

# ANTHROQUEST

news of human origins, behavior, and survival

number 27

the I.s.b. leakey foundation newsletter

winter 1983

## BETWEEN BRAIN AND SKY

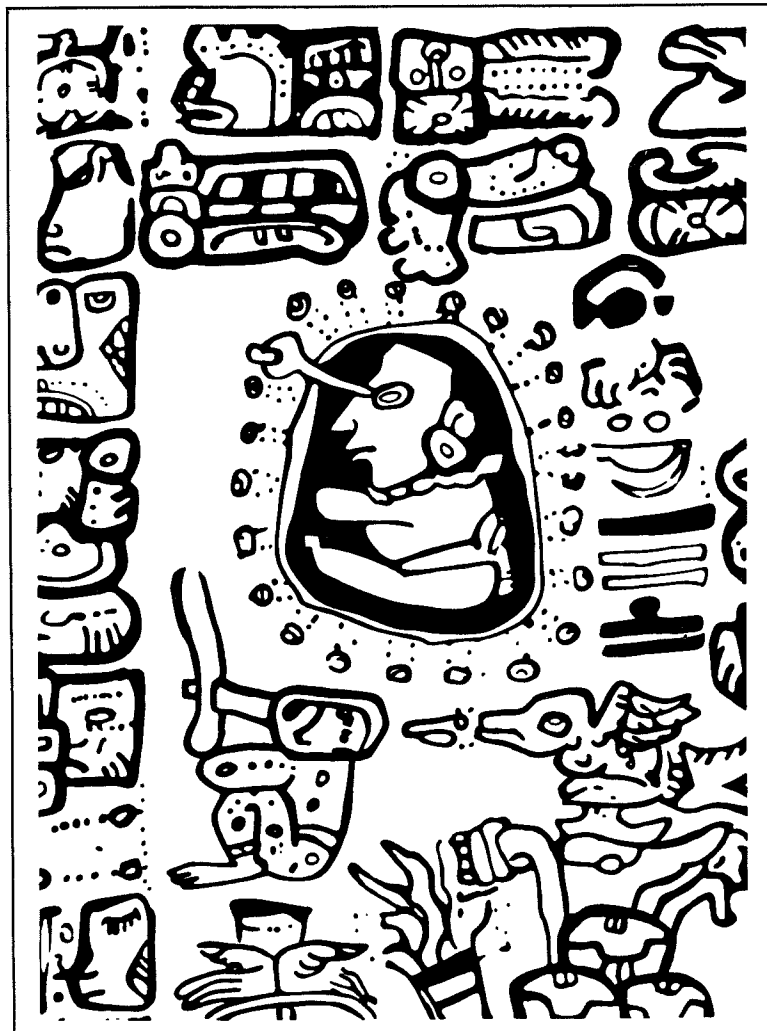
E. C. KRUPP

Director, Griffith Observatory, Los Angeles

The Desana Indians live in the tropical rain forest of the northwest Amazon. Most of what we know about them is due to anthropologist-archeologist Gerardo Reichel-Dolmatoff, an expert on the Desana and other Indians of Colombia. The Desana don't build giant pyramids or monumental stone temples. They have no written language. They now farm a little bitter manioc, but they much prefer to hunt. They don't wear many clothes. For all practical purposes they are a Stone Age people, although contact with the outside world is transforming — rather, obliterating — their traditional culture. There are only 600 Desana left, but up to now they have adapted well to the jungle environment and have evolved a rich and complex culture.

We wouldn't necessarily conclude, however, that these remote people could tell us anything substantive about the universe and how we get along in it, but the Desana have some very interesting things to say.

They speak of the sky as a brain. Like the human



Maya skywatcher; his eye is grabbing a star.

photo: Griffith Observatory

brain, the sky is bicameral — divided into two hemispheres, and the fissure between them is the Milky Way. The Milky Way, they say, is, in turn, a pair of entwined serpents — an anaconda and a rainbow boa. These two snakes represent many complementary pairs:

rainbow boa	anaconda
male	female
land	water
light color	darkness

The snakes spiral and sway in rhythms that keep time to the 24-hour cycle of day and night, the monthly rhythm of the moon, and the yearly dance of the seasons, the sun, and the stars.

The Desana also say that two such serpents reside in the fissures of their own brains and facilitate the interaction between the left side of their brains and the right. Their brains must resonate with the sky — must dance to the same rhythm — for consciousness to exist.

The Desana have a detailed and comprehensive knowledge of their environment. They know what they need to know to live

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## the L.S.B. leakey foundation

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

The Foundation sponsors:  
International research programs related to the biological and cultural development of humankind.

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

The training and education of students in these fields.

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

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## the L.S.B. leakey foundation news

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# PRESIDENT'S MEMO

The Oxford English Dictionary dates the word "trustee" from 1647 to wit: "It was the costume, when any person trusting would put his trustee to the oath, to bring him into the temple, and to make him swear."

In many estimable foundations, which hold great wealth in trust, the prime duties of the trustees are to dispense it for the most good and the least harm. The Leakey Foundation differs. The monies for our grants are raised afresh each year. While the trustees are the chief source of funds, they are also the chief seekers. This involvement leads to great diligence in expending them wisely. We have developed a tradition of being a hardworking board whose meetings generate excitement because new ideas keep popping up to seize the imagination.

Even the best ideas are not self-executing. We have a minimum office staff. So good ideas lie fallow unless a trustee will fertilize them, guard them and see them to fruition.

An example of trustee initiative was the followup to an idea broached at our May meeting by Professor Irvén DeVore of Harvard for a symposium on Human Diet, Behavior and Adaptation. Trustees Kay Woods and Gay Bradley immediately went to work to make it possible for a tentative date in November, 1984, in San Francisco. They were joined by Mr. and Mrs. Charles M. Hobson III and the Comdisco Financial Services Foundation, who offered \$10,000 to partially underwrite the symposium which will attract distinguished scientists from a wide area.

Every foundation needs a wise owl. George Jagels has been as wise as he has been generous and that is two big hoots. We still call upon him, as a Life Trustee, for counsel. It is to honor George and Maggie that we have named the gathering of distinguished brain scientists at Caltech this January the Jagels Lectures.

We are most fortunate to have two new trustees. Dr. John D. Roberts has just retired as Provost of Caltech but remains active as one of the world's leading chemists. He is the cousin of our founder, the late Allen O'Brien, and has been a Fellow of the Foundation from its origin. We are also proud to welcome as a member of our Science and Grants Committee, Professor David Gates of the University of Michigan. His primary work has been in botany — biophysical ecology but he is by nature a renaissance man.

A psychologist who studies organizations recently asked me to identify one factor that accounts for the phenomenal success of the Leakey Foundation. To me it lies in the present structure of American society. A number of highly talented women, who could be professionally employed, volunteer their skills to our Foundation.

Kaye Jamison, for instance, has just retired to be a Life Trustee after enormous success in launching and carrying through our paleoproject, "Stones and Bones," to improve the high school teaching of archeology in America.

Among other Leakey women who have headed special executive missions are Kay Woods, Gay Bradley, Joan Travis, Barbara Newsom, Fleur Cowles, Fran Muir, Dielle Seignious, Diana Callery, Norma Schlesinger, Liz Brady, Tita Caldwell and Ann Willis. Which leads me back to the single gender use of "trustee" in 1647. Our 1983 Leakey leadership involves a second gender, who make us not "swear" but smile!

The strength of the Leakey effort derives not only from the strength of current trustees, but equally as much to the continued dedication and insights of retired trustees. A beautiful example comes in a letter from Paul D. MacLean, M.D., Chief of the Laboratory of Brain Evolution and Behavior at the National Institute of Mental Health. Paul made a stirring speech at our 1979 Santa Fe meeting on the need to keep the fire of hope burning in younger scientists. In a recent letter, he returns to that theme. I quote a paragraph with his kind permission:

"We are living through a dreary period when there was never a greater need for private foundation support for young investigators seeking careers in the currently less 'glamorous' (though still basic!) life sciences. The Leakey Foundation is a shining example of what may be accomplished by the use of modest funds to support promising people. Since it takes little oil to keep an eternal flame going, it is to be hoped that now more than ever the Foundation will continue to be an example of the continued health that can be assured while adhering to a lean diet".

*Ned Munger*

*The Foundation sends Best Wishes to all and suggests you consider giving a membership for the holidays.*

# SEXISM AMONG GORILLAS?

Dian Fossey

From the moss laden limbs of aged trees flowed strands of lichen that blended in with the mountain mist seeming to form a near impenetrable curtain throughout the thick forest. Somewhere nearby there was, I knew, a lone silverback — a sexually mature gorilla male — whose travel was motivated by only one quest — a female.

As usual, sound preceded sight. Powerful, resonant chestbeats announced his approach. Suddenly the mist parted to reveal a great lone silverback. The immense male stood upright, alternatively beat his chest with cupped palms while, almost simultaneously, producing a deafening roar that exposed his black tartared teeth. To be sure, he was an impressive sight from his partially webbed toes to the very tip of his mammoth head crest. For about forty-five minutes I sat spellbound, mesmerized with every movement of the gigantic male. It was only when the PBS pledge break terminated my first viewing of the classic *King Kong* movie that I could muse about some of the considerable relevancies of this vicariously enjoyed celluloid experience.

How did "they" — producers, directors and other artisans — manage to simulate to such a high degree of credibility, not only the habitat of a mountain gorilla (let us disregard a few Pleistocenic whimsies), but also a number of morphological characteristics of a subspecies discovered only thirty-one years before the epic *King Kong* was released.

Just take, for example, the tartar-stained teeth of the mythical, roaring misanthrope. In their natural habitat, gorillas' teeth become heavily stained with tartar incrustations that result from tannins commonly found in foliage food items such as bark, fruits, galls, leaves and stems. In captivity, these astringent substances occupy a lesser part of the diet; thus the teeth and gums lose all vestiges of their previous vegetative staining. Amazingly, all of Kong's teeth also lost

their tartared appearance after his brief stay in the Big Apple. I, for one, was duly impressed by this bit of authenticity. All the more so when Kong's successor, who uttered his roars in splendid technicolor some years later, exhibited two rows of dentures designed to stir envy in



the most fastidious of hygienists.

King Kong had other more obvious physical attributes in keeping with his wild cousins. Gorillas have the highest degree of sexual dimorphism among the great apes, with the adult male reaching twice the size and weight of the female.

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**“. . . he was an impressive sight from his partially webbed toes to the very top of his mammoth head crest.”**

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Additionally, in polygamous species such as the gorilla, evolution has selected for an extensive development of secondary sexual characteristics which possibly encourage competition for permanent access to females while endowing the males with competence in intraspecific aggressive encounters. Perhaps this is the reason there was never a Queen Kong — she could not have had half as much sales (sex?) appeal. Let us consider some of the specializations that serve to distinguish the adult male gorilla, both mythical and factual, not only from his female counterpart but, as well, from any other species

of hominid.

Even to the neophytic gorilla enthusiast, a great sagittal head crest was quite evident in King Kong. The mitre-like crest, underlined by fibrous tissues, begins to develop in a male at roughly eleven years of age, or when the animal is approaching sexual maturity. The structure results from powerful jaw muscles pushing up a vertical ridge of bone needed as an attachment site along the center of the brain case. Likewise, an adult male's robust mandibular jaw muscles are responsible for a far greater prognathous profile than may be apparent in the mature female gorilla.

Some scientists suggest that pronounced head crests and mandibular extensions of the silverback have evolved as mechanisms for efficient food consumption. Their viewpoints are largely based upon field observations in West Africa from where it was revealed that the lowland gorilla (*Gorilla gorilla gorilla*), whose relatively soft diet consists of roughly 50 percent fruit, does not have as marked a head crest nor as pronounced mandibles as does the mountain gorilla (*Gorilla gorilla beringei*) for whom tough fibrous vegetation — bamboo, bark, roots — constitutes some 76 percent of the food intake. Dietary variances between the two subspecies have also been acknowledged as the most plausible reason for the massive, strengthened molars of both sexes of mountain gorillas, endowments offering more grinding surface than the cheek teeth of the lowland subspecies.

Because behavior elucidates anatomy just as anatomy clarifies behavior, we may be relieved from the supposition that natural selection has singularly deprived our Queen Kong of sagittal crests and conspicuous canines due to her lesser alimentary needs. Consider the findings from examination of fifty-three skeletal specimens collected throughout the Virungas over the past fifteen years. In all post-vertebral specimens, significant



A mixed group of mountain gorillas inspecting Dr. Fossey.

canine wear evidenced the importance of the eye teeth as dietary tools, yet it was also found that 26 percent of the silverback crania had healed head wounds. None were found in the female specimens. Likewise, 15 percent of the silverback specimens had missing or broken canines, yet all those of the females were intact. This evidence, combined with visual observations of intraspecific male aggression, suggests that at least some of the increased morphological specializations of the silverback serve directly for group protection.

As might be expected simply from appearances, gorillas have the largest brain of any ape, yet the smallest relative to body weight. At birth the gorilla brain is roughly 60 percent larger than that of a newborn human (ca. 400cc as compared to ca. 240 cc), but the ratio between gorilla and human decreases to about 36 percent in adulthood. In the adult male gorilla cranial capacities form some 0.5 percent (roughly 420 to 752 cc) of the body weight and some 0.3 percent (roughly 340 to 595 cc) in the adult female. In the human adult the brain weight is slightly more than two percent

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of the body weight as man is characterized by a striking postnatal growth of brain and cranial vault while, in the apes, it is the facial portion of the skull that grows significantly after birth.

Contained within the facial region of the mountain gorilla are far wider nostrils

than in either of the other two subspecies, both of which live at lower elevations. It has been suggested that the broad, expanded nostrils of the *beringei* are adaptations for breathing colder air. A second altitudinal modification of the subspecies is the small, inset ears and short limbs, other examples of Allen's rule which advocates a decrease in extremity size as a means of heat regulation in colder climates.

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**“. . . behavior elucidates anatomy just as anatomy clarifies behavior. . .”**

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The gorilla's sense of smell is reputed to be roughly equivalent to that of man; however, there appear to be certain sex-specific morphological provisions that possibly contribute toward olfactory communication and dispersion by only silverbacks.

All primates have vast distributions of apocrine glands in their skin, but only man, chimpanzees and gorillas have large aggregations of apocrine, eccrine and sebaceous glands in their axillae. In adult male gorillas, and to a far lesser extent in females, the apocrine glands are arranged in four to seven layers in the armpits, and it is this axillary organ that is responsible for the strong, rank odor of the silverback. Once again Queen Kong appears to have been short-changed in the distribution of dimorphic endowments. To consider a possible reason for this particular disparity between the sexes we need only to return once more to the role of the silverback as the protector and defender of his familial group.

In the wild should a gorilla group be jeopardized by the sounds of an approaching band of poachers, the silverback immediately releases his powerful fear odor which serves to instantly disseminate alarm to his group members. Silently, and without revealing their location as a vocalization would do, the 'flee' message has been conveyed throughout the retreating group. It is not intended to imply that the odor release is a deliberated behavior but only that it is able

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to function as an extremely effective signal. Had females been provisioned with a similar means of spreading alarm throughout their group, it is likely that a plethora of conflicting messages might result. Causes of females' alarm would be more apt to be related toward the well-being of their offspring than that of the group as a whole, thus minimizing the benefits of cohesiveness secured under the dominion of a single leader.

In man, chimpanzee and gorilla are also found numerous eccrine glands in the palms of the hands and the soles of the feet. Only in man do these glands serve the purpose of thermoregulation and, because they develop very late in primate gestation, it is possible that they are a newly evolved acquisition. The glands also have an important lubrication function, but the extent of their contribution toward olfactory communication is not yet known. From field observations it has been noted that, upon encountering the travel route of another group or lone individual, gorillas expend an inordinate amount of attention seeming to investigate recently traversed ground. Such is not the case when moving over untrodden areas. As well, young immatures, when separated from their mothers, will often appear to seek groundlevel olfactory clues though distress vocalizations and visual sightings are more commonly employed to reestablish maternal contact. In consideration of the gorilla's mode of terrestriality, it is not an unreasonable speculation that such glands have been adapted for odor dissemination while, in the more arboreal orangutan, the eccrine glands are only lightly distributed along the plantar surfaces of the hands and feet.

The most fundamental means of odor perception by the gorilla was reliably illustrated by our mythical friend in several poignant scenes from both the old and the new versions of Kong. While gently tickling and partially disrobing his intractable captive, the love-smitten beast frequently placed his fingers to his nose

in an inquisitive manner exactly as gorillas in their natural habitat perceive scents of foreign objects. Certainly if there ever was a foreign object in poor Kong's habitat, it was the vociferous Fay Wray. Sensitive, the silverback's winged nostrils flared in and out below his frowning eyebrows as his countenance expressed clear puzzlement concerning the nature of his prize. Happily, the majority of gorillas living in their natural habitats do not have Fay Wrays cluttering their landscapes, though observers' thermoses, notebooks and camera equipment are curiously smelled and gently investigated in much the same manner as was the clamorous blonde.

As our hero, mine at least, attempted to guard his protesting subject from her ill-fated rescuers, Kong's creators did not overlook his knuckle-walking style of locomotion and, as well, adhered fairly accurately to those body proportions that allude to the gorilla's arboreal ancestry. The transition from an arboreal to a terrestrial mode of life is considered to have been a comparatively recent change as suggested by the morphological similarity of the gorilla's hands and feet in the late fetal stages to those of arboreal primates. The gorilla's hands are exceptionally broad in order to support the weight of the massive chest and shoulders. As modifications for knuckle walking, the fingers have been shortened to prevent hyperextension and the wrist bones closely packed yet having virtually the same girth as the ankle bones. The oppositional ability of the short thumb enables precision movements required for the selection and preparation of food items, though in the mountain gorilla, the most terrestrial of the three subspecies, the opposable toe is less apparent. The predominance of ground travel has also selected for a lengthy talus (ankle bone) which comprises 40 percent of the foot skeleton in the gorillas as compared to 50 percent in man, 34 percent in chimpanzees and 28 percent in orangutans. The

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arms of the mountain gorilla are shorter than those of the other two subspecies yet remain some 10 to 20 percent longer than their legs and contain humeri that are both thicker and longer than the upper leg bone in man.

As the gorilla quadrupedally travels throughout his forested domain, his spine acts as a "carrying beam," but the shortened vertebral column is just barely able to support the weight of the head

and lengthened upper limbs; thus much of the animal's weight is thrown back over the hindlimbs. During the course of hominoid evolution the lumbar region of the vertebral column has been shortened, with chimpanzees and gorillas averaging four lumbar vertebrae and man, five. Lateral flexibility is limited in the gorilla's trunk because of the shortened lumbar section and the broad and long ilia of the pelvic girdle.

The mountain gorilla subspecies are especially prone to arthritis in the hip joints and the lumbar spinal area. Among the fifty-three Virunga skeletal specimens, ten silverbacks and five females evidenced varying degrees of osteophytic or arthritic conditions. In 60 percent of these cases the exostosis of the vertebrae resulted in either lipping or complete fusion between the vertebral elements, particularly those of the lower thoracic and lumbar vertebrae. There were four cases of complete fusion of the pubic symphysis in both relatively young and old individuals, a condition that otherwise has only been noted in very old

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**"Causes of females' alarm are more apt to be related to the well being of their offspring . . . than the group as a whole. . ."**

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humans where it is less common in females because of the expansion of the pelvis at the point of articulation between the sacrum and ilium during parturition.

The gorilla's cervical vertebrae have unique elongated spines necessary as attachment sites for the massive neck

muscles that support the prognathous skull. For this reason the upper trunk has limited mobility and forces the animal to turn the entire front of his body around in order to look over his shoulder. The weight of the cranium has been lessened by an extensive system of sinuses and

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**"The disparities between the sexes relate to those predominant selection pressures on silverbacks who compete for permanent access to females and live in polygamous social structures."**

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cavities, though their size and frequency are commonly contributive toward maxillary sinus infections or even skull deformities in both males and females.

It may be suggested that some of the above morphological characteristics — those shared by both male and female gorillas — have possibly been selected for the species' relatively recent transition to a terrestrial mode of life. The disparities between the sexes relate to those predominant selection pressures on silverbacks who compete for permanent access to females and live in polygamous social structures. One of the most significant of these dimorphic differences involves behavioral and morphological adaptations bequeathed only to the silverback for his elaborate chestbeating display.

Whether in the deepest jungle or atop the Empire State Building, the ritualized chestbeating display is the hallmark of the sexually mature male gorilla. In order to be a display, a communication must be



*Dian Fossey quietly observing her favorite silverback, Digit.*

ritualized, meaning simply that it has been subjected to natural selection to enhance its value of communication. Although an innate activity, the chest-beating display probably evolved long after gorillas had become terrestrial. As any King Kong buff knows, rising bipedally to beat one's chest, running a few feet, stomping on the ground or whacking

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at foliage can hardly be considered a part of the repertoire of an arboreal ape. Exactly when in hominoid evolution the display evolved is an intriguing question, particularly when we consider the extreme morphological characteristics that, yes Virginia, once again, have been granted only to the silverback. All Kongs are able, when conveying alarm, fright or defense messages, to stand as upright as their hamstring muscles will allow, to rapidly, rhythmically beat upon their chests some six times, alternatively using partially cupped palms over the lower edge of the pectoralis major area. Evolution has hushed similar means of communication by Queen Kongs whose chest-beating efforts result only in flabby, slapping sounds of small communicatory consequence except as a manner of releasing tension or playfulness. (Indeed, one Virunga female was named Maidenform because of her ability to echo her chest-beats twice for every single slap around her pectoral region.)

The answer to this particular disparitive allocation between the sexes may be attributed to physiological endowments.

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Female and immature gorillas do not have the extensive network of laryngeal sacs that have been endowed to silverbacks. Kong's creators did not realize that these air sacs, which function as resonators when beat upon, may be observed as inflated swells in a resting male, or inflated pouches prior to an actual chest-beat. Interestingly enough, even in humans, chimpanzees, orangutans and

siamangs (not gibbons), there remain small remnants of laryngeal pouches which, as in the gorilla, have possibly evolved as reservoirs of air for the prolongation of pertinent spacing communication.

For as yet unperceived reasons, laryngeal pouches remain to convey what are essentially communicatory signals for silverbacks. Not only do they function for chestbeats but also for the prolonged hootseries, a stereotyped, pure frequency long call which, unlike the mechanical chestbeat, has the facility to travel for some two kilometers in the forest. The hootseries is exchanged only between silverbacks and may be considered a type of long distance, intraspecific vocal probe that transmits the individuality of the emitter, always a silverback. Female gorillas are physically unequipped to partake in vocal exchanges between groups, though they often purse their lips in mime of producing a hootseries, all seemingly innate behavior.

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**". . . King Kong represented an  
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inquisitive and gentle nature of  
the species."**

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Somewhere along the complex, still-unfolding trail of evolutionary endowments, intraspecific communicatory confusion has been virtually eliminated among the greatest of the great apes — the gorilla. For what he was, when he was, King Kong represented an extraordinary example of the inquisitive and gentle nature of the species. When your TV tube cools down following your next, perhaps your first, viewing of the old epic, you might want to consider why you have been left with such negative, even hostile, sentiments. Are these feelings really directed toward our greatly maligned and harrassed silverback here or, more likely, toward the thrill-seeking blonde whose lung capacity defied all the rules of sexual dimorphism!

*Dr. Fossey is generally considered the leading authority on the mountain gorilla. Her book, Gorillas in the Mist, was recently published by Houghton Mifflin, New York, \$19.95. It records her experiences and findings during 13 years research of the Virunga gorillas of Rwanda, part of which was funded by the Leakey Foundation.* □

## THE OBSERVER

Completely protected on all sides  
by volcanoes  
a woman, darkhaired, in stained  
jeans  
sleeps in central Africa.  
In her dreams, her notebooks, still  
private as maiden diaries,  
the mountain gorillas move through  
their life term;  
their gentleness survives  
observation. Six bands of them  
inhabit, with her,  
the wooded highland.  
When I lay me down to sleep  
unsheltered by any natural guardians  
from the panicky life-cycle of  
my tribe  
I wake in the old cellblock  
observing the daily executions,  
rehearsing the laws  
I cannot subscribe to,  
envying the pale  
gorilla-scented dawn  
she wakes into, the stream where she  
washes her hair,  
the camera-flash of her quiet  
eye.

Adrienne Rich  
1968

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1950-1974.

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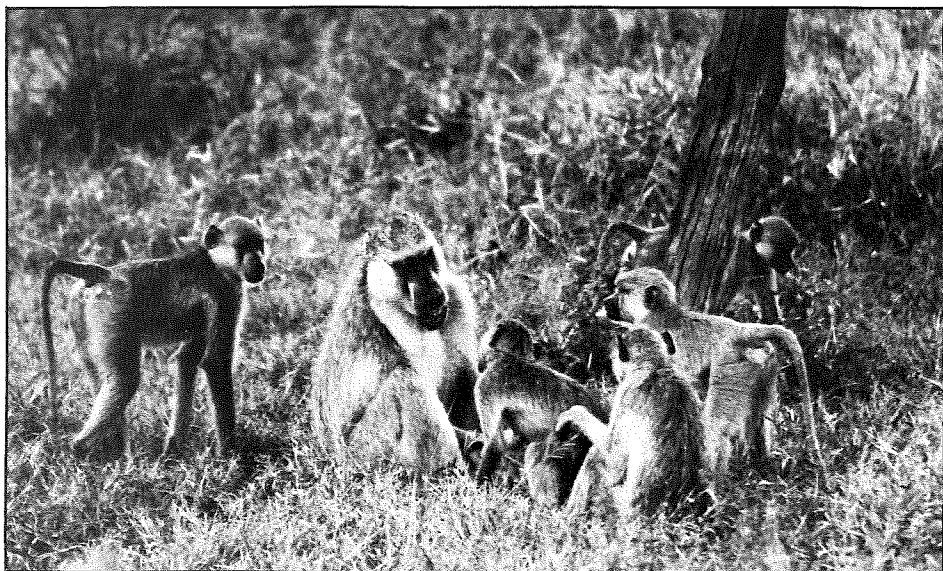
## AWARD

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John D. Roberts, professor of chemistry at Caltech who recently accepted the invitation of the Leakey Foundation to serve as trustee, was awarded the 1983 William Gibbs Gold Medal of the Chicago Section of the American Chemical Society.

The medal is presented annually to "an eminent chemist who, through years of application and devotion, has brought developments that will enable everyone to live more comfortably and to understand the world better." Other previous medalists include Linus Pauling, Madame Marie Curie and Robert S. Millikan. □





*Muroto, a high-ranking adult male, surrounded by and playing with a group of juvenile males and females during the period when Viramba troop's range was small in area and the troop was late in leaving its sleeping sites (March to July).*

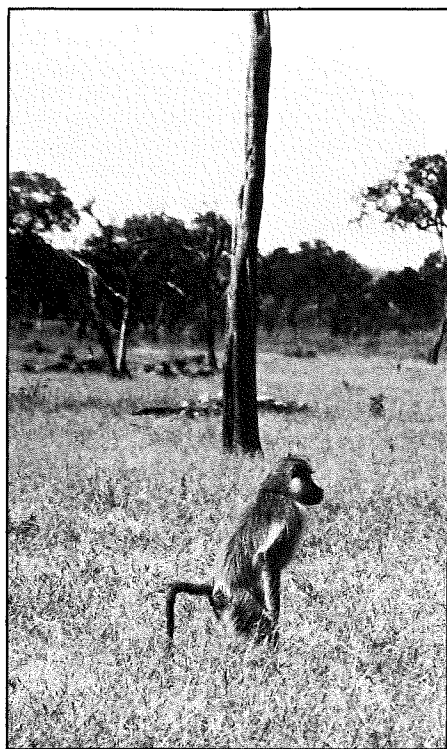
months at Mikumi. A large and pleasant breakfast at the more civilized time of 6:00 a.m. was followed by walks with the troop of sometimes less than half a mile during the entire day. The baboons were easy to find since their range was smaller and they now had favorite sleeping sites and areas of daytime activity. Often we could watch a subject for a full three hour sampling session without moving our position.

Four lines of evidence indicate vegetation density was strongly related to the seasonal changes in the way Viramba troop used its range. First, there were strong and significant correlations between changes in cover density and changes in range use: when Viramba troop's range was smallest in area and a few locations within that area were strongly preferred over others, cover was both most dense and most variable. Second, during the two years we followed Viramba troop, the troop did not expand its range into the hills in the eastern portion of its range until after the annual fires had swept these hills. Third, the growth of vegetation after the rains starting each January was closely associated with the annual withdrawal of the troop from the hills and other areas where this vegetation was most dense. The new vegetation gave the impression of pushing the troop into the short grasses bordering the flood plain of the Mkata River. Fourth, the routes the baboons habitually used for movement were seldom the shortest distance between two points. Rather, the routes selectively crossed through areas where visibility was least restricted.

Seasonal differences in the range of Viramba troop and the way the troop used that range were associated with a

fascinating constellation of systematic changes in its social organization; hours of computer processing of the 40,000 data cards were required before the patterns of these changes gradually came into focus against the background of the day to day variation in the lives of the baboons.

During the months of March to July when Viramba troop's range had contracted in area to about five square miles,



*An adult male bipedally standing to get a better view of a neighboring troop near sleeping site 2 (background).*

the distance between troop members also contracted. While we were following our subjects we were often close enough to talk to each other and usually in sight of each other. During the months of September to February when the troop's range was so large and its day's travel fast and far, it would sometimes be spread out over a distance of more than one and a half miles. During these months we sometimes lost visual contact with each other soon after leaving the sleeping trees and did not meet again until the troop started to converge on the ones they would use that night. Instead of giving the impression of a coherent group of individuals forming a troop, the baboons seemed to form into small groups of three to 20 individuals; these groups were loosely connected with others and strung out along the line of movement of the troop. Indeed, on a few occasions the troop actually fragmented and its members slept at two different sleeping sites; the next morning the baboons would seem to be actively searching for the troop members from whom they had become separated.

The changes in spacing amongst troop members pivoted about the adult males. When the range of the troop and distances between troop members contracted during March to July, all troop members tended to cluster more closely around the adult males. There was a particularly strong and significant tendency for both juvenile males and juvenile females to be closer to the adult males. Troop members may have been closer to the pivotal males, those members with the largest size and canines, because potential dangers from predators were greatest. During March to July, the defensive capabilities of the males may have been more important to other troop members because visibility was most restricted and because, like us, a predator could more readily find the troop in its small range and in one of its predictable sleeping sites or preferred areas during the day.

Individuals who controlled Viramba troop's movement may have avoided areas of dense vegetation to protect juveniles from predators. Indeed, only juveniles were killed by predators during our study and only juveniles and females were wounded by predators. Members of Viramba troop displayed their protectiveness towards juvenile members in several ways. A dramatic example of their responsiveness to the welfare of juveniles was observed when Robo, a juvenile male, was wounded by a female leopard, accompanied by her cub, on the same night that she killed and ate part of one of our juvenile male subjects, Pamba.

Robo was wounded on one of the rare evenings that Viramba troop slept in the same trees as Mgoda troop, the troop of about 27 individuals in which Robo was a member. The two troops may have de-



tected the leopard the previous day and banded together in the same trees in the face of this common threat. Mgodá departed and left the injured and weakened Robo behind at the late hour of 11:05 a.m. Viramba troop stayed under the sleeping trees and several members clustered around Robo; whenever Robo made one of his slow, feeble, and apparently painful movements, several individuals joined in a chorus of gentle contact grunts. Two juvenile males, about the same age as Robo, groomed him for several minutes. All eyes of the troop frequently turned toward Robo; at the same time troop members made ambivalent movements away from the sleeping trees. They gave the distinct and unmistakable impression of impatiently waiting for Robo to recover sufficiently to be able to start out on the day's activities. Unfortunately, Robo was wounded so severely that he would never again travel with a troop.

Viramba troop did not leave its sleeping site until 11:35 a.m. when Robo had just climbed down and finally fallen the last five feet from his sleeping tree. All 119 members of Viramba troop had delayed their daily activities by about two hours to wait for this juvenile male who was not even a member of their troop. Sikio, an old male whose canines were worn down and whose muscles had deteriorated, stayed with Robo at least 15 minutes after all other troop members had departed. Robo's own troop may have left him earlier because they, unlike Viramba troop, were afraid of our presence.

The need for food is a possible cause of the seasonal increase in area of the range of Viramba troop. The troop spent significantly more time gathering food when its range was smallest in area during the months of March to July; this may indicate that food was more plentiful. However, roots from sedges, a major staple of the baboons' diet, were both plentiful and eaten all year long. Although food quality, abundance, and distribution may influence Viramba troop's use of its range, our data indicate the reproductive biology of troop members may also be a strong causal factor linked with the seasonal changes we observed in the baboons' patterns of range use.

Baboons do not have a breeding or birth season since infants are both conceived and born throughout the year. However, there are peaks in the number of breeding (estrous) females and births. The number of females that were in estrus in Viramba troop was positively and significantly related to the seasonal changes in the way in which Viramba troop used its range: when the range was largest in area and most evenly used from September to February the most females were in estrus.

There may be a birth peak during the



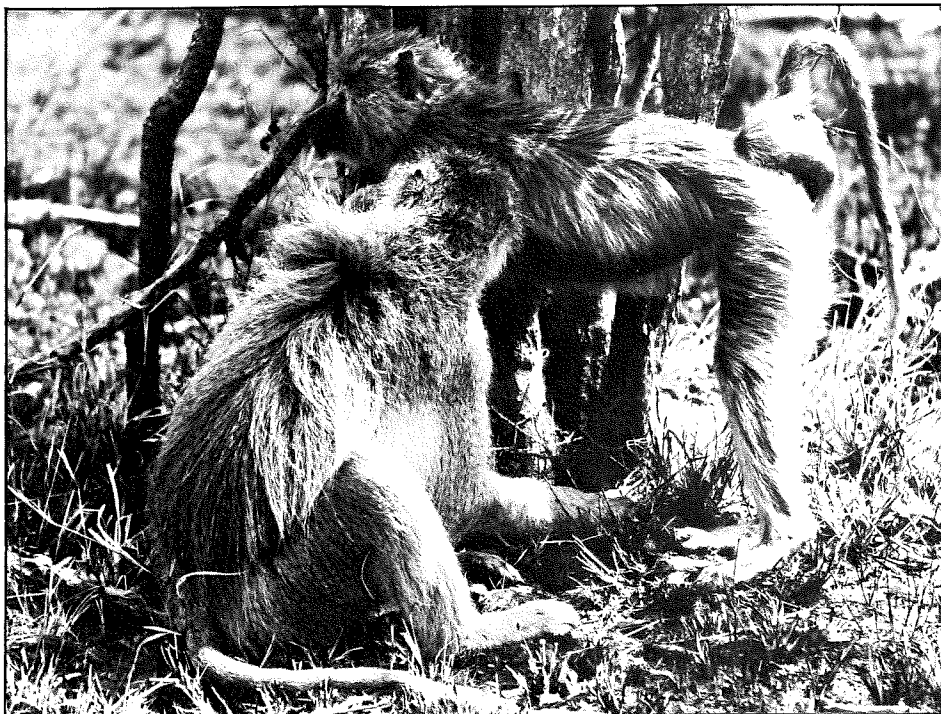
*Robo, a juvenile male who had been attacked by a leopardess, stands wounded and alone under sleeping site 1 after his troop and Viramba troop had left him behind.*

months from March to July, the months during which the range of the troop was smallest in area, since the gestation period of baboons is approximately six months. However, our data reveal no relationship between the timing of the 28 births that occurred in Viramba troop and changes in its patterns of range use.

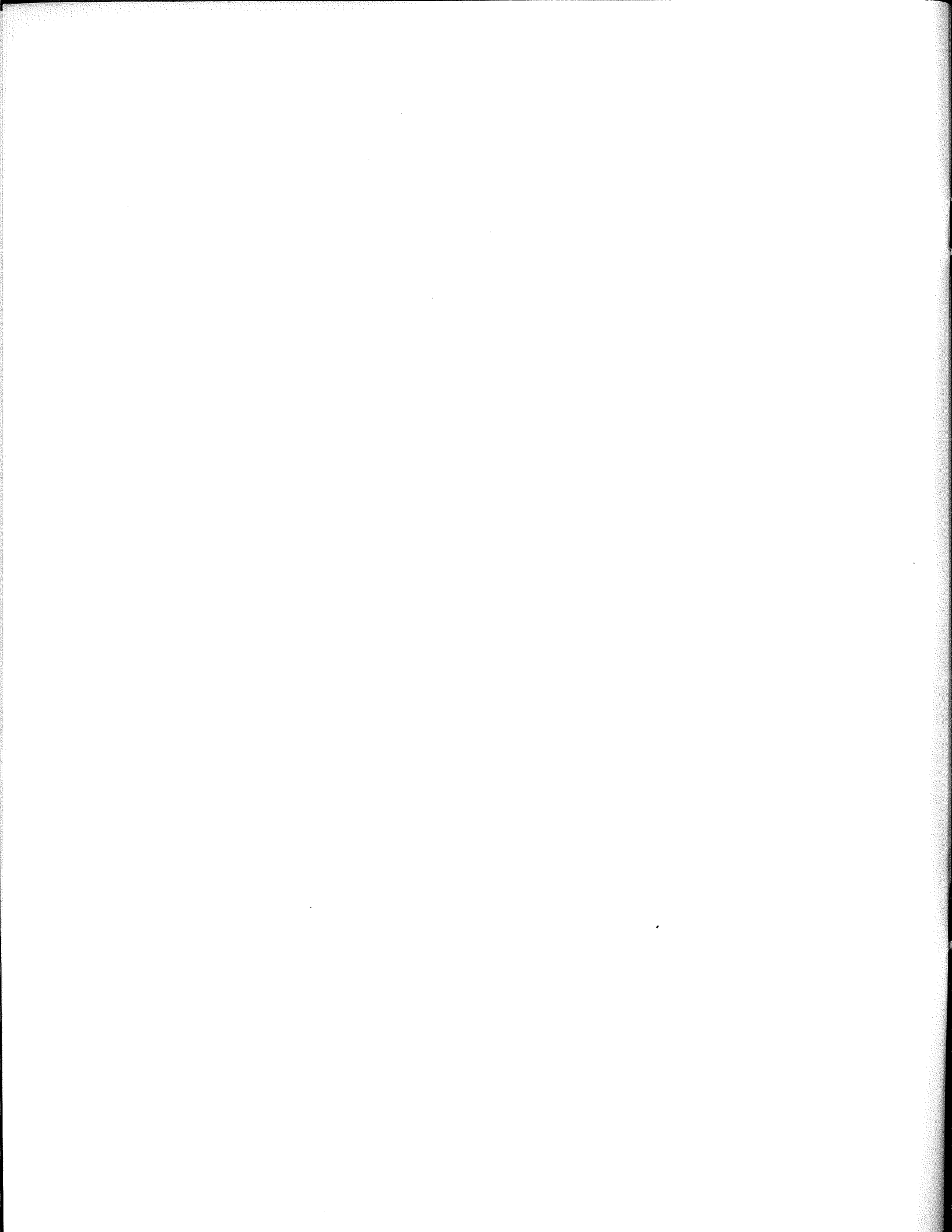
Estrous female baboons have a large and bright red swelling of their bottoms that has puzzled scientists since Darwin. This swelling is an obvious visual clue to scientists used to reliably determine when

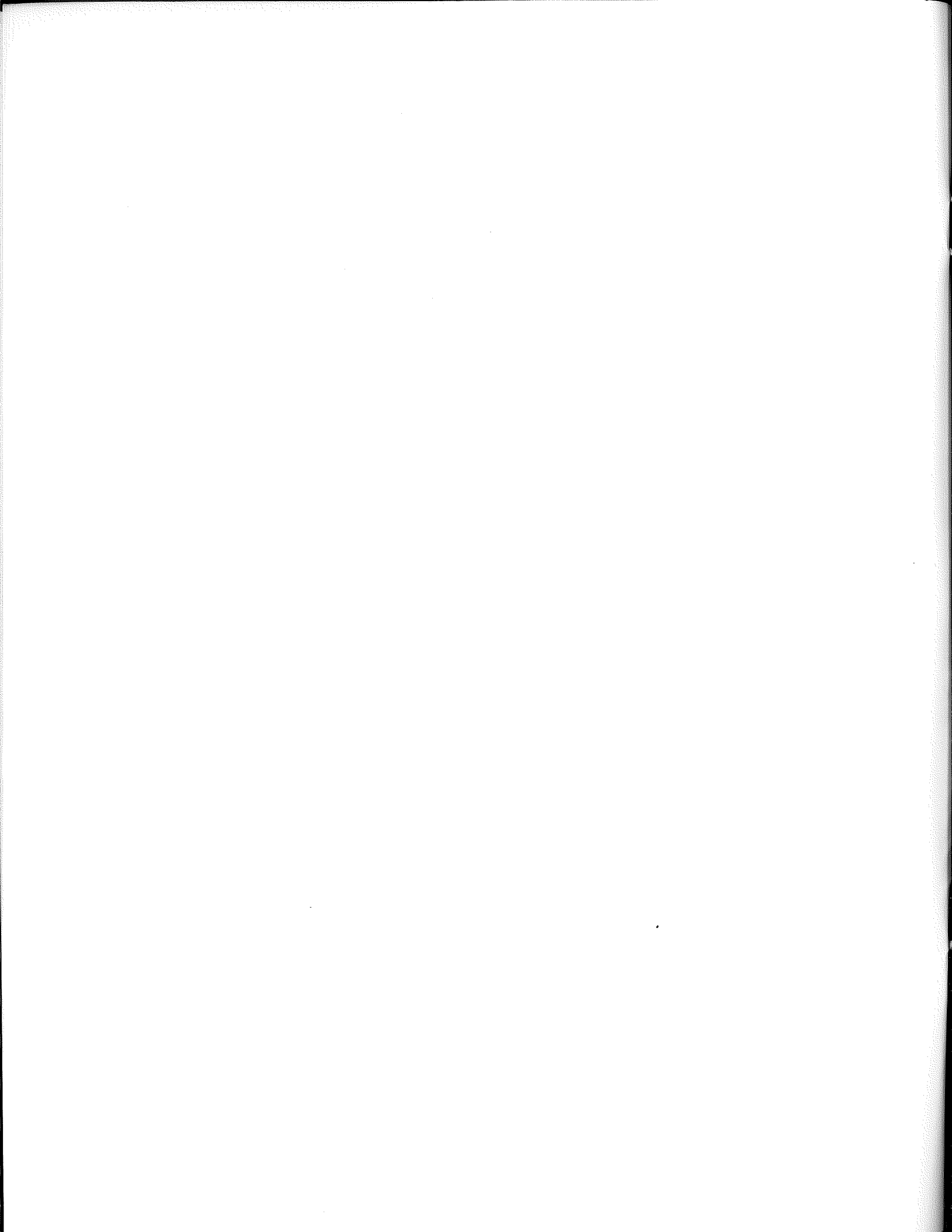
a female is most likely to conceive. It would seem to also be a visual stimulus to baboons indicating when a female is likely to conceive and be receptive to breeding. Yet modern laboratory studies suggest smell, rather than sight, provides the critical stimulus for mating when a male and estrous female are placed together in a cage. The most females were in estrus when the range of Viramba troop was largest in area and when vegetation was least dense. We could certainly see the bright red bottoms of the estrous females from several hundred yards away and it seems very likely that the baboons could see this strong visual stimulus from at least as great a distance. Smell may become more important only after a male and estrous female are in close proximity.

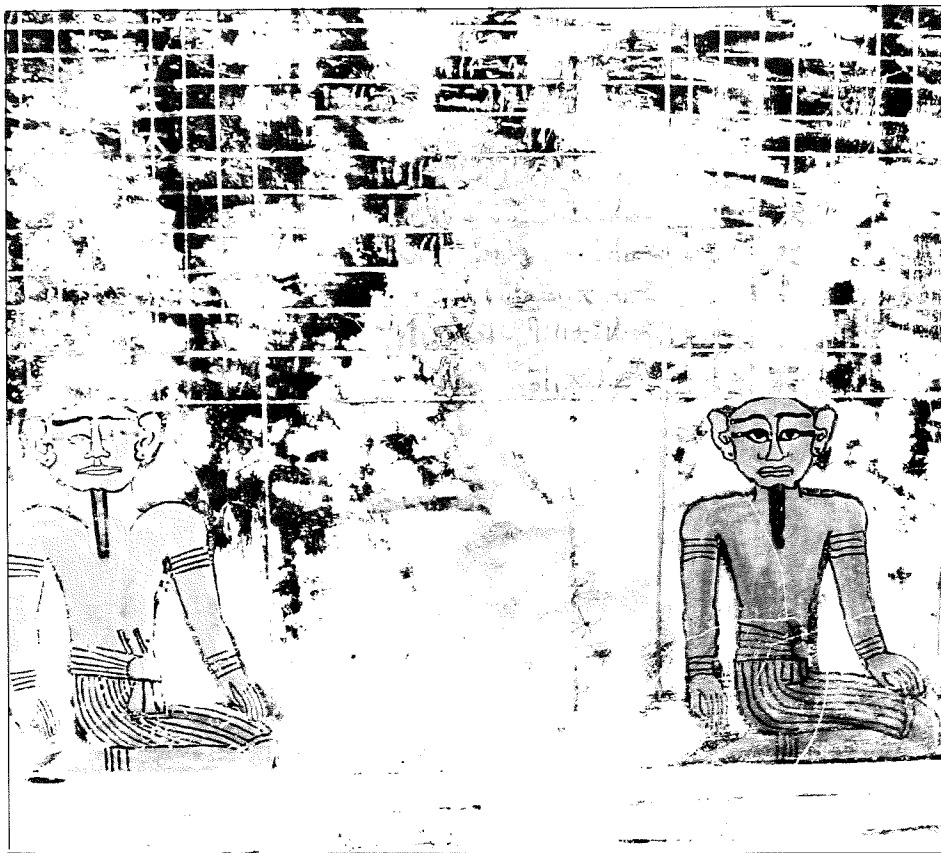
Twenty-six males either emigrated from or immigrated into Viramba troop during our study. More males moved in and out of Viramba troop when (1) the most females were in estrus, (2) the cover was least dense, and (3) the area of the range of Viramba troop was largest. Perhaps those bright red bottoms of the females were serving as a potent signal between troops during this season of decreased vegetation density. Encounters with other troops seem likely to have been most frequent as a consequence of the large area of the troop's range. Consort pairs of males and estrous females could now move to the periphery of their troop for privacy and not endanger the lives of juveniles because of decreased



*A sitting adult male grooming his standing estrous female consort. Consort pairs often moved to the relative privacy of the periphery of their troop during affiliative interactions and copulation. The most females were in estrus when the range of Viramba troop was largest in area, cover was least dense, and when dangers from predators may have been least (March to July).*







Thebes, Valley of the Kings. Tomb of Ramesses VI; Ramesside star clocks. photo: E.C. Krupp

## ASCENT

*Moving up.  
Muck falling from knees.  
Leaves coming into reach.  
Early on, man carved a face  
on rock with rock,  
and lifting it,  
delighted in the God he'd made.  
Before sound was solidly caught  
in sense  
and footprints made a path,  
man threw bones  
and charted the flight of stars  
on tombs.  
Man dug beneath his wondrous  
rock  
and finding elements,  
changed their form with fire.  
When designs and lines,  
numbers and dreams  
let him walk on air,  
he left the earth  
to gather rock  
from another world.*

—B. Sanford Page  
Gallina, New Mexico

in particular, space exploration — is only one component of our complex lives, but it makes us expansive. And an expansive mind is what makes fortuitous connections possible. The process of scientific and technological progress is not always direct or even logical. Often, a fortunate coincidence plays a vital part. It generally is impossible to guarantee that the right things will happen at the right time, and so instead we have found that the best climate is one in which a lot of things are happening and in which it's possible for people to find out about them.

After reviewing what have been — in a way — our past, present, and future experiences with space and the sky, we must conclude that we really do live in extraordinary times. Hominid evolution has been playing in this theater for several million years now, but one of the most consequential events in this multimillion year experiment with the big brain took place in just the last few decades: for the first time we left the surface of the earth. We pressed a footprint upon the landscape of the moon and then sent robot probes to the icy desert of Mars, around the rings of Saturn, and off into interstellar space, to remain there as a monument to cosmic order more permanent than anything our ancestors did.

There is a continuity between us and

our prehistoric ancestors. The path we were walking at Laetoli, in Tanzania, 3.6 million years ago, has taken us to the moon. The imprint of that boot sole on the Sea of Tranquility will be a record for the eons of that time in the distant past when we took a step off the earth, touched down to steady ourselves, and pushed off again for the stars.

We really aren't so different from our ancestors. Certainly our belief systems have changed, but we still have a belief system. Certainly our tools have changed, but we still need tools. There is a link between the old sky-watchers who sometimes drew themselves with eyes literally reaching out and grabbing the stars and the astronomers of our own age who watch at the cold end of a telescope for a hint about the universe.

Our perspective may have changed in the course of our cultural evolution. We have crossed a boundary that confined our ancestors to the earth. But we are no less in need of order and orientation than they. Our telescopes and our spacecraft transform our perception of the cosmos, but our brains, like those of the Desana, will one way or another resonate with the sky.

*Dr. Krupp gave a Leakey Lecture on this subject at Caltech on May 17, 1983.*

## HUMAN BRAIN SYMPOSIUM

A symposium, "The Human Brain and Its Disorders," sponsored by the Leakey Foundation and the California Institute of Technology, will be held at Caltech's Baxter Auditorium on Saturday and Sunday, January 21–22. The speakers for these Jagels Lectures will be Dr. Fred Plum of the New York Hospital, Dr. Norman Geschwind, Beth Israel Hospital, Dr. Nils A. Lassen, Bispebjerg Hospital, Dr. Marcus E. Raichle, Washington University School of Medicine, Dr. Jerome Engel, Jr., UCLA School of Medicine, Dr. Robert Katzman, Albert Einstein School of Medicine, Dr. Seymour S. Kety, McLean Hospital and Frank Duffy of the Children's Hospital Medical Center. These distinguished scientists will speak on higher brain function and ways of studying it and on such malfunctions as epilepsy and senility, including Alzheimer's Disease. The talks will be couched in language appropriate for the educated layman.

# FIELD REPORTS

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

## SOCIOECOLOGY OF MOROCCAN MACAQUES

Patrick Mehlman

The Ghomaran macaques of my recent study show some marked differences from Middle Atlas macaques both in ecology and social organization. But one basic similarity exists for both populations — the overwhelming importance of male-infant care in regard to overall organization. I have found that the Ghomaran macaques do not qualitatively differ from Barbary macaques of the Middle Atlas in male-infant care and in male-male-infant interactions. This indicates that all of the differences described below are aspects of behavior that are malleable in regard to environment (they *may* be adaptations or just random evolutionary "noise"), but male-infant care and male-male-infant interactions are more conservative behaviors that are present in two populations undergoing very different evolutionary selection pressures, and thus most probably species specific characteristics.

The Ghomaran macaques exist at a much lower density than those of the Middle Atlas. While overall group sizes are quite similar (groups of approximately 10 to 50 individuals), demographics are somewhat different. The macaques of my study area show proportionately fewer adult females and subadult males and a younger demographic structure (more immatures) than groups of the Middle Atlas. The most significant difference in population dynamics is the presence of heavy male migration in the Ghomara — something not reported from the Middle Atlas. I have ample documentation of solitary males and movement from group to group, these males covering considerable distances (in one case, greater than eight kilometers).

The Ghomaran macaques show much larger home range sizes and day range distances overall. My target group utilizes about seven square kilometers (at least three times larger than any home ranges of Middle Atlas groups), it can travel up to three kilometers in one day, and can change altitude in one day from 1400 m to just under 2000 m. In addition it is quite well adapted to the massive cliff systems of the area, using them for escape and for sleeping. Caves are also utilized for winter sleeping sites.

Feeding behavior of the Ghomaran

macaques departs markedly from that of macaques of the Middle Atlas. The ecology of the Ghomara is unique in that it supports the only coniferous forests of the Moroccan fir (*Abies pinsapo*) in Africa. The macaques here are entirely adapted to this tree, feeding on its products year round. Their winter diet is primarily the mature needles, their spring diet the male strobiles of the fir, their summer diet includes a sugary protective sap produced by the tree, and finally the autumn diet adds the seeds of the fir cone.

Feeding behavior also departs from that of the Middle Atlas because of the presence of permanent human habitation. Although my study group does not garden raid, the practice is common throughout this area. I have detailed observations of garden raiding — neighboring groups raid the garden of my forestry house residence. I have spent considerable observation time at my bedroom window, watching a neighboring group destroy my garden.

Another feeding behavior important to all groups of this area is the raiding of wheat fields. In late summer the macaques enter mature wheat fields of the local people to eat the grain.

Because of these habits, monkeys in Ghomara suffer heavily from human attack. I have been working on a system of

tethered dogs to prevent garden raiding; it might catch on with the local people.

The major difference in social organization is the incredible amount of dispersion displayed by the Ghomaran macaques. Areas of five hectares (100 x 500 m) are utilized by the target group as normal areas for dispersed feeding and/or progression. This causes the 50 individuals to break down into subgroups and peripheral solitaires, giving much information on social structure. On rarer instances I have recorded solitaires and subgroups 800 m away from the rest of the group. This obviously calls for detailed analysis. How does the group remain cohesive under these conditions?

As examples of specific ethological differences between Middle Atlas and Ghomaran macaques, I might mention two vocalizations used here and not recorded in the Middle Atlas. The first is a unique alarm call for location purposes within the group. The second is a vocalization I have called the "booming roar." This carries for more than a kilometer and is used when members of the target group are trying to locate each other.

I believe these vocalizations are directly related to group dispersion and are an adaptation allowing members to disperse and yet remain in communication. What I find exciting about this is that it may indicate that even the vocal repertoire is capable of being modified to meet local ecological requirements.

I have yet to formulate a comprehensive system to understand inter-male social relationships, but I have arrived at delineating some important factors. Age seems to be the primary one. I have two older, arthritic males who appear to be exempt from agonistic encounters. They move freely through the group and one older male is instrumental in determining



Male macaque with infant on back.

group movement.

Young adult males (and one prime adult male) are peripheralized, spending much time in solitary sitting and feeding. What remains are central males who seem to show dominance relationships, but this is confounded by the presence of coalitions. Any agonistic encounter rapidly escalates into a coalition with three to seven males making shifting alliances. In addition, the more subtle approach-retreat situations are almost non-existent, the males avoiding each other at long distances.

Male-male interactions are further complicated and variable because of a number of affiliative contacts. Seasonal grooming (after mating season and before birth season — March, April) is present between males, as well as "huddles" that in all ethological characters resemble male-male-infant interactions — but no infants are present. Male-male mounting is pervasive as well and I have recorded intromissions with ejaculations.

Several interrelated factors account for male-male interactions and male personality, the most complicated being the simultaneous handling of infants by two males. These interactions are usually rapidly terminated or are associated with positive affiliative behavior (as reported in the Middle Atlas) between the two males. The ethological content is exactly the same as that displayed between two females when handling infants. These facts, coupled with the fact that infants are carried into both aggressive and sexual interactions by males, indicate that it is highly unlikely that males are simply regulating aggression by the use of infants.

Thus, I have found my group to display a variability and complexity in male-male interactions not previously reported. I have also discovered what I feel are "roles" played by males. These are related to the group structure as a whole and I feel they aid in understanding male interactions. It is interesting that the roles I can document are quite similar to those described by Japanese researchers for *M. fuscata*. I have central and peripheral leader males, central males which can be ranked to a degree as higher and lower status males, peripheral males, and finally stranger males.

Some of the most striking differences between the behavior of my study group and that reported for the Middle Atlas groups are in the mating system. Taub documented that his study group had a most remarkable system. Males possessing females inhibited other males from interfering in the courtship process. Males were uni-mounters and copulations were short (about eight seconds). Rather than consort relations in pairs, males and females remained together for brief "consociations" (approximately 15 minutes), females statistically being the more frequent terminators and initiators of con-

sociations. In addition, Taub demonstrated that females attempted to copulate with many males, some achieving copulations with all male members during one day. He argued that female "promiscuity" was a form of sexual selection, females deliberately mating with as many males as possible, confusing paternity and guaranteeing male care of their infants by a number of males.

I have found a very different sexual mating system in my Ghomara study group. There is no "possession principle" inhibiting attacking males from disturbing a consort pair. Central males consistently break up copulation possibilities of peripheral males, and high status central males inhibit lower status central males from copulating with available females. The onset of the mating season in September guarantees serious aggression between males. All fights are complicated by coalitions and serious wounds are caused by aggression directly related to female access. Obviously the males of my study group are behaving quite differently from those of Taub's group. In addition, I have true consorts, a copulating couple remaining together up to eight hours. It is clear that the mating system I am observing is not the same as that of the Middle Atlas, raising the question whether a system even exists for *M. sylvanus*.



Martin Pickford.

## SCREENING ARCHDEACON OWEN'S DUMP

Martin Pickford  
National Museums of Kenya, Nairobi

Terry Harrison, a recent Leakey Foundation grantee, and his wife joined me in Nairobi. After he had time to see the fossil primate collection from last year, we spent five days screening Owen's dump on Maboko Island and have some fine additions to the collection. Among these are two partial maxillae and a mandible of *Victoriapithecus* which reveal a considerable amount about this animal. The mandible in particular is complete enough to give us a detailed reconstruction of arcade shape, symphyseal section and so on. I should think we have about forty isolated teeth and postcranial bones of this monkey.

In addition, we have collected a nice sample of *Kenyapithecus* teeth and more of the enigmatic *Mabokopithecus*. The latter is a very strange primate indeed, being possibly related to *Rangwapithecus*. In fact, a re-examination of all specimens from Maboko hitherto assigned to *Rangwapithecus vancouveringi* indicate that they are probably all referable to *Mabokopithecus* which has many years priority as a name.

We have a good sample of the rest of the fauna of the area, including some lovely bird bones. I went to Kaloma recently to show Dr. Harrison the strata from which the Kaloma *Kenyapithecus* jaw was found. I spent three weeks screening for the canines in 1980. Imagine my surprise at finding this time one of the canines begging to be picked up! This jaw now becomes the only one in Africa of a thick-enameled hominoid to possess a canine *in situ*. It should help a great deal in assigning isolated canines and in general studies of these apes.

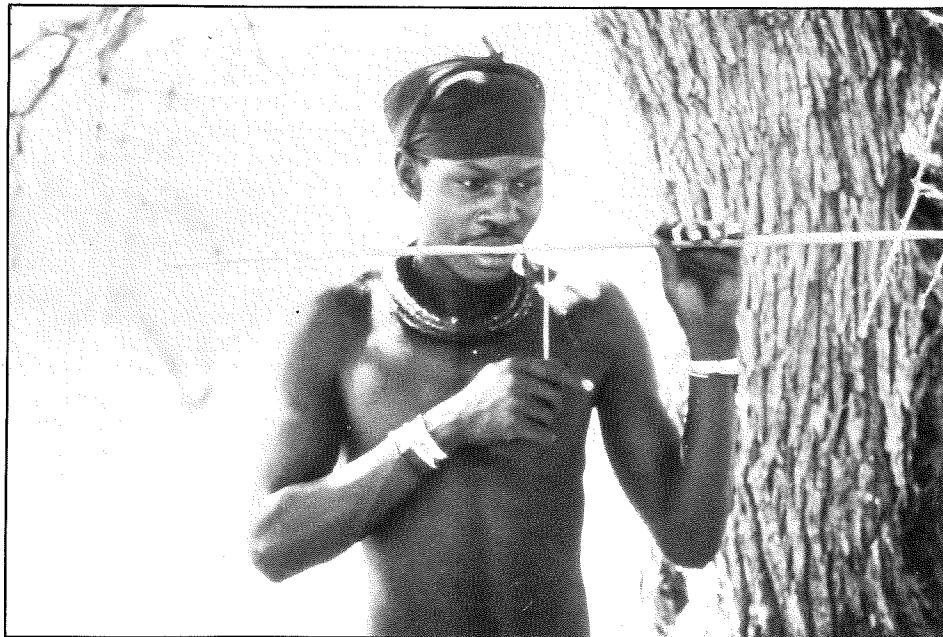
Dr. Terry Harrison adds:

I am writing from Maboko Island on Lake Victoria where I am assisting Dr. Pickford in the field. My research into the relationships of the Miocene primates from Maboko is making pleasing progress. I have carried out a preliminary survey of the fossil primates in Nairobi and have found that several new species are represented in the recent collections. The total number of fossil primate taxa now recorded from Maboko is four to six species, including one medium-sized monkey, at least two small hominoids and one or two large thick-enameled hominoids.

The present field season has already yielded abundant fossils of antelopes, giraffes, chevrotains, elephants, rhinos, pigs, hyaxes, rodents, carnivores, primates, reptiles, birds and invertebrates. The monkeys are particularly numerous and we have already collected over 100

specimens, including several mandibular and maxillary ones of considerable significance. Although there are several species of apes represented in the collection, they are much less common than the monkeys and the material is more fragmentary. Nevertheless, the 50 new hominoid specimens collected this year are very exciting and will undoubtedly yield valuable information on the taxonomy, diet, locomotor patterns, ecological preferences and phylogenetic relationships of Middle Miocene hominoids.

An important discovery this season is the occurrence of fossil leaves in sediments containing fossil primates. The fossil leaves will provide useful information on the environmental setting of the primates during the Miocene. The broad, succulent leaves with well-defined drip points suggest that the primates were living in forested conditions, probably along the margins of rivers.



*Playing the musical bow in Kaokoveld, Namibia.*

## HIMBA ORAL TRADITION

*R. J. Gordon  
TUCSIN, The University Centre  
for Studies in Namibia*

The expedition to the remote Kaokoveld in northwestern Namibia was wrought with stress. One of the Land Rovers overturned and the leader of the expedition, Richard Camby, had to have 47 stitches on his head and face. The threads were pulled in camp by an aspirant medical student with a fairly heavy hand and by a queasy archeologist sterilizing nail scissors and tweezers in a frying pan on the open fire. The area which we visited was declared an "operational area" and was riddled with army personnel and presumably guerrilla activity. Many Himba inhabitants expressed their dilemma of being caught between threats from both

sides of the conflict.

Our main informant insisted that we take him into utter isolation and leave him at a deserted water hole far out in the desert, accompanied only by his wife, thirteen year old daughter and blind mother-in-law.

In the course of talking to people on the topics we were interested in, we taped approximately six and a half hours of conversation, song and music. Herero-speaking Ismael Katjitae was the translator and led many of the conversations. He has also been the driving force and responsible for transcribing all the tapes. The translation was completed with the help of Dr. Beatrice Sandelowsky who guided the work. The data includes information on stone working, food and traditional practices such as circumcision and burial.

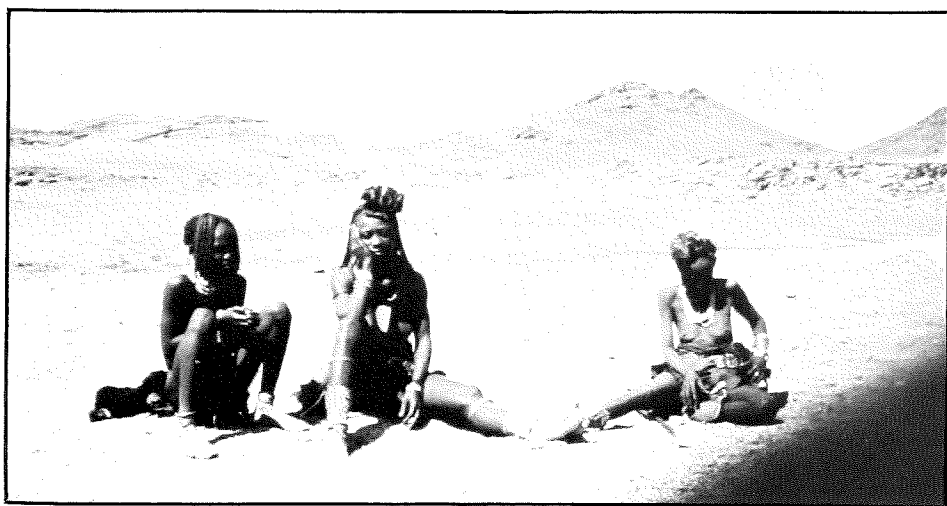
## PALEOMAGNETIC STRATIGRAPHY OF THE KOOBI FORA FORMATION, LAKE TURKANA, KENYA

*John W. Hillhouse  
Geological Division,  
United States Department of the Interior*

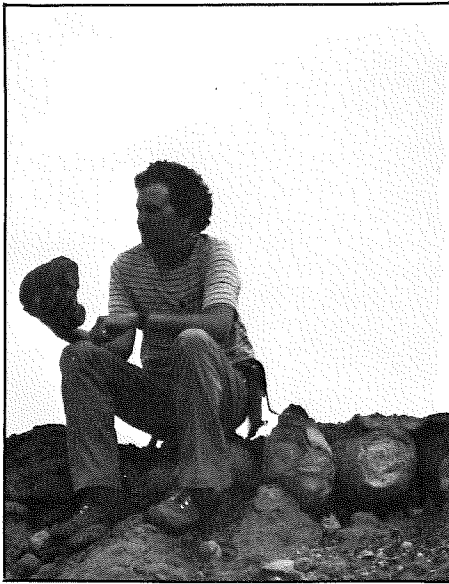
I joined Thure Cerling and Frank Brown (University of Utah) at Koobi Fora last summer, at the base camp of the East Rudolf Research Group at Lake Turkana. Our first goals were to establish stratigraphic columns that could be tied to identified volcanic ash beds in the Kubi Algi Formation and the lower part of the Koobi Fora Formation and to collect samples for paleomagnetic analysis. We operated from a tent camp near Allia Bay, using a Land Rover and equipment supplied by Richard Leakey.

During previous trips to Koobi Fora, Brown and Cerling had identified a number of volcanic ash beds, primarily on the basis of glass chemistry, which linked outcrops throughout the East Rudolf area with the dated Shungura Formation in southern Ethiopia. Using these key markers, we located stratigraphic sections near Kugi Algi, Jarigol, and Lokochot which were suitable for the paleomagnetic study. When combined, these sections span the interval from the Burgi Tuff down to the Moiti complex. I collected 261 oriented specimens, mainly from the volcanic ashes and siltstone beds.

After a stay of three weeks, I returned to Nairobi and met with Dr. Joab Ndombi of the Physics Department, University of Nairobi. Dr. Ndombi has been involved in the Koobi Fora paleomagnetic research since its beginning in 1972, and



*Wife, daughter and mother-in-law of Himba informant far into the Namib desert.*



John Hillhouse.

is collaborating with me in the current project. The original plan to have Ndombi participate in the last week of field work was cancelled due to turmoil in Nairobi during the attempted coup of August 1.

The oriented specimens are now being prepared for magnetic measurements in the U.S. Geological Survey's paleomagnetism laboratory at Menlo Park, California. The samples will be encased in a heat-resistant cement so that thermal demagnetization treatments will be possible. This procedure should be an improvement over the earlier paleomagnetic studies at Koobi Fora which employed alternating field cleaning techniques exclusively. The objectives of the laboratory work are to establish magnetic polarities of the Burgi and Moiti Tuff interval for comparison with the magnetostratigraphy of the Shungura Formation. The ultimate goal is to provide better age control for the lower part of the Koobi Fora Formation, which contains fossil localities important to the study of man and mammalian evolution. Completion of the laboratory work is scheduled for the end of 1983.

### DISCOVERIES AT PONTNEWYDD CAVE, CLWYD, WALES

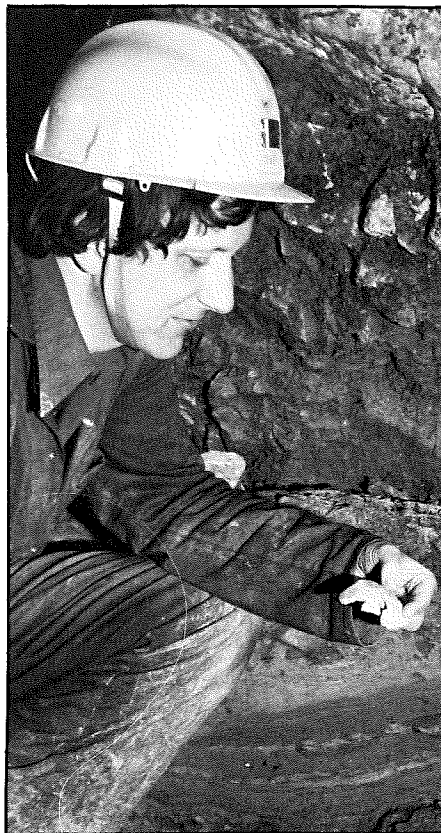
Stephen Green  
National Museum of Wales

A sixth season of excavations at Pontnewydd Cave, under my direction, has yielded new hominid and artifactual finds perhaps a quarter of a million years old. Two hominid left lower first premolars

were discovered and have been identified by Dr. Christopher Stringer of the Natural History Museum as being from a twelve year old and an older, perhaps even adult individual. Both teeth are large-crowned and compare well in size with Neanderthal specimens. The minimum number of individuals represented from the site is now at least three — a nine year old, the twelve year old evidenced this year and an adult.

The Lower Paleolithic occupants of the site produced a late Acheulian industry of handaxes, scrapers, discoidal cores and Levallois cores and flakes, using a variety of volcanic rocks as raw material. This year the site yielded its first flint handaxe and flint Levallois flake.

The excavations took place by kind permission both of the landowner, Major David Williams-Wynn, and of the Welsh Office (the site being a scheduled ancient monument). Important additional financial support was provided, from Britain, by the British Academy, the Society of Antiquaries, the Board of Celtic Studies of the University of Wales, the Cambrian Archaeological Association and, from the U.S.A., by the L.S.B. Leakey Foundation and the Foundation for Research into the Origin of Man.



Stephen Green.



Cécile Mourer-Chauviré.

### BIRD FOSSILS OF OLDUVAI

Cécile Mourer-Chauviré  
University of Florida, Gainesville

I arrived in Gainesville in April, 1983, and since then have been working mainly on the Olduvai birds in collaboration with Professor Brodkorb.

We have finished the study of flamingos, having taken the measurements of all the skeletons of all the species of *Phoenicopteridae* available. The results can be summarized as follows:

1) Although there are great differences in size in the fossil population of flamingos at Olduvai, these can be explained by sexual dimorphism. Comparison of fossil flamingos with recent ones shows no significant difference and all the Olduvai flamingos can be placed in the recent species *Phoenicopterus ruver Linnaeus*, the Greater Flamingo.

2) It is surprising to see the absence of *Phoeniconaias minor*, the Lesser Flamingo, which today outnumbers greatly the Greater Flamingo on the lakes of the Rift Valley. However, this absence can be explained by the fact that the fossil material comes from human occupation sites. The Lesser Flamingo lives presently on very alkaline and saline waters. Early humans would not have been able to survive in this type of environment.

We have begun to write a paper describing an extinct species of cormorant which is plentiful in Bed I. All the measurements of fossil and recent comparative material have been made.

The next paper will be on the *Strigidae* (owls). The Olduvai *Strigidae* include a large form, not very different from Verreaux's Eagle Owl, *Bubo lacteus*, an extinct species which seems to be the immediate ancestor of the Spotted Eagle Owl, *Bubo africanus*, and a form very similar to the recent African Barn Owl, *Tyto alba*. □



The Grant program 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. Members and donors are invited to designate their gifts in support of specific research projects.

Won't you take this opportunity to direct your contribution to the grant project of your choice?

## GRANT SPOTLIGHT

Craig Packer

\$2,900 needed

### DOMINANCE, REPRODUCTIVE RATE AND LONGEVITY IN OLIVE BABOONS

Data concerning lifetime reproductive success in *Papio spp.* are available for wild populations only at Gombe National Park in Tanzania. The baboons there provide the best source for testing the relationship between reproductive rates and longevity in primates. It is imperative to do a follow-up of data collected by the Gombe staff before it can be used in publication; these funds will be spent toward that end.

Richard G. Klein

\$1,500 needed

### MICROCOMPUTER ANALYSIS OF ZOOARCHAEOLOGICAL DATA

This application is a request for funds to purchase a microcomputer to refine programs of zooarchaeological data. Faunal data from stone age sites in southern Africa and Spain will be analyzed. The machine will be available for use by other researchers in the anthropology department at the University of Chicago.

Jan Simek

\$3,000 needed

### EXCAVATIONS AT GROTTA XVI, DORDOGNE, FRANCE

Funds are requested for equipment used in long-term excavations at Grotte XVI. The site represents Upper Paleolithic levels in an area ecologically important to understanding regional resource use.

Raymond Bernor

\$2,400 needed

### THE PALEOBIOLOGY OF CHINESE NEOGENE HIPPARIONINE HORSES AND THEIR USE FOR CORRELATING SOME OLD WORLD LATE MIOCENE HOMINOID-BEARING LOCALITIES

Dr. Bernor plans a study of the Chinese Neogene hipparionine horse fossils housed by the Paleontological Museum in Uppsala, Sweden. The study of the systematics and phylogeny of these horses will be used for geochronological correlation and biogeographic interpretations relevant to Late Miocene hominoid migrations, disjuncts and hominid origins.

Julian Caldecott

\$3,300 needed

### WILDLIFE AND SUBSISTENCE HUNTING IN SARAWAK

Support is sought for a study of the hunting practices of the indigenous population of Sarawak and of the relationship between hunting levels and population density and the structure of various species of wild fauna. The aim of the work is to collect information concerning the conservation of wildlife so that a long-term food source at subsistence level for the local population can be maintained.

Diane Gifford

\$1,200 needed

### TENTH YEAR STUDY OF TAPHONIC SPECIMENS AT LAKE TURKANA

Dr. Gifford's work concerns the formation of fossil assemblages. The remains of over 30 carcasses of large wild antelopes and zebras have been monitored over a ten year period with respect to carnivore damage, disarticulation and scattering, weathering and burial.

Linda Winkler

\$1,500 needed

### AGE RELATED ANATOMICAL CHANGES IN THE CRANIOFACIAL COMPLEX OF THE ORANGUTAN

This research will investigate differences at various ages in the craniofacial anatomy of the orangutan (*Pongo pygmaeus*). The information will broaden the comparative base for assessing systematic issues in hominoid phylogeny, contribute to the study of orangutan anatomy and generate hypotheses about craniofacial age changes in this primate.

Martin Pickford

\$3,500 needed

### SCREENING OF ARCHDEACON OWEN'S DUMP AT MABOKO, KENYA

Reconnaissance screening of sediment at Owen's Dump on Maboko Island in 1982 yielded a rich collection of primate fossils belonging to five taxa of hominoids and two of cercopithecoids plus associated fauna. Funds are required to screen the remaining 74 cubic meters of dump. Standard screening procedures are slow, labor intensive and expensive, but will yield a rich collection of specimens with lower cost per specimen than achieved elsewhere in Kenya.

Adrienne Zihlman \$2,800 needed

### SKELETAL BIOLOGY AND LOCOMOTOR BEHAVIOR OF GOMBE CHIMPANZEES

Dr. Zihlman will spend one month at Gombe in Tanzania to collect data on chimpanzee skeletons with well-documented age, sex and life history information. The Gombe population will also be compared metrically to other chimpanzee populations.

Nicholas Barton \$3,000 needed

### UPPER PALEOLITHIC AND MESOLITHIC SITES AT HENGISTBURY, SOUTH ENGLAND

The project concerns examination of early prehistoric sites and environmental contexts at Hengistbury Head, Dorset. Recent excavations have identified two sites, the first a large Upper Paleolithic camp, the second a Mesolithic settlement dating to the early postglacial period. Support is sought for making core samplings, experiments in flint shattering and microware, flint sourcing and experimental manufacture studies.

Roger Fouts \$10,000 needed  
in designated funds

### INTEGRATION OF COMMUNICATION SYSTEMS AND CULTURAL TRANSMISSION BY AMERICAN SIGN LANGUAGE-USING CHIMPANZEES

The proposed research concerns the quantification of a chimpanzee's acquisition of American Sign Language from the adopted mother and older siblings within the familial unit. Dr. Fouts seeks funds for videotapes, chimpanzee food, veterinary and miscellaneous supplies.

Lewis R. Binford \$3,000 needed

### SITE STRUCTURE AT COMBE GRENAL, FRANCE

Funds are sought to support analysis of lithic and faunal material from the Mousterian site of Combe, Grenal.

R. W. Byrne \$4,000 needed

### FUNCTIONS OF LONG-DISTANCE VOCALIZATIONS IN WILD CHIMPANZEES

Chimpanzees show a complex social organization based on communities of socially interacting animals. The males of a community are related and cooperatively defend a territory; females are generally unrelated and take no part in territorial defense. Dr. Byrne plans to use field playback and filming of responses to determine the role of distance communication in chimpanzee social organization.

*The L.S.B. Leakey Foundation supports research related to human origins, behavior and survival. Priority is given to studies in the areas of human paleontology, archeology and environmental studies of the Miocene, Pliocene and Pleistocene; into the behavior of the Great Apes and other Old World Primate species; and into the ecology and adaptation of living hunter-gatherers. Eligibility is limited to applicants who are doctoral candidates or engaged in postdoctoral research. Potential applicants are encouraged to submit a Petition for Grant Application. On invitation of the Science and Grants Committee, those with projects falling within the range of priorities of the Foundation will be asked to submit a formal application. Deadlines for submission of the formal application are: March 15, June 1, Sept. 1 and Dec. 1.*

*For further information and application forms contact the Leakey Foundation, Foundation Center 1-7, Pasadena, CA 91125.* □

## IN THE NEWS

The Foundation and its members have been noted more and more often recently in various publications. Among these: **People** magazine, October 17, in giving a page to Gordon Getty and his primary interests, and **GFWC Clubwoman** in featuring a report by Kaye Jamison on "Stones and Bones", in the September/October issue.

## SALT LAKE CITY SYMPOSIUM

A Leakey Foundation symposium entitled "In Search of Our Ancestors" will be held February 25, 1984, at the University of Utah, Salt Lake City. Dr. F. Clark Howell of the University of California at Berkeley will moderate and give an overview of the field. The speakers are: Dr. J. Desmond Clark, University of California at Berkeley, on "Tool Manufacture and Behavior," Dr. C. Owen Lovejoy, Kent State University, "Bipedality: The Hallmark of Mankind," Dr. Richard Wrangham, Stanford University, "Human Groups and the Mystery of Primate Kinship," Dr. Alan Walker, Johns Hopkins School of Medicine, "The Bare Bones of Behavior," Dr. James O'Connell, University of Utah, "The Study of Modern Hunting and Gathering Societies," and Dr. Frank Brown, University of Utah, "Radiometric Dating and Its Effect on the Field of Anthropology."

A dinner will be held the evening before at the Salt Lake Country Club at which the scientists, James and Gloria Stewart and Scott M. Matheson, Governor of Utah, will be the honored guests. A film on the life and work of Louis S.B. Leakey will be shown. Further information on the dinner, the symposium, skiing and hotels is available from the Foundation office.

## NEW FELLOWS

The L.S.B. Leakey Foundation is pleased to welcome as new Fellows: Charles B. Jones, Sykesville, Maryland, Ms. Gene Burrill, South Pasadena, California, Dr. and Mrs. Gerold Grodsky, San Francisco, California, and Mrs. Diane Jewell Hayden, Poteet, Texas.

## BOOKS

A paperback reprint of Jane Goodall's renowned book, *IN THE SHADOW OF MAN*, first published in 1971, has been issued this year by Houghton Mifflin. All the original Hugo van Lawick photographs of Dr. Goodall and the chimpanzees of her study group at Gombe, Tanzania, are reprinted. The book is recognized as a classic report of primate research and is also one of the most entertaining stories of animal behavior ever written. \$9.95.

*THE FLOWER GAME* by Fleur Cowles, Morrow, New York, 1983. \$15.95.

Ms. Cowles, a trustee of the Leakey Foundation and former editor of *Flair* magazine, asked nearly 200 friends around the world to select which 10 flowers they would take with them to a desert island, one where, miraculously, any flower would flourish. Interesting responses were received from celebrities, socialites, royalty, writers, actors and botanists. The late Princess Grace, for example, chose zucchini so that she could eat the flower. Ms. Cowles has herself illustrated the book in color.

*PRIMATES AND THE TROPICAL FOREST: Proceedings of a Seminar held September 21, 1982, at the California Institute of Technology.* Editors: Russell Mittermeier and Mark Plotkin. 1983. 54 pp. Softbound. \$7.50, members; \$8.25, non-members.

A well-illustrated volume containing six scientific presentations aimed at furthering understanding of the problems facing primates and their tropical forest habitats worldwide and pointing out the significance to our own species, the human primate. □

## CALENDAR

### JANUARY 21 - 22

Symposium: THE HUMAN BRAIN AND ITS DISORDERS, Caltech, Pasadena, California. See page 12.

### FEBRUARY 25

Symposium: IN SEARCH OF OUR ANCESTORS, Salt Lake City, Utah. See page 18.

### APRIL 1 - 15

Exhibit: BONES OF OUR ANCESTORS, American Museum of Natural History, New York.

### PLEASE NOTE

There will be **NO LEAKEY LECTURE SERIES** at Caltech during the winter-spring, 1984, season.

## L.S.B. LEAKEY FOUNDATION AND SOCIETY MEMBERSHIP COUPON



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N27

# THE NATURE OF THE MOTHER-CHILD BOND IN CHIMPANZEES: IMPLICATIONS FOR THE WESTERN NUCLEAR FAMILY

Jane Goodall

The social structure of the chimpanzee is unique among the non-human primates. They live in communities; at Gombe these usually number between 30 and 50 individuals. Community members recognize each other and may interact frequently, but they do not travel around in a stable troop; rather they move or feed in small temporary associations, the composition of which changes frequently as individuals wander off on their own or in twos or threes, subsequently joining a different association. Only mothers and their dependent young form small units which are stable over a period of years. Such a unit may spend a good deal of time on its own; some mothers are more gregarious than others and join other associations more frequently. Enduring, supportive bonds are established between family members. The father, however, does not form part of such a family unit; since chimpanzees are promiscuous it is often not possible to know which male has fathered which infant. Thus there is no father-child relationship in chimpanzee society, nor are there lasting bonds between non-related adult males and females.

The chimpanzee has a long period of childhood dependency. The mother nurses her youngster for about five years, and even after the birth of the next infant the older offspring, who is then five or six years old, continues to travel with its mother until it is at least eight years old, after which it may begin to leave her for a few days at a time.

Because of the unique social structure, the personality of the mother, her position in society, her age and her sociability can have an unusually profound influence on the development of her offspring. The

presence or absence of siblings and their sex can be very crucial too.

The above can be illustrated by comparing the behavior of two young females, Fifi and Pom, who had very different kinds of mothers, Flo and Passion respectively. Both these females were high ranking and aggressive, but there the similarity between them ended. Flo was affectionate, protective, playful and tolerant. She had a relaxed relationship with the community males and a very social disposition. Passion was much less tolerant and protective, she seldom played, and she was tense during interactions with the adult males. She was something of a loner, spending much time with her offspring away from other members of the community. Fifi had two older brothers; Pom was a first born child.

Fifi went through weaning easily, was fascinated by the next baby born into the family, was relaxed when, for the first time, she attracted the sexual interest of the big males and, when she had her own infant, showed maternal behavior very similar to that of her own mother. Pom had a difficult time during weaning, showed very little interest in the next baby, was tense and nervous during periods of estrus. She also showed maternal behavior similar to that which she had received from her own mother. It seems likely that the differences in the behavior of the two mothers, Flo and Passion, were at least partially responsible for the observed differences in the behavior of their daughters. (One must, of course, bear in mind the fact that hereditary factors were also involved.)

The young male is influenced by his family in similar ways. For him the presence or absence of an older brother may be a most significant factor. The infant or juvenile male spends much time watching older males; if he has a brother he has, as it were, a built-in model. Fifi's second son, Frodo, was clearly fascinated by his big brother's behavior from a very early age and, as soon as he could move about on his own, often tried to imitate

what he had observed. Perhaps because of this he was unusually precocious in his social development.

Just because the bond between mother and child is so strong and so enduring, any kind of disruption, such as temporarily losing the mother, may be very upsetting to the infant. Some youngsters become very "depressed" during weaning (as did Pom) and others may throw violent tantrums. A few young juveniles were (like Pom) clearly upset by the birth of the next baby, at which time they no longer had the undivided attention of their mothers. Most traumatic, of course, is the death of the mother which can have profound physiological and psychological effects on the child — and may, in fact, lead to the death of youngsters under five years of age. One juvenile (Flint) remained unusually dependent on his old mother (Flo) and, when she eventually died, became depressed, even though he was eight and a half years old at the time. He fell sick and died, himself, three and a half weeks later.

Throughout human evolution the children of our species have, for the most part, been brought up in the context of the extended family where relatives can compensate for maternal inadequacy or death. The young of most non-human primates grow up in troops where they are usually surrounded by experienced adults and a number of peers. It seems that the chimpanzee family may be an excellent model for studying the kinds of physiological and psychological disturbances that may arise in children of our modern, western nuclear families or, even more, the single parent families, as a result of overdependence between child and mother, and where a youngster may have to bear most or all of the brunt of an incompetent, uncaring, or even abusive mother.

*Abstract of a talk given by Dr. Goodall in May at the San Francisco Leakey Foundation symposium, "In Search of Man."* □



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