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Rhinoceros unicornis.  By W. A. Laurie, E. M. Lang, and C. P. Groves

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Rhinoceros Linnaeus, 1758

Rhinoceros Linnaeus, 1758. Type species Rhinoceros unicornis Linnaeus 1758.


Monoceros Rafinesque, 1815. Type species Rhinoceros unicornis Linnaeus, 1758. Not of Meuchel, 1787 (Mollusca).

Unicornis Rafinesque, 1815. Type species Rhinoceros unicornis Linnaeus, 1758; not of Montfort, 1810 (Mollusca).

Eurhinoceros Gray, 1867. Type species Rhinoceros javanicus Geoffroy-St. Hilaire and Cuvier, 1824 (= R. sondaicus Desmarest, 1822).

Monocorhinus Wust, 1922. Type species Rhinoceros sondaicus Desmarest, 1822.

CONCEPT AND CONTENT. Order Perissodactyla, Suborder Ceratomorpha, Family Rhinocerotidae, Subfamily Rhinocerotineae. The genus includes two species, the present one and R. sondaicus Desmarest, 1822.

Rhinoceros unicornis Linnaeus, 1758

Indian Rhinoceros

Rhinoceros unicornis Linnaeus, 1758:56. Type locality Bengal. Rhinoceros indicus G. Cuvier, 1817: 239. Type locality India. Rhinoceros asiaticus Blumenbach, 1830:107. No locality given. Rhinoceros stegochelys Falconer and Cautley, 1847: pl. 73, fig. 2; pl. 74, fig. 5; pl. 75, fig. 5. Type locality Upper Siwaliks; fossil. Rhinoceros palaeoindicus Falconer and Cautley, 1847: pl. 73, fig. 1; pl. 74, fig. 1–4; pl. 75, fig. 1–4. Type locality Upper Siwaliks; fossil. Rhinoceros stenoccephalus Gray, 1867:1018. Type locality “Asia.” Rhinoceros namadicus Lydekker, 1876:3. Type locality Narbada Beds; not of Falconer, 1868; fossil. Rhinoceros jamrachii Sclater, 1877a:650. Type locality Manipore district (Manipur). Rhinoceros kendengindicus Dubois, 1908:1259. Type locality Kedon Duren, Java (Trinil beds, Lower or Middle Pleistocene); fossil. Rhinoceros kagusena Deraniyagala, 1958:122. Type locality Kuvirta Gem, 20’, at Hirilayada, Talataiya; fossil. Rhinoceros barinagalingenis Srivastava and Verma, 1972:77. Type locality Pinjor beds (Lower Pleistocene), near Chandigarh, India; fossil.

CONTEXT AND CONTENT. Context as above. The living species is monotypic, but certain Pleistocene representatives are distinguishable at the subspecific level. The type of R. jamrachii was originally referred by Sclater (1877a) to R. sondaicus, but in a later publication (Sclater, 1877b) he re-identified it on the basis of personal examination, with the present species. The Indian rhinoceros is the type species of the genus Rhinoceros (Frequell, 1944a).

DIAGNOSIS. Rhinoceros differs from other genera in having: single, nasal horn; incisors and lower canines present, large; dental formula 1/1, 1/1, p 0/1, p 3/3, m 3/3, total 30; deciduous dentition having dp1; cheekteeth subhypsodont; protoloph on upper premolars fully formed (Guérin, 1980); medians of upper molars of approximately equal depth to postnaris (for figures illustrating these terms, see Groves and Kurtz, 1972, fig. 3); cheek of upper molars springing from apex of metacone; M3 triangular, without metacone bulge; skull short, with occipital plane inclined forward making dorsal profile strongly concave; oral tubular length greater than orbital rim; infraorbital foramen above P2; posterior edge of nasal notch over P1 position, anterior border of orbit over P4; auditory meatus closed inferiorly by fusion of postglenoid and posttympanic processes; vomer longitudinally ridged (Guérin, 1980; Pocock, 1945a; C.P.G., pers. observ.). Lacrimal bridge is usually ligamentous and antorbital process ovate (Cave, 1965). Skeletal fordiom length (humerus + radius + metacarpal III) is less than hindlimb (femur + tibia + metatarsal III); like Dicerorhinus but unlike African rhinoceroses. Beipalatal groove of humerus is wide and shallow, bounded laterally by enlarged, medially hooked tibetocelum majus. Femur has enlarged, laterally-pointed greater trochanter and broad, quadrangular third trochanter. Fibular head is confined beneath a shelf of the tibia, not articulating with femur (unlike African rhinoceroses). Trochlear surface of talus (astragalus) is low and long (Guérin, 1980; C.P.G., pers. observ.). Skin-folds are marked, including scapular, pelvic, humeral, femoral, and subcaudal folds; hairy covering reduced but often visible even in adult. Processus glandis of penis is located on either side of dorsum of glans, with relatively long sessile antero-posterior attachment to glans, and with long narrow projection laterally (Cave, 1964). Large free villi are present in small intestine (Garrod, 1878). Pedal scent glands are present (Cave, 1962).

The species Rhinoceros unicornis is diagnosed as follows: skull heavy, basal length above 600 mm; toothrow length above 241 mm; nasals rugose, their breadth rarely below 110 mm; occiput high, above 190 mm; premaxillae broad, united to maxillae from maturity; vomer thick, firmly united to sides of pterygoid processes; cheekteeth hypsodont, crown height of unworn M1–2 58 to 72 mm (Colbert and Hooper, 1952); index of hypsodonty (heigh at percent of length) of unworn P3–4 is 121.5 to 139.0 (Guérin, 1980); parastyle buttress not pronounced; ectoeloph flat; crista generally well developed, uniting early with crocket; protocoon fold present; cingulum absent; skin-folds heavy; subcaudal fold almost meets pelvis; posterior cervical fold nearly always maintains a horizontal course, failing to meet scapular fold; epidermal polygonal wall separated, raised, rivet-like; intestinal villi long, cylindrical, narrow; caecum and colon broad, elongate (Owen, 1862).

GENERAL CHARACTERS. Rhinoceros unicornis is a heavily built species; weights of two adult females were 1,599 and 1,608 kg, and three adult males weighed 2,070 to 2,132 kg (E.M.L., records from Basel Zoo; Owen, 1862). Average measurements are: head and body length, 4.120 mm; girth, 3.960; height of females, 1,625.0 (range 1,470 to 1,730), n = 115; height of males, 1.754 (range 1,630 to 1,930), n = 9; Anom., 1909; Owen, 1862; Sclater, 1872; authors’ data). Nasal horn slightly back-curved; maximum length in British Museum material was 529 mm (straight), but W.A.L. measured a “trophy” horn in Assam which was 572 mm; Neuvile (1927) mentioned one measuring 800 mm along the curve, but the specimen appears to C.P.G. to be a Ceratotherium simum horn sewn into a skin of R. unicornis. Base of horn is approximately 2.0 cm in thickness at base and 1.5 cm in circumference.

FIGURE 1. Adult male of Rhinoceros unicornis in Kaziranga National Park, India (photo by W.A.L.).

185 by 120 mm, rapidly narrowing until smooth, even stem part (90 by 80 mm) begins approximately 55 mm above base of horn. Breadth of stem is 55 to 75% of breadth of base; base is roughened, irregularly grooved, but with a well-marked deep groove running up the front. In captive animals, the horn is worn down to a thick knob, or into an abnormal shape: Sclater (1877a) recorded one in London Zoo in which the horn grew forward, 46 cm in front of the nose.

Color of hide is grey-brown, becoming pinkish in skin-folds; horn is black (under natural conditions). Epidermal knobs are prominent on body, especially near folds. The posterior cervices fold sometimes crosses the shoulder as in R. sondaicus (W.A.L., observations in Chitawan and Kaziranga). Male shows enormous development of neck-folds ("lab" of Laurie, 1978). Presence of visible body hair has been denied (Cave, 1969), but occasionally may be apparent (Groves, 1967); eyelashes, ear-fringes, and tail-brush are always present.

Captive individuals do not always represent the true appearance of the wild animal. Good photographs taken under natural conditions, in color and in black-and-white, such as those in Ulrich and Ulrich (1964), should be sought for a true impression (also see Fig. 1).

DISTRIBUTION. Nowadays R. unicornis is confined to Nepal (Chitawan Valley) and India (States of Assam and West Bengal), with a few stragglers in northernmost Burma (Fig. 2). Banerjee and Chakraborty (1973) listed remains from metal-ages deposits in Gujarat and Rajasthan. A rockpainting of a rhinoceros occurs in an apparently Mesolithic (about 8,000 to 3,000 B.P.) context at Bhumibetka, near Bhupal, Madhya Pradesh (Mathpal, 1978). Mukherjee (1966) mentioned subfossil remains from Bandra District, Pakistan, and that its remains occurred at Harappa (4,300 to 1,500 B.C.); the age of remains from the Madras region is uncertain. In the early Mughal period, the species still extended as far west as the Punjab foothills, Peshawar, Sind, and the lower Indus (Rao, 1947); in modern times, it has been known mainly from the Terai. Manen-Smith (1909) detailed its former distribution in Nepal; Rockemaker (1980) detailed the former distribution in Eastern India and Bangladesh, and discussed records from China and Indo-China. A preserved specimen was shot in Namblong district, Putao subdivision, Burma, in 1956 (U Tun Yin, 1956), and in February 1962 about six to eight individuals were discovered on the lower slopes of Bumpha Bum, Sumprapham subdivision, Myitkyina district (U Tun Yin, 1967).

Laurie (1978) gave a summary of the status of this species in the mid-1970s as follows: (1) ASSAM. Kaziranga, 600; Loakhova Reserve, “less than 50”; Orang, 25-30; Manas, 40; Sonai Rupai, 15; elsewhere, about 25. (2) WEST BENGAL. Jaladapara, 30-40; Cora mara, 5. (3) NEPAL. Chitawan, 270-310. The figures for Kaziranga and Chitawan in 1982 have increased since this census was made.

FIGURE 3. Skull of Rhinoceros unicornis, old male (B.M.61.5.101), from London Zoo. The abnormal form of the horn is a common consequence of wear seen in zoo specimens (photo by C.P.G.).

FOSSIL RECORD. Most known fossil remains of R. unicornis appear to be of Pleistocene date, probably Middle Pleistocene. The direct precursor of the living Indian rhinoceros was R. u. fossilis Baker and Durand (synonyms stwalesis and palaeindicus). Falsooner and Courtley, from the upper Swallow beds, within the known historic range of the species. R. namadicus Lydekker from the Narbada or Narmada beds is probably synonymous with R. u. fossilis. Hooper (1946) showed that R. kendengindicus Dubois from Java was closely related to the present species and should probably be regarded as a subspecies of it; R. u. kendengindicus occurs in the Djetis and Trinil beds alongside R. sondaicus, but has not been found in the Upper Pleistocene Ngandong deposits where the latter is the only rhinoceros. The unexpectedly wide Pleistocene range of the species has been confirmed by the discovery of R. kagusena in the Ratnapura fauna of Sri Lanka, which is undated but probably Middle Pleistocene (Dermayangala, 1958). This range shows few characters to differentiate it from R. unicornis, and like the Javanese fossul occurs alongside a race of R. sondaicus. Holocene remains of R. unicornis from Rajasthan, Gujarat, and Pakistan (dating 2500 to 1200 B.C.) are mostly larger than their modern, more easterly counterparts (Banerjee and Chakraborty, 1973).

The various fossils of this genus from China can be referred to two species: the Pleistocene R. sinsenis Owen, which though in many respects is intermediate between the two living species, shows progressive characters linking it to R. unicornis (Colbert and Hooper, 1952); and the Upper Pliocene species R. oweni Ringstrom, which was placed in a separate genus Sinorhinus by Kretzoi (1942). Colbert (1942) traced the lineages of the living species.

FORM AND FUNCTION. The integument is insufficiently studied, and its histological structure is unknown; Cave (1969) denied the presence of body hair, and found no follicles on the metatarsal region, but see Groves (1967). Skin is covered with ridgelike knobs. The horn is developed from an area of hyperkeratinization on the snout; other such areas, which are presumably potential horns, may occur on the face (Neuville, 1927), and even a rudimentary frontal horn has been recorded and figured (Hill, 1958). Forefeet and hindfeet have scented glands. Each gland has a distensible orifice 3.5 to 7.5 mm above the sole pad, hidden in a transverse fold opposite the metapodial-autopodial articulation; 38 to 48 by 23 to 26 mm broad with a wall 8 mm thick, which is highly vascularized (Cave, 1962; Owen, 1862). There are two inguinal mammas (as in all rhinocerotes).

Premeaxilla are short and stout and tend to fuse early across midline and with maxillae (Pocock, 1944b). Nasal septum never shows tendency to ossification (Pocock, 1945a). Skull (Fig. 3) is larger and heavier than that of R. sondaicus; nasal bone is more expanded, rounded, and rugose especially in male; occiput high, narrow, making dorsal outline of skull very concave; seen from behind, sides of occiput suddenly steepen, so crest is flat-topped; posterior margin of palate is concave or with a small median projection; basilar bones are narrow, pterygoids compressed; vomer is thick and united to pterygoids; mesopterygoid fossa is relatively narrow and deep (Colbert, 1942; Pocock, 1945b). Lacrimal bridge
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is ligamentous in 93% of skulls (Cave, 1945). Ascending ramus is high. Teeth are hypsodont; height of un worn F3 exceeds breadth; cingulum is flat, with little or no buttress; when present, but may be small on M2, unites early with crochets to enclose a mediasse tract; postseptesse tract forms to form early in wear; postseptesse as deep as median sinus; a protocone fold is present; paracoon and protocone are separated by a fossa in unworn teeh; postseptesse is inclined backward; there is no tubercle, or cingulum remnants, at entrance to valleys. Lower canines huge, tubelike; lower incisors small, peglike. The following values are based on four specimens: length: 1.77 to 85%, width 66% to 75% of femur, humerus 87.3(4) to 92% of femur, tibia 104.0(10) to 107% of radius, total forelimb 93.9% 94% of total hindlimb, humerus 75.8(71) to 81% of basal skull length, metacarpal III 51.85% to 55% of radius. Numbers of vertebrae are: T 19 to 20, L 5 to 4, S 6, C 17 to 22. Spines of T 1 to 4 raised evenly, suddenly decreasing anteriorly to C 7, gradually decreasing posteriorly to T 10; there is a very slight rise in lumbar spinous; there is no keel. Some 3 somewhat approaches this condition. Branchial tuberousities are expanded and angular.
The heart weighed 12.7 kg in an old male (Owen, 1862). W.A.L. weighed the heart of an adult female in Chitawan at 10 kg. Lymph nodes are of hemolymph type; submaxillary node is highly vascularized, completely lacking cortico-medullary differentiation (Cave and Aumonier, 1964).

The brain is described by Owen (1862), and briefly compared to that of Dicerorhinus sumatraensis by Garrod (1878). Convolutions of cerebral hemispheres are less complicated than in the latter species.

The alimentary canal is seven to eight times head and body length. Stomach of an old male was 122 cm long, straight, 56 cm in diameter; the lesser curvature was 53.5 cm long. Bile duct enters duodenum 15 cm from pylorus; villi begin to appear thereafter; villi are long, narrow, cylindrical; Peyster's glands are present. Caeacum was 91.5 cm long, broader than long. Colon was arranged in two folds, 5.8 to 7.6 m long. Liver weighed 9.5 kg in a young female, 20 kg in an old male (Owen, 1862).

Owen's (1862) description of the seminal vesicles was disputed by Bovard and Goss (1887), who reported that they are as in R. sondaicus — tubular and slightly bulbous. Penis in an old male was 114.3 cm long; it had a lobular process glandis and a long medial attachment to the glans penis and free lateral border; uterine horns in a young female were 43.2 cm long. corpus 4 to 5 cm (Cave, 1964; Owen, 1862).

Full-term placenta is bicorneate, one horn being longer and wider than the other. Villi are distributed over entire chorion except for certain strips along the larger vessels of the allantochorion. Two types of villi occur: foliate, similar to those of the Equidae, and plicate, which resemble the aleole of Bovidae (Dolinar et al., 1965). Foliate villi possess diploaryons on the epithelium, with many microvilli and well-developed ergastoplasm. In epithelial plate area there are many pinocyotic vesicles (Ludwig and Villiger, 1965). The placenta weighs 5 kg (E.M.L., pers. observ.).

Only the parapharynx have been described by Cave and Aumonier, 1964. The endocrine system is essentially normal. The parathyroids are present. The glands are in rounded cell-clusters. An 18-year-old male had four glands, one dextral (embedded superficially in corresponding thyroid lobe) and three sinistral in crano-caudal sequence. The placenta weighs 5 kg. All figures compare well with those for African rhinoceroses, but the red cell count is above that for Dicerorhinus and the mean cell volume and chloride concentration are lower, both being comparable to the values for Ceratotherium simum. Hemoglobin concentration, blood urea, and protein level are lower than those of Ceratotherium simum, but are comparable to those of Dicerorhinus; vitamin A and platelet levels are lower than those for African species.

ONTGENY AND REPRODUCTION. A female in Mysore Zoo came into estrus every 21 to 33 days (X = 24; Gowda, 1969). Estrus occurs every 27 to 42 days (Lauret, 1978). Permanent anestrus in a captive female appeared to be connected with presence of leiomyomas in the uterine and vaginal walls (Jones, 1979). Gestation varied from 462 to 491 days; mean of 31 records, 479 days (E.M.L. collected records). Twin cows "about three years old" have been reported (Go, 1950); this must be regarded as suspect, because subadults often join up with calf-cows pairs. Sex ratio at birth is 1.19 males to 1 female (Lang et al., 1977).

Birth is rapid, usually occurring about 30 minutes after the first signs of labor. Females may either lie or stand during parturition. Calves arrive either head or hindfeet first. After the birth, the mother turns round very swiftly to make nasal contact with the calf, tearing the umbilical cord. The neonate is not licked. The placenta is usually eaten, with the calf lying head down.

The calf rises to its feet within about 30 min, and at once tries to suckle. Calves are suckled frequently up to the age of one year and only rarely after the age of 16 months. They are separated from their mothers at about the age of 15 months or when the birth of the next calf is imminent. The calfs are weaned between 8 and 10 kg. (mean of 20, 71.3 kg, E.M.L., pers. observ.). At birth head and body length range from 95.6 to 122 cm, shoulder height is 56 to 67 cm (Chowdhury, 1966; Gee 1953; Gowda, 1969; Hagenbeck, 1966, 1969). Birth weight is 4.4% of maternal; height at birth is 37% of female's weight. Initial rate of growth in captivity is 2 to 3 kg/day. The calf doubles its birth weight in one month; at one year of age it reaches ten times birth weight. (All these data refer to captive specimens.)

Young cubs, with their full complement of milk teeth, are 50 to 65% of the basal length of adult skulls, and when first molars begin to emerge, 78 to 82%. Relative between occipito-nasal and basal lengths remains approximately constant at 90 and 92% throughout the period, but relative zygomatic breadth decreases from 63 to 54% (at time of eruption of first molars), increasing again to 58 to 60% in adult. Nasal breadth in females reaches 99% of adult value by the time the first molars emerge, but in males increases only 77% of adult value. The different horn sizes of the two sexes. Anterior premolars are shed early in adult life (dp1, lower) or during early juvenile stage (dp1, upper).

Growth in the wild is noticeably slower than under the captive conditions. A 4-month-old calf found dead in Chitawan weighed 58 kg, only half the weight of a Basel Zoo calf at a similar age. In the wild, calves under 1 year old are less than 1 m high; under 2 years, up to 1.2 m; under 3 years, up to 1.35 m; up to 5 years, up to 1.45 m, but in the Basel Zoo a 21-month-old female was already 1.36 m high, and a 33-month-old male was 1.57 m.

Females are fully grown at 4 years in captivity, but not for about 6.5 years in the wild, and males at 8 years in captivity, but about 10 years in the wild. It is probable they grow considerably earlier in Africa than in Indian rhinoceroses, Dicerorhinus and Ceratotherium.

Sexual maturity is not, or not much, accelerated, by captive conditions (Dittrich, 1976). Females begin estrous cycles at about 4 years (Jones, 1979) but do not usually conceive until at least a year later; in Chitawan, females have their first calves at 6 to 8 years (X = 7.1). Physical maturity therefore coincides with the initiation of estrous cycles in captivity, but with the onset of fertility in the wild.

Record longevity in captivity is 47 years; three others have lived over 40 years in captivity (Reynolds, 1960).

ECOLOGY. Indian rhinos are found throughout their present range in alluvial plain habitats: riverine grasslands with grass up to 8 m tall and swampy areas with Arundo, Phragmites, Themeda, Saccharum and Narenga, bordered by riverine fringe (Bombus, Syzygium, Anacca and Dalbergia communities) or, in parts of Nepal and Assam, by drier sal (Shorea robusta) or Terminalia forest. The great reduction in the range of the Indian rhino over the last 300 years was caused primarily by the disappearance of most of the alluvial plain grasslands of the northern Indian sub-continent. By the middle of this century rhinos were largely restricted to reserves and their survival depended upon efficient legal protection. The small sizes of the present reserves mean that rhinos are within easy reach of and regularly fed in cultivated land and in woodland areas transformed by human activity and by domestic stock into short grassland with scattered trees and shrub undergrowth. The alluvial plain habitats are characterized by rapid and very marked seasonal changes in weather and vegetation. Fires, the annual monsoon floods, and frequent changes in river courses maintain a high diversity of early successional vegetation stages on the valley floors, and human activity and stock-grazing increase the habitat diversity where the protected areas border on arable or grazing land.

Diet and ranges.—In Chitawan (Nepal) rhinos fed from 183 species of plants belonging to 57 families, but grasses (mainly Saccharum, Narenga and Cyperus) still made up 50% or more in all months, between 70 and 80% of the diet according to season (Lauret, 1978). Other foods included fruits, leaves and branches of shrubs and trees (e.g., Trewia, Callicarpa, Litsea), sedge and ferns (e.g., Cyperus, Scleria, Pteris), submerged and floating aquatic plants (e.g., Hydrola, Vallisneria, Commelina), and agricultural crops (e.g., Oryza, Zea). Considerable seasonal variations in food avail-
ability result in movements of rhinos between vegetation types. Ranges were smaller in the region of greatest vegetational diversity, with home ranges varying from 2 to over 10 km² (Laurie, 1982).

**Interspecific relationships.**—Tigers (Panthera tigris) prey on young calves up to the age of 6 months or possibly more (Laurie, 1982), W.A.L. also has one record of an unsuccessful attack on an adult female Indian rhino. The closest distance reported is by the Chinese Forest rhino have been hunted both for sport (Gooch Behar, 1908; Pollak and Thom, 1900) and for the horn and certain other parts of the body, which are reputed to have powerful magical or medicinal properties in many countries of south, southeast, and eastern Asia. In 1979 the retail price of Indian rhino horn in Taiwan and Hong Kong rose to US$18,000/kg (Martin, 1980).

**Mynahs (Acridotheres tristis) and egrets (Bubulcus ibis)** feed on invertebrates on the rhino's skin or around its feet. Rhinos are bitten by bloodsucking Tabanina flies.

**Population structure.**—Apart from cow-calf pairs, Indian rhinos rarely form groups; there were only 15% of sightings in Chitawan (Laurie, 1982) in other types of group. Only seven groups consisted of more than three individuals and the most common type of group was two or three subadults, especially subadult males, which had recently left their mothers. The largest group recorded in Chitawan was 30 rhinos in one or two herds (Laurie, 1982), though they sometimes occur in temporary associations of up to nine rhinos of various sex and age classes. These groups form at wallows and grazing grounds where animals often feed or rest together but move on separately at the end of each other. The Chitawan population was reported as 32% adult females, 20% adult males, 21% subadults, and 27% calves, so the overall adult sex ratio was 61 males to 100 females (Laurie, 1982). The adult sex ratio varied locally in Chitawan and Assam from 50 females per 100 males (Laurie, 1978) to sex ratio at birth, however, was 119 males to 100 females (see above, under Ontogeny and Reproduction). Both the Kaziranga and Chitawan populations are increasing, possibly as much as 5% per year. Crude population densities vary from 0.4 to 1.8 rhinos/km² in Nepal, but reach more than 2-4 rhinos/km² in Kaziranga, Assam.

**Disease.**—Parasites include lice, ticks (Dermacentor auratus), and gut nematodes (Decrassus, W.A.L. observed). Hemorrhagic septicaemia occurs seasonally in the Chitawan population; the latter was responsible for the deaths of 15 rhinos in Kaziranga in 1974. As the populations of both Kaziranga and Chitawan are increasing and there are no alternative refuges for the rhinos, there are dangers in the future of facilitated epidemics. In captivity, rectal prolapse and intestinal torsion have been recorded; excessive feeding on kale causes hemoglobinuria (Jones, 1979).

**Conservation.**—The already depleted populations of rhinos were reduced even more drastically in India during the nineteenth and early twentieth centuries. Butler (1847) reported that every military officer in Assam became "a keen and skilful sportsman," and some men shot more than 200 rhinos during their careers. Just after the turn of the twentieth century, the British government began to keep a careful count of rhino population, which, according to the British government, had declined in numbers of rhino and prohibited all rhino hunting in India in 1910. A number of reserves were created but illegal poaching still continued as the price of rhino horns increased. The rhino population has been protected by the efforts of the Royal Chitawan National Park and Assam of the Indian government; the population in Kaziranga has increased from an estimated 12 individuals in 1908 to 600 in 1975 and more than 750 in 1980. The Nepalese populations were well protected prior to 1950 in hunting reserves where the ruling family organized lavish hunts and dealt severe penalties for poaching. In the 1950s, however, a resettlement program destroyed large areas of rhino habitat, and poaching was rife for a while. The rhino was almost wiped out in Nepal, and by 1962 only six individuals were left in the wild, and the animals was enforced during the 1960s and led to the establishment of the Royal Chitawan National Park in 1973.

**Rhinos.**—Rhinos are threatened by poaching and human encroachment on their habitat, but there are now additional threats which stem from the concentration of the few remaining rhinos into a small number of tiny reserves and national parks. More than 1,200 of the estimated 1,500 surviving rhinos live in two parks with a total of 500 km² of suitable habitat. Any catastrophe, such as an epidemic disease, severe flooding, or a breakdown in law and order could drastically deplete the total rhino population. Furthermore, in these small patches of alluvial plains there is a danger that changes in the river system could result in rhino populations proceeding to a climatic condition unsuitable for early successional species such as the rhino. There are plans, therefore, to reintroduce rhinos to protected areas within the former range of the species in India and Pakistan.

**Capitivity.**—There are several reports of Indian rhinos being captured, and even trained for work. Schenkkel and Lang (1969) quoted early accounts of rhinos being used to pull ploughs in Assam and there are also reports that rhinos were used in war by the ancient kings of India (Gogginburg, 1946). Butler rhinos were often grazed with domestic cattle in Assam during the early nineteenth century. Pollak and Thom (1900) reported that a washerman in Gauhati had a tame rhino that carried the laundry to and from the river, and served as a pack animal (Reynolds, 1960) confirm that Indian rhinos can be tamed and trained, but they can also be dangerous and unpredictable.

The first recorded captive birth was in Kathmandu in 1826 (Hodgson, 1834) and the next was in Calcutta in 1925 (Ge, 1925). Successful breeding was not achieved in Europe until 1956 (Lang, 1961), but there have been nearly 40 births in zoos since then (Lang, 1961). Beheavior of the Indian rhino in captivity (Buechner and Mackler, 1973; Buechner et al., 1975; Lang, 1961, 1967, 1973). Indian rhinos have been captured in the wild with pit-traps, lassos, and immobilizing darts with the drug etorphine hydrochloride (M99).

**Behavior.**—Indian rhinos are active mainly at night, in early morning, and in the late afternoon. The middle of the day is spent resting, either in the shade or in water (Laurie, 1982). During the monsoon this pattern changes slightly; there are cool, wet days when rhinos feed at mid-day. Crop-raiding takes place exclusively at night—much later during moonless nights than moonlit nights when crop-raiding is more active. Rhinos are also more active in spring (36%) than during the spring (65%) and winter (57%) (Laurie, 1978). There is often a rest period during the night, between midnight and 0300 h.

**Territoriality.**—There is some degree of range exclusivity among breeding bulls but no true territoriality. Only certain "strong" males mate with females, but their ranges overlap with those of both "weak" males, which do not display (see below), and with known, neighboring "strong" males. The rapidly changing distribution of food sources and hence of females possibly precludes year-round defense of a small territory as in Ceratotherium simum (Owen-Smith, 1975). Ranges of breeding males in Chitawan varied from at least 2 to more than 8 km².

**Communication and vocalization.**—Indian rhinos use 10 distinct vocalizations. The main ones are the Snort, used as an initial contact call; the Honk, Bleat, and Roar, used during prolonged agonistic interactions; the Squawk-pant, uttered most frequently by males during prolonged chases after females or other males; and the Moo-grunt, used by calves as a contact call with their mothers (Laurie, 1978). Olfactory communication is important. Scents are carried in the urine, the dung, and the pedal scent glands (Cave, 1962). All age and sex classes of rhinos can detect these scents, and commonly sniff them before defecation. Adult males display by squirting urine in jets behind them and dragging their hind toes at the same time, creating long parallel furrows in the earth (Laurie, 1982). The display is visual and displayed downwind to be seen on the head-on view of the neck folds and bib and the large tufts in the lower jaw.

**Ingestion.**—When feeding on tall grasses, Indian rhinos use the prehensile upper lip to curl around the grass stems, then bend the stems over, bite the tops off and chew them, drawing the tips into the mouth from the side. In very tall grass rhinos often walk forward with the stems, or canes, between their legs, pushing the stems and canes against the ground. The most effective method is used when browsing on saplings, and often brings foliage within the reach of an accompanying calf. Short grasses and herbs are grazed close to the ground using the lips; the tip of the prehensile upper lip is curled back into the mouth and opposed against the lower lip. Plants are often uprooted, the foliage bitten off and the roots dropped again. Aquatic plants are taken by digging the head beneath the water, sometimes to the level of the feet and a meter or more below the water surface (Laurie, 1978).

**Rhinos drink daily from streams, rivers, lakes, puddles, or wallows. Drinking normally lasts a minute or two; the lips are immersed but the animals pause at intervals with head lifted. Rhinos drink very dirty water and heavily contaminated with mud. They lick or eat soil or rock material at various sites at Chitawan (Laurie, 1982); the most frequently visited site, a cliff of micaceous sandstone, contained sodium, potassium, calcium and magnesium in particularly high concentrations.**

**Wallowing.**—Rhinos wallow in lakes, rivers, and temporary pools. In Chitawan they wallowed most frequently between June and
October (51% of observations) and least frequently between December and March (4% of observations; Laurie, 1978). Heat regulation is probably a major function of wallowing, but escape from tsetse flies, especially in tall grasslands during the monsoon, may also be important.

Defensive behavior.—When alarmed rhinos normally take to submerging themselves in wallowing, but escape from tsetse flies, especially in tall grasslands during the monsoon, may also be important.

Interactions between individuals.—Two rhinos, normally members of the same group, often lie together with their flanks touching, or rest their heads on each other's flanks. Prolonged licks are occasionally given to a companion, mostly by subadults in wallows, and by cattle, which are known to occur in wallows. Intermittent periods of sniffing, frequently in combination with wallowing, are also characteristic of this species. Displacements, which include curling back the lips to show the lower tusks, advancing slowly towards the antagonist, or charging with head down. In Chitwan (Laurie, 1982), 37% of agonistic interactions escalated to some kind of horn-to-horn confrontation, resulting, in extreme cases, in head clashes and lunges with the lower tusks to the neck, flanks, and rump of the opponent. If the opponent turns to flee a prolonged chase can develop. Adult males sometimes chase other adult males or adult females for several kilometers. These chases, which are accompanied by loud vocalizations, can result in severe injuries being inflicted.

Reproductive behavior.—Mating takes place throughout the year. As adult male locates an estrous female by following her tracks, sniffing the ground intently from time to time and performing flehmen. He accompanies her intermittently for several days, she usually repelling his advances by simply turning and snorting. Horn-to-horn confrontations eventually develop and often result in severe fights or prolonged chases (Laurie, 1982) with loud vocalizations from the female. Severe tusk wounds are often inflicted on the female.

The mating ceremony itself begins with a chase lasting about 1 h (aggressive phase), followed by the two quietly standing together, or sometimes even by symbolic succiling (cow at bull) of from 1 to 3 h (peaceful phase). Both constantly squat-urinate, accompanied by rhythmic squeak-panting. Mounting is usually achieved only after several attempts, the bull initially rests his head on the rump of the cow. Copulation lasts up to 1 h or more. Females grow aggressive shortly after parturition and choose secluded areas to give birth.

Up to the age of 6 months calves are left alone for periods as long as 90 min while their mothers feed up to 800 m away.

GENETICS. The diploid chromosome number is 82; there are 30 major autosomal arms. The karyotype differs from that of Ceraterotherium simum, which has the same diploid number, in having a subtelocentric and fewer telocentric chromosomes (Wurster and Benschirke, 1966).

There is a clear-cut polymorphism in the occurrence, in a very few individuals, of a posterior cervical skin-fold resembling that of R. sondaicus, that is, running over the withers from side to side. One individual with this morph was a calf whose mother had the normal condition.

The descent of the present healthy, 750-strong Kaziranga population from a dozen or so (in 1908) appears to have had no adverse genetic effects.

REMARKS. This species of rhinoceros was the first to be exhibited alive in Europe during post-Roman times; in 1515, the specimen from which Albrecht Durer made his well-known woodcut (Rookmaker, 1973).


Dubois, E. 1908. De l’anatomie des A hot et des Tindi


LITERATURE CITED


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