

## GENUS *Diceros*

### Black Rhinoceros

*Diceros* J. E. Gray, 1821. London Med. Repos. 15: 306.

*Diceros* is a polytypic genus, represented by a single extant species, the Black Rhinoceros *Diceros bicornis*. This species once was widespread in sub-Saharan Africa, from the Niger R. in the west to Somalia in the north-east, and southwards to South Africa. It was never found in the Congolese rainforests. The animal exists in a large variety of habitats, including savanna, bushveld and dry thornbush, from sea-level to high mountain forests.

The members of *Diceros*, like the other extant African rhinoceros genus *Ceratotherium*, bear two nasal horns. *Diceros* is distinguished from *Ceratotherium* by the shorter skull, pointed upper lip, swayed back, and generally smaller size (Guggisberg 1966, Hillman Smith & Groves 1994, Joubert 1996). The extinct rhino from the regions around the Cape of Good Hope was larger than other populations (Rookmaaker & Groves 1978). Inter-specific hybridization has occurred between a female *Ceratotherium simum simum* and a male *Diceros bicornis* kept in an 800 ha enclosure of South Africa's National Zoological Gardens Game Breeding Centre (Robinson *et al.* 2005).

Fossil remains of species referable to *Diceros* have been found in many parts of Africa. *Diceros douariensis* was found in the Mio-Pliocene of Tunisia (Guérin 1966) and *Diceros australis* in deposits of the middle Miocene of Namibia (Guérin 2000). In East Africa, the genus was represented by *Diceros praecox* in the early to late Pliocene



Black Rhinoceros *Diceros bicornis*.

(Geraads 2005), although previously some of the remains had been classified under *Ceratotherium* (Hooijer & Patterson 1972). *Diceros bicornis* first appears at the 4 mya level in Pliocene deposits in Kenya and Ethiopia, and at 2.5 mya the molar crowns became as high as in the recent specimens (Hooijer 1978, Prothero *et al.* 1986).

Kees Rookmaaker

### *Diceros bicornis* BLACK RHINOCEROS (BROWSE RHINOCEROS, HOOK-LIPPED RHINOCEROS)

Fr. Rhinoceros noir; Ger. Spitzmaul-Nashorn

*Diceros bicornis* (Linnaeus, 1758). Syst. Nat., 10th edn, 1: 56. 'Habitat in India', but Cape of Good Hope, fide Thomas (1911).

**Taxonomy** Groves (1967) reviewed earlier classifications and reduced the number of subspecies recognized based on cranial dimensions and other characters to seven in different regions of Africa. This classification has since been questioned, as it was based on small sample sizes (du Toit 1986), and was not supported by a preliminary analysis of data from more skulls (du Toit 1987). A proposal from a 1986 African Rhino Workshop in Cincinnati was adopted by the first IUCN African Elephant and Rhino Action Plan (Cumming *et al.* 1990) resulting in the recognition of four Black Rhino ecotypes or 'subspecies' conservation units (Cumming *et al.* 1990). The IUCN Species Survival Commission's African Rhino Specialist Group recognized these four subspecies conservation units in different areas (Emslie & Brooks 1999) although only three survive: Southern-central (*Diceros bicornis minor*); South-western (*D. b. bicornis*); and Eastern (*D. b. michaeli*); the Western (*D. b. longipes*) was recently declared extinct.

Historically, the boundaries between these subspecies were not 'hard-edged', in contrast to the markedly discontinuous range of the two White Rhinoceros *Ceratotherium simum* subspecies. However, there are major differences in the habitat and climates in the core areas of the three remaining subspecies, and it is likely that each has specific genetic or behavioural adaptations to the environment. While some conservationists have preferred to refer to the Black Rhino subspecies as ecotypes due to their contiguous distribution and perceived

limited genetic differences between them, genetic analyses indicate that the Southern-central, South-western and Eastern Black Rhino are sufficiently distinct to support the current subspecies distinction (Harley *et al.* 2005). The more discontinuous distribution of the recently extinct Western Black Rhino, and the single genetic sample analysed to date, support its classification as a separate subspecies (Harley *et al.* 2005). Genetic variation in mitochondrial DNA of *D. b. minor* (from Zimbabwe animals) and *D. b. michaeli* (from East Africa) revealed that these two subspecies represent separate ancestral lineages, which diverged between 0.93 and 1.3 million years (Brown & Houlden 2000). These genetic studies support recognition of four subspecies, although K. Rookmaaker (pers. comm.) notes they too were also based on small sample sizes and ignored many populations.

Controversy surrounds the formal subspecies nomenclature. *Diceros b. bicornis* has been described as being restricted to the Western Cape and further north, at least to middle Namibia, and is believed to have gone extinct (Ansell 1974, Rookmaaker & Groves 1978) leading to a questioning of the use of the subspecies name *D. b. bicornis* to refer to the animals derived from the surviving arid-adapted animals from N Namibia (Hopwood 1939, Groves 1967, Rookmaaker 2005b, P. Lloyd pers. comm.). However, this view has been challenged. It has been argued that the animals from N Namibia can be amalgamated with those in the Western Cape and

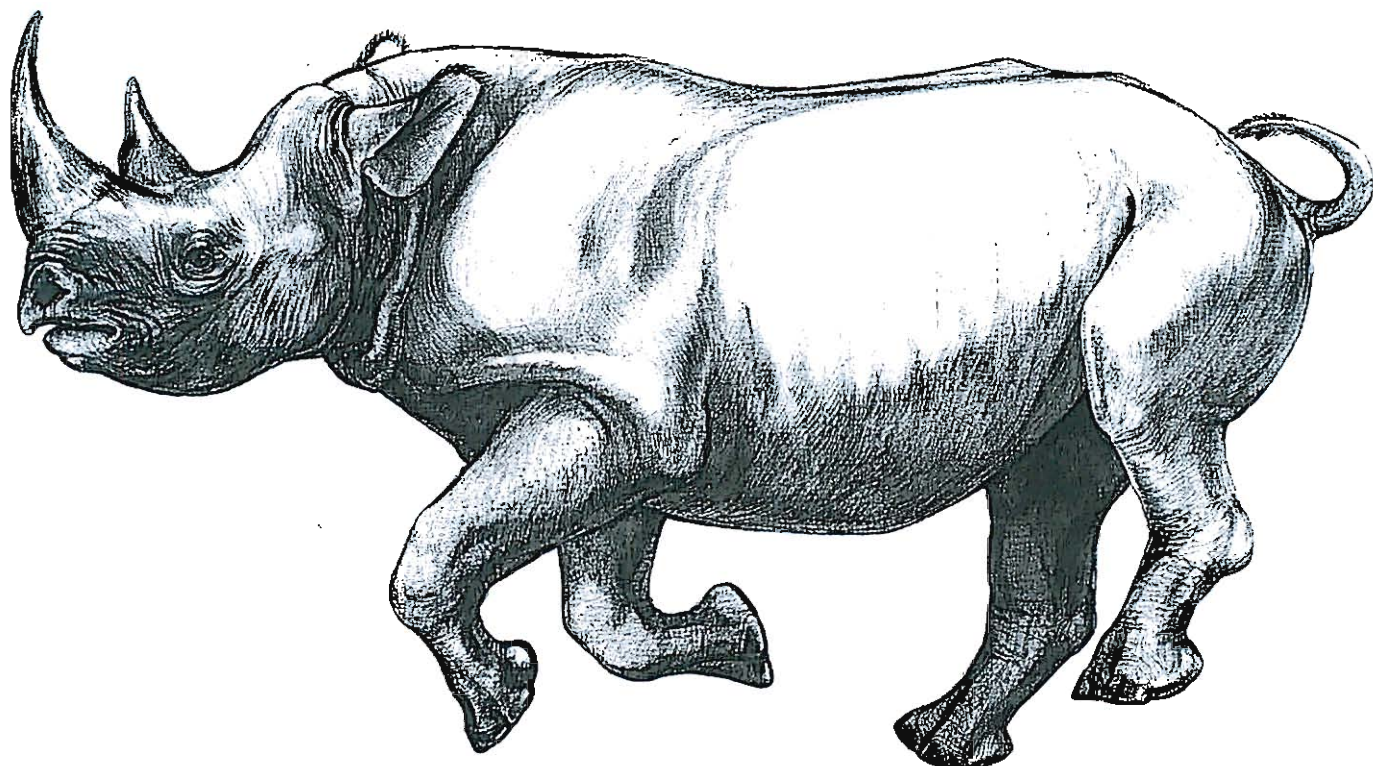
S Namibia that died out (Hall-Martin 1985, Du Toit 1987), on the basis that (1) the largest skulls Du Toit (1987) measured were from N Namibian animals, which was in keeping with Rookmaaker & Groves' (1978) description of *D. b. bicornis* in the Western Cape and S Namibia as a very large rhino; and (2) on the ecological similarities between the earlier postulated range of *D. b. bicornis* and that of extant Namibian rhino (Hall-Martin 1985). Further evidence supporting this amalgamation (which may be correct; Rookmaaker 1996) comes from an old map of Greater Kudu *Tragelaphus strepsiceros* distribution in Namibia (Shortridge 1934), which shows this species had a contiguous distribution along the Molopo, Nossob, Oliphant, Auob, Great Fish and Orange Rivers (i.e. all the way to the south of the country and well into the supposed range of *D. b. bicornis*). Dietary overlap (for both species and size classes) between Greater Kudu and Black Rhino can be quite considerable (Macfarlane 1997), and it has been noted that where Greater Kudu generally do well, the Black Rhino normally also thrives. For these reasons, it is quite possible that at one time there may have been a continuous distribution of Black Rhinos from N Namibia all the way to the Western Cape supporting the current use of the *D. b. bicornis* subspecies name (although much of the clinal genetic variation in the southern part of the range will have been lost). This is the view currently adopted by the SADC Rhino Management Group (SADC RMG).

The current boundary between the South-western and Southern-central subspecies in southern Africa is somewhat arbitrary, imperfectly known and is primarily a practical construct given that all populations of these two subspecies in South Africa outside of Hluhluwe–iMfolozi and uMkhuze in KwaZulu–Natal have been reintroduced. Following from earlier Conservation Plans, the South-western Black Rhino is today considered as the most arid-adapted subspecies. In earlier versions of the South African Black Rhino management plan, the SADC RMG, which manages the plan, used the 400 mm isohyet from Dent *et al.*'s (1989) mean annual precipitation map in Schulze (1997) as the primary basis for setting a putative east/west subspecies boundary in the Eastern Cape. However, since 2007, the subspecies boundary in the Eastern Cape has been revised to take into account the probable impact of a 'Transkei Gap' on rhino movement. This area, in the north-east of the province north of the Kei R., has now been classified as extralimital, and no new populations of Black Rhino will be allowed to be established in this area. The remainder of the province is now designated as *D. b. bicornis* range together with the Western Cape and Northern Cape provinces. Although no new populations will be countenanced, any existing Eastern Cape *D. b. minor* populations are being allowed to remain. Other provinces are demarcated as *D. b. minor* range. Rhinos in the miombo woodlands of the Selous G. R. in S Tanzania are classified as being Southern-central Black Rhinos, while the populations in N Tanzanian areas with more nutrient-rich soils and a dual wet season are classified as being Eastern Black Rhinos. While these classifications of Tanzanian Black Rhinos on habitat and climatic grounds, as well as surviving populations' proximity to rhino populations in neighbouring countries seems reasonable, there have been no genetic analyses to test their validity. Rookmaaker (2005b, pers comm.) argues that due to changes in the perceived geographical ranges for the four groups, and the Principle of Priority, Code of Zoological Nomenclature (4th edition para 23), *D. b. minor* and *D. b. michaeli*

should automatically be renamed *D. b. keitloa* and *D. b. brucei*, respectively (given the current AfrSNG subspecies classification and distribution). On account of such concerns about the current classification and subspecies distributions, a continent-wide revision of Black Rhino taxonomy is needed.

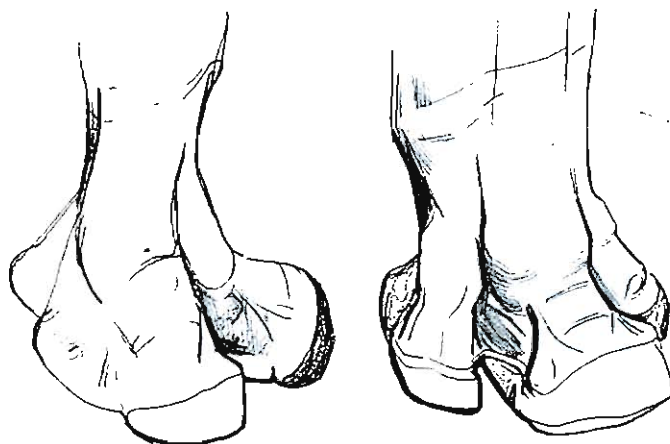
Synonyms: *africanus*, *angolensis*, *atbarensis*, *brucei*, *camperi*, *capensis*, *chobiensis*, *gordoni*, *holmwoodi*, *keitloa*, *ketloa*, *ladoensis*, *longipes*, *major*, *michaeli*, *minor*, *niger*, *nyasae*, *occidentalis*, *palustris*, *platyceros*, *pleioceros*, *porrhoceros*, *punyana*, *rendilis*, *somaliensis*. Chromosome number:  $2n = 84$ ; the X chromosome is a large submetacentric (Hungerford *et al.* 1967, Heinichen 1969b, Houck *et al.* 1995). Robinson *et al.* (2005) have recently confirmed a case of inter-specific hybridization in rhinoceroses, wherein a calf was born to a young White Rhino cow and a Black Rhino bull held together in a small enclosure (without an adult White Rhino bull being present); the hybrid showed a mixture of phenotypic traits characteristic of the two species, including ear shape resembling that of the Black Rhino, an upper-lip more in keeping with the shape of the White Rhino (but also exhibiting a small upper-lip protrusion, not unlike the prehensile lip in the Black Rhino), and head length was intermediate between the two. It is not known if the hybrid was reproductively impaired.

**Description** Second smallest of the rhino species, with the Sumatran Rhino *Dicerorhinus sumatrensis* being smaller. Stands about 1.6 m at the shoulder and has a mass of around 800–1350 kg. Sometimes known as the Hook-lipped Rhino on account of its hooked prehensile upper lip, which it can use like an elephant's trunk to grab hold of branches and pull them into the mouth (unlike the grazing White Rhino, the Black Rhino is a browser eating primarily trees, bushes, herbs and succulents). In silhouette the neck hump is not as pronounced as that of the White Rhino. The much smaller head is generally held higher than the White Rhino, unless feeding at ground level. Back has a much more concave saddle-like appearance in profile compared with the White Rhino whose prominent vertebral crest two-thirds of the way along the back is much more pronounced. Ears rounded and trumpet-shaped, tips pointing upwards from the middle of the ear. Ears fringed with hair (as in the White Rhino), and the amount of hair on the ears varies between individuals. Body hairs otherwise sparse. Body barrel-shaped due to an extended ribcage. Overall body colour a marginally darker battleship grey than that of the White Rhino. However both species of rhino can take on the colour of the soil and mud in which they have been wallowing. Eastern subspecies has marked rib-like skin folds on its flanks. There are also prominent folds of skin near the top of the forelimbs, and where the upper part of each hindlimb joins the body. Limbs thickset with three toes on each foot, each with large nails that mark clearly in the spoor. Toes and feet smaller than those of the White Rhino and so spoor of the Black Rhino is smaller, more rounded and with smaller toe prints compared with the White Rhino, whose spoor is more elongated in appearance with a more pronounced groove in the middle of the back of the print. Cushioned pads on the soles of the feet have a hard surface with a mosaic of irregular cracks; the patterns can be used to identify individual animals for short periods of time, as they can change. Tail is short with a sparse fringe of bristly hairs. Some animals may miss part of their tails, and it is thought this is caused by unsuccessful hunting attempts by Spotted Hyaenas *Crocuta crocuta*.

Black Rhinoceros *Diceros bicornis*.

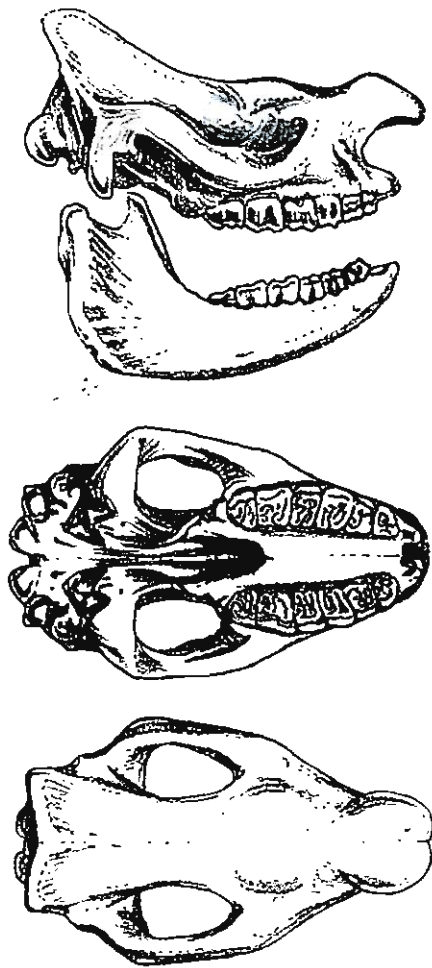
Two horns present on snout; these are made up of compressed keratinous fibres and do not have a bony core. In general, the anterior horn is invariably longer than the posterior horn. For example, in Hluhluwe–iMfolozi in 1973 only 2.5% of ♂♂ had anterior horns equal in length to the posterior, and none shorter ( $n = 120$ ); in 1985, no ♂♂ had anterior horns equal in length or shorter than the posterior. Incidence is slightly higher for ♀♀: 5.7% shorter in 1973 ( $n = 106$ ) and 4.3% in 1985 ( $n = 69$ ) (Hitchins 1989). Horn length and basal circumference greater in adult ♂♂ than in adult ♀♀. In a sample of horns from KwaZulu–Natal and Kruger N. P., the mass of anterior and posterior horns amounted to some 2.65 kg of horn per animal (Pienaar *et al.* 1991, Pienaar 1993; see Horn Measurements). Base of the anterior horn is circular in shape in contrast to the White Rhino, whose anterior horn has a squarish base. In general Black Rhino horns are thinner and less chunky than White Rhino horns. Intrinsic anterior horn growth is similar to the White Rhino (Pienaar *et al.* 1991, Rachlow & Berger 1997). Berger *et al.* (1993) determined regrowth rates for dehorned Black Rhino at 60 mm and 27 mm per year for anterior and posterior horns, respectively; regrowth was more rapid in juveniles, at 89 mm and 44 mm per year, respectively. Horns from both African species are much larger than those of the three Asian species. Chemistry (carbon and nitrogen isotope ratios) of rhino horn differs between the two species reflecting their different diets (Lee-Thorp *et al.* 1992, Emslie *et al.* 2001, Amin *et al.* 2003).

Females bear two inguinal nipples. Males lack a scrotum, and the muscular penis points backwards when enclosed in its sheath. Apart from genitalia, there is little sexual dimorphism, except that ♂♂ attain a bigger body mass than ♀♀, and have noticeably more heavily set chests and necks. In the Southern-central Black Rhino, ♀♀ invariably have thinner longer horns compared with adult ♂♂, which tend to have shorter chunkier horns. However, Eastern Black Rhino horns do not clearly exhibit this trend.



Rhinoceros forelimbs.

Skull is shorter than that of the White Rhino, the supraoccipital crest not extending upwards and backwards to the extent seen in the White Rhino. Occipital crest lacks broad rugose area on top characteristic of the White Rhino, while zygomatic arches are heavily built to give a firm attachment for the masseter muscles that activate the massive lower jaw. The adult dental formula is  $I^{0/0}, C^{0/0}, P^{4/3-4}, M^{3/3} = 26-28$ . One to two lower incisors in the deciduous dentition. In the adult dentition, sometimes only three premolars are present in the upper and lower jaws. Upper and lower second molars are the largest of the cheekteeth (Skinner & Chimimba 2005). Goddard (1970b) and Hitchins (1978) describe patterns of tooth eruption and toothwear patterns. A slightly modified version of Hitchins' (1978) visual scale together with using horn configuration information (Module 6 of Adcock & Emslie 2004) has become the standardized method used for visually ageing animals across the continent using a six category A–F scale.



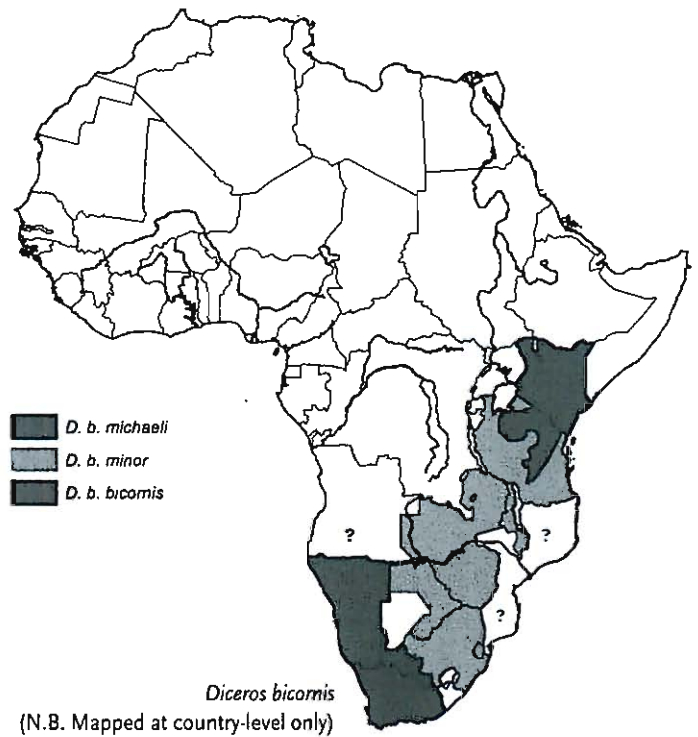
Lateral, palatal and dorsal views of skull of Black Rhinoceros *Diceros bicornis*.

### Geographic Variation

*D. b. longipes* (Western Black Rhino). Formerly occurred in the savanna of central–West Africa, and latterly confined to N Cameroon; recently declared extinct by the IUCN following the failure of surveys to find any surviving individuals. Slightly longer legs relative to body length (hence the subspecies name *D. b. longipes*). The high degree of homozygosity across the nine loci studied in the single Western Black Rhino sample showed the least genetic diversity of all the individuals examined, and was consistent with a major loss of genetic diversity in this population (Harley *et al.* 2005).

*D. b. michaeli* (Eastern Black Rhino): historically, in S Sudan, Ethiopia, Somalia to Kenya, NC Tanzania and Rwanda; currently only confirmed surviving in Kenya, N Tanzania and Rwanda, with an extralimital population established in South Africa in Limpopo Province. Longer, more slender and more curved horns than the two southern subspecies; noticeable skin folds, which resemble ribs on its flanks (these folds are not obvious in the other subspecies).

*D. b. minor* (Southern-central Black Rhino): KwaZulu–Natal in South Africa through Swaziland, Mozambique (where now possibly extinct), Zimbabwe, N Botswana (reintroduced), and Malawi into W and S Tanzania. Formerly in N Angola and S DR Congo. Smallest of the subspecies and in some parts of its range is vulnerable to developing large red sores on its chest (see Predators, Parasites and Diseases).



*Diceros bicornis*  
(N.B. Mapped at country-level only)

*D. b. bicornis* (South-western Black Rhino): formerly in Namibia, S Angola, W Botswana and Western Cape and Eastern Cape, south of Kei R. (South Africa), though now extinct in Botswana with perhaps a few individuals surviving in S Angola. Largest of the subspecies; in some parts of the range, and most noticeably in the very arid west Kunene region in NE Namibia, often possesses very thick straight horns (the anterior horns of other Black Rhino subspecies are invariably slim and curved when the animal is adult).

### Similar Species

*Ceratotherium simum*. Sympatric over various parts of the range of the Southern White Rhino (although historically had a more restricted distribution than the Black Rhino). Considerably larger, with lips broadly squared rather than hooked upper lip (indicative of its preference for graze not browse); pronounced nuchal hump visible when the head is raised; skull longer and narrower, with occipital part produced backwards beyond the condyles; high crowned molars and premolars adapted for grazing; more-pointed ears, with tips pointing sideways from the outside edge of the ear.

### Distribution

**Historical Distribution** The probable distribution of the Black Rhinoceros ca. 1700 encompassed pretty much the whole of southern and eastern Africa, including S Angola, and all but the arid south-west strip of Namibia and the north-western parts of Zambia. The far east of DR Congo served as the probable western edge of the distribution with a northernmost distributional band (500–1000 km wide) stretching westwards from S Somalia through Ethiopia, S Sudan, S Chad, N Central African Republic, N Cameroon and N Nigeria (see Cumming *et al.* 1990, Emslie & Brooks 1999).

The former westerly limit of the species, and its distribution in West Africa as a whole, has been investigated by Rookmaaker (2004), who could find no evidence of the existence of the species in Senegal, Gambia, Mali, Guinea Bissau, Guinea, Sierra Leone, or from Ghana,

Togo and Benin. In addition, evidence from Liberia and Burkina Faso mainly rested upon the existence of indigenous names for the species in these countries. Furthermore, records from N Côte d'Ivoire could not be substantiated, the sighting of tracks in 1853 by Heinrich Barth in Niger on the western bank of the river seemingly the only reliable evidence from that region. Based on this, Rookmaaker (2004) proposed two options for the historical distribution of the Black Rhino in 1700 (perhaps coinciding with that in 1900): first, on the basis of the footprints seen by Barth, the species may have occurred westward up to longitude 1°E near the Niger R.; or, second, the western boundary of the range could be placed some 700 km further eastward in the north-central part of Nigeria.

Early in the nineteenth century, the Black Rhino was still the most numerous of the world's rhino species, with several hundred thousand rhinos roaming the African continent from central–West Africa to the slopes of Table Mountain in the far south (Emslie & Brooks 1999). Early European travellers reported Black Rhino to be both widespread and common throughout much of the continent.

**Current Distribution** Whereas in 1980, Tanzania, Zambia and the Central African Republic were the major range states for the Black Rhino (probably holding around two-thirds of the continent's animals), currently, 98% of the continent's wild Black Rhinos occur in four range states: South Africa, Namibia, Zimbabwe and Kenya (Milliken *et al.* 2009). The same four states also conserve 96% of Africa's wild White Rhinos (Milliken *et al.* 2009). Today, the Black Rhino is extinct in the Central African Republic, and, with the failure of recent surveys to locate any surviving individuals in N Cameroon, has been declared extinct. Smaller numbers of Black Rhinos occur in Tanzania, while small numbers have also been reintroduced into Malawi, N Botswana, Swaziland and Zambia. A very few Black Rhino have been reported to survive in S Angola, while a single animal has been seen in Mozambique (Emslie 2011). A lone individual in Akagera N.P., Rwanda (Milliken *et al.* 2009) has now died; presence in Ethiopia has not been confirmed.

**Habitat** The Black Rhino can occur wherever herb and woody browse occurs in sufficient amounts to support a population. As a result, Black Rhinos can survive in a wide range of habitats, including deserts, semi-deserts, wooded savannas, woodlands, forests and even sub-alpine heathlands (up to 3700 m on Mt Kenya; Young & Evans 1993). They occur in areas with average annual rainfalls from 100 mm to 1300 mm. The density at which they can exist in these habitats varies over 100-fold, from less than 1 rhino per 100 km<sup>2</sup> in the desert plains of Western Kunene (Hearn 1999) to more than 1 rhino per 1 km<sup>2</sup> in the best thicket vegetation. Historically, the highest densities have been found in *Commiphora/Bauhinia* thickets in Tsavo West, Kenya (Goddard 1970a), *Acacia* thickets in Hluhluwe, South Africa in the 1960s (Hitchins 1969), and deciduous thickets in the middle Zambezi Valley in the 1960s (Jarman 1971). These latter areas have annual rainfalls of 600–900 mm. In East Africa, patches of ground-water forest marked by an overstorey of *Acacia xanthophloea* and a dense year-round understorey herb and shrub layer also support very high rhino densities, such as Lake Nakuru N. P., Kenya (Kenyan Rhino Programme data) and Lerai forests of Ngorongoro Crater (Goddard 1967), although currently the forest in the crater is rarely used by rhinos, for which the most plausible explanation is that there is less cover since the 1960s, and greater competition for browse and

disturbance from Savanna Elephants *Loxodonta africana* (Mills *et al.* 2006). Succulent valley bushveld also currently provides high quality habitat. In contrast, rhinos occur at low densities in the open East African savanna grassland habitats within the Serengeti–Mara ecosystem, where browse availability is very sparse (Frame 1980, Walpole *et al.* 2001, Adcock *et al.* 2005).

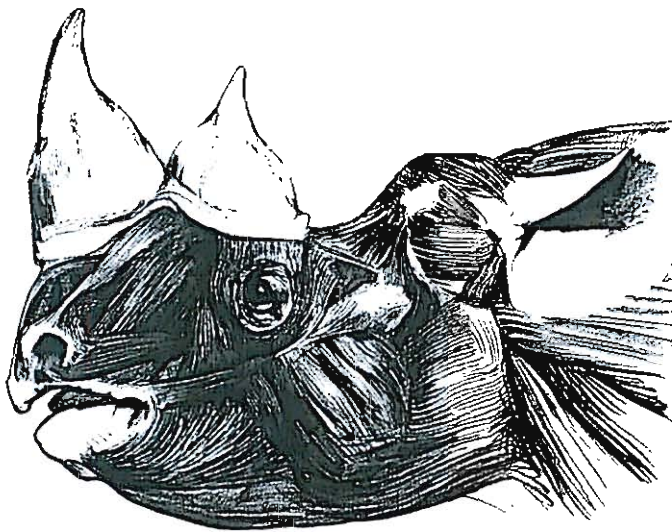
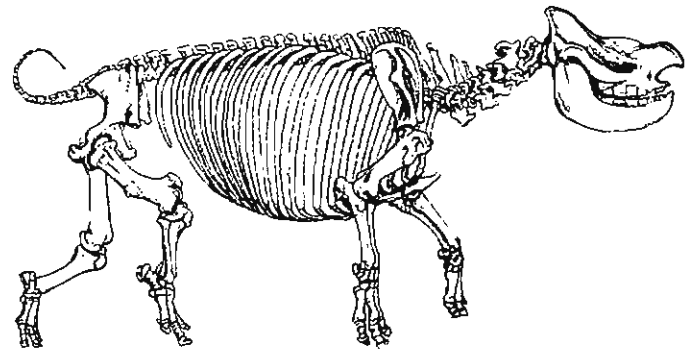
Intermediate rhino carrying capacities of 0.25–0.5 Black Rhino per km<sup>2</sup> occur in some Kenyan areas, woodland areas in the northern and western Serengeti, succulent valley bushveld in the Eastern Cape and Zululand thornveld (Adcock 2001, Adcock *et al.* 2005). Nutrient-poor habitats including broadleaved miombo woodlands have low carrying capacities. In some parts of southern Africa, frost also reduces Black Rhino carrying capacity. Black Rhino carrying capacities over much of southern Africa are only in the region of 0.1 rhino/km<sup>2</sup>.

The availability of good and intermediate quality browse is the main factor determining Black Rhino density in a habitat (Adcock 2001). How fast the browse grows also influences carrying capacity, and this is determined by amounts of annual rainfall, rainfall seasonality, minimum temperatures, the fertility of the soil and the resulting plant species composition (Adcock 2001). The proportional plant species composition of the available browse and its palatability to the Black Rhino are also important (Adcock 2001, Buk 2004).

Black Rhinos are water-dependent in the majority of habitats, and rhino home-ranges are arranged relative to permanent water sources in an area. Rhinos can, however, move a fair distance from water within their range. In Etosha N. P., only 1.1% of aerial Black Rhino sightings were greater than 14 km from water (R. H. Emslie *et al.* pers. obs.). In other areas, rhinos prefer to stay within 4–8 km of water (Buk 2004, K. Adcock pers. obs.). However, where sufficient water-containing succulent vegetation occurs, Black Rhinos can survive for several months in the total absence of surface water (Olduvai Gorge, Tanzania, Goddard 1968; Liwonde N. P., Malawi, R. Bhima pers. comm.).

**Abundance** It has been estimated that there may have been as many as 850,000 Black Rhinos in Africa around 1700 (Adcock & Emslie 2004), and throughout most of the twentieth century the Black Rhino was still the most numerous of the world's rhino species. However, relentless hunting of the species and clearance of land for settlement and agriculture resulted in the population being reduced from a probable several hundred thousand at the start of the century. There may still have been as many as 100,000 animals in Africa in 1960, but by 1970 it was estimated that there were only 65,000 left, at which time Kenya still had some 16,000–20,000 animals (Martin & Martin 1982).

Between 1970 and 1992 large-scale poaching caused a dramatic 96% collapse in numbers. The most important cause of this decline was a dramatic increase in the price of rhino horn (Leader-Williams 1988). From 1992 to 1995 total numbers remained relatively stable with increases in some countries (those with the best protected and managed populations) being negated by declines in others. The minimum population estimate in 1995 was approximately 2410 (Emslie & Brooks 1999). Since 1995, Black Rhino numbers at a continental level have steadily increased, reaching 3610 by the end of 2003 (Emslie 2004a), 3725 by December 2005 (Emslie *et al.* 2007), 4230 by December 2007 (Milliken *et al.* 2009) and 4880 by 2010 (Emslie 2011). Two countries have shown net increases in numbers of Black Rhinos over the period 1980–2010: South Africa and Namibia, from estimated 630+300 in 1980 (Emslie & Brooks 1999) to 1915+1750,

Black Rhinoceros *Diceros bicornis* detail of head myology.Black Rhinoceros *Diceros bicornis* skeleton.

respectively, in 2010 (Emslie 2011). In both countries, investments in conservation programmes, including monitoring and law enforcement, have been high. As of December 2005, an additional 240 Black Rhino (171 *D. b. michaeli* and 69 *D. b. minor*) occurred in captivity worldwide (Emslie *et al.* 2007).

Table 8 gives the December 2010 population estimates (excluding speculative guesstimates) by subspecies by country compiled by IUCN/SSC's African Rhino Specialist Group as of December 31, 2010 (Emslie 2011).

**Adaptations** Black Rhinos have very good hearing and sense of smell, but their eyesight is poor. Animals can react to a person walking past in clear view at ranges of 60 m, yet if the wind direction is favourable they appear unable to identify a motionless human observer (especially if the person's shape does not contrast with the surroundings) at ranges greater than around 30 m (Schenkel & Schenkel-Hullinger 1969). Black Rhinos downwind of man have been known to react at a distance of 800 m, and in most instances sound or smell will alert rhinos to the presence of humans rather than sight (Schenkel & Schenkel-Hullinger 1969). Sometimes, the screeching of oxpeckers

*Buphagus* spp. can alert rhinos to the nearby presence of a human.

The prehensile upper lip is an adaptation that facilitates browsing. The lip is used in much the same way as an elephant uses its trunk to grab and pull browse into the mouth. As in the White Rhino, the big heavy skull, absence of incisor and canine teeth in both jaws, and high-crowned premolars and molars, possessing convoluted enamel layers on their biting surfaces, are adaptations for grinding up coarse food. The Black Rhino is a hindgut fermenter with a capacious large caecum where digestion of plant fibre occurs (and see Clemens & Maloiy 1982).

The skin is thick, and being large animals rhinos have an unfavourable surface area to body-weight ratio making thermoregulation difficult and important. In the heat of the day, they often lie up in wallows, under shady trees, or in areas of closed thicket/woodland. They also like to lie up on ridge tops where they can take advantage of any breezes. A subcutaneous layer of fat and muscle builds up as the condition of the animal improves, providing a buffer against malnutrition during the dry season. Wallowing in mud may condition the skin and give some protection against biting flies whilst also trapping many ticks in mud, which can then get rubbed off against favoured trees/tree stumps or rubbing rocks. Trees and rocks are also used to relieve itches, particularly inside the legs, the chest, around the base of the horns and along the flanks.

In the dry season, when surface water is limited, Black Rhinos may only drink on average every 2–3 days (P. Erb pers. comm).

Table 8. Population estimates by subspecies and by country of Black Rhinoceros (December 2010).

Country	<i>D. b. bicornis</i> (South-western)	<i>D. b. michaeli</i> (Eastern)	<i>D. b. minor</i> (Southern-central)	Total
Angola	1		1	1
Botswana			7	7
Kenya		594		594
Malawi			24	24
Mozambique			1	1
Namibia	1750			1750
South Africa	171	60*	1684	1915
Swaziland			17	17
Tanzania		88	25	113
Zambia			27	27
Zimbabwe			431	431
<b>Total</b>	<b>1920</b>	<b>740</b>	<b>2220</b>	<b>4880</b>

\*The *D. b. michaeli* population in South Africa is out of range.

Drinking generally takes place during the early evening through to early morning, so that travelling to and from water occurs during the cooler hours; in Namibia, 64–100% of drinking occurs between sunset and midnight (P. Erb pers. comm.). Black Rhinos also appear to do much of their feeding when it is dark, and this may aid thermoregulation as well as allow animals to feed more easily in more exposed areas.

Despite their large size, Black Rhinos can gallop at an estimated 55 km/h when charging or fleeing from danger. They are more prone to charge intruders than White Rhinos; however, Black Rhinos will often turn and run away from danger, especially if this is downhill and they can run into cover. When disturbed they are also likely to run further than White Rhinos before stopping. Individual Black Rhinos are idiosyncratic, and while some individuals can be aggressive and may frequently charge people or even vehicles, others are placid and tolerate human activity in their vicinity.

**Foraging and Food** Black Rhinos are browsers, consuming primarily woody plants and herbs. Grass is generally only eaten incidentally while foraging for low-growing herbs, but new soft grass leaf growth is voluntarily taken on occasion, and can form over 10% of the wet-season diet (Goddard 1968). A wide range of browse species eaten in any given habitat, but while over 100 species may be ingested during a year's foraging, 90% of the diet commonly comprises fewer than 20 species (Hall-Martin *et al.* 1982, Loutit *et al.* 1987, Kotze & Zacharias 1993, Oloo *et al.* 1994, Emslie 1999, Breebart 2000, Brown 2004, Buk 2004).

Species from the families Euphorbiaceae and Tiliaceae, and the Mimosoideae and Papilionoideae subfamilies of the legumes, are important in the diet in most ecosystems. Plant species of the genera *Euphorbia*, *Grewia* and *Acacia* are particularly important and preferred, and *Spirostachys* and *Acalypha* feature prominently among the genera of Euphorbiaceae eaten. Among the more herbaceous plant forms favoured by Black Rhinos, species from the Acanthaceae, Amaranthaceae and Malvaceae family feature strongly, including species from *Barlaria*, *Blepharis*, *Acaranthus*, *Amaranthus*, *Cyathula*, *Hibiscus*, *Pavonia*, *Sida* and *Abutilon*.

A wide diversity of secondary plant chemicals occur in Black Rhino browse species, many of which are potentially harmful. The ability to cope with these chemicals is an interesting feature of their feeding ecology that is not well understood. Black Rhinos produce tannin-binding saliva in response to food types rich in tannins (Napier 1998). The large liver also plays an important role in metabolizing a wide range of chemicals, but they still need to balance their exposure to any one chemical, which they seem to do by limiting intake of some plant species types (even if favoured) and diluting such intake with browse containing different chemicals (e.g. *Spirostachys africana*, Emslie 1999). However, coping with high levels of tannin-type secondary plant chemicals carries a cost, increasing mineral usage (e.g. nitrogen; Illius & Jessop 1995), and negatively affecting food digestibility and mineral and energy uptake (Jansman 1993, Shung-MacCoubrey *et al.* 1997). In habitats on nutrient-poor geologies, where the bulk of available browse biomass contains significant levels of secondary chemicals (polyphenols and tannins), Black Rhino densities are lower than expected from their rainfall and apparent browse availability characteristics alone (Adcock 2001). In Nairobi N. P. Black Rhinos were found to select for plants with low phenol and alkaloid contents (Muya & Oguge 2000).

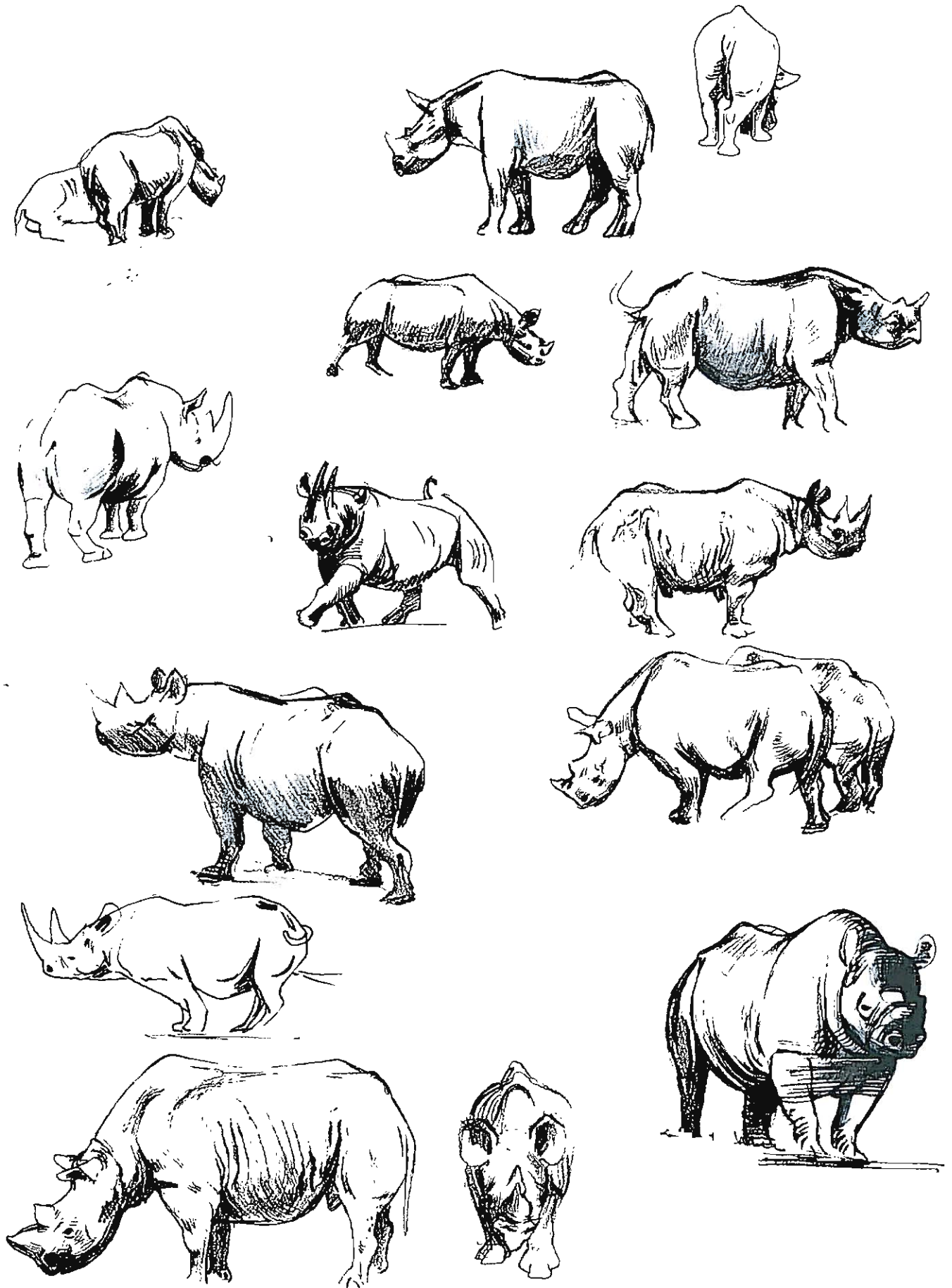
Black Rhinos feed within a specific height range. About 98% of their intake is from browse located within 2 m of the ground, and the 0.5–1.5 m height range is most preferred (Kotze & Zacharias 1993, Macfarlane 1997, Emslie 1999, Breebart 2000, Brown 2004, Buk 2004). They do, however, push over trees, especially those with a spindly growth form, to access browse above 2 m. High branches can also be pulled or broken down to feed on. Because smaller size classes of most woody species are preferred, tall, rank grass growth (common in higher-rainfall ecosystems) can substantially interfere with feeding. This can lead to rhinos avoiding areas of long grass altogether, or to feed on less-preferred, taller plants instead (Emslie 1999). In captivity, they have been recorded feeding on an average of  $37.8 \pm 9.0$  kg (wet mass) of thorny, woody plants per day (Maddock *et al.* 1995). The dung boluses contain much coarse woody material, which exhibits the characteristic neat pruning of twigs at a 30–45° angle. By way of contrast, elephants tend to shred the edges of branches when they browse.

Black Rhinos often feed on burnt plants and recoppicing browse in burnt areas (Mukinya 1977, Emslie 1999, P. du Preez pers. comm.), preferring areas with intermediate intensity burns (Emslie 1999). Increasing attention is being paid to the negative impact that other potentially competing browsers may have or have had on Black Rhino habitats and carrying capacities (Kuria 1995, Birkett 2002, Walpole *et al.* 2004).

**Social and Reproductive Behaviour** Black Rhinos tend to be solitary animals, although ♀♀ are less solitary than ♂♂, as they are usually associated with one or more of their immature or subadult offspring. Adults spend most of their time and do most of their feeding within defined home-ranges. Mature adult home-ranges tend to be stable in location for several years (Adcock *et al.* 1998). However, in establishing Black Rhino populations, ranges may shift over time (Lent & Fike 2003). The ranges of subadult and young adult animals are not stable and tend to be larger than those of most mature adults (Adcock *et al.* 1998). The log of average adult male Black Rhino home-range size in an area is inversely proportional to the log of Black Rhino carrying capacity of an area, as predicted by regression modelling (Adcock 2001), even though individual rhino home-range sizes vary greatly (Adcock 2001; and see, for example, Hitchins 1969, Mukinya 1973, Frame 1980, Conway & Goodman 1989). Thus, in very arid areas of low rhino carrying capacity, such as 0.01 rhino/km<sup>2</sup>, ranges average around 380 km<sup>2</sup> (Hearn 1999). Areas that can carry ten times more rhinos (0.1 rhino/km<sup>2</sup>) tend to have ranges averaging 43–44 km<sup>2</sup>; while areas that can carry 1 rhino/km<sup>2</sup> tend to have ranges averaging around 5 km<sup>2</sup>.

Male territoriality has been shown in all areas where the actual ages and range layouts of the ♂♂ have been monitored (Klingel & Klingel 1966c, Frame 1980, Adcock 1998, Tatman *et al.* 2000, Lent & Fike 2003). Mature adult ♂♂ usually show territorial behaviour in that a single 'dominant' bull resides in a specific range, which overlaps little with the ranges of other bulls of a similar status. Such a bull is usually a mature adult well over ten years old. Other 'subordinate' bulls, which are usually subadults or younger adults, are tolerated within a dominant bull's range until they start to display challenging or territorial behaviour. Social dominance seems to be achieved between the ages of 9 and 17, some years after sexual maturity is reached at 7–8 years of age.

A dominant bull will aggressively chase a non-tolerated ♂ from his territory. Young bulls are often killed or injured in these interactions.



Black Rhinoceros *Diceros bicornis*.



Dispelled bulls must lead a fringe existence in unoccupied areas, or must wander continuously to avoid dominant bulls, until they can find or claim their own territory. Old ♂♂ that can no longer defend their territories also die in fights, or can become confined to a small area of marginal habitat until they die. Dominant bulls are predominantly solitary, but younger, subordinate ♂♂ may associate with each other or with adult ♀♀ on occasion. Male territoriality limits the number of mature ♂♂ that can co-exist in fenced rhino sanctuaries (Adcock 1994, 1998).

There is some evidence that overt territorial behaviour can be suspended around specific important, but limited, resources, where rhinos can gather in groups of five or more. Examples include around waterholes in arid ecosystems (e.g. aggregations of up to 16 individuals in Etosha N. P. in Namibia; Cunningham & Berger 1997, B. Loutit pers. comm.), or around prized resources such as succulent euphorbias (e.g. Dwarf Succulent Valley Bushveld habitat in South Africa; Lent & Fike 2003), and, formerly, in patches of deciduous thicket (made up of *Combretum*, *Grewia*, *Baphia*, *Burttia*, *Pseudoprosopis* and *Albizia* spp.) in Uzigua and Manyoni districts of Tanzania (J. Kingdon pers. comm.). They also aggregate over such resources when artificially confined, as in Ngulia Sanctuary in Tsavo West, Kenya (R. Ketch pers. comm.) and in *Euphorbia* forests in Lake Nakuru N. P. (P. Okuku pers. comm.). Females occupy home-ranges that can overlap those of other ♀♀ and ♂♂. Meetings between different adult ♀♀ (and associated calves) are peaceful. Encounters are sometimes deliberately sought if rhinos detect each other when moving through a common area, but these invariably are of a temporary nature.

Black Rhinos use olfactory communication, including scent-marking by dung scattering and urine spraying. Dung middens are scattered seemingly at random along paths and used by all passers-by. Black Rhinos often defecate on White Rhino territorial dung middens where the two species coexist. The depositor of dung may sniff it and may sweep and root it with the forehorn (especially ♂♂) before shuffling through it with stiff legs (Estes 1991). Black Rhinos scatter their dung by kicking backwards in slow motion, leaving characteristic parallel scrapes. Females in oestrus dump whitish urine, which advertises their status to ♂♂ who test this with flehmen behaviour. Bulls also spray-urinate on small bushes (Estes 1991).

When an oestrous ♀ moves into a ♂'s territory, the resident ♂ rhino will court her and mating may ensue. Courting can be a lengthy affair. This involves the ♂ engaging in stiff-legged walking, some jousting of horns with the ♀, and restrained jabbing of his horn under her groin, front legs or belly. Females may attack courting ♂♂ on occasion. Actual copulation may last 12–43 min (Goddard 1966, Hitchins & Anderson 1983).

Related rhinos tend to maintain long-term bonds and often join up with each for short periods over their lifetime. In East Africa, such groups (clans) of related rhinos have been found to occur in particular 'distribution areas', which show little or no overlap with the distribution areas of other such groups (Mukinya 1973, Morgan-Davies 1996, Tatman *et al.* 2000).

Young ♀♀ can wander widely before they produce their first calf. They then settle into a more established home-range that may or may not coincide with that of their mother. Pregnant ♀♀ have been known to return temporarily to their own birth area when they are due to give birth (H. Hansen pers. comm.). As the time for parturition

approaches, the ♀ will chase her previous calf away, and will find a secluded bushy area to give birth in. Females sometimes hide their infant calves when they go to waterholes (P. Erb pers. comm.) or when feeding in exposed areas. Newborn calves walk and suckle within hours of birth. The older, rejected calves (aged 2–3½ years) at this stage become more vulnerable to predation, aggression by ♂ rhinos, and other mishaps. They appear to be insecure on their own, and usually attempt to join another ♀ or occasionally young ♂, or even a White Rhino ♀ who will tolerate their presence. After 3–8 months, the mother may allow her former calves to return to her company. Calves start to break ties with their mother from 2–3½ years on, but ♂ calves in particular may not truly leave their mothers permanently until they are six or seven years.

The explosive puffing snort of an alarmed Black Rhino can precede a dangerous charge, but more often Black Rhinos run away from perceived threats. A calf emits a high-pitched whine or squeal to attract its mother's attention. A ♂ may also squeal when courting a ♀, and all Black Rhinos can make this sound when in pain or distress.

Black Rhinos are often found in association with Fork-tailed Drongos *Dicrurus adsimilis*, which hawk insects by flying along the sides of resting rhinos, and with oxpeckers, which feed on ticks and skin secretions. The birds also give a harsh alarm call, which has led to oxpeckers being called *askari ya faru*, or the 'rhino's policemen' in Swahili.

**Reproduction and Population Structure** Fertility depends to some extent on body condition and weight. Animals can become sexually mature in their fourth or fifth year if they can achieve 80% of their adult body weight by this stage. Most ♀♀ achieve sexual maturity during their sixth year, resulting in average ages at first calving of 7–8 years (though some breed earlier). Males seem to commonly achieve sexual maturity (spermatogenesis) at an older age of 7–8 years (Hitchins & Anderson 1983, Bertschinger 1994). Fertility can be delayed in both sexes due to nutritional stress, or social pressures in the case of young ♂♂.

Oestrous cycles have a mean of 35 days, but true oestrus only occurs for one or two days during each cycle (Hindle *et al.* 1992, Bertschinger 1994). Cycling can occur year-round, but is influenced by ♀ nutritional status. Several populations have shown conception peaks at times of the year that correspond to improved rainfall conditions, and thus nutritional status of the ♀ in the months preceding conception (Adcock 2000, 2003). The timing of these peaks varies across Africa with the seasonality (winter versus summer) of the annual rainfall pattern.

Gestation period is 15.4 months and calves weigh 25–40 kg at birth (Penny 1987, Bertschinger 1994). The calving interval varies widely, depending on the age of the ♀ and the nutritional conditions in the habitat. Under good habitat conditions and at densities below carrying capacity most ♀♀ can produce several consecutive calves at 2–2.5 year intervals. Where conditions are less favourable, the average inter-calving interval exceeds three years. In many such cases, a calf may be conceived but is lost as the pregnancy nears full term, or shortly after birth. Old ♀♀ (28 years plus) have difficulty regaining body condition after weaning each calf, and tend to have longer intervals between calves.

Mortality rates within the first year of life range from 8–14% on average in South Africa and Namibia. Mortality in subadults averages

2–4%, less than 2% in young and prime age adults (Adcock 2003), and probably 4% or more in older rhinos. Male rhinos have a higher mortality rate than ♀♀, and fighting is the most common cause of their death. Most ♀♀ die of old age. Longevity for *D. b. michaeli* in captivity has been given as 45 years and 10 months (Jones 1993).

More male calves are born than female calves (Adcock *et al.* 2010), but male mortality rate is higher leading to adult sex ratios biased towards ♀♀. Because of male territoriality limiting male numbers in all but the largest fenced areas, adult sex ratios tend to average 1.3–1.5 ♀♀ per ♂ in many populations. Larger populations have average sex ratios of 1.1–1.2 ♀♀ per ♂.

The intrinsic rate of increase in Black Rhinos is around 8–9% annually (Owen-Smith 1988, 2001, Emslie 1999), similar to White Rhinos (although in practice breeding rates of the browsing Black Rhino lag behind those of the grazing White Rhino). In areas that have been stocked with rhinos at below their habitat carrying capacity, and having ♀-biased sex ratios and low mortality rates, they can commonly achieve average population growth rates of 10–15% per year. In populations approaching carrying capacity, overall mortality can exceed 4% annually (involving mainly infants and subadults), and inter-calving intervals lengthen. This results in average growth rates of zero or a few per cent (Adcock 2003). Black Rhino populations that have been allowed to approach or exceed estimated long-term ecological carrying capacity have consistently exhibited declines in population. Vegetation changes and increases in the density of competing browsers, as well as fluctuating rainfall, also will affect performance.

**Predators, Parasites and Diseases** Calves and subadults are vulnerable to predation by Lions *Panthera leo*, Leopards *Panthera pardus* and Spotted Hyaenas *Crocuta crocuta* (e.g. Goddard 1966, Joubert & Eloff 1970, Elliot 1987, Scott & Scott 2003). Brain *et al.* (1999) reported on the killing of three subadult Black Rhinos by a coalition of three male Lions in Etosha N. P. within the space of a few months; the three rhinos killed were of very similar size (1.27–1.31 m at the shoulder) and age (3–4 years) and the authors suggested that subadult rhinos that have just left their mothers may be particularly susceptible to Lion predation. In N Tanzania, Goddard (1966) estimated that there was a 16% loss of calves less than two years old to Lion and Spotted Hyaena predation.

In contrast to White Rhinos, a Black Rhino calf tends to follow rather than precede its mother when running away from danger. This behaviour is thought to make this species more vulnerable to predation. However, upon hearing alarm squeals of her calf, a Black Rhino mother will turn to defend her calf. Calves less than three months old appear to be at greatest risk from predation.

Black Rhino numbers have increased rapidly in many populations with a full complement of predators, and it appears that, while some young and subadult animals are undoubtedly lost to predation, rhinos stocked at sustainable carrying capacities can withstand predation. Thus, predators are not generally a major influence on population performance in most populations. An exception to this is in the Ngorongoro Crater, where Spotted Hyaena densities have been very high while Black Rhino densities have become very low through poaching, and the terrain has become open with limited bushy areas for cows to hide calves. Mortality of Black Rhinos in their first year of life here is more than 30% (Adcock *et al.* 2004, Emslie 2004b). If

one assumes inter-calving intervals in excess of four years represent undetected neonatal mortalities, neonatal mortality of Black Rhinos in the Crater may have been as high as 41–47% (Adcock *et al.* 2004, Emslie 2004b, Mills *et al.* 2006).

Southern African Development Community Rhino Management Group data since 1989 indicate that the proportion of detected mortalities in populations in areas with large predators that were ascribed to predation was 6.9%, with suspected Lion predation accounting for 13 of 16 predator-linked mortalities out of a total sample size of 233 mortalities (SADC RMG data – K. Adcock unpubl.). Lion predation may be overestimated, as in some cases, lions may have simply discovered a Black Rhino carcass and scavenged from it rather than killing it. Similarly, Spotted Hyaena predation levels are likely to be underestimated from recorded mortality data as little evidence may remain if a very young calf is killed and eaten in the bush.

Aggressive encounters with Savanna Elephants *Loxodonta africana* and African Buffalo *Syncerus caffer* have also been recorded. In 159 encounters between elephants and Black Rhinos in Etosha, ♀ elephants dominated both sexes of Black Rhino, while Black Rhino ♂♂, though not ♀♀, were capable of displacing elephant bulls (Berger & Cunningham 1998). Some Black Rhinos have been killed by young bull elephants in some populations where elephants were re-introduced using young orphaned animals from culls rather than family groups with big mature adult elephant bulls (Slotow *et al.* 2001). To date, many more White Rhinos have been killed by these juvenile, bull delinquents than Black Rhinos. Only 2.1% (5/233) recorded Black Rhino deaths in the SADC RMG region since 1989 have been ascribed to elephants (SADC RMG data – K. Adcock unpubl.). It is still too early to conclude with certainty, but the introduction of large adult bulls into populations such as Pilanesberg and Hluhluwe–iMfolozi appears to have reduced mortality.

Black Rhinos are susceptible to trypanosomiasis, and *Trypanosoma brucei*, *T. congolense* and *T. vivax* have been reported from Black Rhinos (Penzhorn *et al.* 1994). Black Rhinos translocated from non-trypanosomiasis areas to trypanosomiasis areas are at risk until they build up immunity. Translocation mortality risks can be reduced with good boma care and setting up Tsetse Fly traps in the area surrounding holding bomas to reduce fly densities and give the animals time to build up immunity (Wambwa 2004).

Anthrax has killed the occasional animal, but at a continental scale its impact has been limited. Since 1989 only two Black Rhinos have been recorded as dying from anthrax in the SADC RMG region (0.9% of all recorded deaths since 1989). In total, including cancer and anthrax, disease accounted for 3.4% (eight) of all recorded mortalities in parks with large predators ( $n = 233$ ; SADC RMG data – K. Adcock unpubl.).

A total of 35–38 tick species have been recovered from Black Rhinos (see Penzhorn *et al.* 1994 for checklist), of which three tick species are primarily rhino parasites: *Amblyomma rhinocerotis*, *Dermacentor rhinocrinus* and *Amblyomma personatum* (Penzhorn *et al.* 1994; and see Knapp *et al.* 1997). Common sites of tick attachment are skin folds in the perineal region, in and around the ears and around the eyes (Penzhorn *et al.* 1994). Oxpeckers and terrapins in wallows assist rhinos by eating ticks. Rhinos also wallow in mud and then rub themselves on special rubbing posts, trees and rocks in an attempt to remove ticks on their skin. *Babesia* and *Theileria*-

like organisms have been found in healthy White Rhinos (Bigalke *et al.* 1970); however, deaths of a small number of Black Rhinos in Ngorongoro and Addo Elephant N. P. have been linked to tick-borne diseases caused by protozoan parasites identified as *Babesia bicornis* and *Theileria bicornis*. In these cases it is believed that general stress associated with translocation and drought-induced malnutrition, and a build up of ticks following a lack of burning were key factors predisposing these animals to succumb to babesiosis (Hilsberg *et al.* 2003, Adcock *et al.* 2004, Mills *et al.* 2006). Aspergillosis is another example of a latent infection/disease that can be exacerbated by translocation stress (Kock & Miller 2004).

Large swarms of the large blood-sucking fly *Rhinomusca dutoiti* and *R. brucei* are often seen along the sides of Black Rhinos. Birds such as oxpeckers and drongos *Dicrurus* spp. often hawk these flies. These flies lay their eggs in rhino dung middens where their larvae develop. Much smaller flies of the genus *Lyperosia* are also commonly associated with rhinos and their middens. Large numbers of gyrostigmatid (bot) fly larvae (*Gyrostigma pavesii* and *G. conjungens*), up to 40 mm long, may be found attached to the stomach walls of rhinos. At least 30 species of helminths (see Penzhorn *et al.* 1994 for a checklist) are known to parasitize the Black Rhino. Ciliated intestinal protozoa are reported on by Van Hoven *et al.* (1988) and Obanda *et al.* (2008).

In some areas, such as in KwaZulu-Natal (Schulz & Kluge 1960, Hitchins & Keep 1970) and parts of Kenya (Round 1964, Tremlett 1964) and Zimbabwe (Kock & Kock 1990), Black Rhinos can develop characteristic large skin lesions on their chests and shoulders due to a filarial parasitic worm. Where this parasite is absent, these lesions do not develop. As the positions and size of the lesions change with a rhino's age, over time and with season (Hitchins & Keep 1970), they are not useful features for identifying individual animals (Adcock & Emslie 2004).

Black Rhinos have unusual blood chemistry as their red blood cells are sensitive to oxidative stress. This has predisposed this species to high mortality rates in captivity. Captive Black Rhinos have suffered from a wide range of conditions (Wambwa 2004), including acute episodic haemolytic anaemia, chronic haemolytic anaemia, superficial necrolytic dermatopathy, haemosiderosis, idiopathic and toxic hepatopathies, a susceptibility to fungal pneumonias and other infectious agents, and other incompletely understood disorders (Miller 1992, 1994, Munson *et al.* 1998). These conditions are seldom if ever seen in the wild (Wambwa 2004). Attempts are being made to improve captive diets in an attempt to prevent a build up of iron in captive animals and reduce mortality levels in captivity.

**Conservation** IUCN Category: Critically Endangered A2abcd (*D. b. minor* – Critically Endangered A2abcd; *D. b. bicornis* – Vulnerable D1; *D. b. michaeli* – Critically Endangered A2abcd; *D. b. longipes* – Extinct). CITES: Appendix I.

The population of Black Rhinos has declined by over 90% over the last sixty-odd years, reaching a low of 2410 in 1995 (Emslie & Brooks 1999). However, since then, numbers have been increasing steadily at a continental level, doubling to 4880 by the end of 2010 (Emslie 2011). For the most part, the large free-ranging populations of rhinos that used to roam over huge areas, and which could not be adequately protected, have been eliminated or reduced to very low

numbers. The bulk of remaining Black Rhinos occur in areas with more concentrated security. However, following surveys over most of its possible range in 2006, the Western Black Rhino in Cameroon has been declared extinct as no signs of any individuals were found by survey teams in 2006 or in the following five years, while evidence of general wildlife poaching was widespread (Emslie *et al.* 2007).

Black Rhinos are found under a range of management and ownership models. In 2010, 71.2% of Africa's Black Rhinos were conserved in state-run protected areas. The bulk of privately managed Black Rhinos in 2010 were under custodianship on behalf of the state (19.9% of all Black Rhinos) with 6.8% being privately owned (A/RSG data unpubl.). This differs from White Rhinos, where, in 2010, 27.3% were privately owned. Approximately 3.2% of Africa's Black Rhinos are conserved on communally owned and managed land. In summary, as of December 2010, there were 17 strongholds of the species with over 50 animals (up from 11 in 1995), including Etosha N. P., Kunene, Hluhluwe-iMfolozi N. P., Kruger N. P., Great Fish Reserve, Nairobi N. P., Lake Nakuru N. P., Pilanesberg N. P., uMkhuze G. R., an intensive protection zone in Hwange N. P., and three Zimbabwean conservancies, three privately managed Kenyan areas and two privately owned South African populations (Emslie 2011).

For practical conservation management, current Continental, Regional and National Black Rhino Conservation Plans all stipulate that the different subspecies of Black Rhino should not be mixed (unless major declines in numbers and loss of genetic variability in future dictates otherwise). See also Taxonomy.

As with White Rhinos, the primary threat remains the high price of rhino horn (Leader-Williams 1988) and the resultant poaching for the illegal international rhino horn trade. Rhino horn has two main uses: traditional use in Chinese medicine, and for making ornately carved handles for ceremonial daggers (Jambiyas) worn in some Middle East countries (Martin & Martin 1982). Since the 1960s wars, the free flow of weapons into Africa, civil unrest, poverty, economic problems and declining conservation budgets have had a significant impact on rhino numbers in many countries (Emslie & Brooks 1999). Habitat changes and increasing densities of competing species can also cause rhino populations to decline, while poor (conservative) biological management also threatens rhino growth rates. Maintaining sufficient capacity and resources to do effective field rhino conservation is a challenge. In Zimbabwe, for example, where Black Rhino numbers (but not White Rhinos) declined slightly (–1.7%) between December 2003 and December 2005, significant field conservation effort (i.e. protection and translocations to maintain productivity of established populations and create additional populations), coupled with political will, have been the primary reasons for continued successes (Emslie *et al.* 2007).

The Black Rhino has been listed on CITES Appendix I since 1977, with all international commercial trade in Black Rhino and their products prohibited. To help reduce illegal trade, and complement CITES international trade bans, domestic anti-trade measures and legislation were implemented in the 1990s by a number of consumer states. However, live breeding groups of Black Rhino have been translocated between countries to help re-establish populations in a number of range states. At the 13th CITES Conference of the Parties in 2004, proposals for hunting quotas for five surplus male Black

Rhino were also approved for both Namibia and South Africa (for more details on the rationale behind these hunting proposals and the debate at CITES CoP 13, see Emslie 2004c).

Strategies that have been central to increasing numbers include monitoring and managing rhinos on a metapopulation basis for rapid growth (Emslie 2001), and concentrating law enforcement effort at levels where it can be effective (Leader-Williams *et al.* 1990, Emslie & Brooks 1999). Work is currently ongoing to study the social impacts of translocations with a view to developing improved biological management and translocation guidelines (W. Linklater pers. comm.).

### Measurements

*Diceros bicornis*

HB: 2900–3750 mm

T: 600–700 mm

HF: n. d.

E: n. d.

Sh. ht: 1370–1800 mm

WT: 700–1400 kg

Kingdon 1997; sample number not given

Notes: The mean mass of a small sample of Black Rhinos from Hluhluwe G.R., KwaZulu–Natal was 852 kg for ♂♂ (n = 8) and 884 kg for ♀♀ (n = 6) (Hitchins 1968). Du Toit (2005) also gives a slightly lower average mass at maturity for ♂♂ of 852 kg (700–1020 kg) compared with ♀♀ 880 kg (720–1130 kg). Estes (1991), on the other hand, describes ♀♀ as large as ♂♂, but ± 100 kg lighter. Mature adult ♂♂ develop visibly bigger neck muscles, and some ♂♂ are obviously big animals and are likely to be the heaviest animals (J. Flamand pers. comm.); however, a pregnant ♀ normally weighs as much as the average ♂ (Q. Rochat pers. comm.). The heavier mean for ♀♀ in some references may be due to the inclusion of a number of

animals in late pregnancy. Four ♀♀ and four ♂♂ (*D. b. minor*) over 6/7 years of age had average weights of 1020 kg (range 972–1149 kg) and 1164 kg (range 1044–1228 kg), respectively. Q. Rochat (pers. comm.) concurs with statements there is not too much difference in weight between sexes and that some ♀♀ are bigger than some ♂♂. None the less, the largest animals are very big bulls. These latter figures, taken from rhinos weighed in crates using a crane with an electronic scale (accurate to 5 kg), are also higher than previously reported, possibly due to more accurate weighing or because other weights were derived from younger animals being translocated.

Average mass per individual (subspecies not specified) in an entire population is 818 kg (Bothma & Van Rooyen 1990). Du Toit (2005) gives a mean mass for *D. b. minor* of 852 kg but notes that *D. b. bicornis* is larger with adult bulls weighing up to 1300 kg.

### Horn measurements:

*Diceros bicornis*

Anterior basal circumference (♂♂): 492.7 ± 69.5 mm, n = 58

Anterior basal circumference (♀♀): 453.5 ± 44.2 mm, n = 38

Anterior horn length (♂♂): 446.1 ± 101.2 mm, n = 63

Anterior horn length (♀♀): 417.6 ± 107.9 mm, n = 49

Anterior horn WT (unsexed): 1.7 ± 0.7 (0.2–3.8) kg, n = 75

Posterior horn WT (unsexed): 0.9 ± 0.5 (0.02–2.4) kg, n = 74

Kruger N.P. and KwaZulu–Natal, South Africa (Pienaar *et al.* 1991, Pienaar 1993)

Note: The maximum front horn length is 1359 mm from Kenya (Selous 1899)

**Key References** Emslie 2001; Emslie & Brooks 1999; Frame 1980; Hitchins 1969, 1978, 1989; Mukinya 1973, 1977.

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