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Dicerorhinus sumatrensis.

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Dicerorhinus Gloger, 1841

Didermocerus Brookes, 1828:75. Rejected (Groves, 1967) because not intended for permanent scientific record as required by the International Code of Zoological Nomenclature. Type species *D. sumatrensis* Brookes, 1828 (= *Rhinoceros sumatrensis* Fischer, 1814).

Dicerorhinus Gloger, 1841:125. Type species "*Rhinoceros sumatrensis* Cuvier."

Ceratorhinus Gray, 1868:1021. Type species "*Rhinoceros sumatrensis* Cuvier."

CONTEXT AND CONTENT. Order Perissodactyla, Suborder Ceratomorpha, Family Rhinocerotidae, Subfamily Rhinocerotinae. The genus *Dicerorhinus* includes one living species as treated below, and about 12 extinct species.

Dicerorhinus sumatrensis (Fischer, 1814)

Sumatran Rhinoceros, Asiatic Two-horned Rhinoceros
Hairy Rhinoceros, Badak Kerbau, Badak Sumbu

Rhinoceros Sumatrensis Fischer, 1814:301. Type locality "Sumatra." Based on the "Double-horned rhinoceros of Sumatra" of Bell (1793), which was from 10 miles from Fort Marlborough, near Bencoolen (= Bintuhan), Sumatra.

Rhinoceros Sumatranus Raffles, 1821:268. Type locality Bencoolen, Sumatra.

Rhinoceros Crossii Gray, 1854:251. Type locality unknown.

Ceratorhinus niger Gray, 1873:357. Type locality "Malacca." According to Sclater (1877:651) the type was from Sunghi-njong District, Malaya.

Ceratorhinus Blythii Gray, 1873:360. Type locality Tenasserim.

CONTEXT AND CONTENT. Context given above. Three living and one subfossil subspecies were recognized by the latest reviser (Groves, 1967), in which synonymy is given:

D. s. sumatrensis (Fischer, 1814:301), see above (*sumatranus* Raffles, *niger* Gray, and *blythii* Gray are synonyms).

D. s. harrissoni (Groves, 1965:128). Type locality Suan-Lambah, Sabah, Borneo.

D. s. lasiotis (Buckland, 1872:89). Type locality near Chittagong, East Bengal.

D. s. eugenei Sody, 1946:151. Type locality Padang Caves (early Holocene), Sumatra.

Sclater (1872*a*, 1872*b*) recognized two species, *R. sumatrensis* and *R. lasiotis*, largely on differences in color and texture of hair. Gray (1872, 1873) interpreted Sclater's *R. lasiotis* as representing the typical Sumatran rhinoceros, and the specimen identified as "*sumatrensis*" by Sclater (1872*a*, 1872*b*) as *Ceratorhinus crossii* or as a new species, *C. niger*; a third species, *C. blythii*, was erected on the basis of skulls figured by Blyth (1862). Thomas (1901) demonstrated that the differences between the two living specimens studied by Sclater and Gray resulted from a difference in age; Thomas retained *lasiotis* provisionally as a larger northern race of *sumatrensis*. Groves (1965) showed that northern and southern races are not different in size, but that the Bornean race is significantly smaller than the others; *niger* was provisionally retained but in a later revision (1967) synonymized with *sumatrensis*.

Rhinoceros crossii Gray, 1854, is usually regarded as a synonym of this species, but direct proof is lacking; both Blyth (1862) and Gray (1872) were inclined to place the "species" (based on a single abnormal horn) in this group or genus, an opinion supported by a new study of horns (Groves, 1971); Blyth figured a similar, but much smaller horn, known to be from a Sumatran rhinoceros.

DIAGNOSIS. The smallest living species of Rhinocerotidae (figure 1), maximum shoulder height 1.45 m; body hair copious in young, largely disappearing with age; dental formula i 1/0, c 0/1, p 3/3, m 3/3, total 28; lower canines enlarged, tusklike; molars similar to those of *Rhinoceros*, especially *R. sondaicus*, but medisinus deeper than postsinus, and protocone fold present; skull elongated anterior to orbit, shortened posteriorly; orbitonasal length greater than orbitoaural; subaural channel remaining open throughout life in living species; mandible slender with vertical ascending ramus and pronounced gonial tuberosity. Two horns, frontal placed some distance behind nasal, over eye or somewhat posterior; both with broad, rugose basal region, rapidly narrowing to short but slender stem region; no anterior groove on nasal horn; muzzle anterior and lateral to nasal horn heavily keratinized; nostrils with straight, immobile upper border. Body-folds less pronounced than in *Rhinoceros*, more so than in Dicerotinae; postscapular fold complete, passing over shoulder, and fold at base of forelimb also complete, but folds in posterior region of body incomplete, poorly developed. Small intestine with *valvulae conniventes*, but lacking thick villous processes and Peyer's patches seen in *Rhinoceros*. Penile *processūs glandis* teat-like, with restricted pedunculate attachment to *dorsum glandis* and free and ventrally dependent for rest of length (Cave, 1964). The skull is shown in figure 2 and a second upper molar in figure 3.

GENERAL CHARACTERS. This is a short-bodied rhinoceros with the frontal horn often so inconspicuous that it appears to be single-horned. The nasal horn is generally short, the record from a well-authenticated specimen being 381 mm (Hubback, 1939), but two horns in the British Museum, probably referable to this species, measure 800 and 690 mm (the former is the type of *crossii* Gray, 1854). Head and body length 2.36 to 3.175 m, girth 1.98 to 2.44 m, shoulder height 1.12 to 1.45 m (Anderson, 1872; Evans, 1904; Peacock, 1931; Hubback, 1939). A weight given by Skafte (1961) was 800 kg, but an adult female was said by Ullrich (1955) to have weighed 2000 kg. The facial skin is characteristically wrinkled in the neighborhood of the eye, and the muzzle is rounded and unwrinkled due to the heavy keratinization. The skin is dark gray-brown; the horn is black (in the wild).

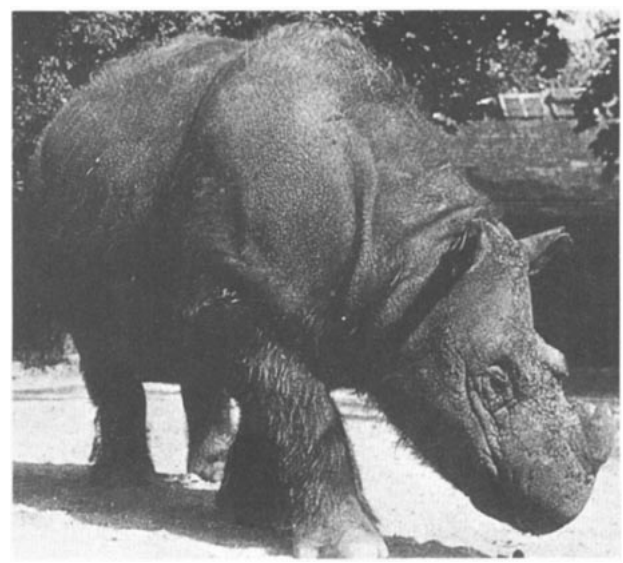

FIGURE 1. Adult female "Subur" in Copenhagen Zoo. Captured in 1959 in Little Siak River district, Riau, Sumatra. Shape of horns modified by abnormal wear in captivity. Photo taken about 1963 or 1964 by the late Dr. Erna Mohr.

FIGURE 2. Skull of *Dicerorhinus sumatrensis harrissoni* from Baram River district, Sarawak. Cambridge Zoology Museum no. H.6,383. Shown from top to bottom in dorsal, ventral and lateral views, and lateral view of lower jaw. Photo, L. Morley.

The nominate subspecies is a large race with comparatively small teeth and backwardly inclined occipital crest; *D. s. harrissoni* is small, with forwardly inclined occiput; and *D. s. lasiotis* is similar to the nominate race in size but with large teeth and broad occipital crest. The subfossil *D. s. eugenei* had larger teeth than any living subspecies.

DISTRIBUTION. In recent times the species occurred on Borneo (*harrissoni*), Sumatra and Malaya (*sumatrensis*), and the Asiatic mainland as far north as Assam (*lasiotis*) (figure 4). It still occurs over most of its former range, but populations are sparse and localized. It appears never to have been recorded from Bangka, Belitung, or the Rhio-Lingga islands, but at one time inhabited, or was a constant visitor to, some of the Mergui islands (U Tun Yin, 1954*a*). The present status of the species is dealt with in comments on ecology (paragraph on conservation) below.

There is some dispute over the northern borders of the range of the species. Peacock (1933) and Ansell (1947)

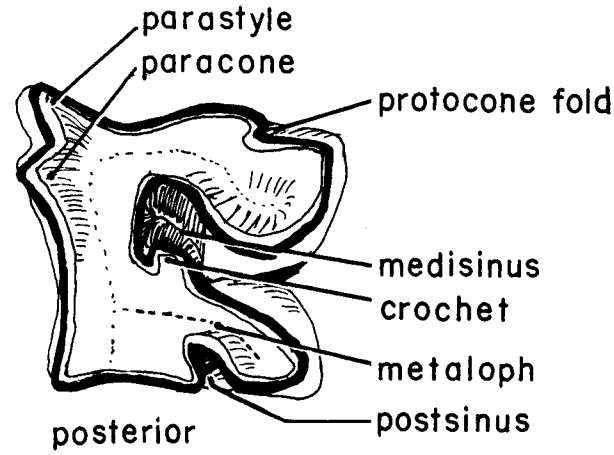

FIGURE 3. Right second upper molar of *D. sumatrensis*, to show parts mentioned in text.

reported it from all parts of Burma—from Shwe-U-Daung (Mogok District) and Arakan south to Bassein, Pegu Yomas, and the Salween and Tenasserim drainages. In India and Bangla Desh, it is known from the Lushai and Chittagong hills (Sclater, 1872*b*; Talbot, 1960), Comillah (Flower, 1878), and the Cossyah hills south of Charyolah (Anderson, 1872). Although neither Talbot (1960) nor Groves (1967) noted its occurrence north of Cam-ranh in Indo-China, it was reported by Delacour (1966) to have occurred in the 1920's in the hills behind Quangtri, and he also examined in 1925 the head of a two-horned rhinoceros at Nonghet (near Xieng-Khouang), killed in the region 15 or 20 years earlier. As for China, a specimen from Mong-le (22°30'N, 102°00'E), Yunnan, was mentioned by Hubback. Thus it may well have inhabited much of the mountainous region of Indo-China and the Burma-China border, although in the former region *R. sondaicus* was always said to be the commoner species.

FOSSIL RECORD. The only remains of the living species are the subfossil teeth from the Padang caves (Hooijer, 1946) and some late Pleistocene or early Holocene remains

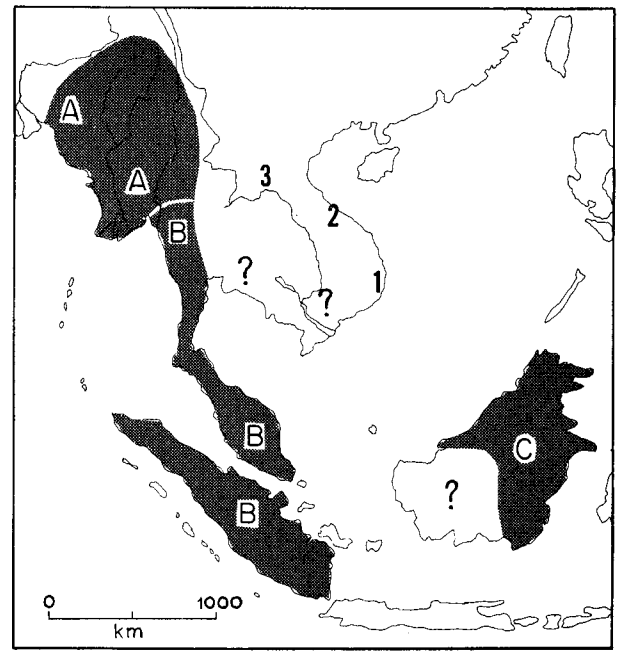

FIGURE 4. Range of the Sumatran rhinoceros in southeast Asia. Subspecies are indicated by letters: A, *D. s. lasiotis*; B, *D. s. sumatrensis*; and C, *D. s. harrissoni*. Areas of possible, but undocumented former occurrence indicated by question marks. Documented places of former occurrence, well outside main distributional area, are: 1, Cam-ranh, 2, Quangtri, and 3, Nonghet.

from Niah in Sarawak (Medway, 1966), of which a humerus 350 mm long is rather larger than that of the living Bornean race, as the Padang teeth are larger than those of any living race. *Dicerorhinus* contains a dozen or more fossil species which are treated by Chow (1963*a*, 1963*b*), Hooijer (1967), and Guérin *et al.* (1969). A brief survey of the evolution of the genus is given under Remarks.

FORM. The skin is 16 mm thick at its thickest part (Evans, 1904) and usually dark gray-brown, but a white specimen was shot in Kamaing subdivision, Burma, in 1925 (U Tun Yin, 1956*b*). Cave (1969) suggested that the disappearance of most of the hairy coat with age is due to natural changes with age rather than to abrasion; the species' hairiness is seen as a consequence of small size. The skin is like thick leather with small, rough, polygonal grains, but that of the soles was described by Krumbiegel (1965) as "strikingly soft and tender," in contrast to that of *Diceros*. The horn develops by a gradual thickening of the stratum corneum on the snout (Ryder, 1962), and the coarse grain of the skin disappears little by little with wear (Neuville, 1927). A female in the Copenhagen Zoo wrenched off her nasal horn; such horn-loss, described as "shedding," is said to occur in the wild also (Ullrich, 1955).

On the skeleton, the subaural channel may narrow with age, but has never been recorded to close entirely; the orbitonasal length is greater than the orbitoaural. The posterior end of the vomer is united to the floor of the mesopterygoid fossa (Pocock, 1945*b*). A partially ossified nasal septum may occur (Pocock, 1945*a*). The lacrimal bridge is invariably osseous, and the antorbital process mastoid in form (Cave, 1965). Premaxillae are firmly fused with maxillae from an early age. A second upper incisor has not positively been recorded, but alveoli for them are occasionally seen (Pocock, 1944). The lower canine is sometimes interpreted as the second lower incisor. The deciduous dentition possesses an extra upper and lower premolar. The height of unworn molar crowns is 46 to 50 mm; a protocone fold is present; a crochet originates from apex of metaloph; there is no crista or antecrochet, and rarely a slight trace of cingulum at entrance to median valley; there is a marked paracone bulge. The infraorbital foramen is over the border between the second and third premolars, the nasal notch over the second premolar, and the anterior border of the orbit over the first, or the border between first and second, molars. Radius length is 85% of length of humerus, tibia 74.5% of femur, humerus 88.9% of femur, tibia 100% of radius, total forelimb length 96.6% of total hindlimb, humerus 73% of basal skull length, third metacarpal 53.6% of radius. Vertebral formula—7 cervical, 19 thoracic, 3 lumbar, 4 sacral, and 26 caudal; spines of second and third thoracics are elongated, reducing anteriorly to posterior cervical and posteriorly more gradually reduced to the twelfth thoracic; no spinal elongation in lumbar region, and no anticlinal vertebra although the first sacral approaches this condition (Groves, personal observations).

The heart of an old female weighed 10 lbs (4.5 kg) (Garrod, 1873). Lymph nodes are as in other rhinos, but as a rule there is "no evidence of haemolymph function" (Cave and Aumonier, 1962). The cerebrum was described as "more convoluted" than in *Rhinoceros* (Beddard and Treves, 1887). The lungs have not been described. There is a diverticulum in the nasal cavity (Garrod, 1873).

The stomach is more tubular than in *Rhinoceros* and bent round with the two orifices approximated; the greater curvature measures 1575 mm, the lesser 153. There are three well-differentiated cardiac fields—cardiac cuticular, mucosal, and pyloric secretory (Cave and Aumonier, 1963). The intestinal tract is 7 to 8 times the body length. The bile duct opens 305 mm from the pylorus. *Valvulae conniventes* begin 150 mm beyond pylorus. The caecum is 915 mm long and pyriform; a glandular mass, probably secreting watery mucus, is in the caecum near ileocaecal valve. The colon is 4.9 m long (Home, 1821; Garrod, 1873; Cave and Aumonier, 1963). The distal part of first colic loop is narrower than in *R. sondaicus* and the fold of colic mesentery more limited, not fed by a special artery. The ileocaecal fossa is "of a forefinger's diameter" (Beddard, 1889). The liver weighs 15 lbs (6.8 kg), the right lateral lobe is larger than the right central, the caudate lobe 390 mm long, and the Spigelian lobe remarkably long and thin, 210 mm long and 18 by 6 mm wide (Garrod, 1873).

The uterus is bicornuate, each horn 420 mm long and the corpus 90 mm (Garrod, 1873). Seminal vesicles seem broader than in *Rhinoceros* and have 2 dextral and 4 sinistral ducts (Beddard and Treves, 1887).

In regard to the endocrine system, the parathyroid parenchyma is disposed as rounded cell-clusters, highly vascularized. One pair, symmetrically arranged, was found in an aged female (Cave and Aumonier, 1966).

FUNCTION. No physiological data are recorded. Fondness for bathing was interpreted by Cave (1969) as a thermoregulatory mechanism.

ONTOGENY. Reported gestation of 8 months (Anderson, 1872) seems unlikely, considering the 15 to 18 months found in other species of rhinos.

A newborn measured 914 mm in length, 610 mm in height, and weighed approximately 50 lbs (23 kg—see Bartlett, 1873). These measurements are not less than those of newborn of larger species of rhinoceros, and skull measurements confirm this. At the time of first appearance (in open crypt) of the first upper molar, the basal skull length is already 92 to 93% of adult size, and full size is reached well before the third molar is in occlusion. The occipitonasal length increases slightly with age in the larger races as the occipital crest extends backwards, to 100.5 to 103.5% of the basal length, but in *D. s. harrissoni* it remains constant at 98%. The zygomatic breadth changes little in proportion to skull length, but the nasal breadth continues to increase up to and beyond the maximum growth of skull length, at least in males (Groves, personal observations).

A newborn had a horn 20 mm high and a smooth spot indicated position of frontal horn. The color was nearly black, the body covered with short, crisp, black hair. The hoofs were turned under the feet and were quite soft at the tips. The animal suckled, then lay down in a dark corner (Bartlett, 1873).

A 10-month-old young was 720 mm high. One of similar size but unknown age weighed 45 to 50 kg and had an anterior horn 50 mm long and a slight indication of the posterior one; its body was very hairy (Ullrich, 1955). At 7 years, one was a little over 3 feet (910 mm) high, with still not much trace of a posterior horn (Hubback, 1939); at 10 years a height of 1.30 m is recorded and a length of 2.20 m—almost within the adult range (Krumbiegel, 1960). The hair, long and shaggy, almost fleecy in the young after the neonate stage (Ullrich, 1955; Krumbiegel, 1960), is still fine and copious, reddish brown in young adults, but with age becomes sparse, bristly (almost like hedgehog spines) and black (Thomas, 1901; Hubback, 1939).

ECOLOGY. Man is the only known predator, though doubtless the young may fall victim to large carnivores. They are attacked by ticks and by *Tabanus* flies. A female at Basel Zoo, 1959–1963, was much emaciated, dying of anaemia; though adult she was only 1.12 m high and weighed 350 kg.

Their habitat is mainly in hilly country, near water. Krumbiegel (1960) called it a "Saunatier," and stressed its need for high humidity. According to Strickland (1967) it is probably basically a species of the forest margin; it seems to be attracted to man-made secondary growth, where it may feed on cultivated plants. The bulls especially are often seen near villages (Kurt, 1971). It inhabits both Tropical Rain Forest and Mountain Moss Forest. In Atjeh, 13 out of 33 known rhino-occupied areas are on the boundary between these two forest types, at 1000 to 1500 m (Kurt, personal observations). In the Shwe-U-Daung Reserve, Burma, it occasionally ascends to open country above 1200 m (Peacock, 1931). It can ascend and descend steep slopes with great agility; it swims well (Evans, 1905) and has been known to swim in the sea (U Tun Yin, 1954*b*).

These rhinos engage in seasonal movements, keeping to hilly country when the lowlands are flooded during the rains, descending when the weather has become cool near the end of the rains, and returning to high ground by March (Thom, 1935), possibly to escape the attacks of horse-flies that abound at lower levels during the dry season (Skafte, 1961). It is said by most authors to be regular in its movements, making well-defined trails to wallows and feeding grounds, and changing its feeding grounds every 10 to 15 days (U Tun Yin, 1954; Skafte, 1961); Strickland (1967) claimed that periodicity was less marked than previously suggested, although in the Leuser area rhino "roads" are well known to the locals; males seem to be more nomadic than females (Kurt, 1971).

The females seem to live in territories, each centered on a wallow. The diameter of a territory is some 500 to 700 m;

each is surrounded by feeding grounds, which are visited by several different animals. Within the territory is a dense system of tracks leading to and from the wallow, which is usually located on a mountain top or a catchment area of a small stream. The home range of a female is from 2 to 3.5 km in diameter; home ranges overlap widely and contain several regular feeding areas (Strickland, 1967; Kurt, 1971).

Foods include fruit, leaves, twigs, and bark, and these animals are especially fond of wild mangoes and figs (Evans, 1904; Hubback, 1939) and species of bamboo (Evans, 1905; Thom, 1935). Metcalfe (1961) also mentioned figs (*Ficus*), and other plants including fruits of five species and leaves of 19 species. Kurt (1971) identified 14 species, of which leaves were used of 11, bark of six, and fruit of only one. According to Strickland (1967), the favored food plants are all species found in secondary growth. Some of the plants eaten by this species are toxic to man (especially the nettle *Laportea microstigma*). The horns are used to break down small trees of as much as an arm's width, according to professional rhino hunters in Atjeh. The species is known to visit salt-licks.

Simon (1966) suggested that the total world population is about 100 to 170, as follows: Thailand (on Tenasserim border) six, Cambodia 10, Borneo 10, Burma 20 to 30, Malaya 47, Atjeh 20, Riau 25, Lampongs 15. Other authors give different estimates. For Malaya, Hislop (1966) estimated 30, in the states of Johore, Selangor, Perak, Kedah, Trengganu, and Pahang; a supposed *Rhinoceros sondaicus* photographed in Malaya in 1957 (Ali and Santapau, 1958) was actually of the present species.

In the Loser (Leuser) Reserve, Atjeh, Milton (1964) estimated about 20 head; however a more recent estimate, using actual observations and analysis of tracks, and the information of professional rhino hunters, suggests a minimum of 60 and a maximum of 100 animals (Kurt, 1971). Skafte (1961) suggested a large population in Riau; he is alone in estimating the world population as high as 2000. Poaching is rife; the yearly reduction of population by teams of professional hunters in Atjeh is some two to three animals, mostly females or juveniles since the traps are built in the territories of females. This is therefore a serious threat; but far more so is the destruction of forest by logging concerns—the whole of the rhino's habitat in Riau has been made over to timber concessions, and these are operating in Atjeh also.

For Borneo, Banks (1931) gave previously known localities, and by comparison Burgess (1961) listed only the upper Kinabatangan River, Darvel Bay, Dent Peninsula, near Ranau, and the Interior Residency of Sabah as recent records.

In Burma, Hubback (1939) reported it in the Singpo country, 27°30′N, 97°E. Christison (1945) reported its existence in five separate districts of Arakan, but by 1955 it had vanished from at least one of these (U Tun Yin, 1956*a*). In 1955 there were about 30 in Kamaing subdivision, probably of this species (U Tun Yin, 1956*b*). Other Burmese records were given by U Tun Yin (1954*a*, 1954*b*) and Ansell (1947). U Tun Yin (1967) put the total number in Burma at about 26, and pointed out a glaring loophole in the law—the species is totally protected except for "medicinal purposes," and several high officials thus have been able to obtain permits for the destruction of rhinos in recent years. Simon (1966) suggested that the Burmese rhinos should be trapped and released in three selected areas, (1) northern Burma, (2) Arakan Yomas, and (3) Tenasserim; they would thus be easier to protect, and would have more chance of finding a mate. However, even in a comparatively well-maintained reserve, the Shwe-U-Daung, at least 17 were killed after 1940, and only two or three still existed there 10 years ago (Ali and Santapau, 1959).

Until 1959, 55 Sumatran rhinos had been kept in captivity, most of them quite successfully, the longevity record being 32 years and 8 months (for "Begum," type of *lasiotis*, in London). Indeed, this species was the first rhinoceros to breed in captivity—in Calcutta, in 1889 (Reynolds, 1960). In 1959, three females were captured in Sumatra in stockades over well-used wallows (Skafte, 1961, 1964). In view of the data of Kurt (1971), such a method would be more likely to catch females, which are sedentary and probably territorial, than the more nomadic males. One of the three mentioned above lived until 1972 in Copenhagen Zoo.

BEHAVIOR. Mating has been observed in the wild (Bartlett, 1873), but not reported in detail. Young have been seen at heel in January (Evans, 1905).

These rhinos feed before dawn and after sunset and move mostly by night (Thom, 1935). Much of the day is spent in wallows (Strickland, 1967). The Basel captive female would bathe and wallow mostly in the morning (Lang, 1959).

They are tough and agile (Hubback, 1939; Evans, 1905). They lie, sleeping or resting, with one or both forelegs stretched out in front, in contrast to *Diceros* (Krumbiegel, 1965). Before lying down, an individual arranges the straw around it with its forefeet (Lang, 1959).

They make a humming or buzzing sound when wallowing (Thom, 1935)—this is evidently the same sound as that described by Hubback (1939) as being low and plaintive, like the low notes of a gibbon. When disturbed, an animal dashes off with a terrific snort (Thom, 1935); when hard-pressed it gives a "loud whistling bray" (Thom, 1935), or a squeal, "between a bark and a quack" (Hubback, 1939).

Males are usually solitary, females in mother-offspring units; the largest group found consisted of three animals. The males seem to visit territories of females after the calves are weaned (Kurt, 1971). Hubback (1939) considered that there is evidence that males may fight over a female.

Young saplings, which form the major food source, are much damaged, either bitten off or bent over or stepped on, or broken off with the horns (Strickland, 1967; Kurt, 1971). Food is plucked with teeth rather than with lips (Krumbiegel, 1965).

The female squirts out urine first in short bursts, then in a long stream, as much as 6 m behind it (Anderson, 1872; Lang, 1959; Andersen, 1961; Schenkel and Lang, 1969), whereas the male sprays urine onto the surrounding bushes to a height of up to 1.8 m (Hubback, 1939). Although some earlier reports claimed that this species makes communal dunghills like other rhinos, neither Talbot (1960), Kurt (1971), nor Strickland (1967) found evidence of this. Schenkel and Lang (1969) attributed Strickland's negative finding to the sparsity of local populations in his area, but communal dunghills do not occur in areas of Atjeh where several animals have coexisted for long periods, and local hunters know nothing of them. Their absence is in contrast to their regular production by members of the genus *Rhinoceros*.

Wallows are often rainwater ponds on hilltops, and are dug out by the rhinos themselves. They regularly are located in the center of a territory and are connected by a system of tracks; the surrounding area is cleared of vegetation for 10 to 35 m, and used as a resting place. Talbot gave measurements of wallows as 2 to 4 m by 1 to 1.5 m; Kurt found them up to 8 m in diameter. Wallowing is thought (Hubback, 1939; Skafte, 1961; Schenkel and Lang, 1969) to provide protection against insects, or (Cave, 1969) to be a cooling mechanism; Hubback (1939) indeed noted that individuals wallow more in hot weather.

Lang (1959) described the scratching of the inside of the foreleg with the other forefoot. Horns may be sharpened on special trees (Kurt, 1971).

When disturbed, these rhinos generally make off at a smart gallop through the undergrowth (Evans, 1905; Thom, 1935), and at times they can be dangerous. Peacock (1931) thought them "very pugnacious." The animals charge with jaws open, and defend themselves with the tusklike lower canines by biting, or occasionally with the horn (Evans, 1904). Hubback (1939), however, denied that the horns are used. A captured animal tried to twist the poles of its stockade with its horn, and rose on its hindlegs in an apparent attempt to push the fence down (Skafte, 1961).

GENETICS. Nothing whatever is known of the genetics of this species.

REMARKS. As presently defined, *Dicerorhinus* is the genus that gave rise to all living Rhinocerotidae; in this sense, and in that it closely resembles certain Miocene species, the Sumatran rhino may be regarded as a living fossil. Fossil representatives of the genus fall into two grades: a primitive grade with low, forwardly inclined occiput and large anterior dentition; and a more specialized grade with long, upwardly or backwardly inclined occipital crest and anterior teeth reduced or absent. The specialized forms also tend toward closure of the subaural channel. The groups are:

a. Primitive group.

D. tagicus, Upper Oligocene to Lower Miocene of Europe.
D. leakeyi, Lower Miocene of East Africa.
D. caucasicus, Middle Miocene of Europe.
D. sansaniensis, Middle to Upper Miocene of Europe.
D. schleiermacheri, Upper Miocene to Lower Pliocene of Europe.
D. sumatrensis, Holocene of Southeast Asia.

b. Specialized group.

D. primaevus, Upper Miocene of North Africa.
D. pikermiensis (= *orientalis*), Lower Pliocene of Europe and China.
D. megarhinus, Upper Pliocene of Europe.
D. etruscus, Lower Pleistocene of Europe.
D. yunchuchenensis, Lower Pleistocene of China.
D. kirchbergensis (= *merckii*), Middle Pleistocene of Europe and Siberia.
D. choukoutienensis, Middle Pleistocene of China.
D. hemitoechus, Upper Pleistocene of Europe.

The specialized group was removed by Kretzoi (1942) to a new genus, *Stephanorhinus*, but it is uncertain whether it is monophyletic, or whether some species are not closer to the Pleistocene woolly rhinoceros, *Coelodonta*.

Insofar as the Sumatran rhinoceros has progressive features linking it to one or other of the living genera, it is closest to *Rhinoceros*. Being so close to *sansaniensis* and other Miocene species, lack of a fossil record is somewhat surprising, especially because *Rhinoceros* is common as a fossil in the Oriental Region. The Pre-Holocene distribution is a complete mystery.

LITERATURE CITED

Ali, S., and H. Santapau. 1958. Rediscovery of the smaller Asiatic one-horned rhinoceros (*Rhinoceros sondaicus* Desmarest) in Malaya. Jour. Bombay Nat. Hist. Soc. 55: 554–556.

— 1959. Present status of the two-horned rhinoceros, *Didermocerus sumatrensis* (Fischer) in the Shwe-U-Daung Reserve, Burma. Jour. Bombay Nat. Hist. Soc. 56:625.

Andersen, S. 1961. Sumatran rhinoceros at Copenhagen Zoo. Internat. Zoo Yearbook 3:56–57.

Anderson, J. 1872. Notes on a *Rhinoceros sumatrensis* Cuvier. Proc. Zool. Soc. London pp. 129–132.

Ansell, W. F. H. 1947. A note on the position of rhinoceros in Burma. Jour. Bombay Nat. Hist. Soc. 47:249–276.

Banks, E. 1931. A popular account of the mammals of Borneo. Jour. Malay Branch Royal Asiatic Soc. 9 (2):1–139.

Bartlett, A. D. 1873. On the birth of a Sumatran rhinoceros. Proc. Zool. Soc. London pp. 104–106.

Beddard, F. E. 1889. On the anatomy of *Rhinoceros sumatrensis*. Proc. Zool. Soc. London pp. 7–25.

Beddard, F. E., and F. Treves. 1887. On the anatomy of the Sondaic rhinoceros. Trans. Zool. Soc. London 12: 183–197.

Bell, W. 1793. The double-horned rhinoceros of Sumatra. Phil. Trans. Roy. Soc. London 1:3–6.

Blyth, E. 1862. A memoir of the living Asiatic species of rhinoceros. Jour. Asiatic Soc. Bengal 31:151–175.

Brookes, J. 1828. Catalogue of the Anatomical and Zoological Museum of Joshua Brookes. London 76 pp.

Buckland, F. 1872. A new rhinoceros at the Zoological Gardens. Land and Water 14:89.

Burgess, P. F. 1961. Wildlife conservation in North Borneo. Malayan Nat. Jour. (Spec. Issue, 21st Anniversary) pp. 143–151.

Cave, A. J. E. 1964. The processus glandis in the Rhinocerotidae. Proc. Zool. Soc. London 143:569–586.

— 1965. Traction epiphyses in the mammalian skull. Proc. Zool. Soc. London 145:495–508.

— 1969. Hairs and vibrissae in the Rhinocerotidae. Jour. Zool. 157:247–257.

Cave, A. J. E., and F. J. Aumonier. 1962. Lymph node structure in the Sumatran rhinoceros. Jour. Royal Microsc. Soc. 81:73–77.

— 1963. The visceral histology of the Sumatran rhinoceros. Jour. Royal Microsc. Soc. 82:29–37.

— 1966. Parathyroid histology in the Rhinocerotidae. Jour. Royal Microsc. Soc. 86:51–57.

Chow Ben-shun. 1963*a*. A new species of *Dicerorhinus* from Yushe, Shansi, China. Vert. Palas. 7:325–329.

— 1963*b*. On the skull of *Dicerorhinus choukoutienensis* Wang from Choukoutien, locality 20. Vert. Palas. 7: 62–70.

Christison, P. 1945. A note on the present distribution of the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) in the Arakan district of Burma. Jour. Bombay Nat. Hist. Soc. 45:604–605.

Delacour, J. 1966. The living air. Country Life Ltd., London, 173 pp.

Evans, G. H. 1904. The Asiatic two-horned rhinoceros (*Rhinoceros sumatrensis*). Jour. Bombay Nat. Hist. Soc. 16:160–161.

— 1905. Notes on rhinoceroses in Burma, *R. sondaicus* and *sumatrensis*. Jour. Bombay Nat. Hist. Soc. 16:555–561.

Fischer, G. 1814. Zoognosia: tabulis synopticis illustrata. Vol. 3, N. S. Vsevolozsky, Moscow, xxiv + 732 pp.

Flower, W. H. 1878. On the skull of a rhinoceros (*R. lasiotis* Scl.?) from India. Proc. Zool. Soc. London pp. 634–636.

Garrod, A. H. 1873. On the visceral anatomy of the Sumatran rhinoceros, *Ceratorhinus sumatrensis*. Proc. Zool. Soc. London pp. 92–104.

Gloger, C. W. L. 1841. Gemeinnütziges Hand- und Hilfsbuch der Naturgeschichte. Aug. Schultz and Comp., Breslau, vol. 1, xxxiv + 495 pp.

Gray, J. E. 1854. On a new species of rhinoceros. Proc. Zool. Soc. London pp. 250–251.

— 1868. Observations on the preserved specimens and skeletons of the Rhinocerotidae in the collection of the British Museum and Royal College of Surgeons, including descriptions of three new species. Proc. Zool. Soc. London 1867:1003–1032.

— 1872. On the double-horned Asiatic rhinoceros. Ann. Mag. Nat. Hist., ser. 4, 10:208–209.

— 1873. On the dentition of rhinoceroses (Rhinocerotes) and on the characters afforded by their skulls. Ann. Mag. Nat. Hist., ser. 4, 11:356–361.

Groves, C. P. 1965. Description of a new subspecies of rhinoceros, from Borneo, *Didermocerus sumatrensis harrissoni*. Säugetierk. Mitt. 13:128–131.

— 1967. On the rhinoceroses of Southeast Asia. Säugetierk. Mitt. 15:221–237.

— 1971. Species characters in Rhinoceros horns. Z. Säugetierk. 36:238–252.

Guérin, C., R. Ballesio, and H. Méon-Vilain. 1969. Le *Dicerorhinus megarhinus* (Mammalia, Rhinocerotidae) du Pliocène de St-Laurent-des-Arbres (Gard). Docum. Lab. Géol. Fac. Sci. Lyon 31:55–145.

Hislop, J. A. 1966. Rhinoceros and seladang—Malaya's vanishing species. Oryx 8:353–359.

Hooijer, D. A. 1946. Prehistoric and fossil rhinoceroses from the Malay archipelago and India. Zool. Meded. Leiden 26:1–138, 10 pls.

— 1967. Fossil mammals of Africa, no. 21: Miocene rhinoceroses of East Africa. Bull. Brit. Mus. Nat. Hist., Geol. 13 (2):119–190, 15 pls.

Home, E. 1821. An account of the skeletons of the Dugong, two-horned rhinoceros, and Tapir of Sumatra, sent to England by Sir Thomas Stamford Raffles, Governor of Bencoolen. Phil. Trans. Royal Soc. London pp. 268–275.

Hubback, T. R. 1939. The Asiatic two-horned rhinoceros. Jour. Mammal. 20:1–20. (Virtually identical article published in Jour. Bombay Nat. Hist. Soc. 40:594–617, in 1939 also.)

Kretzoi, M. 1942. Bemerkungen zum Systematik der nachmiozänen Nashorn-Gattungen. Földt. Közl. (Geol. Mitt.) 72:309–318.

Krumbiegel, I. 1960. Die asiatischen Nashorne (Dicerorhinus Gloger und Rhinoceros Linné). Säugetierk. Mitt. 8:12–20.

— 1965. Das Kopenhagener Sumatranashorn, *Didermocerus sumatrensis* (Fischer, 1814). Säugetierk. Mitt. 13:97–100.

Kurt, F. 1971. Final report to IUCN/SSC and WWF International of WWF Project 596: Leuser Reserve (Sumatra). World Wildlife Fund.

Lang, E. M. 1959. Ein Sumatra-Nashorn im Baseler Zoo. Säugetierk. Mitt. 7:177.

Medway, Lord. 1966. Niah Cave Animal Bone. VIII—Rhinoceros in Late Quaternary Borneo. Sarawak Mus. Jour. 1966:77–82.

Metcalfe, G. T. C. 1961. Rhinoceros in Malaya and their future. Malayan Nat. Jour. (Spec. Issue 21st Anniversary) pp. 183–192.

Milton, O. 1961. The Shwe-U-Daung, a rhinoceros sanctuary in Burma. Malayan Nat. Jour. (Spec. Issue 21st Anniversary) pp. 103–106.

— 1964. The Orang-utan and rhinoceros in North Sumatra. Oryx 7:177–184.

Neuville, H. 1927. Remarques et comparaisons relatives aux Phanères des Rhinocéros. Arch. Mus. Hist. Nat. Paris ser. 6, 2:179–208.

Peacock, E. H. 1931. The Shwe-U-Daung Sanctuary, Upper Burma, with a note on the Asiatic two-horned rhinoceros (*R. sumatrensis*). Jour. Bombay Nat. Hist. Soc. 35: 446–448.

— 1933. A game book for Burma and adjoining territories. H. F. and G. Witherby, London, 292 pp.

Pocock, R. I. 1944. The premaxillae in the Asiatic rhinoceroses. Ann. Mag. Nat. Hist., ser. 11, 11:834–842.

— 1945*a*. The nasal septum in existing Asiatic rhinoceroses. Ann. Mag. Nat. Hist., ser. 11, 12:341–344.

— 1945*b*. Some cranial and dental characters of existing species of Asiatic rhinoceroses. Proc. Zool. Soc. London 114:437–450.

Prater, S. H. 1939. Additional notes on the Asiatic two-horned rhinoceros. Jour. Bombay Nat. Hist. Soc. 40: 618–627 (not cited in text).

Raffles, T. S. 1821. Descriptive catalogue of a zoological collection, made on account of the Honourable East India Company, in the island of Sumatra and its vicinity, under the direction of Sir Thomas Stamford Raffles, Lieutenant-Governor of Fort Marlborough, with additional notes illustrative of the Natural History of these countries. Linn. Trans. 13:239–340.

Reynolds, R. J. 1960. Asian rhinos in captivity. Internat. Zoo Yearbook 2:17–42.

Ryder, M. L. 1962. Structure of rhinoceros horn. Nature 193:1199–1201.

Schenkel, R., and E. M. Lang. 1969. Das Verhalten der Nashörner. Handbuch der Zoologie 10(25):1–56.

Sclater, P. L. 1872*a*. [Note in] Proc. Zool. Soc. London pp. 493–494.

— 1872*b*. [Note in] Proc. Zool. Soc. London pp. 790–794.

— 1877. On the rhinoceroses now or lately living in the Society's menagerie. Trans. Zool. Soc. London 9:645–660.

Simon, N. [ed.] Red Data Book, Vol. 1. International Union for Conservation of Nature, Morges, Switzerland. Sumatran rhinoceros (sheet of January 1966).

Skafte, H. 1961. A contribution to the preservation of the Sumatran rhinoceros. Acta Trop. 18:167–176.

— 1964. Rhino country. Robert Hale Ltd., London. 191 pp., 25 pls.

Sody, H. J. V. 1946. [Review of] Prehistoric and fossil rhinoceroses of the Malay Archipelago and India, by D. A. Hooyer. Naturwet. Tijdschr. Ned. Indie, 102:151.

Strickland, D. L. 1967. Ecology of the Rhinoceros in Malaya. Malayan Nat. Jour. 20:1–17.

Talbot, L. M. 1960. A look at threatened species. Oryx 5:153–294.

Thom, W. S. 1935. Rhinoceros shooting in Burma. Jour. Bombay Nat. Hist. Soc. 38:138–150.

Thomas, O. 1901. Notes on the type specimen of *Rhinoceros lasiotis* Sclater, with remarks on the generic position of the living species of rhinoceros. Proc. Zool. Soc. London pp. 154–158.

Ullrich, W. 1955. Bemerkenswerte Aufnahmen eines junges Sumatra-Nashorns (*Dicerorhinus sumatrensis*). Zool. Garten 22:29–33.

U Tun Yin. 1954. A note of the position of rhinoceros in the Union of Burma (1953). Jour. Bombay Nat. Hist. Soc. 52:83–87.

— 1954. A supplementary note on the status of rhinoceros and thamin (*Panolia eldi thamin*) in the Union of Burma, 1953. Jour. Bombay Nat. Hist. Soc. 52:301–303.

— 1956*a*. A supplementary note on the status of rhinoceros in the Union of Burma, 1955. Jour. Bombay Nat. Hist. Soc. 53:257–258.

— 1956*b*. Rhinoceros in the Kachin State. Jour. Bombay Nat. Hist. Soc. 53:692–694.

— 1967. Wild animals of Burma. U Khin Pe Gyi, Rangoon, xi + 301 pp.

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