Portraits in the Wild

Behavior Studies of East African Mammals

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Illustrations

III

The Black Rhinoceros

When John Goddard died in July 1971 in Zambia at the age of thirty-five, the scientific community of East Africa lost one of its most respected members and the rhinoceros lost a very good friend, for Goddard devoted seven years of his life to the black rhinoceros, and he probably knew more about that animal than anyone else in the world.[1]

The rhinoceros does not have many friends in this world. It is considered a stupid, ill-tempered brute that attacks at the slightest provocation. This is not altogether untrue, but the rhino has not had an easy time of it, to say the least. It has been mercilessly pursued by hunters for its horns, which in powdered form are sold as an aphrodisiac in the East. The rhino is very nearsighted and cannot even see his enemy until it is too late. Most hunters agree that it is the easiest of all the big game animals to kill. But in recent years, when the rhino appeared to be in danger of imminent extinction, the conservationists have come to its aid. In 1960 it was estimated that there were only twenty-five hundred rhinos left in all of Kenya, and in a 6000-square-mile area that included most of the Serengeti National Park and the Ngorongoro Crater in Tanzania, a census produced only fifty-five rhinos.

But what did this actually mean in terms of the rhino's future?

[1] Five species of rhinoceros exist today: two in Africa — the black rhinoceros, *Diceros bicornis*, and the less numerous square-lipped or white rhinoceros, *Ceratotherium simum*; three in Asia — the Sumatran rhinoceros, *Dicerorhinus sumatrensis*, the Javan rhinoceros, *Rhinoceros sondaicus*, and the Indian Rhinoceros, *Rhinoceros unicornis*. The three Asian species are barely surviving.

Were there really so few and were they going to die out? As is usual in cases of panic like this, no thorough census of the existing rhino populations had been made and little was known about the rhino itself.

An intensive and systematic study of the rhino was needed, and this is exactly what John Goddard was asked to carry out by the Tanzanian government. Goddard came out to Tanzania in 1964 from Canada, with his wife and small daughter, to take up the position of Game Biologist for the Ngorongoro Conservation Area. There he studied two distinct rhino populations: the one in the Ngorongoro Crater and the one in Olduvai Gorge, the famous site where Louis and Mary Leakey found the tools, homes, and eventually the skulls of early man. Goddard was able to continue his studies and gather valuable comparative data, when, after three years in Tanzania, he went on to study the rhino population in Tsavo National Park in Kenya. (This Park, believed to have the largest population of black rhinos remaining in Africa, has steadily been undergoing severe damage from elephants and fire, which together are radically changing the habitat from woodland to open grassland.) In the 1960–61 drought in Tsavo at least 282 rhinos had died from malnutrition. No one knew how many remained or whether those that did could survive the change in habitat. The rhino is a browser, and the parks authorities feared there would not be enough woody vegetation in the new habitat to support the large rhino population.

The main purpose of Goddard's work was to determine the state of the black rhinoceros populations in each of his three study areas; that is, to see how many rhinos there were and whether the populations were stable, increasing, or decreasing. In order to answer these questions it was necessary to make an accurate census of the populations and to collect data on birth rates, mortality, life span, calving intervals, age at maturity, etc. It was also important to understand the social structure, to find out the average range of an animal, and to study its feeding behavior. In other words, Goddard had to find out just about everything there was to know about the rhinoceros.

Since the rhino populations in Ngorongoro and Olduvai are relatively small, Goddard decided to use the method of individual recognition in his study. While observing the plains zebra in Ngorongoro Crater from 1962 to 1965, Hans and Ute Klingel (see chapter IV) had photographed all the rhinos they encountered and found that they were able to identify individuals by differences in horns, ears, and by scars on the body, combined with sex and age. Altogether they recorded sixty-one different rhinos in the crater, thirty-four of which used the crater most of the time and twenty-seven of which appeared to be temporary visitors.

When Goddard arrived in 1964, the Klingels gave him a duplicate set of their photographs. Goddard added to their records and made a new set of files for Olduvai. He also improved on their technique by photographing each rhino from the front in order to use the wrinkle contours on the snout as a further aid to identification. In some cases he found that horns alone could be misleading, especially if the horns were small. Also rhino horns have a tendency to break, which could cause confusion. Snout wrinkles apparently remain constant.

In the open area of the Ngorongoro Crater Goddard could do most of his observing from his Land-Rover, but in the bushier areas of Olduvai and Tsavo he had to work on foot, and to his wife's great consternation he refused to take a gun with him, relying on the rhino's myopia. He tried to keep upwind of the rhino, making his observations from the tops of rocks, anthills, or trees whenever possible. However, he did comment rather wryly that while watching one rhino "the possibility of encountering another rhinoceros concealed from view should also not be overlooked."

By his identification technique Goddard eventually recognized 108 rhinos on the floor of Ngorongoro Crater, which is 102 square miles, and 70 in Olduvai Gorge, in an area of 170 square miles. These figures indicated a larger population than was thought to exist, which was a welcome relief to conservationists. In Tsavo, by combining ground observations and extensive aerial counts, Goddard estimated the population to be over 7000, which came as a surprise to almost everyone. (Before Goddard's study, most es-

timates had been based on the numbers of rhino seen while driving or walking through an area. Rhinos are difficult to see in thick bush, and without the aid of aerial counts, underestimates were invariably made.) He found that the density of rhinos in Tsavo (8034 square miles) ranged from 4 rhinos per square mile to 1 rhino per 10 square miles, depending on the habitat. Although the area was huge, he did get to know individual rhinos — he catalogued 700 rhinos, or approximately 10 percent of the population, by his photographic method.

However, these revelations about the number of rhinos did not necessarily mean that the rhino was no longer in danger. The rhino's behavior and ecology in each of these areas had to be examined before a statement could be made about its future.

While Goddard was studying the rhino in Tanzania, two Swiss zoologists, Rudolf Schenkel and his wife, Lotte Schenkel-Hullinger, who were staff members of the University of Nairobi, also carried out a part-time study of the rhinos in Amboseli Game Reserve and in one area of Tsavo (East) National Park from January 1963 to October 1966. They visited these areas for periods of up to three months whenever they could get away from their duties at the university. Their work on the ecology and behavior of the black rhinoceros was published in a 101-page monograph. Their results complement Goddard's, and the combined studies now provide a fairly thorough picture of the way of life of the rhinoceros.

It is not easy to put the rhinoceros into a definite category in terms of social structure. It is not a herding animal or a pairing animal. The rhino is essentially solitary but not exclusively so. The most common sightings are of single animals or a mother and calf, but groups of three, four, and five rhinos have also been seen; Goddard once saw a group of thirteen. Every possible combination of sexes and ages has been seen. Two adult males have been seen feeding and lying together. Groups of three often consist of an adult female, her calf, and an immature rhino that may or may not be her previous offspring. Some of these group associations may last a few hours (as did, for instance, the group of thirteen

rhinos that Goddard saw); others may last for months. The Klingels recorded two adult cows remaining with each other for thirteen months; and a bull, a cow and calf, and an immature bull were seen together for four months.

It had been assumed by some observers that the rhinoceros is territorial; that is, that a bull will defend a given area from intrusion by other males of his species and that he specifically marks out his territory by strategically placing dung heaps and spraying bushes with urine. Observations by both Goddard and the Schenkels indicate that the rhino is not territorial, but that each rhino does have a well-defined home range. Rhinos will tolerate the presence of other rhinos in their home range and will even keep company with other rhinos for a while, but they are not basically gregarious and apparently prefer being on their own. In fact, Schenkel reports that if two rhinos are walking along or feeding along the same path, moving toward each other, one will often avoid the other by making a large detour off the track. The only strong bond is that between mother and calf, which lasts for two to four years.

Goddard plotted the home ranges of most of his known animals and discovered that the home ranges overlapped considerably; each range overlapped with one or more other ranges by a mean of 35 percent. One adult bull shared 40 percent of his home range with another adult bull. Obviously, rhinos whose home ranges overlap will frequently meet and thus know each other.

The size of the home range differs according to sex, age, and habitat. On the floor of Ngorongoro the mean home range for an adult male is 6.1 square miles, for an adult female 5.8, for an immature male 13.9, and for an immature female 10.7. In the arid, bushier area of Olduvai the mean home range for an adult male is 8.5 square miles, for an adult female 13.7, for an immature male 14.5, and for an immature female 8.4. In the wet season the home range is considerably larger, as there is a greater variety of palatable plants available throughout the area during this time. In the dry season the rhinos tend to stay near water and marshes and do not range so far.

Serious fighting is not a major factor in rhino interactions. Within a community such as the one on the floor of the Ngorongoro Crater, an individual usually knows the other rhinos that it encounters. However, when a stranger enters a new area, there may be a violent reaction, especially if the newcomer is a male and has been seen by another bull. Goddard reported that strangers sometimes came down into the crater to obtain salt. Whenever they were seen, there was a fierce reaction. "The resident rhinoceros invariably attacks and is extremely vocal. The head is lowered, eyes rolled, ears flattened, tail raised, and the animal curls its upper lip, emitting a screaming groan. The stranger is invariably silent and on the defensive, but repels the vicious charges of its opponent. The anterior horns are used for goring, or for clubbing the other animal on the sides of the head. If the intruder retreats, he is pursued, sometimes for up to a mile." In nearly all the incidents of this type that Goddard witnessed, the stranger was driven out; in one case, however, the intruder forced out the resident, who eventually had to occupy an adjoining home range.

When rhinos who know each other meet, they react in different ways according to the sexes involved. A. T. A. Ritchie, former Chief Game Warden of Kenya and a long-time rhino observer, described the general pattern of rhino meetings quite succinctly: "At normal times two rhinos on meeting regard each other at first with suspicion, then incipient defiance and potential resentment, but these soon pass and leave the tolerance of indifference."

The Schenkels reported that a mother rhino and calf on meeting another female rhino with calf have a special greeting ceremony. If within hearing or smell, they will actually change directions in order to meet one another. The mothers approach each other and touch noses, then the calves touch noses, and sometimes each mother will greet the other's calf. After greeting, they remain together for a few seconds and then go their separate ways.

When rhinos meet at a wallow, the rhino or rhinos in possession of the wallow may very well show aggression to any newcomers. According to Schenkel this is usually accomplished by symbolized

horning, in which the animal jerks its head and horn up in the air. The rhino might not even bother to stand up in order to do this, but simply lift its head while lying down. If the newcomer is deterred, it will wait nearby or lie down a few yards from the others just outside the wallow.

When a male and female meet and the female is not in estrus, another sequence of events occurs. On seeing each other, they each emit a puffing snort; then the bull approaches the female, usually with short mincing steps, sometimes swishing his head from side to side or jerking his horn into the air. If the female responds, either by approaching or attacking, the male turns and runs away, making a circle, and then returns to the female with the same short steps. This behavior may go on for hours until one of the animals decides to leave.

Meetings between bulls vary greatly. They may simply try to avoid each other and walk away, or they may show some type of testing behavior, which can range from lifting the head in a threatening manner and staring at each other to rushing forward with lowered heads and shrill screams. In the latter case, the bulls make a number of these rushes and finally stop nose to nose, without quite touching. One may end up chasing the other. On one occasion the Schenkels saw a bull fall down while it was being chased by another. The other bull stopped next to the fallen one and then walked away. He did not take advantage of the situation by horning the other animal, which indicates something about the quality of the aggression in encounters of this sort. More serious and violent fights might occur when there is a female in estrus or when a stranger appears.

If, as indicated, the rhino is not territorial, there remains the mystery of the rhino's dung deposits. There have been many theories put forth about the dung heaps, but the scientists are still not altogether sure of the function of the behavior. Instead of simply dropping its dung anywhere, the rhino has a number of places throughout its home range where it deposits dung. While still defecating or immediately afterward, the rhino scrapes its back feet through the dung (in an action like that of a domestic

dog), breaking up the dung and spreading it around. The rhino may also sniff at the dung and root in the deposit with its horn. Several rhinos — including males, females, and even very young calves — may use the same dung heap. This communal use tends to contradict the theory that the dung heaps mark a territory held by an individual, and the possibility of a territory held by a group of rhinos seems unlikely but deserves further investigation. Whatever the case, the dung heaps are thought to convey information to other rhinos.

Goddard tried some experiments with rhino dung in order to see if rhinos could distinguish dung of different rhinos and to see what their reactions would be to the various samples of dung. Dung was collected from the rhino being tested, other rhinos in overlapping home ranges, and rhinos in far distant home ranges. These samples were put in a net bag and towed near the experimental animal. Artificial deposits of the three kinds of dung were also made and the reactions of ten rhinos were recorded. Some of the results follow: "60% followed the scent of their own dung, and 50% defecated on an artificial deposit of their own faeces; 70% followed scent trails of dung from animals with which they shared a home range, but only 20% defecated on artificial deposits of these animals. Only 30% followed scent trails of dung taken from animals several miles distant and 30% defecated on deposits from these animals . . . On one occasion a dung sample was collected from a rhinoceros and introduced to the same animal 48 hours later; the sample was then towed for a distance of just over two miles. The trail was zig-zagged to determine if the animal actually followed the set trail, which it did exactly, and 38 minutes later it was alongside the Land-Rover still sniffing the trail laid by the sample."

Goddard thought that the kicking and scraping action causes the dung to adhere to the hind feet, so that the rhino leaves a scent trail as it walks. During his studies Goddard immobilized forty rhinos, and while working on the drugged animals he noted that they all had characteristically smelly feet. Goddard suggested that with its very poor eyesight the rhino may need these scent

trails in order to orient itself in its home range and also to keep in contact with other animals. Although the results are not conclusive, the experiments indicate that the rhino can recognize dung deposits and scent trails of the rhinos with which it shares its home range. As it moves about in its world of smells, the rhino can tell which rhinos have been through its home range and which way they are going. If it wants to follow another rhino for any reason, it will have no trouble doing so.

Urination does not take place at the same time as defecation, but it also appears to play a definite role for the rhino. The Schenkels reported that bulls perform nonritualized and ritualized urination: in the nonritualized type, the bull simply releases urine downward and backward between his hind legs onto the ground; in ritualized urination, the bull ejects a fine shower of urine in bursts, usually onto a shrub or bush. These bursts are aimed horizontally and backward and can reach distances of three to four yards.

Sometimes the ritualized urination is part of a more complex series of actions, which involves attacking a bush, horning and trampling it, then urinating on it, followed by walking over it and then scraping the area. This may be done with other bulls or cows around or when the bull is completely on its own. Schenkel believes that it is a way of scent-marking, which announces the presence of a bull. When there are other rhinos around, it is a way of "showing off"; when the rhino is alone, it functions as an indirect communication to other rhinos. The sense of smell plays an extremely important part in the life of the rhino, and many of its actions that probably once were direct contacts have now become symbolic and indirect.

Life begins for the black rhinoceros after a gestation period varying from fifteen to eighteen months. Most of the gestation records are from zoos, but Goddard was able to get two records from Ngorongoro Crater when he saw a cow mating and months later saw the newborn calf whose birth date could be estimated to within five days. The two gestation periods he recorded were approximately 446 and 478 days (about fifteen and sixteen months).

There have been no scientific observations of births in the wild, but births have been seen in zoos. The calf weighs about 85 pounds at birth and can walk within three hours. A rhino calf born in the Frankfurt Zoo stood up less than ten minutes after birth, only to fall down almost immediately, but it was back up again shortly after, and although very wobbly, it managed to stay on its feet and even walked around a bit. It found the teats and suckled approximately three hours after birth.

No detailed studies of cow-calf relations in the rhino have been carried out to date. Apparently it is difficult to observe very young rhino babies, as the mothers keep to thick bush when their calves are small, and even when they are older, both mothers and calves are wary. Perhaps as rhinos become tamer in the national parks, a study of this sort can be undertaken. However, both Goddard and the Schenkels have made interesting and valuable observations of rhino calves.

For the first few days after birth in the wild, the mother walks very slowly on her accustomed paths, and after that, the calf is able to keep up at the regular pace, which in any case is still rather slow. The calf keeps very close to the mother, either at her side or behind her. In the first weeks of life the calf suckles often for short periods.

When the calf is still only a few weeks old, it begins to feed on small twigs. It soon leaves its mother's side for short periods, sometimes venturing as far as 25 yards away. A rhino calf appears to be more alert than an adult and also seems to have better eyesight. During the cooler hours of the day it may become playful, running around the mother and even butting her. But as long as the calf remains with the mother, it is totally oriented to her and the two of them form a coordinated unit.

When it is still small, the calf suckles by standing up at right angles to the mother. The female has two teats, situated between the hind legs. As the calf gets older and larger, it has to lie down in order to reach the teats. The mother remains standing. The Schenkels report that a calf suckles for about four minutes each time, but they do not know how often it will do so during a day.

The calf suckles for over one year and may not be totally weaned until it is two years old.

If a cow and calf become separated, the cow emits a high-pitched mew and the calf reacts immediately by going directly to her. Hunters and scientists have used this mewing sound to call a rhino out of the bush. Goddard used the call when he could not see an individual and needed to recognize it. When a calf is in distress, it emits a bellowing squeal. The calves that Goddard immobilized squealed in this way and inevitably brought all the rhinos within hearing distance to their aid, not just their mothers. This must have been somewhat disconcerting for Goddard as he tried to work on the immobilized animal.

As long as the mother and calf are together, the mother will vigorously defend her calf against predators. Goddard related one incident in which a lion tried to kill an eleven-month-old calf: "At 1030 hours three sub-adult male lions were seen watching a rhinoceros with her calf. One lion got up and approached them. As he neared the animals he broke into a run. The calf snuggled against its mother, who moved toward the approaching lion. The calf retreated and the lion pursued it, separating it from the female. The mother followed the pursuing lion at a steady trot, and the calf doubled back to the female. The adult immediately engaged the lion, who diverted his attention to her. He bit her just above the hock, attempting to hang on, and clawed her thigh. The female wheeled around with incredible speed and gored him twice in the centre of the ribs, using the anterior horns with quick stabbing thrusts. The lion rolled over, completely winded. The rhinoceros then gored the lion once in the centre of the neck, followed by another thrust through the base of the mandible, killing him instantly. The other two lions had not moved during the entire proceedings."

The rhino calf stays with its mother until she has another calf, which could be as long as four or five years. If for some reason the female does not have another calf, her present calf may stay on with her, but in the normal course of events the calf is rejected when it is between two and four years old. It tries to stay with

the mother but is actively chased away — viciously so, once the new calf is born. The older calf finds itself on its own and usually tries to join another youngster, or another female with or without a calf, or sometimes even a bull. Adult females, other than its mother, are more tolerant of the newly independent calf. When people report seeing a female rhino with two calves of different ages, the older calf is more likely the offspring of a cow from a nearby home range.

Goddard's figures show that the home ranges for immature animals are usually larger than those for adults and he speculated about the function of this phenomenon. When the rejected calf joins up with another rhino, then the young animal wanders not only in its mother's home range, but also in the home range of its new companion. Goddard concluded that "these factors (the larger home range of the immature animal, and the intolerance of the mother for her offspring) may serve an evolutionary function, assuring population dispersal in a species which is very sedentary and therefore susceptible to the effect of inbreeding."

When the young rhino becomes independent of its mother, it is not yet fully grown. Both males and females may continue growing until they are seven or eight years old. An adult rhino weighs between 2000 and 4000 pounds, and its shoulder height is 5 feet 6 inches to 5 feet 8 inches.

Records from zoos indicate that mating takes place around the sixth year for both the male and female rhinoceros. In the Hanover Zoo the female of a pair of rhinos began having estrous periods every month during her sixth year. The male showed no interest until he turned six years, and then copulated with the female, who produced a calf the following year. However, Goddard found that four known-age rhinos in Ngorongoro reached sexual maturity at an earlier age. One male was seen mating at four years and three months, and three females got pregnant at approximately four and a half years of age.

Courtship and mating behavior in the black rhinoceros is complex and fascinating. Mating apparently takes place at any time of the year and at any time of the day, although evidence in the

Schenkels' study area indicated possible rutting periods, one in March and April and another in July. In the July period they observed that almost overnight a large proportion of bulls and cows began sexual activities.

Precopulatory or courtship behavior involves complex encounters between the bull and cow. When the female comes into estrus, she walks about, squirting small amounts of urine on the ground. The bull comes along, sniffs the urine, and performs Flehmen.

During the early stages of courtship the male approaches the female with great caution. The female may walk a considerable distance with the male following behind. When she stops, the male approaches with a short, stiff-legged gait, dragging his rigid hind legs along the ground, but if she turns toward him or approaches, he may run off in a circle and then hesitantly come back to her again. Eventually they may stand facing each other, jousting gently with their horns. The approaching, circling, and jousting phase may go on for several hours.

Observers have reported that the male and female fight seriously and viciously during courtship, but both Goddard and the Schenkels deny this. In their observations these encounters never involved truly serious fights. On one occasion Goddard saw a female fiercely attack a bull, emitting the characteristic puffing snort. The bull turned and ran off in a circle, then approached her again with the stiff-legged gait. He eventually mounted her and she did not attack him again. Another female allowed a bull to mount her, but each time he dismounted she viciously attacked him. On all the other occasions when Goddard witnessed mating behavior, he saw nothing more serious than the jousting; the female did not attack the bull. Sometimes the bull would swing his head from side to side, sweeping his horn along the ground. The bull also frequently horns the female between the legs or under the stomach, but in a relatively harmless manner.

After the walking and jousting phase the female relaxes and accepts the male. The bull rests his head on the female's back and,

using his neck as a lever, rises up and moves forward until his forefeet are behind the female's shoulders. Once in this position he may stay up for ten minutes before being dislodged by the female. No attempt at copulation occurs. He may mount the female in this way as many as twenty times over a period of several hours. In between mountings the pair usually feeds and walks.

True copulation occurs after the long period of mountings. Then the male moves forward still further, and either with upper body held high or with his chin right down on the shoulders of the female, he achieves coitus. The rhino is a remarkable animal in that copulation lasts for quite a long time compared to the few seconds most animals take. Rhinos copulate for thirty minutes or even longer — there is one record of thirty-six minutes. Goddard reported that the male remained silent but that "the female periodically emitted a low pitched squeal during coitus." He also observed that the calf of the female paid no attention to the proceedings once the female obviously accepted the male, but that other animals in the area, such as wildebeests and spotted hyenas, took "an intense interest in the courtship activities." Goddard thought that the lengthy copulation might be one reason behind the belief that the rhino's horn is an aphrodisiac. The shape of the horn is considered phallic and must also be an important element behind the myth. Scientists have proved that there is no truth in the belief, at least not from a chemical or hormonal point of view; the psychological effect is something else again.

It has been suggested that the male and female remain closely associated after mating. Goddard's records indicate that this varies widely, depending largely on whether or not the female normally uses the home range of the male with whom she has mated. One pair remained together for four months after mating, while the male of another pair left the day after he was seen mating with the female. Nor is the female necessarily faithful to one male. Goddard saw one female mounted by two different bulls in a six-hour period.

Violent, aggressive behavior can be displayed when more than

one bull is in the vicinity of an estrous female. Goddard watched one female who was being closely followed by a bull. A second bull arrived and the first bull immediately "charged the second male viciously, his ears flattened, upper lip contorted, and emitting a ghastly puffing shriek. The second male was silent, but retreated in the face of the charge." In the meantime a third male approached, and he too was charged in the same way by the first male. The first and third males proceeded to fight, jousting with their horns and trying to hit each other on the sides of the head. As the fight continued, the female and the second male went off together, and he mounted her after a period of jousting and running about, but they did not copulate.

There does not appear to be a rank order among the bulls of a rhino community as there is with elephants and giraffes. The female apparently goes off with whoever happens to be around. Further studies may reveal subtle differences in positions among bulls and subsequent differences in reaction by females, but for now it looks as though there is no well-defined hierarchy.

Goddard estimated that once a female reaches maturity, she can produce a calf every twenty-seven months. When her calf is about a year old and still suckling, she comes into estrus and mates. However, evidence from zoos and from the wild suggests that the female comes into estrus within a few weeks after giving birth, but that conception does not take place until a year after parturition, even though she may mate with bulls before this. Although twenty-seven months is the estimated minimal calving interval, Goddard found that the average calving interval based on the existing population in Olduvai and Ngorongoro was one calf per female every four years. He suggested that there are self-regulatory mechanisms at work reducing the fertility rate.

Goddard was happy to report that, according to these results, the populations in Ngorongoro, Olduvai, and Tsavo were stable; that is, the birth rate was keeping pace with the mortality rate. The recruitment rates (the number of young added to a population per year), in Ngorongoro and Olduvai were both about 7 percent, while in Tsavo it was 10 percent.

Once a rhinoceros is an adult, it becomes more and more sedentary, and it may remain in the same home range for the rest of its life. As an adult, its home range becomes smaller and its daily activity patterns become fairly predictable. Some people have said that the adult rhino does exactly the same thing every day, following exactly the same paths, drinking, resting, and eating at exactly the same times every day. This is certainly an exaggeration, but the rhino does settle down to a somewhat routine way of life.

The rhino's day depends largely on whether it is going to walk to water. In the Schenkels' study area in Tsavo East, the rhinos do not drink every day but at intervals of several days, so that some days are spent moving toward water, others moving away from it, and others not moving at all, but remaining in the feeding area.

In Ngorongoro, where water is readily available, each day takes on something of a routine as follows: Early in the morning the rhino feeds and walks about. As the day gets hotter, usually by about nine o'clock, the rhino finds a place in which to lie down and rest. Oddly, rhinos do not seem to seek shade during the heat of the day. They have been seen at noontime lying in the hot sun, when an acacia tree provided shade less than 20 yards away. The rhino prefers sleeping in a dusty or sandy depression. What advantage this might have is not clearly understood.

Goddard watched a resting rhino for ten hours and discovered that it stood up for ten to fifteen minutes every ninety minutes or so. Resting or sleeping rhinos usually lie with their legs curled under them; thus they may get stiff and need to stand up from time to time. Calves are sometimes seen lying flat out on their sides, but adults are rarely seen in this position.

In the afternoon rhinos become active again, walking and feeding. It is at this time that they wallow if there is mud around. More than 90 percent of Goddard's observations of wallowing occurred between four and six o'clock in the afternoon. Wallowing is important to the rhino as a cooling mechanism. It has been variously claimed that rhinos have no sweat glands and that they have more per square inch than most animals. Whatever the case

is, wallowing would still cool the animal after a day's accumulation of heat. In order to wallow, the rhino lies down and covers itself with mud, wallowing first on one side and then on the other, sometimes actually rolling right over on its back. The mud also helps to rid the rhino of ticks and flies, and the mud and dust adhering to the skin act as camouflage. Like the elephant, the rhino takes on the color of the soil in its habitat. Without mud, the black rhino is actually a grayish color.

In Ngorongoro the rhinos go to water in the evening and may stay there for several hours. They often meet other rhinos at the water holes and this is the time when rhinos interact. It has been reported that they run about, squealing and snorting. Many a camper has spent a sleepless night when camped near a favorite rhino watering place.

After drinking, the rhino returns to its normal feeding area, sometimes stopping and feeding along the way. The rhinos that live on the walls of the crater come down to the crater floor at night to get water and then return to the walls before daybreak. From night observations, Goddard concluded that rhinos are usually active most of the night, but he also saw individuals sleeping.

Goddard suspected that in the more arid region of Olduvai Gorge (where annual rainfall is 16 inches, compared to 26 inches at Ngorongoro), some rhinos did not drink at all during the dry season. There they feed on succulent plants such as the finger euphorbia, which contains a white latex fluid. In the dry season they also chew on plants with a high moisture content, such as *Sansevieria ehrenbergii* and *Cissus quadrangularis.* Evidence showed that the rhinos stuck to their small home ranges, even after all the water holes had dried up. There was no indication that they walked long distances to the nearest available water. Goddard postulated that the rhinos could live on the water from the moisture-rich plants alone. The finger euphorbia, which in Olduvai makes up 70 percent of the rhino's diet during the dry season, is not indigenous to Africa but was introduced from India and has spread. Goddard said, "It is interesting to speculate on the influ-

ence that the colonization and spread of this plant has had on the utilization of arid habitats by this animal."

In most parts of East Africa the rhino is not alone during these daily activities but is accompanied by another species of animal — either the red-billed or the yellow-billed oxpecker, both commonly called tick birds. These gregarious, noisy birds play an important role for the rhino. In Swahili they are called *askari wa kifaru* ("the rhino's policemen," or guards), and they are just that. When they hear or see anything alarming, especially man, they chatter and call, stimulating the rhino to react. While asleep, the rhino relies on these birds to act as its sight and hearing. The rhino's reactions will vary, depending on its individual disposition and the particular behavior of the tick birds. If the rhino is lying down and the tick birds have raised the alarm, it may simply lift its head or move its ears about, it may get up and smell the air, or it may get up and run, either toward or away from the object of alarm.

The tick birds benefit from their association with the rhino by finding food on the rhino's body. While it was always assumed that the tick birds' major food consisted of ticks and flies, Goddard thought that they mainly ate the blood from the open sores that all black rhinos seem to have. The source of these sores, or skin lesions, has been something of a mystery to scientists.

P. M. Hitchins, working on rhinos in the Natal Parks of South Africa, used the skin lesions as a field method for aging rhinos, since the lesions appear at regular intervals in different parts of the body as the rhino grows. All adult black rhinos in Natal have skin lesions situated behind the shoulders and on the chest, neck, and forelegs. A calf is born without them, but between the ages of six months and one year they begin to appear on the chest as bare pink patches. By three years, they are found on the chest and sides, but not behind the shoulders, as in adults. By four and a half to five and a half years, they are found in all the usual areas of the adult. The skin lesions appear as black, blood-encrusted areas that ulcerate and hemorrhage from time to time.

Upon further investigation scientists found the filaria parasite,

Stephanofilaria dinniki, in every skin lesion examined. It is known that parasites of this type require blood-sucking flies or ticks to complete their life cycle. There are many of these kinds of ticks and flies associated with the rhino. Hitchins and M. E. Keep, a veterinarian who also worked on the problem, concluded that the filaria are introduced to the animal by a blood-sucking insect, and the filaria then cause the skin lesions, although it is not known why they prefer specific sites. The skin lesions along with the resultant hemorrhages attract more blood-sucking flies and ticks; thus the life cycle is able to continue. On top of this, the oxpeckers keep the sores open and festering, and secondary bacterial infections aggravate the situation.

It had been suggested that the skin lesions were found only on debilitated rhinos, but since every rhino in the Hluhluwe Game Reserve in Natal had them and was apparently healthy in every other way, this could not be the case. In Kenya every rhino captured by the Game Capture Unit for translocation had skin lesions, and these rhinos were also otherwise in perfectly good condition.

The following experiment substantiated Hitchins and Keep's theory. A black rhino calf was captured in Hluhluwe at one year old and was sent at one and a half to a paddock situated 100 miles from the nearest population of black rhinos. By the age of five and a half, this rhino had not shown any sign of skin lesions, while every rhino in the Hluhluwe Game Reserve showed skin lesions by that age. It was concluded that there were no insects carrying the *S. dinniki* parasite in the area of the paddock, and therefore the animal was not infected and no lesions developed.

One further, fascinating note on the subject of skin lesions: A. T. A. Ritchie reports that "these sores appear to exercise a strong element of fetishism" during courtship.

As a very important part of his work, Goddard carried out extremely detailed studies of feeding behavior in Ngorongoro, Olduvai, and Tsavo. He set out to discover what rhinos eat, in what quantities, the availability of these plants, and, particularly in Tsavo, whether or not rhinos were in serious competition with

elephants. Goddard watched individual rhinos feeding for an hour at a time, noting what they ate and what they rejected in a semicircle in front of their heads. He often made these observations on foot from only 10 yards away. Altogether he spent 377 hours watching feeding rhinos.

It was already known that the rhino is a browser, and Goddard confirmed that grass makes up only a very small proportion of its diet. In Ngorongoro and Olduvai the rhinos ate 191 species of plants from 49 botanical families. In Tsavo they ate 102 species from 32 botanical families. They showed a preference for herbs and shrubs, particularly legumes, which make up 60 percent of their diet in both the wet and dry seasons. Rhinos are highly selective, eating only certain specimens of a species. Goddard thought that they were able to detect by smell which specimens have nutritional value. They invariably reject dry and sterile plants.

It is interesting to watch a feeding rhino. With its prehensile upper lip it grasps vegetation, maneuvers it into its mouth, and cuts off what it wants with its teeth. The rhino moves from bush to bush or herb to herb, sniffing and selecting. It eats different parts of different plants, sometimes just the leaves, sometimes just the stems or tips of shoots, and sometimes just the bark. Much of the food it prefers are small ground plants interspersed among the grass; rhinos are often seen feeding out on a grassy plain with no shrubs in sight and have been mistakenly thought to be grazing. They do eat some grass, usually in the wet season, but only a very small amount.

One of the weirder facts to emerge about the rhino is that it is coprophagous — dung-eating. The Klingels were the first to report on this very unusual habit. Over a period of several days they watched four rhinos eating wildebeest droppings. "The rhinos selected fresh or superficially dried dung. They picked a whole heap of dung from the ground and chewed it, losing parts of it in the process, but swallowing most of it. Whilst engaged in this activity, they did not feed on any plant, but walked determinedly from one dung heap to the next. The reason for this ex-

traordinary behaviour is not known, but possibly a mineral or other deficiency is balanced in this manner." Goddard saw rhinos eating dung on eight occasions, always in September or October, when it is dry and there are few legumes available. He also thought it might be a way of supplementing the diet with minerals found in the dung.

A discussion of the rhinoceros would not be complete without mentioning its temperament. Is the rhino really such a vicious, stupid brute? Goddard always stood up for the rhino, but then each scientist usually takes the side of the animal he is studying. Actually, what happens is that the scientist gets to know his animal so well that he knows how to approach it, how close he can get, and generally what to expect of it. In many cases he knows individuals' particular dispositions. In an excellent M-G-M–TV documentary on Goddard and his work called *Kifaru — the Black Rhinoceros*, Goddard revealed his feelings about the rhino: "The deeper you get into the study of one animal, the more you realize how very little you really know about it; and as time progresses, you find your attitude changes. At first it's just a very large, ugly, prehistoric-looking animal. But as you get deeper and deeper into the study and know these animals individually, you realize rapidly that these animals do have temperaments, moods, and, to be quite unscientific, personality." Goddard made a plea for the rhinoceros, saying it is "a shortsighted, harmless old beast that deserves, I think, the greatest degree of sympathy that you can give it."

Goddard felt that one of the reasons the rhino has such a bad name is its characteristic reaction to alarm. When the oxpeckers shriek and fly off, the rhino gets up. If he cannot detect anything on the wind, then he races forward, sometimes at an alarming speed, to investigate the cause of the oxpeckers' excitement. People mistake this investigating for a charge. Whatever the case might be, the rhino is a singularly terrifying animal met at close range, and when, puffing and snorting, it bears down on one like a runaway locomotive, one scarcely wants to contemplate the fine distinction between investigating and charging.

However, one cannot really conclude, as Goddard did, that the rhino is harmless. Goddard's knowledge of the rhinos in his study area certainly helped him, but a dangerous situation can sometimes arise. Rudolf Schenkel was charged and chased by a bull rhino that he had approached on foot. He was in an open area, outlined against the sky, so the rhino was able to see him, and immediately charged. Schenkel ran forward shouting at it, but it still came at him. When Schenkel swerved past the rhino and ran for a small fallen tree, the rhino turned and came after him, even though he had now caught the human scent, which would normally make a rhino turn away. The man and the rhino ran around the tree a number of times, and as Schenkel was trying to climb the tree, the rhino caught and tossed him. Schenkel landed on the rhino's shoulders and then fell to the ground. He crawled under the tree, but the rhino even pushed his way in there to get him. Schenkel lay with one foot in the air, and the rhino came to a stop with his nose against it. He pushed against the foot once and then suddenly turned and trotted off, leaving Schenkel bruised but intact.

Iain Douglas-Hamilton was not so lucky. He was walking in thick bush looking for an elephant migration route out of Lake Manyara National Park when he suddenly came on two rhinos, a mother and an almost full-grown calf. They came for him immediately; he turned and ran, dodging and swerving between bushes, but they followed his every twist and turn. (A rhino can reach speeds of 35 miles an hour and despite its bulk is amazingly agile and can turn on a dime.) Then his sandal broke and he fell. The female came charging over him and went her way. He was left with a crushed vertebra that halted his work for more than a month.

However, in both Tsavo and Manyara rhinos have long been hunted and have every excuse for feeling aggressive toward man. In places where they have been hunted with poison arrows they are particularly truculent. Dispositions vary from one area to another. In Maasailand and other pastoral areas the rhinos tend to be more placid because they have largely been left in peace. In

any population there are differences among individuals, so that, as A. T. A. Ritchie remarked, "some are moderately even-tempered, and some irritable; some brave and some timid; some volatile and some phlegmatic." Basically the reaction of an individual rhino depends on the amount of harassment and hunting that goes on in the area where it lives and the particular conditions under which that animal is met.

Where rhinos are left in peace they may live well into old age. There are no records of maximum life spans for rhinos living in the wild, but there are records from zoos. In the Chicago Zoo there was a rhino who was thirty-six years old at the time of Goddard's study. The record is forty-nine years old, but this was for an Indian one-horned rhino (*Rhinoceros unicornis*). For wild black rhinos, Goddard estimated a maximum longevity of forty years.

Goddard arrived at his estimate of longevity by taking the zoo records and combining them with examinations of the teeth of living and dead rhinos. The rhino has four premolars and three permanent molars on both sides of the lower and upper jaws. By old age the rhino has lost its premolars and the larger permanent molars have worn down. Goddard devised a technique for determining the age at death of the skulls that were collected throughout his study areas. He immobilized forty rhinos in order to take measurements of their bodies, skulls, and teeth, and to measure the eruption and wear of the teeth. Once the rhino was immobilized with drugs fired from a dart gun, he pried the animal's mouth open and, with the aid of a flashlight, examined the teeth. Goddard stated quite nonchalantly that "with the rhinoceros under heavy anaesthesia this is a relatively simple procedure."

More than five hundred skulls of dead rhinos were collected in Tsavo, and by measuring these skulls and teeth and comparing them to the data from the living rhinos, Goddard worked out twenty age classes and was able to give an approximate chronological age to each skull and thus work out the life expectancy at any given age. His results showed that mortality was highest in the first and second years of life and then rose again after the age of twenty-five. He concluded that, assuming a stable population, the

mean expectation of life at birth for a rhino is 8.4 years, rising to 10.2 years at four years of age, and then falling.

Predation is not a major factor in rhino mortalities, although adult rhinos are subject to rare predation by lions and hyenas. Young rhinos are more vulnerable, but they usually have their mothers to protect them. Goddard saw five incidents in which hyenas unsuccessfully tried to pull down rhino calves. There have been reports of hippos and crocodiles killing rhinos and also stories of elephants killing rhinos. There is a belief that elephants and rhinos are bitter enemies, but it can be assumed that this myth is based on a few rare incidents. In Tsavo, where there are at least twenty thousand elephants and seven thousand rhinos that are constantly meeting each other, neither Goddard nor the Schenkels saw anything more serious than a few aggressive gestures at water holes.

The greatest single cause of death for the rhino is man. Large-scale poaching of the rhinoceros is prevalent wherever there are rhinos left, and even the national parks and game reserves are not completely safe. The horns are smuggled out of Africa on small Arab dhows and even large freighters, or export permits are illegally obtained and the poached horns go out in regular shipments. At approximately $22 a pound for horn sold in Mombasa, there is certainly enough incentive for trying to bypass the laws. The front horn averages about 10 pounds, the back 6. When rhinoceros horns are sold in the Far East in powdered form, they can fetch as much as $30 an ounce.

Another kind of poaching is in some ways even more disturbing — the killing of rhinos by dissatisfied tribesmen as a form of political protest, a fairly recent phenomenon. In Amboseli Game Reserve a minimum of nineteen rhinos were lost through human actions between September 1967 and the end of 1970. Of these, fifteen died of spear wounds inflicted by Maasai tribesmen. According to David Western, an ecologist working in Amboseli, and Daniel Sindiyo, the former warden of the Reserve, most of these spearings were a result of the unsettled political situation in the area. Negotiations were being carried out to turn the Reserve

into a national park, closing it to the Maasai. A settlement satisfactory to the elders has since been reached, and the area has been taken over by Kenya National Parks. Although the spearing rate has decreased, rhinos are still being killed, and their future in Amboseli does not look promising. From a population numbering about sixty in 1967, they have been reduced to fewer than twenty-five in 1975.

If an adult rhino survives the hazards of predation, hunting, disease, accident, and drought, and lives to an old age, then the most probable cause of death will be malnutrition due to the wearing down and loss of teeth. The rhino harbors diseases such as typhoid, pneumonia, trypanosomiasis (sleeping sickness), and others. When the rhino becomes debilitated because of an inadequate diet, these diseases tend to take over. This also happens during drought, when food supplies dwindle. The rhino is particularly vulnerable to drought because of its sedentary habits. If its home range becomes devastated, the rhino will not move on to a new area. This is what happened along a section of the Athi River in Tsavo National Park in the 1960–61 drought. The rhinos would not move away from the river, their food sources were completely used up, and at least 282 died.

The ecological relationship between elephants and rhinos in Tsavo has been a constant worry to conservationists. As we have seen, a combination of elephants and fire is changing vast areas of Tsavo from woodland to open grassland. It was thought that the rhino would not be able to survive this change, because there would no longer be enough browse available in the grassland. However, Goddard discovered that even in the areas transformed from bush to grassland, there are still enough legumes available to the rhino in the form of small woody plants that grow naturally among the grass. Under normal conditions there is no serious food competition between the elephant and rhino, because for much of the year the elephant's diet consists mostly of grass. During the dry season, when the grass has dried up, elephants turn to browse; but it is usually only during droughts, when the situation is prolonged, or in severely overcrowded conditions that the browse vegetation suffers drastically.

In 1969, at the end of his study, Goddard was able to say that the future of the rhinos looked good in Tsavo. The population was stable, and nutritious vegetation was abundant. However, he said, if there were another serious drought, there would again be severe food competition along the rivers and rhinos would die. Goddard did not live to see his predictions come true, for by the end of the 1970–71 drought in Tsavo close to three hundred rhinos had died. In this drought the elephants were hit even harder, and it is estimated that at least six thousand died. The elephants that died were mainly the females and calves — in fact, exactly the animals that scientists had recommended culling in order to reduce the population. Unless there is large-scale immigration of elephants into the Park, the elephant population is expected to go down over the next twenty years, and this should slow down the rate of habitat change.

So it appears that the rhino is not going to become extinct within the next few years, and it looks as though there will even be places where relatively large numbers of them will be able to continue to exist. Outside the national parks there is probably not much hope for the rhino. Human population growth, with the concomitant expansion of settlement areas, will eventually prove the rhino's worst enemy. But for a while yet, man will still be able to see and appreciate this remarkable animal that has survived from the Miocene.