food items such as achiote to make red paint, latex to mix with achiote for hairpaste, tobacco to chew, and some raw materials for bows and arrows.

In our sample, Yora men only left camp to fish, hunt and collect on 27 percent of all days. Plantains were almost always collected during fishing trips. Women, on the other hand, devoted much less time to subsistence labor, only spending 7 percent of all days on hunting/fishing/collection excursions. Food processing time for women was also minimal because the plantains were either eaten raw, or boiled or roasted without processing. Consistent with their low time input to subsistence, women only acquired 6 percent of the total calories consumed by the group. In fact, this figure actually overestimates their contribution because men spent hours poling the canoes to collection sites, and women only harvested the plantains upon arrival. Yora women's subsistence effort (at least during the period we observed) is one of the lowest yet reported for traditional societies. This may be due to the fact that men can combine plantain collection with fishing and hunting. Women must be transported to the collection site for the few minutes that they will gather. It may be simpler for the men to do the whole job. In fact, Pandiko's wife was not observed to engage in direct food acquisition or to travel with foraging parties on the river during the entire field session. This may be due, in part, to the fact that she had a very young child and the insects on the river are quite numerous and noxious. The other woman with a young child only went on one day-long foraging trips, and her baby returned with his entire body covered in bites.

Male children often accompanied adult men and did some fishing with hook and line, but their total catch was less than 10 kilograms. Female children also frequently accompanied Yora men, and produced a few turtle and bird eggs.

In general, the Yora spent relatively little time in subsistence work during our field period. Part of this may have been due to an observer effect. We noticed that although the Yora did almost no work during our first week with them (most of this time period was not included in our sample, however), they seemed to work much more after we had been with them a while. The initial excitement of our arrival may have been sufficient to stimulate them to stay in camp. Also, as previously mentioned, the Yora became extremely ill following the visit of their relatives from the Mishagua drainage. They did almost no work during the days when they were very sick. Their low subsistence effort may also be partially due to the ease with which they could acquire large quantities of plantains.

Behavior on foraging trips. Data obtained on the 14 days we followed a focal man on his hunting/fishing/collecting trips out of camp (six of these days were overnight trips with a group of Yora men, women, and children) allow for a more detailed description of dry season food acquisition. On these trips we made a map of major resource patches used by the Yora, and the travel time to each. We also recorded encounters with all potentially edible resources and the Yora reaction to each. When Yora attempted to acquire a food item, we were able to measure the time expended and the success rate.

We observed a common pattern throughout our stay. Two or more men, sometimes accompanied by boys, girls and/or women, would leave in the morning and travel up or downstream by canoe. One man would generally propel the canoe with a cane pole while another would shoot fish from the bow of the boat, or get out and walk along the bank hunting fish with bow and arrow. The target early in the day was generally bocachico fish. These fish would either be saved to eat or used for bait in hook and line fishing. Return rate data indicate that the success rate in kg/hr for this type of fishing is much higher further away from the main settlement indicating significant resource depletion near the settlement. The overall goal of this first phase of the trip seems primarily to be to travel some distance away from the settlement and to acquire bait.

After traveling for one or more hours, men search for a large deep pool in the river to fish with hook and line. Once again, return rate data indicate that more distant pools are more productive. When a large deep pool is near but no bait has been acquired, men will walk up a small stream with a machete trying to kill minnows. Although we observed about an equal amount of time dedicated to bow and arrow fishing and hook and line fishing, hook and line fishing was twice as efficient. This is mainly because it allows the hunter to acquire prey of a much larger size than can normally be killed with an arrow. It is no wonder that the Yora undertake long journeys to acquire hook and line technology, and prior to outside contact the Yora must either have fished for longer hours, eaten less meat, or some combination of the two.

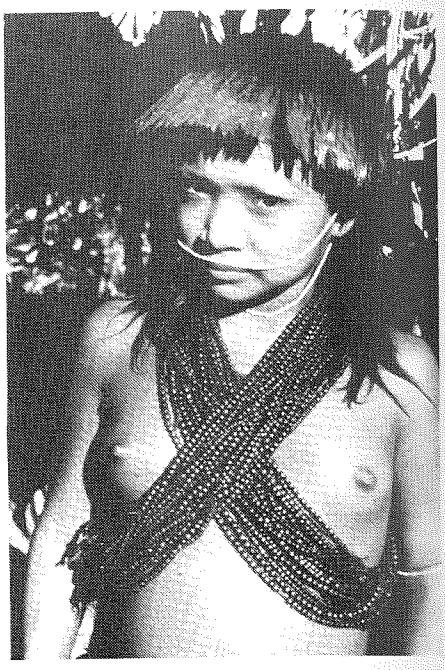
If men encountered large fish (5-30kg) in the river's shallows, they would try to spear the fish with their unstrung bow. Their zeal and ability to chase down and impale large fish in the river's shallows suggests this may have been a major source of food before the acquisition of hook and line gear.

Another form of hunting that may be practiced on a trip is for the crocodile-like caiman. Yora men would walk up small streams looking for fresh caiman tracks. A systematic search along the stream edge, in holes, logs, and other debris generally lead to discovery of the prey. Once the caiman was found, it was speared with an unstrung bow. This form of hunting is extremely productive (13.16kgs/hr, not including travel time to the stream). We wonder why it was not practiced more.

When all meat-getting activities are combined, an overall foraging meat return rate for Yora men can be calculated. On focal follows, the Yora spent 181.4 hours traveling, and searching for fish and game. The total amount acquired during these follows was 126.4kg (live weight), for a mean return rate of 0.70kg/hr (live weight). When all activities are combined, our data again indicate resource depletion near the village settlement. The mean foraging return rate was only 0.06kg/hr within one hour travel time from the settlement, but it steadily increased until 5 hours from the settlement (the maximum distance we travelled) where we measured a return rate of 3.47kg meat per hour spent foraging.

As mentioned above, two principal resources were collected during these foraging trips. When beaches were passed during the mid-to-late dry season, Yora often left their canoes to inspect the beaches for turtle eggs. Children also frequently ran along the banks looking for bird eggs. However, plantains were by far, the most important collected resource. When the Yora were ready to return to their settlement, they would begin to collect plantains at one of the large, well-known patches. Some children and all adults and adolescents would leave the boat in search of large stalks of plantains. They would cut down the large trees with machetes, or simply poke them with a sharp stick until they doubled over.

Plantain collecting was extremely efficient because no time was spent clearing gardens or weeding. When wild plantain patches are encountered, Yora can gather plantains at a rate of 44.8 kg/hr. Plantains, fish and other resources were shared out and although this sharing was extensive, it was, by no means, equal and was generally biased toward close kin.



A young married woman painted with achiote.

Why fish rather than hunt? Besides collecting data concerning the typical Yora dry season subsistence pattern, we attempted to determine why it was not different in some ways. Specifically, given the very high density of mammalian fauna in Manu Park, we wondered why Yora men did not hunt in the forest more often. During the entire 2-1/2 month period, we observed that they stayed close to the rivers and virtually ignored most signs of forest game. In order to test the proposition that this was primarily due to the greater ease of obtaining meat by fishing during this season, we asked two hunters to spend a day hunting in the forest. Results from this single sample day provide some preliminary support for the suggestion that men spent time along the river rather than in the forest because meat can be acquired more efficiently by exploiting riverine resources. The two hunters acquired only 0.42kg meat/man hour. This difference between hunting and fishing efficiency is largely due to the productivity of hook and line technology. Clearly, more data are necessary to test these propositions.

Late dry and wet season subsistence. We can also make some informed guesses about the Yora economy during other periods of the year. In the late dry season, turtle

eggs increase in importance. In late July after we left the Yora to work with Machiguenga in Tayakome, a canoe with some 21 Yora arrived to visit the Machiguenga. The Yora had about 50kg of turtle eggs that had been collected on the beaches along the upper Manu. Undoubtedly a considerable quantity of eggs were eaten on the trip, so it is probable that for about 4 weeks in July and August during the peak turtle egg season, the Yora exploit that resource heavily. The Yora also stated (and Machiguenga informants agreed) that in August during the peak dry season, plantains cease fruiting for a few months. This appeared to cause extreme food stress among the Yora who had no garden crops to eat at that time. They complained that lack of food upstream was one of the reasons they travelled so much in the middle of the dry season.

Information on the wet season economic pattern could only be obtained from interviews during our stay. Yora stated (and again, the Machiguenga corroborated this claim) that they do not spend much time along the river during the wet season, but instead move up the small tributaries. Mammalian game seem to be important at this time of the year, especially woolly and spider monkeys. Fish are hard to obtain because the rivers are high and muddy. Plantains are said to be superabundant, and many forest fruits are ripe during the wet season. How the Yora coordinate plantain collection with forest hunting is still unclear. Only further field studies will allow us to understand the details of wet season subsistence.

Food sharing. Because food sharing is an important and fascinating human behavior, we collected a small amount of quantitative data concerning Yora sharing patterns. On six occasions we recorded everything shared out when the foraging party arrived at the settlement, on three occasions we recorded in detail the sharing that took place in the canoe before the party arrived, and on six occasions we recorded quantitative food sharing on overnight trips. These data allow us to present a sketchy picture of "primary" food sharing. In addition, we recorded the recipients of already cooked food for seven meals in order to learn about the "secondary" food sharing pattern. The meat sharing pattern strongly favored the nuclear family when food is brought back to the settlement, but is widespread and equal shares are given to all families on overnight trips. Plantains were shared less than meat and were shared out both before and after cooking. It is also interesting to note that plantains were frequently hidden in the forest while they were being allowed to ripen. The Yora claimed that other Yora would have stolen them if they were left in their houses.

The Yora sharing pattern shows that food distribution is not necessarily egalitarian in the supposedly "egalitarian" societies. We found a similar pattern among the Ache of Paraguay. On overnight foraging trips, the Ache share all meat equally. At their horticultural colony, food sharing is more kin-biased and more is kept by the hunter's family.

Inter-village visitation was common, with guests always arriving painted and decorated.

Conclusion. The Yora are an important study population because they are recently contacted and live in one of the most isolated areas of the Amazon. They have suffered great mortality in the past two years due to introduced infectious diseases. Dry season subsistence activities center around plantain collecting and fishing, done primarily by adult males. Horticultural activities seem to vary a good deal from year to year, ranging from complete abandonment of gardening to small scale temporary gardens that appear to emphasize maize as the primary crop. The recent introduction of metal tools will probably lead to increased importance of agriculture. Depletion of riverine resources takes place at a rapid rate in new settlements. This has important implications for understanding Amazonian settlement patterns. The changes taking place in the Yora economy should allow us to test some general models about shifts in subsistence regimes around the world. However, because most of the Yora diet is provided by plantains which are the descendents of cultigens planted by their enemies whose territories they invaded recently, the implications of the Yora economic pattern for modeling pre-Columbian interfluvial settlement patterns in South America are not clear.

The humanitarian implications of our research are clear. All native groups that are newly contacted should be provided with immediate but also long-term access to modern medical care for the first several years following contact. The Yaminahua case is not unique. Our experience with the Ache in Paraguay and accounts of other contacts throughout Amazonia show the same pattern. Intervisitation between groups leads to massive epidemics. If untreated, a third or more of the individuals in a population can die within a very few years. Vaccination and then antibiotic administration can reduce mortality from these contact-related diseases to near zero. Too often, however, the initial response is too late. And, even more often, the groups are neglected after the initial excitement associated with contact wanes. Failure of responsible groups to provide both initial and follow-up medical services inevitably results in disaster. ■

BIBLIOGRAPHY

Lathrap, D., 1970. *The Upper Amazon.* New York: Praeger.

Hames, R. and Vickers, W. 1983. *Adaptive Responses of Native Amazonians.* Academic Press: New York.

Roosevelt, A., 1980. *Parmana.* Academic Press: New York.

GRANT SPOTLIGHT

The grant program, the major purpose of the L.S.B. Leakey Foundation under the guidance of the distinguished Science and Grants Committee, depends upon public support for its success. Every penny of your contribution dollar directly supports the grant awards.

GRANT GUIDELINES

The Foundation was formed to further research into human origins, behavior, and survival. Recent priorities have included research into the environments, archeology, and human paleontology of the Miocene, Pliocene and Pleistocene; into the behavior of the Great Apes and other Old World primate species; and into the ecology and adaptations of living hunter-gatherer peoples. Other areas of study related to human evolution have been funded occasionally.

The majority of the Foundation's general grants have been between $3,000-$5,000. Priority is normally given to the exploratory phase of promising new projects. Doctoral students and post-doctoral researchers are encouraged to apply.

Deadlines for submission of the formal applications are: General and Baldwin: March 1, September 1 and December 1. Fellowship for Great Ape: May 1. Fellowship for the Study of Foraging Peoples: May 1.

For further information and application forms, contact the L.S.B. Leakey Foundation, Foundation Center 1-7, Pasadena, CA 91125.

Yoel Rak — *$12,000 per year (second of 3 years)*

THE ORIGIN OF MODERN HUMANS IN THE MEDITERRANEAN LEVANT

The required progress report needed to continue the funding for this project has been provided: excavations at Kebara Cave, Mt. Carmel, Israel.

Horst Stelkis — *$10,000 funded*

SOCIO-ECOLOGY OF CHIMPANZEES IN THE ISHASHA RIVER REGION, EASTERN ZAIRE

This proposal is to census the population of chimpanzees (*Pan troglodytes*) living in the Ishasha River gallery forest of the Parc National des Virunga, Eastern Zaire, and to initiate studies of their socio-ecology with the explicit aim of testing hypotheses about early hominid subsistence and land-use patterns in East Africa. The first year of the project has several objectives: 1) provide a census of the population in this unusual, highly restricted habitat; 2) habituate the chimpanzees to the presence of humans; 3) begin systematic description of the habitat; 4) begin documentation of chimpanzee ranging behavior, food resource utilization, and intergroup relations; and 5) make recommendations to government and park personnel on conservation efforts.

Robert L. Tompkins — *$5,273 funded*

RELATIVE DENTAL DEVELOPMENT IN UPPER PLEISTOCENE HOMINIDS AND RECENT HUMANS

This work is an investigation into the relative rates and patterns of dental mineralization in Upper Pleistocene fossil hominids compared to three recent human geographic populations. Frequency distributions of the various stages of development that any one tooth displays relative to a specified stage of development of a "reference" tooth will be derived for the recent human samples. The research will have relevance to current debates concerning developmental rates in fossil hominids, and provide data on modern population variability in dental development.

Michael J. Shott — *$2,280 funded*

PALEO-INDIAN LANDSCAPES AND CARIBOU KILLS: PROSPECTS AT THE GAINEY SITE

The major Paleo-Indian site in Michigan is dated to between 12,000 to 11,000 B.P. Judging from the size and complexity of its assemblage, Gainey was occupied repeatedly. Environmental reconstruction and ethnographic parallels suggest that it lay near the north end of a Paleo-Indian band territory and was occupied at least in part to prey upon caribou migrating between summer and winter ranges. The landscape is a promising area in which to seek the large-scale, direct evidence of caribou hunting that has so far escaped eastern North American archeologists.

Salvatore Capaldo — *$4,000 funded*

ISOLATING THE HOMINID BEHAVIORAL SIGNATURE FROM DUAL-PATTERNED BONE ASSEMBLAGES

This research has two objectives: 1) to use experimental bone assemblages in the Serengeti to identify the sources of discrepancies between Binford, et. al. and Blumenschine; and 2) expand their work by mapping sites, by including postcranial axial bones, and by directly observing hyenas as they modify experimental bone assemblages. Hyenas will be given access to experimentally produced bone assemblages simulating hominid meat and marrow processing. Data will be collected before hyena modification on the spatial distribution and frequency of unmarked and tool-marked bone, and the body part profile of axial and appendicular bone. After hyena repatterning, these data will again be recorded and similar data on tooth-marked bone will be collected.

Sid Sitkoff & Milton Anisman — *$5,000 funded*

STONES AND BONES, A LABORATORY APPROACH TO PHYSICAL ANTHROPOLOGY

This innovative program designed to enrich and meet the needs of students in life science, biology and physical anthropology courses, grades 7 to 12. The format is interdisciplinary in design and emphasizes active student participation through laboratory explorations. The project is administered by the Los Angeles Unified School District and funds are disbursed as needed for various workshops and teacher training.

Clark S. Larsen — *$2,665 funded*

STRESS IN THE KRAPINA NEANDERTALS

This investigation will document episodic stress via the study of enamel hypoplasias in the Krapina Neandertal dental sample that is housed in the collections of the Croation Natural History Museum, Zagreb, Yugoslavia. Enamel hypoplasias are defects that provide a retrospective picture of prenatal and postnatal stress episodes. The study includes the impact of environmental stress on a Neandertal population from a rockshelter near the town of Krapina, Yugoslavia.

David P.M. Hadoto — *$3,000 funded*

GEOMORPHOLOGY OF THE UGANDA RIFT VALLEY

The project's goal is to put the fossiliferous sediments of the Western Rift Valley into their proper geomorphological settings, with a view to understanding their origin and that of the fossils found therein. The proposed work ties in closely to a paleontological survey currently being undertaken. The study sets out to document the processes leading to the accumulation of volcanic-free sequences and will enable paleontologists to place their faunas into a proper geological framework.

Pamela Willoughby — *$5,000 funded*

EARLY AND MIDDLE STONE AGE TECHNOLOGY AND ADAPTATION IN SOUTHERN AND CENTRAL TANZANIA

This project embraces both site survey and excavation of later Acheulean and Middle Stone Age sites, as well as reanalyses of already recovered artifact collections. It represents the first stage in a long-term, field-oriented program directed at answering questions about the origin and early evolution of technology. The initial concentration will be on sites near the modern town of Iringa, Tanzania. A secondary focus will be on the Western Rift near Zambia in the southwest corner of the country.

Eva L. Bynum — *$4,000 funded*

A COMPARATIVE STUDY OF THE DISTRIBUTION, ECOLOGY AND BEHAVIOR OF MACACA TONKEANA AND MACACA HECKI IN CENTRAL SULAWESI, INDONESIA

This project seeks increased understanding of the cladistic relationships among the seven morphologically distinct macaque forms found in Sulawesi. This project is a part of a large multidisciplinary program called the Sulawesi Primate Project.

Lawrence Martin — *$10,000 funded*

PALEONTOLOGICAL AND GEOLOGICAL SURVEY OF THE MIOCENE SITE AT YASSIOREN (SINAP), TURKEY

This project includes a detailed paleontological and geological survey of the Sinap area and mapping the occurrence of fossiliferous localities within the site. New fossil material from all three levels will permit comparison of their composition, age and paleoecology. Fauna from each level will be used for paleoecology and dating as well as for understanding the evolution and adaptations of the animals involved.

Randy V. Bellomo — *$2,000 funded*

ACTUALISTIC STUDIES OF FIRE ON CONTEMPORARY AFRICAN LANDSCAPES

Traces of fire have been reported from four early Pleistocene localities in East Africa over the last decade. Two have been found in Ethiopia, at the Middle Awash and at Gadeb; and two in Kenya at Chesowanja and at Koobi Fora. The purpose of this project is to develop a methodology for identifying traces of fire in African archeological contexts regardless of age. These studies might help determine if there is evidence for the presence of humanly controlled fire in Africa prior to its appearance in other regions of the Old World.

William Sanders — *$3,500 funded*

FUNCTION, ALLOMETRY AND PHYLOGENY OF THE AUSTRALOPITHECINE LOWER PRECAUDAL SPINE

This proposal seeks to comprehend: 1) the functional affinities of the australopithecine spines, compared to functional complexes of the modern human spine correlated with bipedality and with homologous bone-ligament-muscle units in other catarrhines; 2) the distinctions in vertebral proportions between early hominids and modern humans, in the context of geometric scaling, and 3) the evolutionary development of Australopithecine vertebral morphology, relative to extant hominoids and an hypothetical ancestral African ape-human morphotype.

Alan H. Simmons — *$2,000 funded*

ARCHEOLOGICAL RESEARCH AT AKROTIRI-AETOKREMNOS, CYPRUS

Support is requested to supplement NGS funding for the interdisciplinary excavation of Akrotiri-Aetokremnos (Site E) in southern Cyprus. The site is the earliest documented site in Cyprus by at least 500 years, or more, and contains abundant amounts of pygmy hippopotami, a species previously believed to have been extinct before human occupation of the Island.

Francine Darmon *$2,000 funded*

BEGINNING OF AGRICULTURE IN THE MIDDLE EAST FROM PALYNOLOGICAL STUDIES

This study will establish the pollen analysis of sites of Natufian and prepottery Neolithic periods in the Middle East in order to reconstitute the paleovegetation of the archeological sites and induce from these studies the corresponding climatic fluctuations. It will also help to locate the beginning of agriculture and reconstitute a coherent picture of the paleoenvironment during this period.

Dong Zhuan *$5,000 per year (3 year maximum)*

ARCHEOLOGICAL SURVEY IN CHINA AND GRADUATE STUDY AT INDIANA UNIVERSITY

This project consists of two steps: academic training at Indiana University and subsequent archeological investigations in China. During the next two years Zhuan will continue his coursework and take the qualifying doctoral examination. In 1991 and 1992 he will concentrate on fieldwork, returning to North China to conduct systematic archeological surveys in selected areas concentrating on a few early Paleolithic sites.

Carol V. Ward *$5,000 funded*

FUNCTIONAL MORPHOLOGY OF THE PROCONSUL BONY PELVIS

The project aims to describe and interpret the functional morphology of the *Proconsul* innominates. To accomplish this, plans are to make extensive comparisons with a large sample of primates having known locomotor behaviors. Because of the scarcity of pelvic remains in the fossil record and the important phylogenetic position of *Proconsul*, studying the bony pelvis will greatly improve our understanding of catarrhine evolution.

Helen L. Ball *$5,000 funded*

BEHAVIORAL RESPONSES OF FEMALE RHESUS MACAQUES TO NEW MALES

This study of free-ranging rhesus macaques at Cayo Santiago, is an investigation of the responses of females, of different relative social positions and at different life cycle stages, to the presence and proximity of new males. Females from two social groups, one high ranking and large and one low ranking and small, will be observed simultaneously to investigate the effects of group rank and group size on the behavioral strategies of females within those groups.

Jolee Ann West *$3,000 funded*

THE SIGNIFICANCE OF AQUATIC VERTEBRATES TO EARLY HOMINID SUBSISTENCE AND SEASONALITY

This research involves systematic surface survey and collection of aquatic remains in various lake margin and stream channel microhabitats surrounding Lake Turkana, Kenya and also survey and collection of remains from contexts representing active accumulation by humans and carnivores.

TAMARINS: BODY SIZE/WEIGHT

In commenting on the breeding patterns of the Panamanian Tamarin, Dennis Rasmussen (A/Q Summer 1989) argues that the absence of differences in body size and body weight between males and females, provides some evidence in support of a monogamous mating system. He poses the question: *"If tamarins are polyandrous, why then are the females not larger than the males?"* Dr. Rasmussen offers the possibility that similarity in body size between males and females may reflect *"an equal amount of variation in reproductive success within each sex"* rather than a monogamous breeding pattern.

Although at present there are no data on variations in individual reproductive success in any callitrichine species, there are data on body weights of wild-trapped adult males and females. Tabulated data shown indicates that in several species females are 4-5 percent larger than males. Thus, the answer to the question of why female tamarins are not larger than males is—they generally are.

Dr. Paul A. Garber
Department of Anthropology
University of Illinois

MEAN BODY WEIGHTS IN WILD-TRAPPED ADULT MALE AND FEMALE TAMARINS

SPECIES	SEX	SAMPLE SIZE	WEIGHT[1] (g)	F:M RATIO
Panamanian Tamarin	Female	41	507	1.04:1
(Saquinus geoffroyi)	Male	53	486	
Moustached Tamarin	Female	104	530	1.05:1
(Saquinus mystax)	Male	161	501	
Moustached Tamarin	Female	11	593	1.05:1
(Saquinus mystax)	Male	16	564	
Red-Bellied Tamarin	Female	18	515	1.08:1
(Saquinus labiatus)	Male	34	477	
Saddle-back Tamarin	Female	41	369	1.04:1
(Saquinus fuscicollis nigrifrons)	Male	51	354	

[1] Pregnant females are not included in the sample.

Data on adult body weights are from Dawson (1976), Garber and Teaford (1986), and Snowdon and Soini (1988).

LEAKEY FOUNDATION NAMED FUNDS

The Foundation is seeking support in several areas of human origins research. These "named" funds honor a special individual and provide support in perpetuity for knowledge of our earliest ancestors. We would like to ask you to consider adding your name to the list of donors by making a contribution to any of the following named funds.

MARY LEAKEY FUND FOR PREHISTORIC ARCHEOLOGY IN AFRICA

The goals of the Leakey Foundation in studying human origins are the discovery and recognition of sites, the intense and appropriate study of those sites, and the preservation of this knowledge for posterity. Mary Leakey has made extraordinary contributions to each of these levels of research.

The support generated by the fund for scientific research will continue that legacy.

DIAN FOSSEY MEMORIAL FUND FOR GORILLA RESEARCH

Dian Fossey's twenty years of research changed the world's perception of this endangered species. The work continues at the Karisoke research site in Rwanda, but research must be expanded and efforts must be accelerated to protect this threatened species.

The support generated by this fund will continue Dian Fossey's work.

MARGARET GELL-MANN FUND

Named to honor the late wife of Dr. Murray Gell-Mann, this fund will be used to finance research relevant to the preservation of the great apes or to the preservation of the physical existence or cultural continuity of hunting and gathering peoples. These are the two classes of living beings of greatest interest to the Leakey Foundation and both are in grave danger of extermination.

GLYNN L. ISAAC FELLOWSHIP FUND

During the twenty years that span the period of his work, Glynn Isaac was an acknowledged leader in the most significant advances in the understanding of human behavior from study of prehistoric cultural residues. With a deep and genuine love of teaching, Glynn was interested in training nationals from African countries in various branches of paleoanthropology.

This fellowship will enable young researchers to continue and expand the new approaches to the study of human origins that Glynn Isaac so successfully developed in Africa.

EXECUTIVE DIRECTOR

At the annual Board of Trustees meeting held last October in Denver, Colorado, Leslie A. Fox was appointed Executive Director of the Foundation.

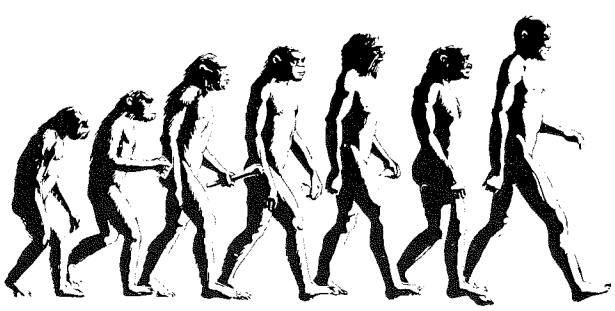
Leslie Fox comes to the Foundation from Harvard University where she was Director of Development for the John F. Kennedy School of Government. Her career in institutional advancement includes experience in several humanistic and scientific disciplines. She and her husband have recently returned to California where he joins the faculty of U.C. Berkeley.

"It is particularly exciting for me to join the Foundation at this time in its long and distinguished history," said Ms. Fox, and added, *"We plan to expand both the size and scope of our research and educational programs in the coming years."*

Mason Phelps also announced another appointment at the annual meeting, that of Dr. Richard E. Leakey as a Life Trustee. This, in tribute for his landmark contributions to our greater understanding of human origins and mankind's continued survival toward a better tomorrow.

HONORS

Distinguished scholar and U.C. Berkeley professor, Dr. F. Clark Howell, Co-Chairman of the Leakey Foundation Science and Grants Committee, was the recipient of additional honors in the spring of 1989. In April he was elected as a Foreign Member of the Academy of the Institut de France. The following month he was made a Life Fellow of the Royal Anthropological Institute of Great Britain and Ireland.



TM

A NEW PERSPECTIVE ON NEANDERTALS FROM THE LEVANTINE MOUSTERIAN

John J. Shea
Harvard University

John J. Shea

Abstract. New radiometric dates from Israel suggest anatomically-modern humans may have preceded Neandertals in that region between 50-100,00 years ago. The functional analysis of stone tools associated with these hominids provides clues to their adaptation and the likely course of their ecological relationships.

One of the most startling recent developments in paleoanthropology has been in the dating of Late Pleistocene hominid fossils from Israel. New age estimates, based on assays of remnant low-level radioactivity in burnt flints and animal teeth, have assessed an antiquity of 55-60,00 years ago for the hominid-bearing levels of Kebara Cave and an even greater antiquity, 80,000-100,000 years ago, for the hominid-bearing strata of the Skhul and Qafzeh caves. These dates suggest the early antomically-modern *Homo sapiens* from Qafzeh and Skhul were present in the Levant 20-40,000 years earlier than the Neandertals from Kebara and other Southwest Asian sites. These estimates appear to sever what has for long been thought an ancestral relationship between Neandertals and antomically-modern humans in Southwest Asia.

Research on the anatomy and behavior of Neandertals suggests they were creatures with physical prowess far beyond the aspirations of even the best Olympic athletes. If their abilities to use stone technology are taken as a measure of their intelligence and adaptive ability, then the archeological record suggests few major differences between Neandertals and early modern humans. In Neandertals our ancestors would have confronted hominids perhaps very different in appearance, but every bit as intelligent as themselves. Why we are here today and they are not is one of the most intriguing questions in paleoanthropology.

Few hominid fossils evoke such picturesque images in the popular imagination as do the Neandertals. Their fossils were first cited as support for Darwin's theory of human evolution and then set off from the line of human ancestry as an evolutionary dead-end by many turn of the century scholars. Ironically, many researchers saw the fraudulent Piltdown skull as a more likely human ancestor. It was only in the 1940s and 1950s as fossils of archaic appearance were discovered in Africa, the Near East, and Southeast Asia, that a Neandertal phase of human evolution was envisaged. More recently, evidence has accumulated from fossil and genetic studies suggesting that Neandertals may occupy a non-ancestral position in human phylogeny.

One of the most persistent stereotypes in paleoanthropology is that of the Neandertal as a primordial brute, a dim-witted and muscle-bound creature unable to react to climatic change who was edged-out, if not actually exterminated, by intelligent and gracile modern humans. The view that there was an inevitability to Neandertal extinction and modern human success remains a formidable obstacle to paleoanthropological research, even as a popular misconception, by removing the burden from scientists to propose realistic scenarios for their extinction and for the origins and dispersal of modern humans.

Background: Late Pleistocene Hominid Taxonomy. Neandertals are believed to have evolved in Western Eurasia before 100,000 years ago. Fossil discoveries and mitochondrial DNA studies indicate early anatomically-modern humans have an African origin of similar antiquity. Our understanding of the Late Pleistocene fossil record now strongly suggests Neandertals and early anatomically-modern populations represent divergent hominid lineages and probably separate species; *Homo neanderthalensis* (King) and *Homo sapiens* (Linnaeus).

The term "Neandertal" describes a group of Late Pleistocene hominid fossils from Western Eurasia dating to between about 35-130,000 years ago which share a distinct suite of anatomical characteristics setting them apart from more ancient and more recent hominids, as well as from fossils of equivalent age from other regions. Some characteristics, including hyper robust postcranial anatomy, thick walled bones and a long, low cranial vault with prominent brow ridges, are thought to have been inherited by Neandertals without much modification from earlier Middle Pleistocene hominids. Other features, mostly facial and cranial characteristics, appear to have evolved uniquely among Neandertals.

In terms of locomotion, Neandertals appear to have been well-suited to movements executed with great speed and power. Their bodies were compactly-built and the enlarged articular surfaces and thick cortical walls of Neandertal limb bones indicate a degree of peak strength well beyond the ability of most modern humans. Although Neandertal skulls are long and low, their shape cannot be used to support differences in the mental abilities of Neandertals and modern

humans. Such differences would only be reflected in the soft tissues of the brain itself, and in any case some Neandertal cranial volumes exceed the modern average. The shape of the Neandertal cranial vault may be related to providing more force to the anterior teeth, perhaps for use as a "fifth hand." One very controversial interpretation of Neandertal cranial anatomy is that proposed by Philip Lieberman, who views their oral cavity as so crowded that Neandertal speech would have been nasalized and delivered rather slowly with a high rate of signal error. On the other hand, such a crowded oral cavity may have allowed Neandertals to chew food more efficiently than modern humans. Two further anatomical observations support the idea of Neandertals as living a hard, violent life; the near ubiquity among Neandertals of healed head and forearm traumas, the kinds of wounds which result from hand-to-hand combat; and age estimates which suggest few if any Neandertals appear to have lived beyond their thirties and forties to post-reproductive age.

In anatomical terms, early modern fossils represent a greater departure from their Middle Pleistocene ancestors than do the Neandertals. Although early anatomically-modern humans were far more ruggedly built than recent human populations, they were generally less robust than Neandertals. While the relatively slender, longer limbs of the early moderns were in part a thermodynamic legacy of their tropical origins, these features suggest a distinct ability for highly efficient prolonged forward movement, such as walking and endurance running. The arms and hands of early moderns are generally weaker than those of Neandertals. The shape of modern human skulls may allow a more varied range of sounds to be delivered at speeds far in excess of that possible with the Neandertal configuration of the upper respiratory tract. If this is true, then it is possible speech played a more important role in early modern human behavior than it did among Neandertals. Early modern fossils also exhibit greater rates of dental wear and a lower incidence of skeletal trauma than comparably aged Neandertals, suggesting a prolonged period of post-reproductive survival, possibly into their sixties.

If there were deep and fundamental contrasts between the behavior of Neandertals and anatomically-modern humans, as has been maintained by generations of paleoanthropologists, then finding both types of hominid fossils with virtually the same stone industry represents a significant departure from the expectations of this model. Such a departure occurred in the Levantine region of Southwest Asia with the discovery in the 1930s of hominid fossils in the Tabun and Skhul Caves of the Wadi el-Hughara on Mount Carmel. Unfortunately, the Neandertal fossils from Tabun and the early anatomically-modern fossils from Skhul were described as members of a single hominid population with a wide range of physical variation, one speculated to have been intermediate between Neandertals and early modern humans. Since the 1960s, further excavations of Middle Paleolithic sites from the Levant have recovered additional modern humans in the Qafzeh Cave near Nazareth and additional Neandertals with similar stone industries at the Amud Cave in the Galilee and at Kebara Cave on Mount Carmel. A large sample of Neandertals is also known from Shanidar Cave in Iraq. Although it appears both fossil hominids were present in the Levant between 50,000-100,000 years ago, early modern humans and Neandertals never appear together in the Middle Paleolithic strata of the same cave. The differences between these two hominid types previously interpreted as phylogenetic transformations within an evolving lineage must now be reinterpreted as bio-behavioral contrasts in the adaptations of different hominid species.

Comparing Neandertal and Early Modern Human Behavior. Clearly, there were some behavioral differences between Neandertals and early modern humans. Neandertals became extinct around 35,000 years ago, at the very same time when modern humans were expanding their range to include Northern Eurasia, Australia, and the New World. The main obstacle to comparing the behavior of Neandertals to that of early anatomically-modern humans has been in finding cases where these hominid populations could be contrasted fairly. Attempts based on the European record typically contrast the activities of Neandertals from the Middle Paleolithic cultures in early last glacial conditions, between 35-110,000 years ago, with the activities of anatomically-modern humans from the Upper Paleolithic cultures in the late last glaciation, 12-35,000 years ago. Because the climate of Europe changed dramatically between these two periods, any differences observed may be due less to fundamental behavioral contrasts than to the subsistence and settlement problems imposed by radically different environments.

In Southwest Asia both Neandertals and early anatomically-modern humans are associated with the same Levantine Mousterian stone industry under roughly equivalent climatic conditions between 50-100,000 years ago. This is an ideal situation in which to determine whether major behavioral contrasts are reflected in the associated archeological record. However, evaluating the relationship between Neandertals and early modern humans requires far more detail about the actual behavior and paleoecology of Late Pleistocene hominids than can be discovered by the analysis of their fossils alone. While the hominid fossils and their phylogenetic relationships command more popular attention, the Levantine Mousterian industries associated with these fossils in Southwest Asia also have important implications for understanding hominid behavioral evolution.

What is needed is some way of reliably determining not only the kinds, but also the relative frequencies of the activities of which the stone industries are the residues. One approach to solving this problem is to reconstruct the uses of prehistoric stone tools from wear patterns occurring on their edges and surfaces: lithic use-wear analysis. My research employs this kind of analysis to describe the activities of Middle Paleolithic hominids in the Levant.

Functional Analysis of Levantine Mousterian Assemblages. What is use-wear and how can it be interpreted? As the surface of a stone tool

slides against the material being worked, friction alters the natural shape of the edges and the topography of the stone, leaving microscopic fractures, scratches and abrasion that can be seen at relatively low magnifications, between 45-120X.

In order to learn how to interpret use-wear, I began a program of experiments in which stone tools were used in a variety of tasks similar to those which probably occurred in prehistoric times, such as projectile (spear and arrow) use, butchery, hide scraping, bone carving, processing soft plant matter, woodworking, digging and flintknapping. Artifacts damaged by non-use factors, such as trampling and stream abrasion, were also examined, so that such wear would not be mistaken for use-wear. Performing more than 1000 different experimental uses increased the likelihood of creating wear patterns identical to those in the archeological record. In order to assure that wear patterns could be interpreted correctly, a series of "blind tests" were taken in which stone tools used by other individuals were given to me for analysis. Among 109 tool uses tested, the location of the worn part of the tool was identified correctly 96 percent of the time. The action employed was correctly reconstructed on 84 percent of the tools, and the worked material was identified correctly on 72 percent. These results provide an estimate of the accuracy possible for functional interpretations of Levantine Mousterian tools based on use-wear analysis at low magnifications.

The archeological collections so far analyzed in greatest detail have been those from recent excavations at the Kebara and Qafzeh Caves. Faunal collections from these sites suggest a broadly comparable climate during the Levantine Mousterian occupation, with both caves located among oak-dominated Mediterranean forests. Both Kebara and Qafzeh Caves were filled rapidly by fine, ashy sediments, providing almost ideal conditions for use-wear analysis. Although parts of these cave sediments were disturbed by spring activity during the last glaciation, large blocks of sediment containing flint tools in remarkably fresh condition remain relatively undisturbed. It was from these sediments, which also contained hominid fossils, that archeological samples were drawn. A total of 7084 artifacts were examined, all of the artifacts from Kebara Units IX-XII and Qafzeh Unit XVII.

Of these stone tools, 512 or 7 percent, exhibited wear traces. Prehistoric stone tool uses were reconstructed by matching use-wear patterns to those in the experimental reference collection. This was done for all the worn artifacts, and an estimate was made of the relative frequency of different activities represented in the stone tool assemblages from these sites. Surprisingly, the range and relative frequency of stone tool uses represented is virtually the same at both sites (Table 1). Most of the tools feature wear traces reproduced by a variety of woodworking tasks. The next most frequent set of wear patterns are those matching the results of experimental butchery. Bone working traces represent something of an enigma, as bone tools are rare in the Levantine Mousterian. It is possible these wear traces may have resulted from contact with bone during butchery. On the other hand, stone tools applied to bone dull rapidly and thus may have been more frequently discarded, leaving an abundance of wear traces disproportionately larger than the actual frequency of this activity. The impact of projectile points against unyielding materials is suggested by some patterns similar to those occurring on stone spear and arrow points, wear that is generally found with traces suggesting the abrasion of hafting fibers against the edges of the same tool. Wear traces attributable to hide scraping indicate both hominid populations had mastered the art of leather production. Wear traces attributable to cutting soft plant matter, possibly leaves and brush, may reflect the cutting of vegetation for bedding or brush for fire tinder.

Mousterian assemblages from these and other cave sites in the Mediterranean lowlands of the Levant all present very similar functional characteristics. These functional characteristics do not seem to change either with the antiquity of the assemblages or to vary with their fossil hominid associations, Neandertals at Kebara, early anatomically-modern humans at Qafzeh. The functional characteristics of these assemblages, therefore, probably reflect a set of activities carried out in caves by both Neandertal and early anatomically-modern human populations in response to similar paleoenvironments.

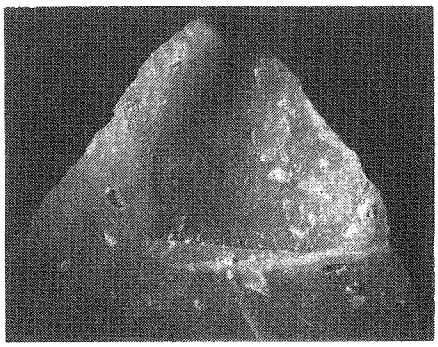
TABLE 1. Functional Characteristics of Levantine Mousterian assemblages associated with Neandertals (Kebara) and with anatomically-modern humans (Qafzeh).

	Kebara IX-XII	Qafzeh XVII
n artifacts	5714	1370
worn tools	448	64
tool uses	689	94
tool uses by activity categories		
projectile impact	50 (7%)	3 (3%)
butchery	104 (15%)	11 (11%)
hide-scraping	35 (5%)	5 (5%)
bone-contact	83 (12%)	16 (17%)
processing soft plant matter	32 (5%)	8 (9%)
woodworking	262 (38%)	35 (37%)
haft wear	87 (13%)	8 (9%)
other/unknown	36 (5%)	8 (9%)

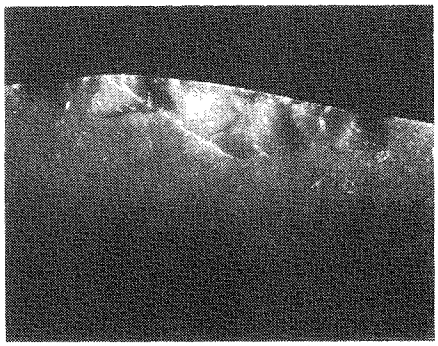
Behavioral Ecology and Late Pleistocene Hominid Evolution. Ofer Bar-Yosef has recently argued that the rapidly cooling early glacial conditions of 65-75,000 years ago may have forced Neandertals south into the Levant and Central Asia from the steppe regions of Southeastern Europe. If anatomically-modern humans were already present in Southwest Asia 80-100,000 years ago, what happened when these populations encountered each other? Was there a long period when two anatomically distinct human species coexisted in the same small part of Southwest Asia? Did one species displace the other? A consideration of the interrelationship of climatic change, behavioral ecology and hominid evolution may help to answer these questions.

Might immigrant Neandertals have interbred with early anatomically-modern humans? Unfortunately, it is difficult to evaluate genetic distance, and thus the possibility of interbreeding, from the morphology of fossils alone. That Neandertal and early modern fossils never occur in the same cave deposits suggests they did not occupy overlapping ranges for prolonged periods of time and may not have had the opportunity to interbreed on a significant scale.

Could these groups have partitioned themselves into non-overlapping niches? The functional characteristics of the stone industries with which they are associated in the Levant 50-100,000 years ago indicate Neandertal and early anatomically-modern populations shared quite similar ways of subsisting in the Levantine environment for tens of thousands of years. The same animal species were hunted by both populations. These are significant obstacles to long term coexistence. Moreover, there is no evidence to suggest early anatomically-modern populations enjoyed any particular competitive advantage over Neandertals. The present situation, in which all Levantine Neandertals appear to be more recent than the Levantine early modern humans, suggests it may have been the anatomically-modern humans who became extinct or were displaced.



Single large step-terminated bending fracture indicating projectile impact.



Unifacial cluster of shallow feather-and hinge-terminated microfractures indicating woodworking. Bright polish is visible only on the immediate area of the edge.

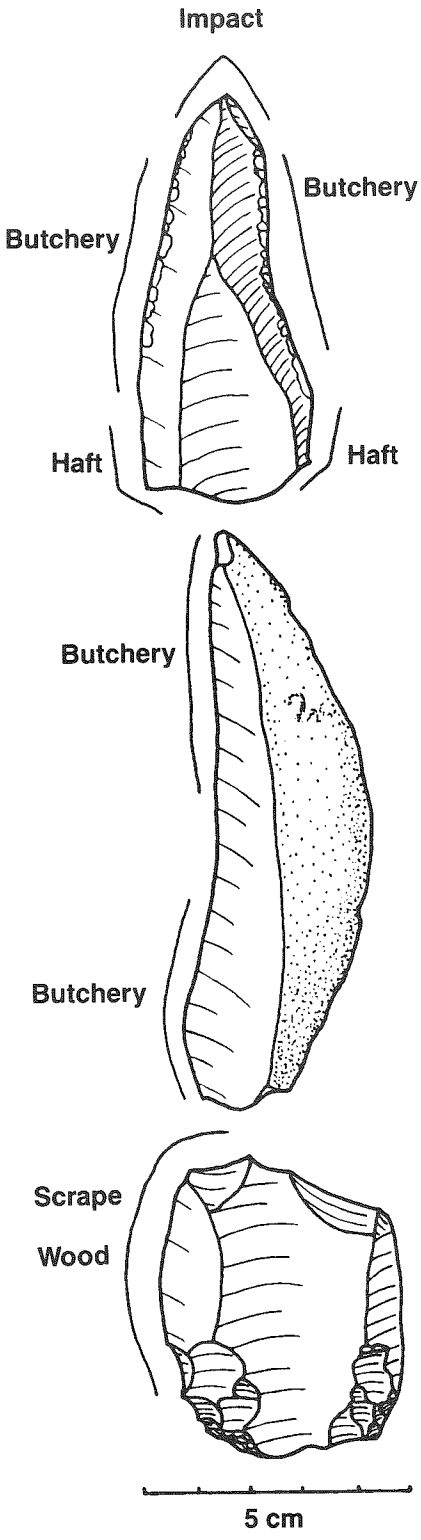
Neandertal fossils first appear in Europe 90-130,000 years ago. During this time, most of Europe was covered by rich temperate woodlands. There is much food in such environments, but it is mainly plant foods, leaves, seeds, nuts, roots and tubers. Collecting such foods requires few tools and certainly far less physical strength than was habitually exerted by Neandertals, judging from their skeletal remains. The superior physical prowess of Neandertals most likely arose from competition with other Neandertals for access to the dense stands of fruits, nuts and other plant foods of the temperate forests.

But such extreme strength has a high metabolic cost. To maintain themselves, Neandertals may have needed to consume a wide variety of the food sources immediately available to them, the bulk of which would have been plant foods. In such a situation, efficient chewing may have been more important than articulate speech in affecting the shape of the Neandertal oral cavity. Neandertals undoubtedly hunted as well, but the faunal remains from European Middle Paleolithic sites suggest an opportunistic pattern of hunting and scavenging, one that contrasts markedly with the more systematic pattern of predation inferred for Upper Paleolithic sites associated with modern humans. The need to defend rich patches of plant food resources from conspecifics may have prevented Neandertals from aggregating in large numbers for prolonged periods, and excluded them from living in environments where food was seasonally scarce or highly mobile. If this was true, then Neandertal ranging patterns may have been controlled by the amount of plant food available in an environment. In North Central Europe, the occurrence of polar desert conditions 65-75,000 years ago coincides with an interruption of Middle Paleolithic/Neandertal settlement. In contrast, anatomically-modern humans successfully colonized more severe polar deserts between 12-22,000 years ago, at the peak of the last glaciation.

As colder conditions became established in Western Eurasia between 65-75,000 years ago, some Neandertals may have moved south into the Levant, a region already populated by early anatomically-modern humans. The adaptation of Neandertals to this new habitat may have involved performing the same range of tool using activities as modern humans, including hunting. Neandertals may even have found themselves at a competitive advantage in the Levantine lowlands, in part because of their ability to control access to rich stands of fruits and nutting trees through their superior physical strength. If they remained in the Levant at all, modern humans may have done so in the highland savanna-steppe of the Negev, Sinai and Transjordan by concentrating their efforts on the resources of that region, mainly large herds of highly mobile game. Unfortunately no fossil remains are known from these highland areas. However, use-wear analysis of Levantine Mousterian assemblages from southern Jordan show a greater proportion of edges worn from projectile impact and butchery than do sites from the lowlands of northern Israel.

To occupy the steppe-savannas on the southern periphery of the Levant would have been a novel adaptation for Eurasian Neandertals, but one with which anatomically-modern populations had been acquainted in Africa for tens of millennia. The patchily distributed plant resources and mobile animal herds of the open savanna would have required frequent long-distance movements and regular changes in group size to accommodate seasonal fluctuations in resource availability. These are hallmarks of arid land adaptions by contemporary hunter-gatherer societies. Early modern humans would have been at a locomotor advantage in such prolonged movements. Speech is an effective way to rapidly communicate information about mobile and unpredictably located resources. If anatomically-modern humans possessed a superior capacity for speech, this may have given them an additional competitive edge in the occupation of environments that were of marginal value to Neandertals.

As glacial ice volume increased between 32-64,000 years ago, terrestrial productivity dropped worldwide, creating extensive pine forests, tundra, subtropical deserts and savannas. These are all ecosystems in which humanly exploitable food resources are either highly mobile, highly seasonal and/or so widely dispersed as to require a tremendous expenditure of energy to find them. As the Levant became cooler and drier near the middle of the last glaciation, the food resources of Mediterranean forests would have become less accessible as plants directed water into the growth of woody structural elements. In such environments Neandertals would have faced increasing competition for plant foods from such arboreal predators as birds and monkeys. In the savanna and desert margin regions of the southern Levant, cooler conditions would have increased the retention of rainfall on the ground, expanding the low brush and grass cover, leading in turn to an increase of large herbivore game. If the populations of savanna dwelling anatomically-modern humans were flourishing at a time when forest dwelling Neandertals were experiencing subsistence stress, then a competitive situation may have developed in which modern humans were better able to exploit resources and to reproduce themselves in areas where their ranges overlapped with those of Neandertals. A cycle may have begun at the boundaries of these two species, culminating in the replacement of Neandertals throughout Western Eurasia by anatomically-modern humans.



Levantine Mousterian stone tools with functions reconstructed from use-wear analysis.

Conclusion. For decades Neandertals have been portrayed as passive creatures who obligingly cleared the evolutionary stage for their anatomically-modern descendants. This is a neat, simple arrangement of the hominid fossil record. Unfortunately, it is wrong. As a fossil taxon with a consistent suite of morphological characteristics that persists for tens of millennia within a limited geographic distribution, Neandertals amply satisfy the paleontological criteria for being a separate species from anatomically-modern humans. That their behavior, as reflected in the Levantine Mousterian archeological record, mimics that of early modern humans is hardly surprising for two closely related species living in similar environments. Such mimicry only reflects one of many ways in which species compete with one another. That Neandertals became extinct and our ancestors survived was not an inevitable result of their evolution, but rather an event which can be explained by reference to evolutionary processes observable today. ■

ACKNOWLEDGEMENTS. *This is a contribution to the "Origins of Modern Humans in Southwest Asia Project." My research was supported by grants from Harvard University, the L.S.B. Leakey Foundation and the National Science Foundation.*

ADDITIONAL READING

Mellars, Paul A. and Christopher B. Stringer (editors). 1989 *The Human Revolution: Behavioural and Biological Perspectives on the Origins of Modern Humans,* Edinburgh University Press.

Spencer, Frank. 1984 The Neandertals and Their Evolutionary Significance: A Brief Historical Survey. In F. Smith and F. Spencer (eds.) *The Origins of Modern Humans: A World Survey of the Fossil Evidence.* pp. 1-50. New York: Alan R. Liss.

Trinkaus, Erik. 1986 The Neandertals and Modern Human Origins. *Annual Review of Anthropology* 15: 193-218.

HAGAHAI SETTLEMENT PATTERN AND SUBSISTENCE (PAPUA, NEW GUINEA)

Dr. David J. Boyd
University of California, Davis

In 1983, the Hagahai initiated their first direct and sustained contact with outsiders. By ending their isolation from our world, they became one of a small number of recently contacted peoples in the world and one of the few contemporary human populations about which very little currently is known. The three-month period (7 September—10 December 1987) of field research reported here commenced the study of Hagahai ecological adaptation with a preliminary assessment of settlement pattern and substance strategy.

The Hagahai. The Hagahai live in a remote mountainous region on the northern fringe of the Papua New Guinea highlands. It is a tropical forest zone with altitudes from 200-1800m. Hagahai territory is bounded roughly on the southwest by the Yuat River Gorge and on the north and east by the peaks of the Schrader Range.

Hagahai is the name used to designate five groups of people who speak the same language (also termed Hagahai) and who occupy contiguous territories.

The population of 245 exhibits a sex ratio highly biased in favor of men: overall, there are 151 men for each 100 women. While there is variation in the sex ratio between the groups, none approaches a balanced ratio. It is likely that selective female infanticide has been a major contributing factor to the sex imbalance, but informants insist the practice has been stopped recently. The Hagahai population also is characterized by a relative lack of children. Only 37 percent of the population is 15 years of age or younger. These two factors combine to produce an extreme shortage of marriageable women and potentially severe problems for maintaining a reproductively vital population.

Settlement Pattern. The distribution of Hagahai people over the landscape reflects their highly mobile lifestyle. Individuals affiliate with a primary residential site, but spend much of their time away from their primary residences tending gardens and tree crops, foraging for wild resources, and visiting other households. When absent from their primary residences, they live at secondary sites that are scattered throughout the forest near gardens, groves of productive trees (e.g., sago, pandanus, breadfruit), and favored hunting, fishing, and foraging zones.

Primary residential sites consist of one to four houses of "permanent" construction, several centrally located earthoven/firepit holes, outdoor storage platforms, and a pig sty, all surrounded by interplanted banana, papaya, pandanus, and breadfruit trees. The houses are low- walled, rectangular structures with simple pitched roofs and without constructed floors. Exterior walls commonly are made of wooden slabs positioned vertically and lashed together with vines over a sapling frame; the roof, with a substantial overhang, is thatched with swordgrass or sago or pandanus leaves and rises to the ridge 2-3m high. Separate doorways for men and women open onto an interior space that is sexually segregated, a full or partial wall often separating men's and women's quarters. Firepits are the focal interior feature and some portion of space will be used to house small pigs. Personal belongings are bundled and stored in the rafters.

Secondary residential sites, which vary greatly in size and accommodations, are characterized by a minimal combination of some form of shelter and at least one firepit or earthoven. The most simple shelters are natural rock outcrop formations. These are quite numerous in Hagahai territory. Another natural shelter is provided by shallow openings in the base of massive trees. These "nests" are quite small, but adequate for 1 or 2 people. The most simple man-made secondary sites consist of single-sided leantos of piled brush or leafy thatch. These can be constructed (and reconstructed) in a few minutes and are encountered frequently in the forest. Slightly more complex are shelters with a tipped roof atop four posts and those with a roof and one wall. The most substantial secondary residences are small versions of structures found at primary sites. Indeed, established secondary sites often are chosen as locations for new primary residences.

The Hagahai maintain 19 primary residential living sites. The average site population is 13 people, but ranges from 5-27. The smallest site consists of one nuclear family; the largest site is composed of two pairs of brothers, their four wives (two of whom are sisters), an adult, unmarried sister, and 17 children. Unfortunately, genealogical information remains incomplete so it is not possible to determine the relationships between many co-residents at other sites. What does seem apparent, however, is that sons usually continue to live with a surviving father even after marriage, and brothers often reside together. There also are several examples of male affines, related through sister-exchange marriages, joining to form single primary residences.

Subsistence Practices. Hagahai subsistence practices are organized as a "mixed" system that incorporates horticulture, arboculture, pig husbandry, hunting, fishing, and foraging.

Horticultural production activities follow an extensive form of swidden cultivation. The gardening cycle begins in mid-year (ca. May-June) with the clearing of new plots in primary and mature secondary forest. Men generally make one pass through the site felling the largest trees in a fashion designed also to take down as many small trees as possible. Women do most of the ground clear-

ing with bushknives while men finish cutting trees and begin collecting fencing materials. Both sexes assist with piling and burning the debris and with planting, although it appears that women provide the bulk of labor for these tasks. There is no tilling of the soil; planting materials are stuck in ground loosened slightly with a digging stick. Men busy themselves with building strong, heavily buttressed log fences, up to 1.5m high, to protect the gardens from wild and domestic pigs. Fence construction is the most labor intensive horticultural task.

Two kinds of gardens are distinguished on the basis of whether the predominant ground crop is taro or sweet potato. Aside from this difference, all gardens are complexly interplanted with the standard array of Melanesian crops. In addition to taro and sweet potato, Hagahai gardeners seem to emphasize bananas, yams, tapioca, lowland pitpit, sugarcane, winged bean, papaya, corn, assorted greens, and tobacco. Of the more recently introduced crops, only the New World taro, pumpkin, cucumber, peanuts, and pineapple are widely planted.

Garden-making is a cooperative affair. One person, referred to as the "father/mother" of the garden, chooses a site on land to which they have access rights and begins initial clearing. Others, who will include coresidents as well as relatives and friends who live elsewhere, are invited to help with the clearing and fencing activities and, in turn, are allocated plots within the garden. Members of invited households burn, plant, and tend their own plots. Invited participants often reciprocate by starting a new garden on their own land and inviting the sponsor of the earlier garden to join in the effort.

The practice of dividing gardens among several people allows each household to exploit a number of food- producing sites scattered around their own territory and on the territory of others. The strategy of households is to have gardens ready in places where they intend to spend time during the year, e.g., near the living sites of relatives and friends, and in the vicinity of favored hunting, fishing, and foraging zones. The ready availability of food at various locations increases subsistence security and facilitates the mobile strategy of resource exploitation by allowing stays of longer duration away from primary residences. Indeed, as individuals and small groups move through the forest, they often pass from one garden to the next checking fences, monitoring maturing crops, and harvesting the occasional meal.

David Boyd and group of Hagahai boys in a newly cleared and planted garden.

Hagahai arboculture focuses mainly on five trees: sago, "marita" pandanus, breadfruit, papaya, and bananas. Sago is planted in small swampy areas that stay wet yearround. Each tree is individually owned by the person who plants it or by a descendent who inherits it. Both men and women own sago trees. When a tree is cut, the pith is processed by a group of people invited by the owner to share in the work and in the starchy flour produced. The flour usually is wrapped in leaves and cooked in an earthoven. It is a highly prized food. The other four cultivated trees are planted around all primary residential sites, often in dense stands. As noted above, bananas and papaya also are included in all gardens. Often, too, pandanus and breadfruit are planted in older gardens just before they are left fallow. Indeed, mature pandanus and breadfruit trees are excellent markers of abandoned residential and garden sites. No wild varieties of any of these trees are exploited for foodstuffs.

Hagahai raise domestic pigs that, in the past, were butchered, cooked, and exchanged as part of a mortuary complex. Today, pigs are cooked and exchanged by successful pig-raisers who sponsor prestigious social gatherings that may attract several hundred people who come to sing and dance. These "singsing" events are by far the largest group activities in which Hagahai people participate.

Pigs are always acquired as young animals through trade of feathers and furs to neighboring groups or by the capture of wild piglets. A person also may be given a sow by a close relative and can build a herd with her offspring. When piglets are weaned, they are subjected to intensive attention for several months. They are fed, fondled, and transported by their keepers, who are in nearly constant contact with them, and are taken into the houses to sleep at night. As they mature into young shoats, they are led on a rope on their keeper's daily rounds and are tied in the sty for the night. Pigs are encouraged to remain near the house site by daily feedings of sweet potatoes, papaya, and human food scraps. Women bear the major burden of tending pigs and old women confirm that they have always

been involved in pig husbandry. Often, as pigs mature, they return less frequently to the house site, foraging instead in the bush for their food. Owners say they then go find the general location where the pig has decided to live and occasionally take food to renew their contact. One man also added that sometimes the owner will make a garden in the vicinity so he can more easily get food to his pig. When the animal is ready to butcher, the owner tries to lead the beast to the site of the impending feast, but if this proves impossible, the pig is dispatched in the forest and the carcass is carried to the cooking site. There are no reliable estimates of the number of pigs kept by the Hagahai.

The Hagahai round out their subsistence adaptation by exploiting a large array of wild plants and animals. Wild pigs are taken with bow-and-arrow and with pit and deadfall traps. Traps often are placed near or just inside gardens which attract the attention of foraging pigs. Pigs are the largest game animal available and appear to be the most important source of animal protein for the Hagahai. A variety of other smaller mammals, including phalangers, possums, tree kangaroos, wallabies, sugar gliders, and fruit bats, are hunted with bow-and-arrow and clubs. Those species with valued fur are carefully skinned; the pelts are sun-dried and traded with neighboring groups.

A hunter's strategy usually involves going to an area where he recently has seen animal tracks, food leavings, and feces. Also, he will determine to check regularly areas around trees and vines, the nuts and fruits of which are known to be consumed by a prey species. A good dog is a much valued companion when hunting terrestrial animals. Dogs greatly expand the territory a hunter can cover and are able to run and corner pigs and tree other prey. Once treed, the animal sought may be reached by the hunter climbing the same tree, or one nearby. If it proves impossible to get a clear shot or to land an effective blow, the hunter will fell the tree to pursue his quarry.

Birds are shot from blinds located near fruiting trees and nesting and drinking sites; they, of course, are prized for their plumes as well as their meat. All of the above prey species are actively sought by solitary hunters or by groups of 2-4 men. Only rarely do larger groups cooperate in a hunt.

Lizards, one species of which grows to over a meter in length, may be shot or clubbed. Evidence for the consumption of snakes is ambiguous: many people stated flatly that they did not eat snakes, while others said that they only ate large snakes. I was unable to clear up this discrepancy. Freshwater eels and small fish are taken from the rivers with bark traps and, very recently, hook-and-line. Frogs are killed by boys with sticks who roam the bush from the age of 7 or 8 looking for manageable prey. Various grubs and beetles are eaten on the spot.

Numerous wild plant species are utilized for food, fiber, tobacco wrappers, betelnut condiment, and medicine. To date, over 100 exploited wild plants have been identified and the list continues to expand. Nearly 90 species provide edible fruit or leaves, although it is not yet known what the actual contribution of wild plant matter is to the local diet.

Conclusion. The Hagahai are mobile forager-horticulturalists who live at low densities and are widely scattered over their mountainous territory. Their mixed subsistence strategy exploits both wild and cultivated resources and presses lightly on their environment. Until this decade, they pursued their livelihood with little concern for, and little attention from, the outside world.

Recent influences promise to alter rapidly the Hagahai world. The Western Highlands Baptist Union has established missions in Luyaluya and Mamusi territories. Mission workers, with the support of government representatives, are demanding that the Hagahai relinquish their mobile adaptation and settle in permanent communities at the missions. Promises of health care, schools, and commerce are used to promote this population aggregation and many Hagahai seem willing to comply. Several primary residential sites are now located near the missions, and many people have secondary residences within a one-hour walk of a mission. A mission airstrip is nearly operational at Mamusi, coffee tree seedlings have been introduced to begin production of a cash crop, and wage labor migration by young men looms on the horizon.

This array of powerful forces makes it probable that the Hagahai will shift towards a sedentary horticultural adaptation characteristic of more densely settled highlands regions. With this change, our opportunity to understand how the Hagahai have organized themselves to survive in this once remote tropical environment will have vanished. ■

NEW FELLOWS

The Trustees and Scientists of the Leakey Foundation welcome and gratefully acknowledge the support of the following Annual Fellows:

Mr. Fred Myers, Mr. Kenneth Rainin, David H. Koch Foundation, The Swig Foundations, Mr. Michel Weill, Mrs. Catherine Teague, Liz Claiborne, Art Ortenberg Foundation, Ms. Claudia Mirkin, Drs. Nancy Ascher & John P. Roberts.

MEMORIAL

Elizabeth Waldron, a most devoted member of the L.S.B. Leakey Foundation Associates, who gave of her time, gentle wisdom and friendship without stint, died in Los Angeles June 3, 1989 of cancer. Her many friends in the Foundation miss her, and remember her with deep affection.

GNAWING AND KNOWING: A STRATEGY FOR MAKING INFERENCES ABOUT HOMINID DIET

Nancy M. Stone
Department of Anthropology, University of New Mexico

Nancy Stone

Archeologists who study the very earliest appearances of our human ancestors ask themselves and their colleagues many questions. They look at the small number of hominid skeletal parts, a large number of stone tools and a huge assortment of modified and unmodified animal bones and wonder, *''What was life like for these creatures?''*

In trying to understand the dynamics affecting the archeological record of, for example, the "Zinjanthropus" site (FLK 22) type locality of *Australopithecus boisei*, in Bed I at Olduvai Gorge (Tanzania), researchers would probably agree that controversy surrounds their efforts, this particularly with respect to models of hominid behavior based on the kinds, number, condition and distribution of animal bones found at the site.

Prior to 1959, when excavation of the "Zinj" site began under the direction of Dr. Mary D. Leakey, it was customary for archeologists to relate all the faunal materials found in association with hominid fossils directly to the actions of early hominids themselves. In the 1940s, for instance, Raymond Dart had recovered Australopithecine skeletal parts from deposits in South Africa that also contained provocatively modified antelope jaw and thigh bones. Dart proposed that the jaws and limb bones had been used by hominids as saws and clubs, and he developed a model of pre-human predatory behavior that was distinctive in its ferocity.

The excavators of the cave site of Zhoukoudian in China had earlier reached a similar conclusion about the carnivorous appetites of the *Homo erectus* specimens found in some of these deposits. In addition to four-legged prey, however, "Peking Man" (*Homo erectus*) was thought to have consumed members of his own species.

The assumption that hominids were aggressive hunters led to a series of stipulative statements about other aspects of early hominid behavior. Successful hunting of medium and large-size prey normally provides more food than any one individual can consume. So, if hominids were hunting, it was argued, food could and therefore would have been shared. Hunting was assumed to have been exclusively an activity of early man, since early woman, once she reached sexual maturity, was thought to have been intermittently disabled by pregnancy and thereafter primarily occupied with the care of offspring. Maternal duties would have limited subsistence contribution of hominid females to plant gathering.

From this model of behavior, a series of expectations was derived for the contents of archeological sites. One should find localizations of stone tools and the debris from their manufacture in association with animal bones bearing cut marks produced by disarticulation and meat removal. These expectations were gratifyingly fulfilled by work at the "Zinj" site, although some of the properties of the site and its contents raised questions about hominid feeding strategies.

Looking at the faunal assemblage in its entirety one initially noticed a striking diversity in the animal species represented. There were bones from baby pigs, birds' eggs, juvenile crocodile teeth that had apparently been shed in the normal course of maturation, and skeletal segments of both medium and large body-size ungulates. Question number one became, *''Did the diet of the associated hominids include all or only some of these species?''*

Louis Leakey's initial judgment was well-reasoned and also prophetic in terms of more recent arguments. He considered that the transition from primarily vegetarian ape to mighty hunter would have been a gradual process. The "Zinj" hominid (*A. boisei*) must therefore have been dining on the less formidable of the animal species in the deposits—the piglets and birds' eggs—and using the associated stone tools for whatever minimal processing was involved. But when a hominid fossil (*Homo habilis*) described as contemporary with, but possessing a larger brain than the eponymous "Zinj," was discovered at the nearby site of FLK NN, it was argued that the habiline family had been the real homemakers at the "Zinj" site. On the basis of evidence of increasing hominid cranial capacity, it appeared reasonable to imagine that habilines were hunting the larger prey species in the deposit, and "Zinj" himself was demoted to the position of a Pleistocene man who came to dinner and died.

One might ask how can scientists using knowledge of the present investigate an unknown past that may have been entirely different from our conventional views? One way is to look for any evidence of incompatibility between our archeological data and the ideas we use to explain them. If this scrutiny reveals conflicts or loose ends, a common practice is to determine whether our explanation can be adjusted to produce a better fit with

the data. A discontinuity between data and interpretation often requires that we completely rethink the picture of the past.

Just such a lack of fit had been suggested by the problem of species diversity at the "Zinj" site, and in the late 1970s other properties of the animal bones led researchers to question the assumption that hominids at this early time period had been even tentative hunters. Data on the anatomical part frequencies of the larger body-size animals indicated that many parts with minimal food value were included in the faunal assemblage. In addition, many of these bones were highly fragmented in ways that suggested that hominids had been consuming the bone marrow rather than the almost nonexistent meat. Comparing the debris from ancient archeological sites to the totally different remains from modern hunting by humans, Lewis R. Binford and others began to argue that hominid access to animal protein appeared to result from scavenging.

This challenge to the prevailing interpretation of evidence has had healthy consequences for early man studies. It has required proponents of the two polar views of hominid subsistence (hunting vs. scavenging) to re-examine the data from the "Zinj" site. It has also prompted investigation into the behavior of living animals in order to evaluate conflicting claims.

The set of observations from the "Zinj" site to which the controversy now points were made by Dr. Henry Bunn (University of Wisconsin-Madison) on a sub-group of the animal bones that not only have cut marks on them from hominid stone tools but are also inscribed with animal tooth marks. These occur in clustered groupings containing stone tools, bones with only gnaw marks, bones with only cut marks and unmodified bones.

Dr. Leakey had originally reported the presence of gnawing on some of the bones from the "Zinj" site. She suggested that hominids had discarded the bones after feeding, and that scavenging carnivores subsequently gnawed on the bones and then abandoned them in place. This interpretation was compatible with the view favoring hunting as the hominid food procurement strategy, and after Bunn introduced his observations of cut marks on the gnawed bones, the model was still used to account for the presence of processing marks from two different kinds of agents.

To Binford, who has studied human hunters in different environmental settings and observed both scavenging and non-scavenging carnivores, this proposed event sequence seemed highly improbable. His skepticism focused on the postulated behavior of a scavenger almost certainly identifiable as the spotted hyena—a prominent carnivore on the African landscape today as well as 1.8 million years ago.

Like many predators, hyenas behave flexibly in response to changing environmental conditions, but wildlife biologists who study this carnivore are unanimous in describing them as major modifiers of the distribution of animal carcasses that result from predation and natural death. Although hyenas may sometimes compete with lions for access to freshly killed carcasses, they are more commonly observed as second-wave feeders who disarticulate and carry away carcass parts to some protected location where there are no competitors for the cartilage, bone marrow and bone tissue itself which they can devour and digest.

It seemed to Binford that if hyenas were scavenging the remains from hominid food consumption, they would be more likely extractive agents that removed bones from hominid-generated sites rather than contributive agents that added another property, in this case tooth marks, to the hominid-processed bones. The presence of both carnivore tooth marks and stone tool cut marks on bones from the "Zinj" site seemed to imply the reverse of the originally proposed event sequence; an inference of hominid scavenging of bones originally gnawed by hyena seemed more reasonable.

The confidence that one can have in this interpretive argument depends on the applicability of the experience of observers of hyena behavior to the circumstances postulated for the "Zinj" site. A series of experiments was designed by Binford to replicate such circumstances in controlled situations that would be directly relevant to an evaluation of the argument. With the generous support of the L.S.B. Leakey Foundation, we went to the Kruger National Park in Southern Africa to work with Dr. M.G.L. Mills, Senior Research Officer of the Park's Nature Conservancy. Gus Mills has conducted long-term research into hyena behavior and is now investigating more generalized predator-prey relationships in the southeastern sector of the Kruger Park.

Within the approximately 21,000 square kilometers set aside as a wild animal refuge, Park officials estimate that at least 211,390 large mammals feed, reproduce and die. These include familiar species like zebra, giraffe, impala, elephant, lion and hyena and also the less well-known tsessebe, reedbuck and kudu. In order to prevent human beings from becoming prey, Park rules require that visitors remain in protected camps behind high barriers from sunset to sunrise each day.

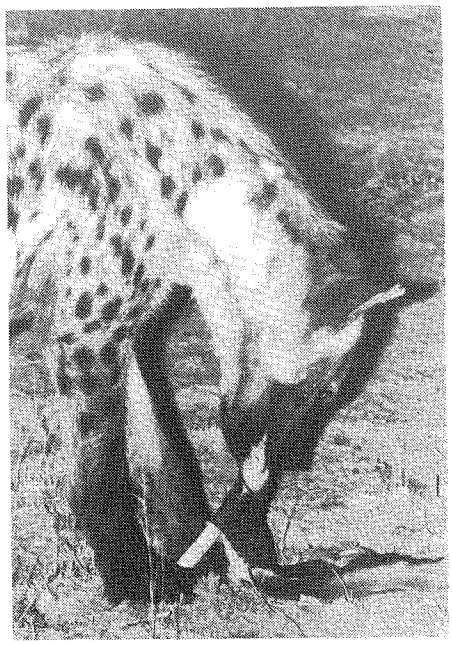
At the refuse dump outside the fenced perimeter of the Skukuza Camp in the late afternoon of August 19, 1986, we set out the first of our four experiments designed to inform us about what hyenas actually do when they encounter processed, discarded bones. We were given access to a supply of African buffalo limb bones from animals killed and butchered as part of the herd monitoring and management program of the Nature Conservancy. All the major muscle masses had been removed from these bones, but some meaty scraps and all cartilage and periosteum remained. In Experiment 1A we selected five complete upper front leg bones (humeri) and seven complete upper rear leg bones (femora) with attached lower leg bones (tibiae). Four of the femora were not modified, but the other eight bones were broken open and processed by Binford to simulate modified bones remaining on the "Zinj" floor. Processing resulted in 20 large bone units, four detached large bone fragments produced by the percussion and several bone splinters still attached to the bone by the tough periosteum tissue. Bone marrow was removed from eight of the bone units and allowed to remain in the bone cavity of 12 units. All of these materials, including the bone marrow, were grouped in a north-south align-

ment between two metal stakes 2.5 meters apart in a large, open area of the dump. The arrangement was then fully recorded.

Within the hour the experiment had attracted some unexpected customers. Two ground hornbills and many marabou storks began to compete with one another for control of the area. The more dominant hornbills attempted to remove the meaty scraps still attached to one broken humerus, and in the process it was relocated 2.8 meters west of its original position. The marabou storks were initially attracted by the marrow, but after consuming it they began to tug at two of the large bone fragments which they moved 1.8 and 2.2 meters east of the original positions and then abandoned. At dusk the storks were roosting in nearby trees, the hornbills had disappeared, and individual impala were wandering through the clearing showing no interest in any of the materials involved in the experiment.

When we arrived early the next morning, very little remained of the boney buffet we had set out the day before. Both jackal and hyena spoor were clearly visible in the sandy, ashy soil surrounding the metal stakes and only two bone splinters from our original arrangement of 20 bone units and four splinters remained in place. We searched extensively over a peripheral area of approximately 10,000 square meters and were able to recover only eight of the original units: 12 units had disappeared from the dump site altogether.

The eight original units that remained were dispersed an average of 17.1 meters from their position on the previous day. The most distant bone was 25.1 meters and the closest was 6 meters from their initial positions in the experimental arrangement. These dispersed bone units had been heavily gnawed by scavenging carnivores and the adhering meat and marrow had been removed. In contrast, the two long bone splinters relocated by storks and the two that had been undisturbed by birds, not only remained where we had last observed them, but they had no animal tooth marks on them.



A hyena gnawing the articular end of a limb bone.

Hyenas approach the task of bone marrow extraction and limb bone consumption by first gnawing on the spongy bone of an articular end. Not surprisingly, most of the recovered bone units had tooth marks in these places. Hyenas had made an interesting selection of bones for complete removal from the site: the four whole thigh bones and all but two of the bone units containing marrow were missing. At least in this case, removal preference could be ranked in terms of the presence of bone marrow and the size of the package. All bones had contained at least some adhering meat, so evaluation of any preference for this condition was deferred until Experiments 2A and 2B were carried out.

Although not strictly comparable to the physical circumstances postulated for the "Zinj" site, the dump site had been chosen from among the range of settings available at the Kruger Park because it represented a magnet location at which many different animal species were known to be intermittently present. Since we also wanted to observe the consequences of scavenging carnivore behavior in a more remote setting, a site in the bushveld was chosen for Experiment 1B.

On a bedrock outcrop upslope from a large, grassy area some distance from the Skukuza Camp, Binford set up processing operations on a group of 12 African buffalo limb bones supplied by the Nature Conservancy staff. The amount of meaty scraps remaining on these bones was comparable to that in Experiment 1A. Three femora with attached proximal tibiae were split and the marrow removed. One complete femur with no attached parts was broken horizontally, but the marrow was not removed. Two femora and five meaty units consisting of proximal tibia and attached patella were unmodified, and a single humerus was split horizontally and the marrow removed. Four large bone splinters and 19 impact chips were produced in the course of bone preparation.

When we returned to the bushveld site the next morning we discovered even fewer bone units remaining from our original arrangement than in the previous experiment. Three large bone splinters and the 19 impact chips were all that remained on the bedrock outcrop, and none had been modified in any way by animal gnawing. Hyena spoor were visible in the soil surrounding the outcrop, and only three of the original 17 large bone units were recovered at an average distance of 34.9 meters from their original placement. The meaty scraps had been removed from all three recovered bones, the spongy bone of the articular ends contained many deep tooth marks, and the proximal end of the one remaining femur had been completely gnawed away.

We considered the results of these two experiments to have provocative negative implications for the proposition that scavenging carnivores had gnawed *in situ* the bony refuse remaining from hominid feeding sessions at the "Zinj" site. We were curious, however, about how hyenas would respond to totally defleshed bones and had designed Experiments 2A and 2B to permit us to observe the results of scavenger encounters with bones that had been stripped of all adhering meat and tissue and which subsequently had been allowed to dry for one (2A) or two (2B) days.

We returned to the dump site with seven complete femora and three complete humeri, none of which had any attached parts. Two of the femora were not modified, but Binford broke the remaining eight bones into a total

of 16 units and the marrow was removed from one-half of the segments. Nineteen large bone splinters and 13 impact chips were produced in the course of this processing, and these were placed between the metal stakes along with the bone marrow and large bone units.

Marabou storks had begun to gather as we were documenting the arrangement, and after we had withdrawn about 50 meters they approached and consumed the pile of bone marrow. Prior to leaving the site they also moved a proximal humerus 1.2 meters to the south of its original location and two bone splinters were relocated 1 meter to the east.

By the next morning, our original arrangement of 18 large bone units and 19 large bone splinters had been considerably reduced and relocated. All 13 of the impact chips had been ignored but only 12 of the 19 bone splinters remained; there were *no* visible animal tooth marks on them, however, None of the 18 large bone units remained in their original placement, and only six were recovered after a search of the surrounding bush. The closest of these was 10 meters west of its original position and the most distant was 30.9 meters. Five of the six bones were extensively covered with tooth pits and scratches, and major portions of the articular ends were simply gnawed away.

A very similar result occurred in the last of our four experiments when we returned to the bushveld site with two complete buffalo humeri and four complete femora. Binford broke open all of the femora but the humeri were unmodified. A total of 10 large units were left on the bedrock outcrop. The three bone splinters and 19 impact chips remaining from Experiment 1B were left in place, and an additional 15 bone splinters and 49 impact chips produced by splitting the femora were left where they fell.

Next morning, none of the bone units remained on the outcrop and only three were located during our search of the grassy area. None of the bones with marrow originally present in them were recovered, and all three of the recovered bone units were covered with tooth marks and sections had been gnawed away. In contrast, the long bone splinters and chips had remained undisturbed on the outcrop.

Detailed tabulations and comparisons of the results of these four experiments were prepared and published, (Journal of Anthropological Archeology), along with a discussion of the implications of this research for conflicting claims about hominid subsistence strategies. These can be summarized in terms of three important general observations: a) 70 percent of the total of 65 bone units involved in the experiments were unrecoverable; b) the average transport distance of the remaining 30 percent was 21.4 meters; and c) only long bone splinters and impact chips, none of which had been gnawed by carnivores, remained in their original positions.

We can now use these observations as a frame of reference against which to evaluate claims that (1) carnivores were attracted to the remains of hominid food consumption at the "Zinj" site, (2) gnawed on the bones exactly where they found them, and (3) left the cut-marked and gnawed bones in their original positions. We would be inclined to say that the first proposition is probable if the remains included meat, bone marrow, and/or spongy bone tissue, but that propositions two and three contradict what our experiments tell us about the behavior of scavenging carnivores. Going one step further, if we were to superimpose the spatial distribution of the recovered bones in our experiments over the reported distribution at the "Zinj" site of bones with both animal tooth marks and stone tool cut marks, it would be apparent that only our *ungnawed* splinters and chips would coincide with clustered tools and bones, and that all of our recovered *gnawed* bones would lie outside the perimeter of the site.

A linkage of our recent observations to earlier speculations about the "Zinj" site would have to result in the conclusion that, given current knowledge, carnivore tooth marks must have preceded hominid cut marks on the bones on which both occur. Such a sequence of modifications could only occur if hominid access to the bones had succeeded carnivore access, which is another way of saying that hominids, too, were scavenging.

Our experiments are relevant to a further aspect of the hominid vs. scavenging carnivore succession controversy. The original suggestion was that although more than 90 percent of the bones remaining at the "Zinj" site were small and fragmentary, hominids had transported many large, meaty animal parts acquired through effective competition with predators at kill sites.

As part of an argument to fit the archeologically-documented, fragmentary faunal remains to a behavioral scenario involving hominid exploitation of big anatomical units, Dr. Bunn has postulated that scavenging carnivores removed a total of 88 long bone articular ends from the "Zinj" site.

Two aspects of this contention are interesting: the identity of the anatomical units of which the removed articular ends were once a part, and the basis for the inference that things absent at excavation were once originally present. Considering the latter aspect first, we have no problem with the routine calculation by archeologists of ratios of long bone splinters to articular ends present at a site in order to evaluate whether there has been selective extraction of parts from a faunal assemblage.

The particular relevance of our experiments to this debate concerns the claim that the missing bones consisted of only three body part classes: femur, tibia and radio-ulna. It is argued that hyenas chose these anatomical parts in preference to articular ends from the humerus (which are represented in the "Zinj" site assemblage) because of their greater food value. Our experiments demonstrate that hyenas appear to have *no* preference for the articular ends of a femur as opposed to a humerus, and that both types of bone units are systematically removed by hyenas when they encounter them. The bias that *does* appear to affect hyena bone selection is related to the presence of meat, bone marrow and/or spongy bone tissue.

Conclusions: from our experiences in the Kruger National Park we learned that some of the ideas about the behavior of scavenging carnivores in the past contradict the observable behavior of the same species in the present. This knowledge in turn casts doubt on the view that hominid hun-

ting was responsible for the accumulation of the faunal material at the "Zinj" site 1.8 million years ago.

Exactly what hominids *were* doing is only partially clear. That they were sometimes scavenging body parts from larger mammals seems a secure inference, but what role, if any, did smaller body-size animals play in hominid diet? Is their presence in the assemblage related to hominids or to other predators? There have been no reports describing cut marks or gnawing patterns on the non-ungulate bones from the "Zinj" site, so it is unclear how to integrate these data with our ideas about hominid subsistence. It is at least possible that almost two million years ago life simply terminated for many small animals at a location that later became a crucial site for understanding the behavior of human ancestors. The task of discriminating between such a background faunal population and those animals exploited by hominids will require continued future work back and forth between observation of relevant dynamics in the natural world and careful analysis of archeological data sets. Clearly, in the domain of scientific investigation, new knowledge begets new questions. ■

Long-Term Study of Adaptation and Social Change in Two Lowland Bolivian Foraging Societies

Allyn MacLean Stearman

Associate Professor of Anthropology, University of Central Florida

Allyn MacLean Stearman

In the summer of 1988 Allyn MacLean Stearman, Associate Professor of Anthropology at the University of Central Florida, had completed research work conducted in lowland Bolivia among the indigenous Siriono and Yuqui peoples. Preliminary analysis of the data completed was provided to several groups who will be monitoring a large Interamerican Development Bank project in the Yuqui area. The following is an abstract of the final report.

Growing interest in developing the Amazon Basin has placed both land and indigenous populations at risk. In response to this situation, recent anthropological research has begun to focus on problems of adaptation, subsistence, and resource utilization to better understand the existing patterns of land use by native populations in this area. One of the goals of this type of research is to create a body of information that will encourage more rational approaches to development objectives in the Amazon Basin and contiguous areas.

This research presents data that monitors the long-term ecological and sociocultural consequences of resource depletion resulting from faunal decline, intensification of horticulture, and increased extraction of forest products. Additionally, problems related to settler incursion, increased participation in a market economy, and the process of acculturation were analyzed. Two indigenous groups were selected for study, the Yuqui and Siriono of lowland Bolivia.

Methodology to achieve the stated objectives of the research project included a census of both groups, mapping of the settlements and foraging territories, the securing of aerial and satellite photographs of these regions spanning a period of ten years or more, and a daily tabulation of all gathered products and animal protein consumed by the censed populations. In addition, interviews were carried out among members of the target groups and their non-indigenous neighbors concerning the nature of sociocultural interactions, labor commitments, cash and credit participation in the commodity market, and competitive use of resources.

Preliminary research results indicate that the Siriono and Yuqui are experiencing differential stresses on their resource bases. While social and environmental factors peculiar to the Siriono region have contributed to a stable system of resource use, the Yuqui are now at risk as their resource base diminishes. The results of both group studies will be made available to Bolivian regional and national institutions concerned with the development of these areas, and to international agencies for use in project initiatives. Results will also be presented in professional journals and publications related to issues of cultural survival and resource management. In the case of the Yuqui, preliminary results have been forwarded to Cultural Survival, the National Wildlife Federation, and the Interamerican Development Bank for consideration in policy-making regarding an IDB development project in the Chimore area where the Yuqui reside. ■

EARLY PALEOINDIAN ECONOMIES OF THE MIDWESTERN UNITED STATES

Dr. Kenneth B. Tankersely
Department of Anthropology, Indiana University

Over the past 60 years, two dominant and competing models of the Early Paleoindian economy in the midwestern United States have emerged. These are, specialized hunting and generalized foraging. Given the fact that the archeological record for this time period and region is restricted to a single diagnostic chipped stone artifact, the fluted projectile point, patterns in the raw material composition and geographic distribution of these artifacts are the only means of evaluating these models.

This study views Early Paleoindian economies in terms of mechanisms of adaptation which include procurement, processing, use, distribution, and exchange of raw material resources. The decisions made with respect to these mechanisms directly affected their adaptability. These decisive choices are preserved as patterns in the distribution of artifacts and archeological sites, i.e., as patterns of lithic exploitation and human settlement. By identifying these patterns, archeologists can reconstruct Early Paleoindian livelihood, type of economy and ultimately the processes of their adaptation.

Specialized hunting and generalized foraging activities vary in their use of the landscape and lithic resources. For example, specialized hunters use a narrower portion of the landscape. Narrow in the sense that specialized hunting is limited to areas that attract and concentrate game, and where game can be monitored, and regions that provide the raw materials needed to manufacture weapons or tools. Many of these tools are transported over great distances because specialized hunting involves a relatively high degree of mobility. Generalized foraging, on the other hand, is a livelihood strategy that could be successful almost anywhere in the temperate latitudes. Foragers tend to disperse themselves across the landscape. Thus, tools used in this generalized activity are usually manufactured from locally available materials because this lifeway involves a lower degree of mobility.

Both these activities produce patterns in the archeological record that can be identified by comparing the regional distribution of lithic raw material with the areal distribution of artifacts manufactured from the same resources. This procedure, however, can easily be biased, a major cause of which is inaccurate identification of lithic raw material and source area of origin. To be precise in identification of geological and archeological samples of lithic material calls for an objective and replicative method. Failure to use such discipline may result in two types of errors—local lithic material may be misidentified as non-local lithic material, and non-local lithic material may be misidentified as local.

By establishing a reference collection of lithic raw material from known source areas in the Midwest, bias problems were avoided. Samples were petrographically examined and reviews included macroscopic and microscopic observations of color, texture, form, and fossil and mineral content. These physical properties provide a basis upon which the raw material composition of Early Paleoindian artifacts can be discriminated.

Of course, bias can occur in any sample of archeological remains that are not systematically collected. The same applies when a sample is not representative of the archeological remains of the region. This study conducted an intensive survey of Early Paleoindian artifacts along a transect that cut across three midwestern states (Indiana, Ohio, and Kentucky) and included a variety of site types, as well as diverse topographic settings, and physiographic zones. Although many of the artifacts sampled are curated in public and private institutions, the vast majority of my survey involved collector interviews.

Error can also creep in through temporal mixing of the data, i.e., the inclusion of later cultural material with Early Paleoindian artifacts. The fluted projectile point is the only chipped stone artifact that is exclusively diagnostic of the Early Paleoindian peoples. Even so, considerable typological confusion occurs in the identification process. Points that date much later are frequently confused with fluted points because basal thinning flakes are mistaken for "true flutes." Fortunately, these later points display temporally distinct traits, such as beveled or serrated lateral edges, excurvate blades, or notched or shouldered bases. To prevent such confusion, fluted points displaying these traits were excluded from this analysis. Only fluted points typologically included in the Clovis, Folsom, or Cumberland clusters were documented.

This investigation identified more than 1,000 fluted points among 15 public curatorial repositories and 55 private collections. Of these, 708 met the minimum standard of county level provenance. A total of 396 of these fluted points were recovered from 144 Early Paleoindian sites. The lithic composition and source area was determined for 88 percent of the fluted points included in this sample.

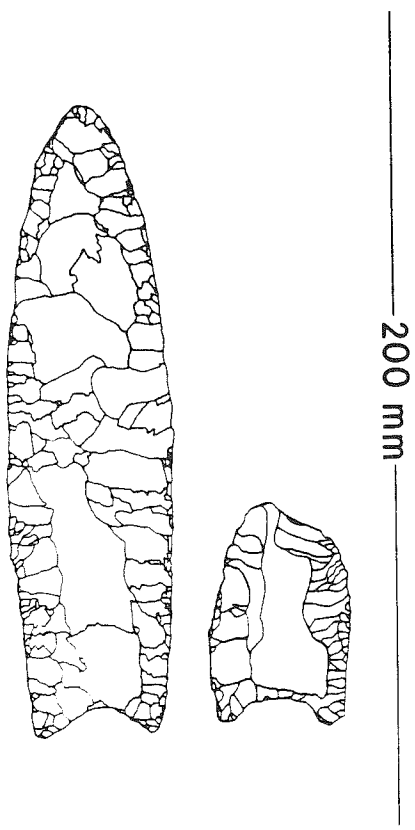
Lithic raw material resources of the Midwest vary greatly between glaciated and unglaciated landscapes. Lithic resources in glaciated regions occur in a variety of unconsolidated secondary deposits. The lithic materials in secondary deposits are inconsistent in terms of their availability, size, quantity and quality. With the exception of bedrock source areas, lithic raw material from secondary deposits is either scarce, too small for fluted point manufacture, or severely weathered and un-

suitable for knapping. Lithic resources in the unglaciated regions, on the other hand, are concentrated in specific bedrock deposits. These primary deposits offer larger, more abundant, and higher quality lithic resources than those typically found in glaciated terrain.

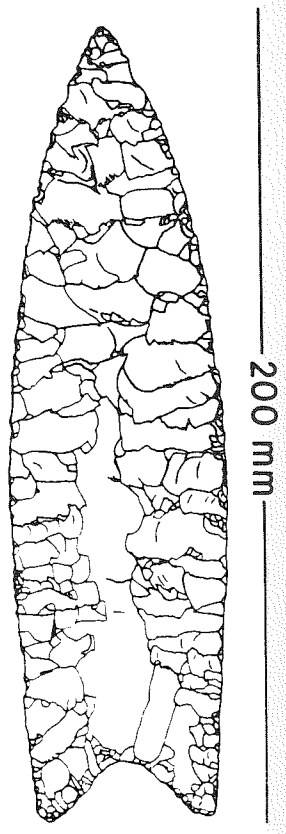
Most of the fluted points I sampled can be traced to three bedrock lithic source areas located in the unglaciated portion of the Midwest: Upper Mercer in eastcentral Ohio, Wyandotte in southcentral Indiana and northcentral Kentucky, and Hopkinsville in southwestern Kentucky. All of these lithic source areas display an abundance of late-stage preforms and fluted points broken in manufacture. I find this not surprising given the fact that the fluting process has a high failure rate; biface breakage is common. Fluted point preforms, or points broken in the process of fluting, are uncommon elsewhere. Most of the lithic material was transported from these three primary source areas in the form of finished fluted points. Given the high rate of breakage in the fluting process, the exportation of finished fluted points may be viewed as a least risk strategy.

There are notable differences between the glaciated and unglaciated regions of the Midwest. Non-local lithic assemblages (i.e., artifacts located more than 30km from their source) occur more frequently in glaciated areas than in unglaciated areas. Neither of the fluted point assemblages sampled from glaciated regions nor those from unglaciated regions are dominated by local lithic material. I discovered that previous reports to the effect that fluted point assemblages from the unglaciated Midwest are dominated by local lithic material are biased. This is possibly due to data collected almost exclusively from sites located in high quality lithic source areas. Such studies skew the data base by creating an over-representation of local raw material caused by including late stage preforms and fluted points broken in manufacture. This problem is further illustrated by the fact that non-local raw material occurs more frequently on non-workshop habitation sites.

High quality chert was the preferred lithic raw material regardless of site type or physiographic setting;



An illustration of prehistoric curation. The Clovis point on the right has been "whittled down" through reuse and resharpening. In its pristine state, this artifact would have had the morphology and metric dimensions of the point on the left.



A pristine Clovis point from Woodford County, Kentucky. This artifact is manufactured from Wyandotte chert; a lithic raw material located 110km from the artifacts findspot.

most of the fluted points sampled confirm this. Poorer quality materials were procured, but mostly on an ad hoc basis. The expedient nature of poor quality lithic procurement is apparent in that nearly all of the fluted points of this type occur in areas where they are locally available.

Curation of high quality lithic materials is illustrated by the fact that most of the fluted points examined display some physical evidence that they were resharpened (or "whittled down") from their original size.

On the other hand, size of the raw material alone cannot explain the patterns of Early Paleoindian lithic exploitation. Many poor quality lithic materials occur in large masses, but they were never used intensively. If Early Paleoindians were highly mobile hunters curating their projectile points, then the most cost-effective production strategy would have been to make them as large as possible, and from the highest quality material available. In the Midwest, the lithic materials most frequently procured by Early Paleoindians are those that provide the greatest quantity of large masses of high quality chert. This strategy is illustrated by the immense size (ca. 200mm in length) and high quality raw material of pristine fluted points and late stage preforms.

While fluted points and Early Paleoindian sites occur over a wide geographic area, I found that they are concentrated in specific topographic settings and microenvironments. Excluding lithic source areas, the greatest accumulations of fluted points and the largest Early Paleoindian sites are concentrated in areas that attract game—specifically, areas that display some combination of sandy terraces, saline springs, and ponded water.

This habitat-use pattern is consistent across the Midwest, regardless of lithic resource availability. Nearly all of the Early Paleoindian sites that I sampled occur in areas where game could have been procured, processed, or monitored. The exceptions are sites that occur in areas that contain high quality lithic resources.

The Early Paleoindian settlement pattern is associated with evidence of high mobility of the kind measured by the distance an artifact "moves" from its raw materials source. Distribution maps of statistically generated fluted point styles demonstrate that the magnitude of mobility is better correlated with time than it is with space. Fluted points morphologically and metrically identical to the Clovis points of the western United States transcend all latitudes, and are manufactured from exotic raw materials located up to 900km from their findspots. Fluted point styles unique to the eastern United States, however, have a more restricted distribution and are frequently manufactured from specific lithic raw materials. The distribution of these styles rarely exceeds 250km. If we assume that non-Clovis fluted point styles developed sometime after the initial peopling of the Midwest, then two temporal trends are apparent, decreasing mobility, and increasing stylistic diversity.

These trends are typically associated with the definition of home ranges. Thus, the distribution of fluted point styles manufactured from specific lithic materials are the best means of illustrating the extent of home ranges. With the exception of classic Clovis points, I found that fluted point styles unique to eastern North America consistently occur within areas that are equidistant from lithic raw material sources of comparable quality, quantity, and size. Data suggest that Early Paleoindians in the Midwest did indeed establish home ranges, but sometime after Clovis peoples colonized the region. It also appears that home ranges included at least one high quality lithic source area, and that they were not less than 75km nor more than 250km in diameter. If home ranges were established, then one would expect to find some evidence for exchange.

It is possible that all of the lithic materials used to manufacture Clovis points were directly procured. After home ranges were established, however, exotic lithic materials were likely procured through exchange networks developed between adjacent home ranges. Indeed, except for Clovis points, all of the fluted points manufactured from exotic lithic materials originated from lithic sources located in nearby home ranges. Sites located at critical resource zones, or stable habitats with predictable concentrations of game resources, were likely the areas where multisocial units interacted. The high frequency of exotic lithic material at these sites may be a scale for this social interaction. Conversely, the low frequency or absence of exotic materials in common lithic source areas suggests that fluted points were not exchanged at these locales. This speculation is also supported by the fact that the majority of the sites located in lithic source areas are small, ephemeral, single visitation sites. While large sites do indeed exist in these areas, their massive and expansive assemblages probably resulted from successive occupations. Site redundancy is attributable to the fact that large sites in lithic source areas not only contain high quality lithic materials, but they are also adjacent to areas that would have attracted and concentrated game.

Although specialized hunters narrow their preferences to a limited number of resources, their survival depends upon a mixed foraging strategy. In other words, specialized hunting economies do not preclude generalized foraging. Indeed, both models can be part of a common economic system, even though one activity is contingent upon a set of factors that are considered maladaptive to the other. This view is not unrealistic if we assume that the last gasp of Late Pleistocene environmental conditions offered these peoples opportunities to encounter a larger biomass of animal protein than was to be available during the Holocene.

The results of this study suggest that Early Paleoindians of the midwestern United States were highly mobile and maintained a specialized hunting economy through cost effective decisions and risk reducing strategies. ■

THIRD TOBIAS ESSAY COMPETITION

The Phillip V. Tobias Essay Prize of the Institute for the Study of Man in Africa (ISMA) was established in 1985 in honor of Professor Tobias, through whose efforts the Institute was established and in recognition of his international standing as a scientist, academic leader and humanist.

The theme for the current year is "Human Biological Diversity in Africa Today".

Submissions of about 6,000 words typed double space, in English, are invited and should reach the secretary of ISMA no later than April 20, 1990. The essay should present the result of original research or of critical reappraisal, and should constitute a significant contribution to current debate on the topic.

A prize of $1,000 will accompany the award and the Institute will seek to facilitate publication of the essay in an appropriate journal. The Institute reserves the right to withhold the award should no entry be adjudged to be of sufficient merit.

Send entries to: The Secretary, The Institute for the Study of Man in Africa, Room 2B10, University of the Witwatersrand Medical School, York Road, Parktown, 2193, Johannesburg, South Africa.

NOTES

The California Academy of Sciences and the L.S.B. Leakey Foundation presented the Allen O'Brien Memorial Lecture by Dr. John G. Fleagle, "Anthropoid Evolution in Africa" last June. Dr. Fleagle, Professor of Anatomical Sciences at the State University of New York at Stony Brook, provided a colorful slide presentation and discussion in which he described the changing players that have filled the various ecological roles in the long prehistory of the primate faunas of the African continent.

Dr. Fleagle was awarded a John Simon Guggenheim Memorial Foundation Fellowship in 1982 and a MacArthur Fellowship in 1988.

BOOKS

The following is a list of books of possible interest to AnthroQuest readers. While they are not sold by or available through the Leakey Foundation office, they can be ordered from local or specialty bookstores.

EXPLORATIONS IN AFRICAN SYSTEMS OF THOUGHT edited by Ivan Karp and Charles S. Bird. Smithsonian Institution Press, Washington, D.C., 1987. pp 337. $14.95 paper.

This paperback edition with its new preface offers thirteen original essays of exploration dealing with African systems of thought. Ivan Karp is curator of African Ethnology at the Smithsonian Institution, and Charles S. Bird is professor of linguistics at Indiana University. The selection of topics is grouped into four basic segments: Modes of Thought, Images of Social Experience, Cultural Dynamics, and Comparisons. Myths and riddles abound in the chapters covering beliefs about the origin of death and the sociology of beer-drinking rituals. The well written papers originated from a speakers seminar held late in 1977 for the African Studies Program at Indiana University. Other reports were added and the overall fine editing makes this volume an outstanding work in this special field on an absorbing topic.

MISSING LINKS: The Hunt for Earliest Man by John Reader. Penguin Books, New York. pp 270, illustrated. $7.95 paper.

This, a new edition, 1988, of *Missing Links* is, says David Pilbeam in the foreword, a *"substantial and solid piece of work" and "describes some of what has gone into the process of understanding our past, and demonstrates that what is said about the past can reveal much of how we perceive ourselves today."*

John Reader has the gift of making the story of the search for fossil remains of our earliest ancestors a lively tale. In addition to the saga of how important discoveries were made, the author lays before us the ideas that developed as a result of the findings. Clearly, the conclusions drawn in one generation, or decade, are not always acceptable to a later time frame and the resolution of these dilemmas is as much a part of the hunt for early man as the evidence and fragments are themselves.

This second edition features beautiful photographs, a useful glossary, and text covering the full range of explored prehistory from 18th century fossil finds and Neandertal man coming to light in 1857, followed by Charles Darwin's published work in 1859, through to an ample account of the more up-to-date sciences that have contributed to the current picture of hominid origins and our evolution.

Reader leaves no stone unturned or bone unpicked in his absorbing tale of a fast changing field where the mystery of the missing links is *"a good deal more complex than has been thought."*

HUMAN EVOLUTION An Illustrated Introduction by Roger Lewin. Second edition. Blackwell Scientific Publications, Cambridge, MA, 1989. pp 153, large format, $33.95 hard cover, $16.95 paper.

Roger Lewin sets the background to his story of human evolution with a review of man's place in nature as presented by pioneers Darwin, Huxley and others, along with turn of the century scientists relating the story of our species as narratives which often *"conform to the structure of the hero folk tale."*

The author gives lucid accounts of key discoveries that have *"touched virtually every aspect of hominid biology, including some major fossil finds, developments in evolutionary biology, ecology, and behavior, and in molecular biology and genetics."*

This revised and expanded edition reflects the changes and progress in paleoanthropology; added chapters include, for example, a unit on the comparative biology of brain size in primates. Included are patterns of inheritance derived from genetic studies said to provide answers, and questions, to the story of Eve out of Africa. The clarity of illustration and diagram material is welcome in a study where jaws and teeth and bipedalism are essential to an understanding of bodies, behavior and social structure. Key questions posed at the end of each chapter are also useful for students and lay readers alike.

CONTEMPORARY CULTURAL ANTHROPOLOGY by Michael C. Howard. Third edition. Scott, Foresman, Illinois. pp 500, illustrated. $22.95 paper.

Michael Howard has selected ethnographic examples from a broad range of contemporary cultures to provide in a single volume a textbook of uncommon value in terms of wealth of material and reference resource. Succinct summaries and suggested reading lists complement the well structured text. From an introduction to anthropology, through to units covering the growth of cultural anthropology, culture and communications, as well as economic systems through to the "Search for Order" chapter, the contents provide an in-depth focus on people and their problems worldwide.

In a final chapter dealing with contemporary adaptation problems, author Howard comes to grips with the plight of underdeveloped third world nations and the contrast with the elite status of Western industrial societies. The problems are immense, and the role of applied anthropology, now grown in the late 20th century to be more professional than heretofore, is shown to be active and prudent in the planning essential to assisting indigenous peoples develop in a way they themselves prefer.

Central to the scope of this major work is the author's benchmark comment, *"Like other animals, we humans are influenced both by our biological makeup and by our environment. But we differ greatly from other animals in the degree to which we have developed culture—learned and socially shared ways of behaving and thinking."*

GANDHIAN UTOPIA: Experiments With Culture by Richard G. Fox. Beacon Press, MA, 1989. pp 330. $27.50 cloth.

This is a book teeming with detail and data documenting a personality who either as a saint, or politician, left a legacy and life-way utopia that has baffled most western minds. Richard G. Fox, professor of anthropology at Duke University, offers a scholarly unveiling of Gandhi as a scientist pursuing the truth, and provides a chronicle of how Gandhi changed a sub-continent of many peoples and was himself transformed.

Fox presents Gandhi's career from his crusading resistance to colonialism, to his nonviolent policy for Indian independence, to his later attempts to bind the wounds caused by the collision of conflicting beliefs during the emergence of a new nation.

To the riddle, *"Can great people change cultural attitudes, or is culture so dominant that it can only renew itself, in its own time?,"* the author answers by plowing all the way from the roots of utopian ideals of the last century through countless experiments with truth, and offers conclusions that give insight to culture itself that are as visionary as the great man portrayed in this compelling volume.

PEOPLE OF THE EARTH: An Introduction to World Prehistory by Brian M. Fagan. Sixth edition. Scott, Foresman/Little, Brown, Glenview, IL, 1988. pp 622, illustrated. $16.76 paper.

Author Fagan belongs to that rare fraternity of writers who can make even the most difficult path seem easy to follow. Although ample technical terms are used to describe the facts and features necessary in any systematic study of world prehistory, they never intrude in the smooth flow of a fascinating account stretching from the dawn of mankind to the Spanish conquest and the start of Western expansion.

Thus, the sixth edition is a welcome text appropriate to the study of archeology, anthropology and world history. Armchair travellers or serious students will recognize the balanced views presented without skirting those points which provide room for debate and without which any study would be lacking in vitality.

Before the long trek begins, the reader has a painless introduction to terminology along with the whys and wherefores of methods of dating, relative chronology, the archeological record and the role of cultural processes, systems and evolution.

Next onto the stage march early humans and we become reacquainted with the order of primates.

Stone tools provide some solutions, and ecological problems present more challenges. Finally, *Homo sapiens* emerge and hunter-gatherers come on the scene. Each chapter has a neatly arranged preview segment highlighting in a few sentences the essentials of the text that follows.

At midpoint, *People of the Earth* has carried the reader past the transition from farming, and through the frontiers of stone tombs and circles to cultures of the Nile and Tigris. The road to more familiar times is rich in information and fresh in style. Fagan's note to instructors points out the theoretical theme for the book as a gradual progress of humankind seen as a member of the world ecological community, and goes on to suggest that, *"Perhaps the greatest message of world prehistory is not that we humans are different but that our behavior is so strikingly similar."*

THE LONGEST RECORD: THE HUMAN CAREER IN AFRICA

An International Conference Honoring Desmond Clark

Professor Desmond Clark stands out above all others as the scholar with the longest and widest record of contributions to the study of Africa's past. To provide a fitting tribute to his distinguished career, on the occasion of his 70th birthday, which also marked the eve of his becoming Professor Emeritus at the University of California, Berkeley, an International Conference titled *"The Longest Record: The Human Career in Africa"* was held at Berkeley in the spring of 1986.

Three hundred scholars, students and friends from all parts of the world gathered to honor him and engage in a series of sessions on the current state of knowledge in African Prehistory. Over 150 papers were presented during 15 working sessions in a five day period. The topics addressed, from an African perspective, the major transitions which occurred during the evolutionary and cultural history of our biological family, the Hominidae.

The organizers accepted all proposed papers in an effort to make the Berkeley Conference a forum for a comprehensive review and an opportunity to take stock of our overall field of endeavor. The papers were presented in single plenary sessions with no concurrent parallel sessions so that participants could hear every paper if they so wished. While the presentations were necessarily limited to ten minutes in duration, a volume of abstracts was subsequently compiled to provide an enduring published reference of the proceedings. In addition, three edited volumes of papers presented at the conference have been published. These include two special editions of the *Journal of Human Evolution* (1987, 1988) and a special edition of *African Archeological Review* (1987).

Further, two volumes were published as special issues of the *Journal of Human Evolution*. The papers in the first of these volumes exemplify the kind of actualistic studies fostered by Desmond Clark. Most papers address issues related to diet and methods of food acquisition in attempting to decipher the archeological record and learn more about hominid behavior. The second volume features papers on paleoenvironments, hominid anatomy, and tools and their interrelationships from the Plio-Pleistocene hominid and archeological record. In this collection, there is a full biographical treatment of Desmond Clark's career as well as a complete bibliography of his publications. The final volume in the conference series is a selection of papers that cover topics on the Acheulean and evidence for hominid movements out of the African continent, archaic *Homo sapiens*, and the Middle Stone Age, speculated Late Pleistocene economies, the beginnings of agriculture, and ethnography.

Desmond Clark was a highly visible participant throughout the conference. In addition to presenting several papers, he chaired two sessions and convened the closing ceremony as well as commenting on the research of colleagues during discussion periods. The conference was a tribute to his contribution to African Prehistory but it also was an occasion to honor Betty, his wife.

Also, we were honoring a generation of illustrious scientists who established the paramount place Africa holds in understanding the emergence and cultural development of our species. We were fortunate to have with us such distinguished figures as Basil Cooke, Jean de Heinzelin, F. Clark Howell, Merrick Posnansky, Phillip Tobias and others.

During the opening remarks at the beginning of the conference, particular reference was made to the support given the conference by the Leakey Foundation. ■

J. W. K. Harris
Dept. of Anthropology
Rutgers University

L. S. B. Leakey Foundation
77 Jack London Square
Oakland, California 94607-3750