pened a few years ago when the English Queen visited the country, not only the nose horn but also the skin, the skeleton, the muscles, and even each hair went to the black market trade. As was confirmed not only by Professor Ullrich, the director of the Dresden Zoo, but also by other visitors of the Kazirange Game Reserve in Assam, poachers even in the nineteen sixties still dug many traps there for the rhino.

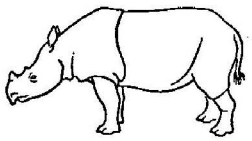
Therefore, all species of rhinoceros are threatened by extinction and urgently need all possible protection. In Africa, only in the National Parks and in the protected areas will one find a good rhinoceros population. The situation in Asia is much more critical. Of the once abundant great Indian rhinoceros, there are presently only a few hundred animals left, whose further existence is not at all assured. The closely related Javan rhinoceros' extinction is imminent; it is only in a tiny area, the Udjung-Kulon Reserve in Java, that 25 to 40 animals are found. The number of surviving Sumatran rhinoceros on the Malayan continent is unknown; according to official statements, there are 170 to 600 animals left. If the World's Nature Conservation efforts do not succeed in establishing effective measures for protection, our descendants will not see a living Javan or Sumatran rhinoceros. Unfortunately, not even the most general data of the life and behavior of these animals are known. The few surviving ones have to lead such a secretive life that any close survey or research is technically impossible.

Asiatic rhinoceros

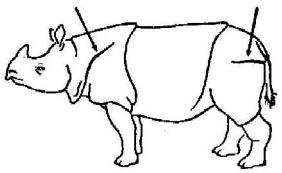
The original, yet also the smallest, living species of rhinoceros is the SUMATRAN RHINOCEROS (◊ *Dicerorhinus sumatrensis,* Color plate, p. 37). HRL 250–280 cm, BH (shoulder) 110–150 cm. It is the sole villous rhinoceros. There are two nose horns; the maximal length of the anterior one is 25 cm; the second one is, in most cases, only a blunt protuberance (or hump). The skin is only slightly sectioned (semi-plated); the ears are fringed with hair; and the coat, while dense, thins out in older animals. Formerly the distribution was over all of East India and Indonesia; presently there are only infrequent sightings. These animals are very rare.

Fig. 2-1.
Former and present distribution of the Sumatran rhinoceros *(Dicerorhinus sumatrensis).* This species now exists only in those few places which are marked by triangles on the map.

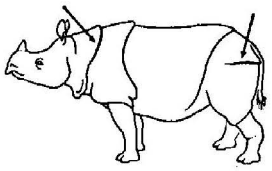
The great Marco Polo (1254–1324), on his travels through East Asia, had seen the Sumatran rhinoceros in the Malayan Archipelago and described it. However, there is hardly anything known about the life in the wild of this animal which will soon become extinct. Earlier zoologists distinguished between the original form on the island of Sumatra *(Dicerorhinus sumatrensis)* and a continental form *(Dicerorhinus sumatrensis lasiotis),* which was also called the rough-eared rhinoceros. But in comparison with specimens in museums and pictures from the wild, this opinion is open to question. According to cautious present-day estimates, there are only a few hundred of these animals on the island of Sumatra, some others on the island of Borneo, in Burma, in Siam, and in the Malaysian preserve of Sungei Dusun (Selangor). But the timber industry, the establishment of rubber plan-



Sumatran Rhinoceros



Great Indian Rhinoceros



Javan Rhinoceros

Fig. 2-2.
The skin folds at the shoulder and base of the tail are differently arranged in the various species of Asiatic rhinoceros.

tations, and other similar interferences with the natural landscape destroy the original habitat of this animal to such an extent that it is uncertain whether the species may be preserved.

Lately only a very few Europeans have encountered Sumatran rhinoceros. On March 14, 1957, a rhinoceros was seen on a coconut plantation at the Slim River near Perak in Malaysia. A farmer was able to take a photograph of it. At first sight it seemed to be a Javan rhinoceros (see p. 44). Some people, therefore, presumed that there might be some surviving specimen of the Javan rhinoceros on the South East Asian continent. Therefore, the photographs were widely distributed. But the lack of a horizontal skin fold on the buttocks indicated clearly that it was actually a Sumatran rhinoceros. It had a fairly dense coat and no ear tufts. From behind such a small, hairy rhinoceros almost looks like a cape buffalo.

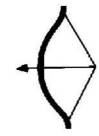
In 1959 two female Sumatran rhinoceros were captured in the area of the Siak River on the island of Sumatra and brought to Europe. One of them arrived at the Basel Zoo in very poor health; her body height at the shoulder was 112 cm and she weighed 386 kg. After almost uninterrupted medical treatment for two years, she died of total deterioration of the kidneys. The other animal remained in good health and was to this date (1967) in the Copenhagen Zoo. Presently, it is the only Sumatran rhinoceros on earth in man's care. Unfortunately, all efforts to find a mate for this animal have been unsuccessful.

After the success achieved in keeping the great Indian rhinoceros in the Basel Zoo, it should be as easy to keep and breed the Sumatran rhinoceros. The first rhinoceros ever to be born in captivity was a Sumatran rhinoceros, born on January 30, 1889, in the Calcutta Zoo in India. Then, these small rhinoceros were not nearly as rare as they are now. However, it would be possible to preserve the species only if there were enough pairs available for the zoological gardens. But by now they have become too rare. It would be absolutely necessary to place the few remaining specimens in their original habitat under rigorous protection. However, the situation in Malaya is rather discouraging. Because many Chinese live in the already limited remaining habitat of the Sumatran rhinoceros, effective protection there seems impossible. Wherever Chinese poachers are at work or buy rhinoceros' horns from the hunting natives, the rhinoceros disappear.

The earliest species of rhinoceros to become known in Europe was the GREAT INDIAN RHINOCEROS (genus *Rhinoceros*). HRL 210-420 cm, TL 60-75 cm, BH (shoulder) 110-200 cm. The weight is 1500-2000 kg; the ♀♀ are somewhat smaller and lighter; footprints of adult ♂♂ measure 28-29 cm in diameter in the front, those of adult ♀♀ measure 26-27 cm in the front, in the rear 23.5-24.5 cm. There is only one horn. The bare skin is not very thick, is well supplied with blood vessels, and is divided into sections by large folds. On individual sections there

are flat bumps which look like rivets on a hull of a ship. Hair occurs only in a few places: the tail tassel, tufts on the tips of the ears, and, in neonates, also a light hair brush at the base of the ear's outer rim. The three toes on each foot are covered by rather large nail plates, and are buffered by massive tissue pads which bulge out when the foot is lifted. The upper lip ends in a strong "finger." The two incisors in the lower jaw grind against the tooth plates in the upper jaw, and since they are razor sharp they are effectively used as weapons.

There are two species: 1. GREAT INDIAN RHINOCEROS (♀ *Rhinoceros unicornis;* Color plate, p. 37), whose shoulder skin fold arches over the shoulder blade. 2. JAVAN RHINOCEROS (♀*Rhinoceros sondaicus;* Color plate, p. 37), is rather similar, but smaller and lighter; ♂♂ have only a weak horn, ♀♀ are often hornless. Their shoulder fold comes up from both sides and meets above the shoulder.



The great Indian rhinoceros *(Rhinoceros unicornis)* is an impressive sight. It does not really have a hunchback as does the African square-lipped rhinoceros but the bull has a bulky, wide neck. The withers and pelvis in most cases are of the same height, but once in a while one may see "overendowed" females. Within the same population, there are both long-legged, slender animals and shorter, heavier types. The pace of the great Indian rhinoceros is a deliberate walk but may also be faster. The trot appears surprisingly elegant, and the gallop is extremely fast. When galloping on a good surface, a great Indian rhinoceros may well reach speeds of up to 35–40 km/hr.

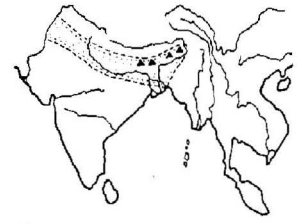


Fig. 2-3.
Former and present distribution of the great Indian rhinoceros *(Rhinoceros unicornis).* Presently it is found only in a few protected areas (marked on the map with triangles).

As is true of all the rhinos, the great Indian rhinoceros is a vegetarian. It feeds on grasses and twigs, pushing them into its mouth with the finger-like extension of the upper lip. In the Basel Zoo, the great Indian rhinoceros are fed, besides the basic diet of good quality hay, which at times may be mixed with alfalfa, a special compound of highly concentrated food containing oil cake and several cereals, the necessary vitamins and minerals, and about 18 percent pure protein. An adult great Indian rhinoceros eats about 15 kg of hay per day and 4–6 kg of the Basel special compound; it drinks 80–100 liters of water.

Great Indian rhinoceros like to rest in the water or in a clay wallow which helps to keep their skin in good condition. In the Basel Zoo, which is perhaps the most experienced in the keeping and breeding of the great Indian rhinoceros, the animals have a pool, heated in the winter, which they use the whole year round. Great Indian rhinoceros are well adapted to life in the water. They are skillful swimmers and divers; even as wide a river as the Brahmaputra is frequently crossed by great Indian rhinos.

Fig. 2-4.
Former and present distribution of the Javan rhinoceros *(Rhinoceros sondaicus).* Today only a few animals live in the Udjong-Kulon Preserve in Java (see arrow).

E. P. Gee, the protector and warden of the Kazirange Reserve in Assam, has found that the rhinos there defecate on certain "rhino-dung heaps." Gee is of the opinion that each great Indian rhinoceros that passes such a dung heap is attracted by the scent—whether its own

Social life of the great Indian rhinoceros

or that of another rhino—and thus is almost stimulated to defecate as if by some compulsion. The director of the Dresden Zoo, Wolfgang Ullrich, saw dung heaps forming mounds up to 70 cm high. He writes: "How strong a stimulus for defecation such a mound represents is demonstrated by the fact that even rhinos in flight will stop there for a few seconds in order to deposit a dropping. These dung heaps are found especially often near wallows, bathing places, and grazing grounds, which are on the edge of open spaces. With their odor they mark the entrances to the tunnel-like paths in the dense elephant grass, thus enabling the rhinos to find the path by olfaction."

According to Gee, the great Indian rhinoceros are not strictly bound to a specific home range; usually a weaker bull will leave the territory after he has lost a fight with a stronger rival. Gee sometimes followed single rhinos when they were roaming through wide areas; he also found gatherings of four to six animals using the same wallow. As Gee reports, the mating season in Assam extends from the end of February to the end of April. Wolfgang Ullrich spent several weeks in the Kazirange Reserve. There he observed the great Indian rhinoceros feeding on the young sprouts of high grass and bamboo shoots, on several herbs in the swamp, and on the water hyacinths which cover the lakes like a carpet. All other animals generally avoid the rhinos, according to Ullrich's observations. The great Indian rhinoceros flee only, at least in most of the cases, from mounted elephants, and then, in contrast to the African black rhinoceros, they do not carry their tails erect but closely pressed to the body. Occasionally, they may attack a riding elephant or at least threaten him; but in most cases, the rhino will veer off just before reaching the elephant. Many of the great Indian rhinoceros have serious injuries and large scars, which in Ullrich's opinion are the result of fights over a territory. There are also some cases known where female rhinos have been injured by a bull.

Public and private rhino paths

In the journal "Der Zoologische Garten" Ullrich wrote on the home ranges and paths of the great Indian rhinoceros: "The grassy jungle is crossed by many paths, which are separated into 'public' and 'private' pathways. The 'public' paths are used by several rhinoceros. They connect wallows, bathing places, and grazing grounds. Wallows and bathing places belong to all rhinos and are not defended. We frequently observed several rhinos resting peacefully beside each other in wallows and ponds. In a small lake covered with water hyacinths, we found nine rhinoceros; several of them, including a calf about four months old and a subadult, were laying close together. Two of them had even put their heads on another's back. At most, only the noses, the eyes, and the ears were visible above the water. Two other rhinos were also resting closely together, about 20 meters away from the group. When three of these rhinos began to feed on the water hyacinths, there was no conflict.

"When a rhinoceros came to the edge of a lake where two others were already resting, those two arose uttering threatening sounds. Then the rhino on the shore would make a snorting sound. It sounded as if someone was blowing air through a hose into water. The two rhinos immediately answered with the same sound, then went back to rest and allowed the newcomer to rest with them.

"Branching off from the 'public' paths near the resting places and the grazing ground are the 'private' paths. Daily we visited a large swamp meadow which was divided into seven grazing territories which belonged to three females with three calves, another adult female, and three adult males. Except for the territory of one of the bulls, all the grazing areas, which were situated at the edge of the pasture, were about 4000 square meters in size. A short 'private' path connected each grazing area with the 'public' paths which led through the grassy jungle around the pasture. The rhinos approached the area on the 'public' paths and then entered to their 'private' paths in order to reach their part of the pasture which they defended against conspecifics. When they were disturbed while grazing, they always fled to their 'private' paths. In the same manner, 'private' paths branched off from the 'public' paths near their sleeping places which are defended in the same way as the grazing territories. The sleeping places are situated in the tall elephant grass, where the rhinos rest from midnight until sunrise and during the hot part of the day at noon."

Reproductive behavior

Except for the observations of Gee, Ripley, and Ullrich about the reproductive behavior of the great Indian rhinoceros, the only other information comes from zoological gardens. Even though this species had already come to Europe during the Middle Ages, they were first bred in a zoo in 1956. A female in heat sprays urine, while the vagina opens up and "flashes." At the same time, she utters rhythmical whistling sounds that are produced by forcing the air in and out during breathing. She comes into heat every 46–48 days and remains so for approximately 24 hours; however, the intervals between heats may vary from 38 to 58 days. The bull reacts immediately to her condition. Shortly after heat begins, the animals will drive one another intensely; we often saw them galloping around the large rhinoceros pen in the Basel Zoo two dozen times. Usually a rest period of several hours follows this driving. Then the animals will stand beside each other; the bull may lie down, and sometimes the female holds her head between his hind legs. After many hours, the first attempt to mount will take place, but only after several such attempts is the bull's penis erect enough to achieve intromission. Both animals remain in the copulation posture for an average of sixty minutes. During one such copulation, we counted up to fifty-six ejaculations. The longest copulation we recorded was eighty-three minutes. After the bull dismounts, the animals pay no further attention to each other.

Birth and the raising of young in the zoo

While the females reach sexual maturity at three years, the bulls do not become sexually mature until they are seven to nine years old. The average gestation period for twelve females in captivity was between 462 and 489 days. The birth started with episodes of labor lasting about one hour; the actual birth, however, took only 15–30 minutes. A neonate great Indian rhinoceros has an average weight of 65 kg; it has folded skin like an adult with all the "rivets" and protuberances. On both sides of the head is a light spot which the English zoologist Cave interprets as a relic of tactile hair. The plum-shaped head is especially conspicuous in the newborn great Indian rhinoceros. There is a flat, smooth, oval plate where the nose horn will grow later. At the age of five weeks, this plate begins to rise. During the development of the sub-adult, the forehead becomes depressed while the area around the ears and the horn arch upward.

The young great Indian rhinoceros grow much faster than has been thought earlier. At the Basel Zoo, we found weight gains of 2–3 kg per day; thus, the weight at birth is multiplied tenfold within one year. Shortly after birth, the BH at the shoulder is 62–64 cm. After one year, it is approximately 120 cm; at the age of two years, about 145 cm. At the age of three and a half to four and a half years, the female is fully grown, while the bulls may keep growing for up to five years. The rhino mother has to produce twenty to twenty-five liters of milk in order to increase the weight of her young to such an extent.

Can the Javan rhinoceros still be saved?

It is most regrettable that we know so much less about the exact appearance or even the behavior of the closely related Javan rhinoceros *(Rhinoceros sondaicus)*. There are only a few specimens in museums and only a few photographs of this moribund species. In former times, the Javan rhinoceros were widely distributed all over East India, Sumatra, and Java. Reliable observers, like Eugen Schuhmacher, a photographer and student of animals, doubt whether the last survivors in the Udjung-Kulon Reserve in Java will be able to sustain the species. Only in 1967 did the World Wildlife Fund manage to send an ethologist, Professor Rudolf Schenkel from Basel, to Java to study the habitat and the behavior of this species, which is literally at the point of extinction. In his letters to me from the Udjung-Kulon Reserve, he reported that the Javan rhinoceros lives in the dense jungle. Its feeding grounds are at the edge of the forests of the coastal area and in the sparse mountain forest, where there are many young trees and openings caused by fallen trees. There it feeds predominantly on young trees whose trunks are no thicker than 10 cm, on the foliage of low-hanging branches, and on bushes. The rhinoceros bends these trees with the upper part of its trunk until they break; then it feeds on some of the leaves from the crown—the rest it does not touch.

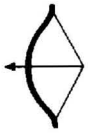
Compared with other rhinoceros, the population density is rather low, which can probably be linked with the scarcity of suitable food

plants. The animals are solitary; the young become independent at a relatively early age. In order to study the behavior of individual animals, which are hardly ever seen in the dense jungle, Schenkel measured their footprints. In adult animals, these are 27–39 cm wide in the front, and 25–27 cm in the rear. In the young who were on their own, Schenkel measured 21.5–22 cm for the front feet and 20–20.5 cm for the hind feet. Presumably, the females, with or without young, remain in a rather fixed home range but they take long trips from there daily. This roaming is even more pronounced in the males. The paths of the Javan rhinoceros are found predominantly on passes which cross mountain ranges and parallel to them, but the paths are most distinct near wallows. These wallows and bathing places, as well as the resting places, are different depending on the season. During the rainy season, the rhinos wallow in creeks, and less frequently in wet places in the brush. However, during the dry season most of these wallows dry out. The Javan rhinoceros also bathes where larger creeks flow into the ocean and occasionally even in the ocean itself.

The bulls spray their urine backwards and upwards at bushes. The fresh urine, which is orange to red in color, smells like horse urine. Until now these red splashes were thought to be nasal secretions. The Javan rhinoceros defectate either in creeks or on regularly visited "manure fields" of five to ten meters in diameter. Often they may leave droppings on their way. Rudolf Schenkel thinks that defecation in Javan rhinoceros is of no special significance in intraspecific communication.

The only species of rhinoceros of which there still is a good population in the wild is the AFRICAN BLACK RHINOCEROS (◊ *Diceros bicornis;* Color plate, p. 37 and pp. 38–40). HRL 300–375 cm, TL approximately 70 cm, BH (shoulder) 150–160 cm. The weight is up to two tons. There are two horns, of which the anterior one is longer (usually about 50 cm, sometimes up to 138 cm). Occasionally there is even a disposition for a third horn. The body is hairless, except for the tips of the tail and ears. Rib-like folds are on the sides of the rump. The upper lip is extended and the tip is suitable for grasping. There are no incisors or canine teeth; there are seven premolars and molars on each side of the jaw. The gestation period is fifteen to sixteen months.

The African black rhinoceros by Bernhard Grzimek



A person on foot who encounters a black rhinoceros really feels rather small and insignificant. One immediately recalls the angry attacks and even fatal accidents one has read about in books on Africa. After all, the black rhinoceros is one of the largest terrestrial mammals, next to the elephant and the square-lipped rhinoceros. The most impressive attributes are the two nose horns. A visitor to a zoo, seeing the animal for the first time, may already imagine them between his ribs. But then zoo rhinos almost never have the remarkable length of horns as do rhinos in the wild. The world record probably is held by