WILD LIFE IN SOUTH AFRICA SERIES

CERATOTHERIUM SIMUM (BURCHELL)

Mammalogy Seminar

B.Sc. (Hons) Wildlife Conservation

University of Pretoria,

by

B.J. Huntley

Nature Conservation Branch

Transvaal Provincial Administration.

August 1967

- Contents -

The purpose of this paper is to summarise as briefly as possible the existing literature on Ceratotherium simum (Burchell). As far as library facilities have allowed, all the major works on the species have been consulted, but time has not permitted a detailed study of the less accessible papers. Reference to unpublished accounts and personal communications has been avoided as far as possible. For this reason much of the most recently collected data have not been included.

I am indebted to the librarians of the Transvaal Museum, the National Zoological Gardens, and the Nature Conservation Branch of the Transvaal Provincial Administration for assistance in obtaining literature.

2. DISCOVERY

The earliest positive record of Ceratotherium simum is that given by Burchell (1817b) in his original description of the species. That the animal was known to hunters and travellers before this date is indicated by Barrow's (1801; 1802) reference to "three white rhinoceroses", described to him by a Bastaard chief of the Khamiesberg area. Shortridge (1934) considers a horn illustrated in a paper by Parsons (1743) to be the earliest publication on this species, but Bigalke (1963) casts doubt on the validity of the statement. Both Cumming (1850) and Riev (1868) consider that the unicorn referred to in the Old Testament (Job, Chapter 36, Verses 10 & 11) was none other than Ceratotherium, while Trouessart (1907, 1909) also thinks this rhinoceros was the unicorn of the ancients. Gowers (1950) provides evidence to show that Ceratotherium was known to the Greeks and Romans, a contention that is very plausible considering the frequent military expeditions made by these races into Ethiopia and the Upper Nile, where the northern sub-species, C.s. cottoni (Lydekker), was no doubt abundant in classical times.

The northern sub-species was not positively recorded until 1900 (Thomas, 1900; Sclater, 1900) but its presence had been suspected since the mid-nineteenth century (von Heuglin, 1869; Drummond 1876; Trouessart, 1909). The northern population was not recognised as a distinct sub-species until 1908 (Lydekker, 1908).

Order: Perissodactyla

sub-order: Ceratomorpha

family: Rhinocerotidae

sub-family: Dicerotinae

genus: Ceratotherium (Gray, 1867).

species: C. simum (Burchell, 1817b)

sub-species: C.s. simum (Burchell)

C.s. cottoni (Lydekker 1908)

The position of Ceratotherium within the Mammalia is well established, the species undoubtedly belongs to the Rhinocerotidae of the Perissodactyla. The phylogenetic history of the family is discussed by Scott and Osborn (1883), Mathew (1931), Wood (1941, 1949) and Hutchinson and Ripley (1954), while the relationships within the family have been discussed by Drummond (1876) Selous (1881), Flower and Lydekker (1891), Lydekker (1892), Thomas (1901), Breuning (1922), Beddard (1923), Thom (1943) and Deraniyagala (1953).

The validity of Ceratotherium as a genus has been debated ever since its proposal one hundred years ago (Gray, 1867). Although many workers have preferred other names, (see list of synonyms below), Ceratotherium is accepted in this account in accord with the concensus of recent opinion on the subject (Player and Feely, 1960; Cave, 1962; Vincent, 1962; Walker 1964; Ansell, 1967).

Synonyms:

Rhinoceros simus Burchell (1817b). "L'intérieur de l'Afrique Meridionale, ... vers le vingt-sixieme degré de latitude." Smith (1834, 1849), Drummond (1876), Buckley (1876), Selous (1881), Sclater (1886, 1890), Millais (1895), Coryndon (1894), Sclater (1901), Lydekker (1908), Trouessart (1909), Berger (1910), Kirby (1920). See also Gray (1867) for further authorities.

Rhinoceros burchellii Lesson (1827).

Rhinoceros camus Griffith (1827).

Rhinaster simus Gray (1840)

Rhinoceros oswellii Gray (1855).

4.1 English names.

Ever since the first reference to Ceratotherium as a "white rhinoceros" (Barrow, 1801) a copious literature has developed on the origin of this ill-conceived name. Drummond (1876), Selous (1899) and Kirby (1920) suggest that the first Ceratotherium seen may have been in the glare of the setting sun, when their backs do shine white, while Lang (1920), Huess (1961) and Bridges (1962) are among the many proponents of the mud-bath theory, that is, that the earliest Ceratotherium seen had a coating of white mud.

Another line of argument is taken by those authors who suggest the English "white rhinoceros" was derived from the mis-translation of certain rather appropriate Cape Dutch names. Several authors think that the original Dutch name was wide mouthed rhinoceros, and suggest that white was taken from weit - wide (Bere, 1962), wyt - wide (Best, 1962) wyd - wide (Owen, in Haberly, 1963), or wijt (Guggisberg, 1966).

A further suggestion is made by Pitman (1931) and Cave (1947) who say that the name is derived from the Dutch "widg" meaning great or huge. (See Shortridge 1934, 1:435 for further remarks on the subject.)

Due to the inappropriateness of the name "white rhinoceros" many other English names have been proposed, including Burchell's, Giant, Great African, Square-lipped, Square-mouthed, and Square-nosed Rhinoceros. These alternatives are either just as inappropriate, or too bulky for general use, and for the purposes of the present paper, the abbreviated scientific names C. simum, C.s. simum, and C.s. cottoni will be used, depending on whether both or only one sub-species is being referred to.

4.2 Other European names.

French: le Rhinnocéros blanc

German: BreitmaulNashorn, StumpfNashorn

Dutch: de Witte Neushoorn

Cape Dutch: Witte Renoster, Vit Rhinaster.

Afrikaans: Wit renoster, Platbek renoster.

4.3 Native names.

(a) for C.s. simum

..., in Shortridge, 1934). Tswana (= Bechuana, = Sechuana) :- Lokhohe, Lokohu, Mokhoohu (Burchell, 1817b), Mohohu (Drummond, 1876), Chukuru (Selous, 1852), Chukudu (Millais, 1895), Tschukurru (Zukowsky, 1924), Kutshoba (Bryden,), Eshukudu, mogohu, kgêtlwa, kôbôbô (van Warmelo in Roberts, 1951) and Chichore (Harris, 1852). Sotho tshukudu/mogohu (van Warmelo, in Roberts, 1951). Venda tshugulu (van Warmelo, in Roberts, 1951). Matabili (=Matabite); Chicore (Harris, 1852), Chickore, Mohoohoo (Gray, 1867), mkofo (Kirby, 1920), Umhofo (Best, 1962)

Ndebele Umhofu (van Warmelo in Roberts, 1951).

Zulu Umkawe, Umkombewoquoto, (Drummond, 1876) Umkava, 'mkava (Kirby,1920), umkhombe (van Warmelo, in Roberts, 1951), Mkhombe or Umkhombe (Maberley,1963.)

Other native names for C.s. simum include "M'fura", used by natives of the Mocambique-Rhodesian border (Fleming, in Shortridge, 1934), "M'combo" used by the natives of Mashonaland (Millais, 1893) and Epandangava" used by natives of South West Africa (Bernard, 1952.

b. Native names for C.s. cottoni

Dinka: Mirer

Luganda: Enkula

Arabic: Abu Garn, Um Garn (Best, 1962).

5. DISTRIBUTION

No aspect of Ceratotherium is more fully documented than its past and present distribution. The voluminous literature on the subject was no doubt stimulated by the near extinction of C.s. simum at the turn of the last century, and its subsequent explosive increase in numbers in the Zululand Reserves. The history of Ceratotherium's distribution in Africa is best discussed under three headings, viz:-

5.1 Pleistocene distribution.

"Throughout the Lower and Middle Pleistocene the white rhinoceros appears to have been common throughout the whole of Africa."(Spinage, 1962, P. 104).

Fossil remains of C. simum have been described from Algeria and Morocco (Pomel, 1895; Boule, 1900; Joleaud, 1931; Arambourg, 1931, 1939; Ennouchi, 1943, 1948, 1957).

Singer 1960).

Early Pleistocene deposits usually showed a predominance of C. simum over Diceros bicornis (Linn.) remains (Hooijer, 1959) while Hopwood (1954) showed a preponderance of Diceros bicornis over C. simum in the Late Pleistocene. This change in status foreshadowed the present day pattern, with C. simum localised in two widely separated centres, while Diceros bicornis is distributed widely over the whole of Eastern and Southern Africa.

The positions of Pleistocene deposits containing Ceratotherium material are indicated in the maps in Figure 1.

(Insert Figure 1).

5.2 Holocene distribution.

The widespread distribution of Ceratotherium in Pleistocene times persisted until the time of Stone-Age Man, and many petroglyphs and rock-paintings have been described of unmistakeable illustrations of Ceratotherium. Pomel (1892) discovered an excellent petroglyph, that of C. simum according to Périnquey (1906) or more likely the Quarternary form described by Pomel (1895) according to Lang (1925).

In Southern Africa C. simus is illustrated in numerous rock-paintings, from Rhodesia (Junor, 1967), South West Africa (Tinley, 1967), and various sites in South Africa (Bleek, 1930; Balsan, 1954; Wilcox, 1956; Schaurte, 1960; Fock, 1966). The Southern African sites are indicated in the map given in Figure 2.

(Insert Figure 2).

5.3 Distribution in historic times.

Of over one hundred accounts of the distribution of C. simum in historic times, six are particularly valuable, namely those of Selous (1893), Heller (1913), Shortridge (1934), Harper (1945), Bigalke (1963) and Sidney (1965).

There is still some disagreement on the exact limits of the range of the two sub-species in historic times (i.e. since the arrival of white men in Africa), and the ranges shown in Figure 2 are not entirely in accord with the maps of Player and Feely (1960) or Bigalke (1963). Other maps illustrating the past and/or present distribution of C. simum have been

A. Distribution of C.s. simum

5.3.1 Cape Province.

The validity of Barrow's record (Barrow, 1801) of "white rhinoceroses" in the neighbourhood of the Khamiesberg, Namaqualand, has been recognised by Bryden (1893) but questioned by Bigalke (1963). Other records of C.s.simum south of the Orange River include those of Coryndon (1894) and Beddard (1902) and Pringle (1822) in Hewitt (1931). These reports are very doubtful however, and have therefore been omitted from figure 2.

North of the Orange River, but south of the Vaal River, (Bigalke, 1963) the remains of a skull collected in the Kimberley district has been reported by Sclater (1900). Further north, in the vicinity of Kuruman, C.s. simum was recorded by Burchell (1817b), Campbell (1827) and Smith (1834) among the earliest accounts.

5.3.2. Orange Free State.

Both Selous (1899) and Kirby (1920) consider that C.s.simum may have ranged into the Orange Free State but do not give supporting evidence. Fossil and semi-fossilized material of C.s. simum from the Kroonstad and Fouresmith areas has been described by Bigalke (1963).

5.3.3. Natal.

The first record of C.s.simum from Natal appears to be that of Delagorgue (1847) followed by the reports of Baldwin (1863), Bryden (1897) and Newton (1903). Changes in the size of the Zululand population will be described below.

5.3.4. Transvaal.

In 1836 Harris saw up to eighty C.s. simum in a day's march in the Magaliesberg district, seeing the species in good numbers in the Marico, Crocodile and Limpopo valleys as well (Harris, 1838). C.s. simum was also noted on the Marico by Cumming (1850) and Baldwin (1863) but towards the end of the 19th Century they were known only from the lowveld, where they were recorded in 1877 (Glynn? 1926) and finally in 1895 by Kirby (1896).

he considered to be those of C.s. simum, and Selous (1899) stated that the species was present in Gazaland in 1871. A specimen shot near the Gorongoza Mountains in 1935 is illustrated in Sidney (1965). Travassos Santos Dias (1961) considers the animal extinct in the country.

5.3.6 Rhodesia.

Selous (1899) states that C.s. simum was common between Gwelo and Umniati Rivers in 1872, and in this paper he gave a good account of the species former distribution in Rhodesia. Coryndon (1894) shot two bulls in Mashonaland in 1893, while the last positive record of C.s.simum in Rhodesia was that of a bull shot by Eyre in 1895 (Sclater, 1900). Fleming in Shortridge (1934) reports the presence of a few in the Nuanetzi - Mocambique border area seen by natives in 1931. Sidney (1965) is of the opinion that a few may still remain in the isolated areas of N.E. Rhodesia.

5.3.7 Zambia.

Pitman (1934) considers that there is no evidence for the presence of C. s. simum north of the Zambesi, but Ansell (1959, 1960) suggests that the sub-species may have occurred between the Zambesi and Mashi rivers in historic times.

5.3.8 Botswana.

C.s. simum was seen in the Marico and Limpopo region in 1836 by Harris (1838) while Andersson (1856), Livingstone (1857), and Baines (1864) saw the animals in large numbers to the west of Lake Ngami. Selous (1881) records the rapid decline and disappearance of the sub-species in the Chobe area over the years 1871 to 1879. Sidney (1965) states that in 1903 four individuals were still lingering in the vicinity of Lake Ngami, and Wilhelm (1933) suggested that a few may still exist (in 1933) on both sides of the Okavango, but gives no supporting evidence.

5.3.9 South West Africa.

According to Castell-Ruedenhausen (1966) C.s. simum occurred as far

Shortridge (1934) regarded the species extinct in S.W. Africa for at least fifty years. Barnard (1950) suggested that the animal still occurs in the Kaokoveld, but this opinion has yet to be confirmed.

3.3.10 Angola.

The history of C.s. simum is poorly documented, but Schultz and Marner (1877) reported them as common in S.E. Angola in 1870, while Zukowsky (1924) quoting Mattenklodt, notes that in 1906 they were still present but very rare in the region. Hill and Carter (1941) consider the species extinct in Angola.

B. Distribution of C.s. cottoni.

The past and present status and distribution of C.s. cottoni has been very well discussed by Sidney (1965). Her map (p.54) is reproduced in figure 3. The distribution of C.s. cottoni will only be

(Insert figure 3.)

briefly described, further details may be obtained from Sidney's excellent account and from the references appended to the short discussions.

3.3.11 Central African Republic and Tchad.

Blancon (1948) states that the last survivors in the former French Equatorial Africa were probably shot in about 1935, but some may occasionally stray into the territory from the Sudan. See also: Blancon (1938, 1952, 1960); Jeannin (1951), Lalbrant (1952); and Bourgoin (1956).

3.3.12. Sudan

The number of C.s. cottoni in 1953 approximated 1000 (Forbes, quoted by Sidney, 1965). Due to the uncertainty of the Sudanese administration, they may be declining (Sidney, 1965), but Schomber (1960) appears to have more faith in the administration especially considering that C.s. cottoni has been adopted as the new states heraldic emblem. See also: Thomas (1900), Sclater (1900, 1902), Powell Cotton (1907), Churchill (1908), Lydekker (1908), Trouessart (1909), Roosevelt (1910), Stevenson Hamilton (1919), Chapman (1922), Christy (1923, 1924), Broekle-

5.3.13 Congo

C.s. cottoni is found only in the north east of the Congo, To the north of the Uele River, where the Parc National de la Garamba is an excellent sanctuary. (Frenchkop, 1947). Sidney (1965) quotes Micha as stating that a count in 1958 gave 1081 animals in the area. See also Long (1920), Parisi (1925), Beaux (1926), Schoutenden (1927, 1946), Lavauden (1935), Offerman (1952), I.P.N.C.B. (1955), Verschuren (1958) and Micha (1959).

5.3.14. Uganda.

Pitman (1931) showed that the Uganda population declined from 180 to 130 in the years 1925 - 1926. By 1929 (Salmon, 1939) they had increased by 50%. Due to strict protection the population has increased considerably in recent years. Heppes (1958b) estimated the total number to be 555, concentrated in the West Nile area. "The future of the Northern race of white rhinoceros in Uganda cannot be described as secure, since these animals are not protected in a National Park". (Sidney, 1965). See also: Pitman (1949, 1950), Heppes (1958a), Blower (1961), Savidge (1961), Sere (1963), Amon (1962) and Dave (1963).

6. NICHE AND HABITAT.

Ceratotherium simum is essentially a grazer, a characteristic which has been referred to by most of the early travellers (Smith, 1949; Cumming, 1850; Drummond, 1875; Selous, 1881; Nichols and Eglington, 1893: Coryndon, 1894).

It appears that the species evolved as a grazer, out of competition of the other African rhinoceros, Diceros bicornis, a browser, and has numerous morphological adaptations to the grazing habit (Zeuner, 1934). Fossil evidence indicates that the species has not undergone noticeable change since the early Pleistocene (see 5.1 above for references). One may infer that the niche occupied by Ceratotherium has also remained stable, and that it has always been a grazer of open woodland vegetation. The species's restriction to this habitat may well explain the disjunct

[illegible] during pluvials and interpluvials. That the separation is of recent age is indicated by the very slight morphological and behavioral differences that have arisen between the northern and southern sub-species.

It is doubted that rivers have checked the distribution of the species (StevensonHamilton, 1917; Bere, 1962) sufficiently to allow the development of sub-species, and I consider that the separation has been due entirely to habitat changes during the Pleistocene, as suggested by Schomber (1960).

Today, C. simum occupies the woodland and savanna vegetation type of Keay (1959). The northern sub-species apparently occupies a moister habitat than the southern, as indicated by the photographs illustrated by Lang (1920) and the fact that Sidney's map (Sidney, 1965 p.54) includes a large portion of swampland along the Bahr el Ghazal.

The southern sub-species occupies undifferentiated dry woodland and savanna types (Keay, 1959) while in historic times the distribution extended into the Brachystegia and Julbernardia woodland of Rhodesia. If the distribution of C.s. simum in historic times (figure 2) is compared with Acocks (1953) map of the vegetation of South Africa in 14,00, it is evident that the range occupied by the sub-species was almost entirely Acocks' Bushveld, with local extensions into Forest and Scrub-Forest, Sweet, Mixed, and Sour grassveld types.

7. ABUNDANCE

7.1 Census techniques.

The large size of and open habitat occupied by C. simum make it a particularly easy animal to count, especially if counts are undertaken in the dry season when most deciduous trees have lost their leaves and grass is either trampled or grazed low. It is therefore surprizing that the counts given by workers early in this century were extremely low. It may well be that these people deliberately under-estimated the populations in order to stimulate public support of the protection of the species.

The use of light airplanes for the censusing of game animals has considerably improved the situation since the [illegible]

advantages of air counts over ground counts, and suggest the most ideal conditions under which aerial counts of C.s.simum should be conducted.

7.2 Abundance of C.s. simum

Early accounts of C.s. simum in South Africa indicate that the species was as abundant in certain regions of the Transvaal as it is today in the most heavily populated areas of the Umfolozi Game Reserve. In 1836 Harris saw eighty white rhinoceroses in a day's march through the Magaliesberg District (Lydekker, 1896), while Player and Feely (1960) state that it is frequently possible to see sixty animals within six miles in parts of the Western Crown lands bordering the Umfolozi Game Reserve.

The exact number of C.s. simum in Zululand at the turn of the century will never be known. The records of Newton (1903) who suggested that only about ten remained, and Kirby (1920) who claims to have counted only twenty, seem to be gross underestimates (Player and Feely, 1960). However, considering the almost phenomenal increase in the population in the last decade, the original stock may not have been very much larger than Kirby stated.

An idea of this rapid increase in numbers may be obtained from the following data:-

In 1929 Lang (in Shortridge, 1934) counted 120; in 1932 Kluge (1950) counted 220; in 1936 (Kluge, 1950) recorded 226, in 1948, 534; an air census in 1953 (Anonymous, 1956) gave 506; another in 1959 (Player and Feely, 1960) gave 567; in 1960 (Feely, 1962) 604 were counted; Simon (1966) gives the number as c.800, while the most recent aerial census (Hitchins, 1967, personal communication) gave a total in the vicinity of one thousand individuals.

7.3 Abundance of C.s. cottoni.

Censuses of the populations of C.s. cottoni have not been undertaken as frequently or as accurately as those on C.s. simum, and the data available to the writer areundoubtedly very out of date. The most recent figures obtained are $\pm$ 350 in Uganda (Grzimek, 1960), 1091 in

8.1 Differences between C. simum and Diceros bicornis.

Comparisons between C. simum and D. bicornis are so numerous that reference to all the accounts would be pointless. The main differences in physical characteristics have been summarised in an excellent paper by Cave (1962) in which he supports Gray's (1867) recognition of Ceratotherium's generic status. The main points listed by Cave are reproduced in table 1. Additional notes of value may be obtained from Sclater (1886) and Player and Feely (1960)

Table 1. External and skeletal differences between Ceratotherium and Diceros. (After Cave, 1962).

Character	Ceratotherium	Diceros
upper lip	non-prehensile	prehensile
cervical hump	present	absent
eye/p. horn	eye behind horn	eye level with horn
costal grooving	absent	marked
mid-dorsal concavity	short	long
no thoric-lumbar vertebrae	22	23
no rib-bearing vertebrae	18	20
cranium shape	dolicocephalic	brachycephalic
adult nasal bones	greatly expanded	minimally expanded
infra-orbital foramen	single	variable 1 - 3
formen ovale	temporo-sphenoidal	intrasphenoidal
incisors	absent	present in young

8.2 Differences between C. s. simum and C.s. cottoni.

The northern population was first recognised as a distinct sub-species by Lydekker in 1908. Heller (1913) considers the greater concavity in the dorsal outline of the skull of C.s. simum the only valid difference, but Lang (1920) doubts whether even this criterion is sufficient to recognise the two populations as sub-species.

8.3 The size of C. simum.

C. simum has been accepted by most authorities as the largest land

to Ceratotherium (Kirby, 1930; Pitman, 1951;), while Roosevelt and Heller (1914) believe that the hippopotamus Hippopotamus amphibis Linn. exceeds Ceratotherium in weight.

The shoulder height of C. simum bulls has been quoted as from 5'5" (Roosevelt & Heller, 1914) to 6'9" (Coryndon, 1894). Most figures given in the earlier literature are in the vicinity of 6'6" (Harris, 1840; Bryden, 1897; Selous, 1899; Coryndon, 1894) but data from perhaps more accurately measured specimens range from 5'7½" to 6'1" (Foster, 1960).

The overall length of C. simum has been quoted as long as 16 feet (Coryndon, 1894) but four adult male and female specimens measured by Forster (op.cit) ranged from 11'0" to 12'5". The weight of these individuals was estimated as between 3½ to 4 tons.

3.4 Skull and dentition.

The basic differences between the skulls of the Rhinocerotidae have been described by Gray (1867), Flower (1876), and Pocock (1945), while Zeuner (1934) gives an excellent account of the evolution of the various adaptive modifications in rhinoceros skulls.

Until very recently material of C. simum was very rare in museum collections and the distribution of skulls and other material has been reported on by Burchell (1817a), Gray (1821, 1867), Jentink (1890), Holland (1901), Nehring (1901), Lydekker (1911), Schoutenden (1911), Lönnberg (1920) and Flower (1929).

The permanent tooth formula for C. simum is $\frac{0}{0}$, $\frac{0}{0}$, $\frac{4}{4}$, $\frac{3}{3}$, pm $\frac{1}{1}$ not being replaced. Further details may be obtained from Bigalke et al (1950), van den Bergh (1955) and Vialli (1955).

3.5 Horn

In common with Diceros bicornus, Ceratotherium simum has two "horns", or more correctly, horn-like appendages composed of closely matted hairs arising from the epidermis covering the snout. The anterior horn is typically much longer than the posterior, but on occasion the former or both may be missing (Lydekker, 1907; Player and Feely, 1960).

The longest horns given by Rowland Ward's latest records (Best, 1962)

Table 2. Record lengths, in inches, of C. simum horns. (After Best, 1962).

Anterior horn	Posterior horn	Locality	Owner
(a) C.s. simum			
62¼	22¼	S. Africa	W. Cordon-Cumming
56½	23½	S. Africa	British Museum
50¾	25	S. Africa	W.N. McMillan
(b) C.s. cottoni			
47½	13½	C. Afr. Rep.	Paris Museum
45¾	24½	Lado	C. Spinks
43½	-	Lado Enclave	S.H. Carnelley

Pitman (1931) states that Schillings mentions a horn of 81 inches but this record has not been substantiated.

Horn length has been used by some African tribes to distinguish between two forms of C.s. simum. Cumming (1850) states that the Bechuanas talked of the "muchocho" or common white rhinoceros, and the "Kobobo" or long horned white rhinoceros. Drummond (1875) notes that the Zulus also distinguish two forms, a much larger "kulumane" and the common "umkawe".

Even eminent taxonomists have been led astray by the size and shape of Ceratotherium horns. Gray (1855) described R. oswellii on the basis of a single anteriorly bent horn. Sclater (1871) illustrated several malformed horns and cast doubt on the validity of Gray's R. oswellii.

Appelman (1959) and van den Bergh (1959) have described the horns and related skull modifications of C.s. cottoni, while general notes on the horns of the northern sub-species have been given in the excellent papers of Heller (1913) and Lang (1930).

The composition and alleged properties of rhinoceros horn is duscussed by Ryder (1962).

8.6 Skin

The folds in the thick "pachydermis" skin of C. simum have been described by Hirby (1930). An topical note on the skin [illegible]

skin is shed twice, firstly at an age between 1½ and 4 months, and then again at about 10 months.

The colour of C. simum's skin has been a very controversial subject, references to it are too numerous to review here. At best it may be described as a dark grey, in living specimens, and dark brown in mounted specimens (Player and Feely, 1960). In practice however, the colour of a rhinoceros' skin depends essentially, in the words of Drummond (1876) "on the kind of mud they may have been wallowing in last."

2.7 Nuchal hump.

Selous (1881, 1899) was one of the first authorities to mention the presence of a large hump on the dorsal part of C. simum's neck. Selous was mainly interested in the culinary value of this hump, but later workers have concerned themselves with the composition and purpose of this feature unique to Ceratotherium within the Rhinocerotidae.

Heller (1913) suggested that it was purely muscular in structure. Kirby (1920) and Lang (c. 1935) were of much the same opinion, the latter author stating that the nuchal hump is "caused by the presence of an immense band of muscle which extends from the Occiput to the remarkably high vertebral process."

That the structure is purely muscular was doubted by Bigalke etal (1950) who found that it develops from three nuchal callosites which grow together and fuse with age. On a basis of an anatomical investigation into the structure of the nuchal hump of a specimen of C.s. cottoni, Cave and Allbrook (1959) state that it is merely a local augmentation of the dermis. A more thorough study by Alexander and Player (1963) on C.s. simum specimens, indicates that the structure is more complex, comprising an outer dermal and epidermal covering, a layer of subdermal fat and muscle tissue together with a much hypertrophied nuchal ligament.

Alexander and Player (1963) make the interesting suggestion that the nuchal hump is a consequence of the better developed elevator muscles and a hypertrophy of the nuchal ligament required by C. simum due to its great heavy head and grazing behaviour.

8.8 Extremities

The limbs of C. simum are short and stocky, terminated by three broad nailed hooves. These leave an unmistakeable track, that of the forefeet being roundish, that of the hindfeet oblong (Lang, 1920). Player and Feely (1960) report that the nails of new-born rhinoceroses are worn off at about 9 months (forefeet) and one year (hindfeet) and replaced by permanent hoof nails.

The ear conch of C. simum is much more elongated and sharply pointed than that of D. bicornis, while the apical margin is clothed in a tuft of hairs (Sclater, 1886).

The tail of C. simus, is also tipped in hairs, and when alarmed or urinating, the tail is curled over its base (Player & Feely, 1960).

8.9 Internal anatomy

Cave (1947, p.142) very rightly stated that "apart from dentition and osteology, the internal anatomy of this creature remains unknown".

Since that date Cave and co-workers have published several papers on variousaspects of rhinoceros anatomy, viz: on the foramen ovale (Cave, 1959);on the skin and nuchal eminence (Cave and Allbrook, 1959);on visceral histology (Armonier and Cave, 1960); on lymph-node histology, (Cave 1963); and on the processes glandis (Cave, 1964).

9. REPRODUCTION

9.1 Sex and age determination.

Knowledge of the sex and age ratios in animal populations is essential to any study of reproductive behavior. Unfortunately the literature on this aspect of C. simum's biology is especially sparse. Very few authors have described sexual criteria, fewer still have given data on age determination.

Sexual dimorphism is very poorly developed, and one needs experience to distinguish sex in C. simum without reference to genetalia. The horns of females are often thinner but longer than those of males, while the males are usually larger in overall size, and have bigger nuchal humps./ (Daniels, 1967).

Bigalke et al (1950), van den Bergh(1955), Player and Feely (1960),

... four age classes, calves of the year, juveniles, sub-adults and adults, on a basis of overall size rather than absolute age.

9.2 Herd structure.

The number of individuals in a group of C. simum has been described as ranging from "... never associated in herds, but are met with singly or in pairs ..." (Cumming, 1850, 1 : 252) to ".. herds of up to 24 have been seen.." (Happes, 1958b : 275).

More usually family groups consist of a bull, cow, a sub-adult and a calf of the year (Coryndon, 1894; Ionides, 1953; Ripley, 1958). Territorial behavior and home range of these breeding groups will be discussed later.

9.3 Breeding season.

There is considerable difference in opinion regarding the presence or absence of a breeding season. Lang (1920) and Ripley (1958) consider that there is no breeding season, mating and calving occurring at all times of the year. According to Pitman (1931), calving occurs at the end of the year, after burning of the grass; Hoppes (1958b) also in reference to C.s. cottoni gives February to May as the calving period. Selous (1899) gives the calving period for C.s. simum as August; Player and Feely (1960) state that the cows are in oestrus from July to September. It would appear that, like most biological phenomena, there are no hard and fast rules regarding the breeding periodicity in C. simum.

9.4 Mating behavior.

The best account of the mating behavior in C. simum is that of Player and Feely (1960). They state that no ritualized courtship occurs, but fighting between rival bulls is frequent, often with fatal results, (see also Hoppes, 1958; Pitman, 1956). The male places both feet on the female's back, and copulation may last over an hour (Player & Feely, 1960).

9.5 Gestation.

The first estimate of gestation period in C. simum appears to be that of [illegible]

but in the same journal, Foster (1960, p.38) gives 19 months. Perhaps the most accurately determined figure is that of Addendorff (1967) who gives 16 months.

9.6 Calving.

Player and Feely (1960) stated that cover is required by C. simum for calving, and Kirby (1920) notes that natives say that cows go into hiding and conceal their calves for several months after birth.

... case of twins was suspected by Selous (1899) and definitely observed by Player and Feely (1960). Lang (?) states that orphaned calves are adopted by other cows.

Weaning, according to Lang (1920) is surprisingly early, calves being independent of their mothers for nourishment after six weeks. Despite this, calves remain in company of the parents for a considerable time, until almost adult size.

Calves are extremely attached to their mothers, numerous accounts having been given of calves warding off strangers from dead cows until they themselves succumb or are captured (Coryndon, 1894; Selous, 1899; Player and Feely, 1960; Foster, 1960).

The feeding and development of calves in captivity is described in detail by Bigalke etal (1950) and van den Bergh (1955, 1958).

9.7 Puberty and calving frequency.

The age of sexual maturity in C. simum does not appear to have been accurately determined although studies on captive specimens must have provided data yet unpublished. Lang (1920) suggested that first breeding occurs at an age of 4 to 5 years, Heppes (1958b) suggests that oestrus commences in about the third year, while Asdell (1946) quoting Kirby (in litt.) states that puberty occurs at an age of 4 to 5 years. (There is an interesting correlation in the data given by Lang 1920, and Kirby!)

Player and Feely (1960) state that oestrus occurs every two years in some cows, every four in others, in C.s. simum. Heppes (1958b) suggests oestrus occurs every three years in C.s. caffer.

three years since puberty, it would have borne approximately ten calves, but this would no doubt be exceptional. However, as Lang (1920) stated, the breeding potential of C. simum is obviously far higher than often suggested, and would explain the almost explosive increase in the Zululand population in recent years.

10. NUTRITIONAL REQUIREMENTS.

10.1 Food type and consumption.

As noted in the section on habitat and niche, C. simum is essentially a grazer, "very partial to the young grass which springs up after the old grass has been burnt off" (Kirby, 1930). Although C.s. simum lives in grassveld dominated by Themeda triandra, they only eat this after a burn, or in drought, being far more fond of the "sweeter" types such as species of Urochloa, Panicum and Digitaria (Player and Feely, 1960). Player (1962) lists Urochloa mossambicensis, Panicum maximum and P. deustum as being grazed short by C. simum in Umfolozi Game Reserve.

During droughts when grass is scarce, C.s.simum have been observed feeding on small shrubs and succulents including Opuntia sp. (Bigalke, 1963) and Sarcostemma viminale (Foster, 1960). A remarkable observation was made by Lotley (1962) who observed a bull C.s. simum chewing and swallowing the bark of Schotia brachypetala.

Bigalke (1961) gives the daily consumption of three specimens of C.s. simum kept in captivity as :-

Dry lucern....	60 lbs.	Cut oat hay....	75 lbs.
Bran mixture..	20 lbs.	Crushed maize..	10 lbs.
Bread	6 lbs.	Vegetables.....	20 - 30 lbs.

No reports on the specific composition of the food eaten by C.s. coutoni in the wild have been seen, but van den Bergh (1952, 1955) gives details of the feeding of captive specimens.

10.2 Adaptations to the grazing habit.

Carpmdon (1894 p. 331) notes that "... it is a puzzle how he manages

rather slight nutritious quality in the digestive organs are enormous, a 'living steam boiler'...".

That the second largest mammal in the world has been able to survive on a diet of grass has been made possible by numerous adaptations to the habit. These include modifications of the upper and lower lips, the molar and premolar teeth, skull shape and articulation, neck musculature and digestive system. The most important paper on the skeletal modifications is that of Zeuner (1934), while Alexander and Player (1962) discuss modifications of the musculature.

10.3 Influence on the vegetation.

Very few authors have commented on the influence of C. simum on the vegetation of its habitat. This is no doubt due to the relative scarcity of the species within most of its range, and consequent very low grazing intensity. C.s. simum favours the sweeter grasses of shaded sites, with the result that trampling and overgrazing hasten the spread of forest. Since the extinction of elephant in the region over 100 years ago, the spread of forest in grassland has not been checked, to the detriment of C.s. simum's range. (Player and Feely, 1960).

10.4 Drinking.

Bigalke etal (1950) state that a captive female calf was not seen to drink water until 154 days old. The calf was receiving a large quantity of milk, however, and possibly did not require other liquids.

In the wild, it appears that C.s. simum drinks once a day, but can possibly do without water for two days on occasion (Player and Feely, 1960). The time of day at which C. simum drinks obviously varies with season and locality.

Selous (1899) states that they drink just after sunset, but in the dry season, when water is scarce, they congregate around waterholes at night. Coryndon (1894) says they don't go down to water until after midnight, while Kirby (1940) says they drink between midnight and 6 a.m., and occasionally between 3 and 10 a.m.

C.s. simum usually at night in winter, but at all hours of the day in summer (Player and Feely, 1960). These workers note that the water utilized in this Reserve is rather brackish, and they consider this an important source of minerals for C.s. simum as salt-licks are not provided.

Kirby (1930) working in the same Reserve states that they drink at fresh streams, in which they don't wallow, however. That C. simum is reluctant to enter rivers has been noted by most workers familiar with their behavior, Pitman (1931) and Hoppes (1958b) observing this in C.s. cottoni and Player and Feely (1960) in C.s. simum.

The wallowing behavior of C. simum will be discussed later.

11. GENERAL BEHAVIOR

11.1 Movements.

"In the afternoon, as the sun got low, they would waken up and begin to feed down to the water,..." (Selous, 1899 p.59). The daily movements of C. simum are primarily between their grazing, resting and watering grounds. Kirby (1930) states that they feed up against the wind, and after drinking walk about 3 - 4 miles before starting eating again. These trips to and fro result in ... "well worn highways, but the daily ten to twenty mile stroll of rhinoceroses endows their haunts with good trails, welcome to all" (Long, 1930 p. 86).

C. simum often seek shelter during windy or cold weather, moving out of the open into cover, or in hot sunny weather, into shade after a wallow (Player and Feely, 1960). Long (?) notes that during hot summer days they move onto the higher ridges or summits while they can catch a cool breeze, and avoid biting flies.

Regular seasonal movements have not been observed in C. simum, but in drought conditions they certainly do move off their normal range in search of food and water (Player and Feely, 1960), and have been noted 25 miles from their normal haunts (Anon, 1964).

Besides the movements forming part of their normal daily activities, it is important to note the behavior of C. simum when alarmed. A sleep-

Once standing, a group of alarmed C. simum, will "immediately raise their heads and ears and stand with their buttocks touching, facing in different directions" (Player and Feely, 1960). These workers also note that C. simum will break away from where they think the danger may be. When moving, the head of C. simum is held very low, almost touching the ground (Selous, 1881) and the calf runs in front of the female (Cumming, 1850).

The speed at which C. simum can gallop has been variously cited as "no match for an averagely good horse" (Selous, 1881), up to 16 miles per hour in short bursts (Potter, 1949), 20 m.p.h. (Foster, 1960), and "gallop for short distances at 25 miles per hour" (Player and Feely, 1960).

11.2 Home Range and Territory.

Few aspects of C. simum's biology are less well documented than the species home range and territorial characteristics.

"There is only the vaguest evidence that the species has anything more than a broadly defined home range" (Ripley, 1958 p.173). It is clear that such features as grazing grounds, wallowing and drinking pools, dung heap and rubbing posts are essential components of C. simum's home range, but that distinct areas are occupied by different family groups has not been shown. Player and Feely (1960) state that during the rainy season when all requirements are available, C.s. simum may remain in an area of twenty to thirty acres, until some requirement runs short.

Indications that C. simum do occupy restricted territories for at least some part of their lives have been noted by Pitman (1956), Micha (1958) and Ripley (1958). None of these authors actually state that territories are definitely protected. Considerably more research in this field is obviously required.

11.3 Senses

Lang (1930, p.71) notes that "the obscurity of night enshrouds their most active phases..." while Mich (1958 p. 114) states "De

... some part of the night in various activities.

But despite the fact that they are partially nocturnal in behavior, C. simum's eyesight is well known as its weakest sense, (Kirby, 1920).

Potter (1949) notes that smell and hearing are very good, and Player and Feely, (1960), state that it is "... most probable that olfactory stimuli make up the greatest part of the animal's external world." Kirby (1920) notes that C.s. simum can smell a person from half a mile, but can only see a stationary object at 25 to 30 yards.

Lang (?) states that the only sounds made by C. simum are "a loud snorting sniff and the grunting squeals of a dying animal" and the "shrill whistling cries of a calf deprived of its parents". Coryndon (1894) compared the cries of a calf to the whinning of a terrier pup. Player and Feely (1960) noted a wide variety of vocalizations by C.s. simum, including the squeaking and shrieking of calves, puffing and snorting of cows, grunting, snorting, trumpetting, rumbling and bellowing of bulls.

11.4 Wallowing

Wallowing in muddy pools is one of the oldest known habits of C. simum and may indirectly be responsible for the best known common name "White Rhinoceros" due to the first specimens seen having a coating of whitish clay. The habit appears to be necessary for the well-being of the animals, Lang (1920) states that when the wallows dry up, the animals migrate, Pitman (1931) also noting this, and he states that C.s. cottoni is also partial to rolling in sandy river beds. This is also reported in C.s. simum by Player and Feely (1960). These authors also give details on the heat regulation in C.s. simum with reference to their wallowing behavior. Foster (1960) gives evidence of a change in the wallowing "time-table" of C.s. simum due to the influence of tsetse fly eradication.

11.5 Defecation and urination

may occasionally return to the same place to defaecate. Pitman (1931) and Liche (1953) notes that C.s. cottoni daily returns to a well used midden, scattering the deposits with its hind limbs. Attwell (1948) also notes the use of communal heaps. Studies on a captive female by Bigalke etal (1950) led them to believe that the dung of C.s. simum, deposited three times per day, was not scattered by the scraping movements made by the species' hind limbs. They also note the occurrence, at night, of coprophagy. Ripley (1958) and Player and Feely (1960), also noted scratching with the hind limbs before and after defaecation, but do not state whether this action is performed to flatten the dung. Player and Feely (1960) and Bigalke (1961) state that the horn is definitely not used to scatter the dung in middens. Lang (?) however, quotes an incident where he observed a bull C.s. simum interfering with the dung of females, using its horn to do so. This dung was not in a heap however. Player and Feely (1960) consider that the position and presence of large dung heaps may be completely fortuitous, and give a list of reasons why they are always associated with certain paths. They also give an excellent account of the animal visitors, invertebrate, mammalian and avian, to the large dung heaps.

Urination iseffected with the tail curled up and the legs straddled as in defaecation (Bigalke etal,1950) In the male, the penis is directed backwards between the hind limbs and the urine ejected as a spray, (Player and Feely, 1960). This phenomenon is illustrated in van den Bergh (1952, 1958).

Urination may be used as a territorial marker by C.s. cottoni, which often urinates on grass (Liche, 1953, p. 114), Ripley (1958, p. 174) states that a dung heap "may serve as a sort of family bulletin board... it may serve as a territorial marker."

11.6 Associations with other animals.

The important role played by the Red-billed oxpecker in warning C. simum of approaching danger was well known to the early hunters (Collons, 1871). These birds, closely related to the [illegible] and water turtles, are

...ely, 1960). Birds collecting insects disturbed by the large mammals include the cattle egret and carmine bee-eater (Verschuren, 1968).

The behavior of C. simum in the presence of other animals has rarely been described, possibly due to their extremely tolerant nature. No instances of C. simum attacking other animals (excluding man) have been reported. The only incidence of predation on C. simum is the calf killed by leopards reported by Lang (1920).

C. simum has, as already noted, always been considered a very placid and timid animal. Cases of deliberate, premeditated attacks on man have never been substantiated. When injured, or in heat, the animals can attack on being disturbed, Oswell (1894) having his horse transfixed by a C.s. simum's horn, and Pitman (1956) reporting a fatal attack on an African woman by C.s. cottoni. In most cases however, where C. simum charge down upon observers, it is usually due to the former's poor vision and alarm than a definite attack.

12. MORTALITY AND LONGEVITY

12.1 Death rate.

The true death rate of C. simum has not yet been established. Player and Feely (1960) state that thirty-two animals were known to have died in the period 1952 to 1957. If this figure is compared with the census figures for the same period (given above) it appears that the minimum death rate is about one per cent per annum. Player and Feely (1960) consider that the thirty-two animals recorded was only a fraction of the true mortality due to the habit of injured and dying animals usually seeking thick cover and therefore concealing the carcase.

12.2 Causes of death.

Of the 32 carcases reported by Player and Feely (1960), most deaths were apparently due to wounds inflicted in fighting.

The Annual Reports of the National Parks Game and Fish Preservation Board contain numerous records of accidental deaths, such as drowning in floods, ...

in the early 1930's "over 100 rhinos are known to have died." They do not state which species were concerned but it may be assumed that C.s. simum were lost during the period.

The only record of predators being responsible for the death of C. simum is that given by Lang (1920) where he notes a young C.s. cottoni calf killed by leopards.

12.3 Parasites, diseases and sores.

The first report of internal parasites in C. simum appears to be that of Rodhain and Bequaert (1919) who studied the life cycle of the oestrid fly (Gyrostigma pavesii). Lang (1930) states that the hide of C. simum is considered too thick to horseflies (Haematopota) to penetrate, but the very small blood sucking fly Lyperosia causes infection and retards healing of sores. Zumpt (1950) described a new species of blood sucking fly, Rhinomusca dutoiti which he found breeding in the dung of C.s. simum.

In a detailed paper discussing the parasites of the African rhinoceroses Zumpt (1964) lists 34 species of ticks collected from these animals. Unfortunately he does not indicate which species of rhinoceros they were collected from. Guglisberg (1966) gives a list of ticks from C. simum, including Dermacentor rhinocerinus, Amblyomma rhinocerotis s. hebraeum, A. variegatum, Rhipicephalus maculatus and R. simus.

Lang (1930) states that nematodes are often abundant, and also especially the short tape worm Taenia sp., but that "they seem to be rather a sign of good health, instead of a serious plague." Zumpt (1964) lists numerous nematodes from both species of rhinoceros, and one cestode, Anoplocephala vulgaris.

Although numerous species of parasites have been collected from the African rhinoceroses, ".. nothing is known of any diseases caused by these parasites.." (Zumpt, 1964, pg.70).

According to Hoppes (1968) C. simum does not appear to suffer much from natural disease. They did not appear to be affected by a rinderpest outbreak in 1962/64 and although they suffer from occasional minor

Injury to the naso-lacrimal duct with subsequent blocking of the duct and infection of the ocular area, and softening of the skin in the vicinity of the eye due to abnormal drainage of tears, has been reported from several C.s. simum by Young (1965). Although lesions in the vicinity of the eye may cause blindness, it is evident that C.s. simum can survive quite happily even when totally blind, as indicated by blind adult specimens captured during the "Operation Rhino" campaign in Zululand (Keep, 1967, personal communication).

13.4 Longevity

Very little is known of the maximum age to which C. simum can live, for unlike most other large mammals it was not until 1946 (Broom, 1946) that a specimen was obtained for a zoo. Fortunately the animal in question, "Zulu-ma" was captured a day after birth and an exact record has been kept of her development (Bigalke et al, 1950). At the time of writing (20.7.67) she is celebrating her 21st birthday and is in excellent health.

The oldest known C. simum is a female reported by Player and Feely (1966) to be 36 years old, yet still bearing calves.

13. COMMERCIAL VALUE

13.1 Past.

In contrast to most other African big game species, C. simum never offered the early hunters sufficient challenge to become well-known as a sporting animal. The ease with which C. simum can be shot is immediately apparent to anyone who has observed them in the field. It is therefore difficult to imagine what enjoyment Anderson (1856) or Chapman (1868) could have derived from slaughtering up to eight at a waterhole in a night, or how Oswell and Vardon (Brydon, 1897) could have destroyed 89 specimens of C. simum and D. bicornis in a single season. Kirk (1864, p. 656) rightly stated that C. simum was "..the first animal that disappears before firearms...".

Some [illegible] from C. simum [illegible]

preferable to beef". This opinion was confirmed by Selous on numerous occasions (Selous, 1881, 1895, 1899). It is very interesting to note that Foster (1960) states that the natives of the Umfolozi area, where the last remnants of the once widespread C.s. simum persisted, never ate the meat of the animal, due to custom. As they did not make much use of any other part of the animal it is not surprising that the sub-species managed to survive in the region.

By far the most valuable, and most exploited product of C. simum is its horn, regarded by Oriental peoples as having strong aphrodisical power (Ryden, 1962). But the horn has not always been used as a love-charm, the southern sub-species was exterminated for other values attributed to the horn. Cutting (1850) notes several uses to which the horn was put by the natives, for cups, mallets, handles, etc. Harris (1852) records that the warriors of Moselikatzie carried throwing clubs fashioned from rhinoceros horn. Bryden (1893 p. 493) notes that "every chief's ambition was to possess a long kerrie or staff fashioned from the fore-horn of this beast".

The death-blow came to C.s.simum in Central Africa in the 1880's when the horn suddenly became popular in England, one trader in Matabeleland employed four hundred natives to shoot the animals, (Selous, 1899).

The demand by Orientals for horns most certainly has been the main factor explaining the decimation of the northern sub-species. In 1916 over one hundred horns were seen in a store in Aba (Christy, 1923), while in 1927 Babault saw 150 horns in Khartoum (Harper, 1945).

Despite rigid legislation for the protection of both sub-species, numbers of C.s. ~~simum~~ C. are still being shot and Roedelberger and Groschoff (1964) state that a pound of horn fetches £4.15.0 at the port of exit.

13.2 Present.

Despite the small trade in rhinoceros horn continuing to this day, the real commercial value of C. simum [illegible]

of rhinoceros products, today the sales are between Wildlife Conservation Boards and bona-fide zoological gardens and similar institutes.

Since the inception of "Operation Rhino" in 1961 over 458 C.s. simum have been captured for distribution to various parts of Southern Africa and overseas zoos (Potter, 1967). Sales to the latter have brought in over R550,000 into the South African economy (Steele, 1967). The capture of C.s.simum in Zululand today can only be described as highly refined art, initiated by Hartboorn (1962) in 1961 and since perfected by a team of extremely competent rangers.

Prior to the use of immobilizing drugs, C. simum had been captured on several occasions with the aid of ropes and brute force. The first specimen of C. simum ever captured would appear to be that noted by Drummond (1875, p. 115). He describes the capture of a calf of the "Kulumane" variety of "white" rhinoceros in Zululand. Whether this was definitely C.s. simum is open to question, however, for although he notes that the "Kulumane" eats only grass, the calf was "remarkably partial to the leaves of the umguni tree..." and also ate the leaves of the "umtabit". These names apparently refer to Sclerocarya birrea and Ziziphus mucronata, which have not been observed being eaten by C.s. simum but are readily consumed by D. bicornis.

Coryndon (1894) notes the capture of a C.s. simum calf in Mashonaland, and Ferguson (1949) records the capture of a young C.s. cottoni in the Sudan. None of these animals were successfully reared however. The translocation of C.s. cottoni in Uganda after capture with ropes has been described by Blower (1961).

The first C.s. simum ever kept in captivity was captured when a day old in 1946. (See Broom, 1946; Bigalke, 1947, 1961; Bigalke et al 1950; Schuck, 1947, 1950; and Young, 1965). The first C.s. cottoni kept in captivity has been exhaustively described by van den Bergh (1952, 1955). General notes on C. simum in captivity have been given by Reynolds (1961), Bridges (1962) and Crandall (1964).

The value of C. simum today is therefore essentially aesthetic, [illegible]

The almost unbelievable increase in the Zululand population of C.S. simum poses an interesting, if difficult, problem. While the market lasts a fair number of specimens can very profitably be sold to overseas menageries, and at less profit, be distributed to other reserves in Africa. But it is becoming increasingly obvious that the day is fast approaching when some other method of control will have to be applied if the population is to be kept within the limits set by the range carrying capacity. The increase has continued almost unabated since the turn of the century, it does not have the characteristics of a cyclic trend of abundance. One can only hope that this explosion is rigidly, albeit artificially controlled, and the "affair Kaibab" is not repeated.

The past and present distribution and numerical status of C. simum has been fully described in earlier sections of this paper. The changing pattern of the species' distribution in historic times has been essentially a factor of the protection, or rather the lack of protection, afforded it by man.

Strict laws protect C. simum throughout its present day range. The execution of the laws passed to protect the species is carried out with widely varying efficiency however. Recent reports on the status of C.s. cottoni are rather conflicting (see 7.3 above) but it does appear that the subspecies is receiving sufficient protection to survive and in fact increase, despite the political instability throughout most of its range.

C.s. simum has been afforded a sanctuary ever since the proclamation of the Umfolozi Game Reserve in 1897. Protection was followed by an initially slow, but more recently phenomenal increase in the population. Player and Feely (1960) describe the legislation passed for the sub-species, protection in detail, and note that in ten years only one individual has been illegally killed, an indication of the efficiency with which the legislation has been effected in the Province. Thirty years ago Dollman (1937) reported that C.s. simum was in a fairly firm position.

"Today, as a result of sound conservation measures, a sub-species once on the brink of extinction, has been restored to abundance." (Anonomous, 1958).

15. CURRENT AND CONTEMPLATED RESEARCH

The bibliography given at the end of this paper may give the impression that a wealth of information is known about C. simum. The position is quite the reverse however, Of the vast number of words that have been written on the species, perhaps not more than ten per cent come from the hand of the original observer, the rest from compilers of popular accounts and general reviews such as the present paper. That information which is available largely concerns the species' former

A vast field of basic research has yet to be covered. Two factors have accounted for the paucity in our knowledge of the species' biology. Firstly, the rarity of working material, and secondly, as always, financial limitations. Both these problems have been solved by the animal itself. In Natal C.s.simum is so abundant today that a dozen specimens could be collected for anatomical and other studies without detriment to the population. Secondly, the export of captive specimens has brought in over R350,000 during the last five years. If only a minor percentage of this revenue were used to finance studies on the animals biology, it would be of lasting value to the species' conservation. It is therefore encouraging to learn that the Natal Parks Board is presently planning a long term study of C.s.simum.

16 BIBLIOGRAPHY

The list of references given below includes those cited in the text plus numerous other publications dealing with C.simum. Although not claiming to be completely up to date, the bibliography contains perhaps 90% of the available literature on the species, and over twice as much as is given in the Zoological Record.

1. Acocks, J.P.H. 1953 Veld types of South Africa. Botanical Survey of South Africa, Memoir No28: 1-192.

2. Adendorff, G. 1967 Veldwagter sien hoe witrenoster ma word. Die Vaderland, 15 March 1967.

3. Alexander, A and Player, I.C. 1965 A note on the nuchal hump of the square-lipped Rhinoceros, Ceratotherium simum simum (Burchell). Lammergeyer 3 (2) : 1-9

4. Andersson, C.J. 1856 Lake Ngami London.

5. Anonymous 1956 et seq. Annual reports of the Game Department, Uganda.

6. Anonymous 1954 Annual report of the Natal Parks, Game and Fish Preservation Board.

7. Anonymous 1956 Annual report of the Natal Parks, Game and Fish Preservation Board.

8. Anonymous 1962 Atlas of Uganda. Dept. of Lands and Surveys, Entebbe: 1-79

9. Anonymous 1963 Les effectifs mondiaux des cinq espèces de rhinocéros Terre et la Vie 110 : 102

10. Anonymous 1965 IUCN Bulletin 15 : 5

11. Ansell, W.F.H. 1959 The possibility of the former occurrence of the white rhinoceros in the Barotse Protectorate. Afr. Wild Life, 13 : 330

12. Ansell, W.F.H. 1960 Mammals of Northern Rhodesia. Lusaka, Government Printer. xxi + 155

13. Ansell, W.F.H. 1967 Perissodactyla. In Meester, J. (ed) Smithsonian Institution Preliminary Identification Manual for African Mammals. Washington: Smithsonian Institution.

14. Appelman, T.J. 1 [illegible] Ceratotherium

15. Arambourg, C 1931 Sur la longévité en Afrique du Nord, du genre Rhinocéros pendant la période quaternaire.
C.R. Acad. Sci. Paris 192 : 1044 - 1046

16. Arambourg, C 1939 Mammifères fossiles du Maroc.
Mém. Soc. Sci. nat. Maroc, Natat. 46 : 1 - 72, 8pls, 15 figs.

17. Arambourg, C 1948 Contribution à l'étude géologique et paléontologique du bassin du lac Rodolphe et de la basse vallée de l'Omo,
Mission Scientifique de l'Omo 1932 -33, 1 (3) 231 - 562.

18. Asdell, S.A. 1946 Patterns of Mammalian Reproduction
New York, Cornstock Pub. Co., Inc
x + 437

19. Astley Maberly, C.T. 1938 With the White Rhinoceros in Zululand.
J. Soc. Pres. Fauna Emp. 34 : 52 - 55

20. Astley Maberly, C.T. 1963 The Game Animals of Southern Africa.
Cape Town, Nelson. x + 292

21. Attwell, R.I.G. 1948 Last strongholds of Rhinoceros
Afr. Wild Life 2, (3) : 33 - 52, 55 photos

22. Aumonier, F.J. and Cave, A.J.E. 1960 A note on the visceral histology of Ceratotherium
J. roy. micr. soc. (3) 78 : 120 - 211, 2pls.

23. Baines, T. 1864 Explorations in South-west Africa.
London.

24. Balsen, F. 1954 Capricorn Road
London : Arco. Publ. Co.

25. Barnard, A.M. 1952 The Naboveld Expedition. Some interesting observations.
Afr. Wild Life 6 : 70 - 79

26. Barrow, J. 1801 An Account of Travels into the Interior of Southern Africa in the years 1797 and 1798 Vol.I
London : T. Cadell Jun. and W. Davies.

27. Barrow, J. 1802 An account of Travels into the Interior of Southern Africa in the years 1797 and 1798
New York: C.F. Hopkins

28. Beaux, C. de. 1925 Su alcuni Mammiferi del Congo Belge, raccolti dal Dott. A. Rosai.
Atti. Soc. Ital. sc. nat. Milano 64 : 67 - 96.

29. Beddard, F.E. 1902 Mammalia [illegible] natural

30. Bere, R.M. 1962 The Wild Mammals of Uganda
London, Longmans XII + 148

31. Best, G.A. (Ed.) 1962 Rowland Ward's Records of Big Game.
XI Edition (Africa).
London: Rowland Ward Ltd.

32. Bigalke, R. 1947 Pretoria Zoo has a baby White Rhinoceros Animal Kingdom,
New York 50 : 54 - 55 3 photos

33. Bigalke, R. 1961 White Rhinos at Pretoria Zoo.
Int. Zoo Year B. 2 : 43 - 44

34. Bigalke, R. 1963 The extermination of the square lipped or white rhinoceros (Ceratotherium simum simum (Burch.) in Transvaal and its reintroduction.
A historical and critical review.
Fauna and Flora 14 : 5 - 14,
1 pl, 1 map.

35. Bigalke, R., Steyn, T., De Vos, D., and Waard, K. 1950 Observations on a juvenile female square lipped or white rhinoceros (Ceratotherium simum simum (Burch.) in the National Zoological Gardens of South Africa.
Proc. Zool. Soc. Lond. 120
519 - 528 3pls.

36. Blancou, L. 1958 Notes sur les mammifères de l'Oubangui Chari. Les Rhinocéros
Mammalia 2 : 111 - 119 map

37. Blancou, L. 1948 Notes sur les mammifères de l'Oubangui Chari. Quelques precisions geographiques au sujet des Ongulés.
Mammalia, Paris 12 : 1 - 14

38. Blancou, L. 1960 Destruction and protection of the fauna of French Equatorial and of French West Africa
Afr. Wild Life 13 : 2?3 - 299

39. Bleek, D.F. 1930 Rock Paintings in South Africa

40. Blower, J.H. 1961 Operation rhino
Wild Life and Sport, 2 (2) :
5 - 10 illus.

41. Bourgoin, P. 1955 Animaux de chasse d'Afrique
Paris : La Toison d'Or

42. Brand, D.J. 1964 Distribution and numeral status of the Southern White Rhinoceros (Ceratotherium simum Burchell) and the Black Rhinoceros (Diceros bicornis Linnaeus) in Southern Africa.
Zoön 2 : 1 - ?

43. Breuning, S. 192? Einige Worte zur Stammesgeschichte [illegible]

44. Bridges, W. 1962 Two square-lipped rhinoceroses come to the Zoo.
Anim. Kingd. 65 : 140 - 150, 7figs

45. Brocklehurst, H.C. 1931 Game animals of the Sudan. Their habits and distribution.
London : Gurney and Jackson

46. Broom, R. 1940 The First White Rhino in captivity.
Nat. Hist. N.Y. 55 (9) :432 - 433
3 photos

47. Bryden, H.A. 1889 Kloof and Karroo
London : Longmans 435pp.

48. Bryden, H.A. 1892 Note on Rhinoceros simus
Field, 80 : 84

49. Bryden, H.A. 1893 Gun and Camera in Southern Africa
London : Edward Stanford 8vo 544

50. Bryden, H.A. 1897 Nature and Sport in South Africa
London.

51. Bryden, H.A.(Ed.) 1899 Great and small game of Africa
London : Rowland Ward Ltd. 1 ol2

52. Burchell, W.J. 1817a? List of quadrupeds brought by Mr Burchell from Southern Africa and presented by him to the British Museum on the 30th September 1817
London : A. Spottiswoode 8pp.

53. Burchell, W.J. 1817b Note sur une nouvelle espèce de Rhinoceros
Bull. sci. Soc. Philom. Paris.
1817 : 95 - 97

54. Burchell, W.J. 1822-24 Travels in the interior of Southern Africa 2vols. London : Longman

55. Carter, H.M. 1965 The Armed Rhinoceros
London : Andre Deutsch

56. Castell-Rueden-Hausen, H. Graf zu 1966 Wild an natuurlewering in Suidwes-Afrika
Unpublished ms.

57. Cave, A.J.E. 1947 Burchell's Rhinocerotial drawings
Proc.Luin. Soc. London 159 :
141 - 146 2pls, 2figs.

58. Cave, A.J.E. 1959 The foramen ovale in the Rhinocerotidae
Proc. int. Congr. Zool. 15 :
419 - 421

59. Cave, A.J.E. 1962 Burchell's original specimens of Rhinoceros simus
Proc. Zool. Soc. Lond. 139 :
691 - 700 4pls.

60. Cave, A.J.E. 1963 The White rhinoceros in Uganda
[illegible]

62. Cave, A.J.E. and Allbrook, D.B. 1959 The skin and nuchal eminence of the white rhinoceros. Proc. zool. Soc. Lond. 132: 99 - 107, 2 figs. 1 pl.

63. Cave, A.J.E. and Aumonier, F.J. 1962 Elephant and rhinoceros lymph-node histology. J. Roy. micr. Soc. 80 : 209 - 214, 2 figs., 2 pls.

64. Chapman, J. 1868 Travels in the Interior of South Africa. 2vols. London.

65. Chapman, A. 192[illegible] The white rhinoceros of the Sudan J. Soc. Pres. Fauna Emp. 2

66. Charter, - 1934 An address ... on the policy of the administration in respect of game preservation in Zululand. Natal Provincial Administration : 1 - 10.

67. Christy, C. 1923 The White Rhinoceros J. Soc. Pres. Fauna Emp. N.S. 3

68. Christy, C. 1924 Big game and pigmies. London: Macmillan & Co., Ltd.

69. Churchill, W. 1908 My African Journey. London.

70. Coryndon, R.T. 1894 On the occurrence of the white or Burchell's Rhinoceros in Mashonaland. Proc. zool. Soc. Lond. 1894 : 329 - 334.

71. Crandall, L.S. 1964 The Management of Wild Mammals in Captivity. Chicago : Univ. of Chicago Press.

72. Cumming, R.G. 1850 Five years of a hunters life in the Far Interior of South Africa. 2vols. London : J. Murray.

73. Dasmann, R.F. 1964 African Game Ranching. New York : Macmillan Co.

Delegorgue, A. 1847 Voyages dans l'Afrique Australe. 2 vols. Paris.

Deraniyagala, [illegible] 1955 The extinct and living sub families of African rhinocerotidae. Spolia Zeylan. 2[illegible] (1) : 13-1[illegible], 3pls.

Dietrich, W.O. 1942 Zur Entwicklungsmechanik des Gebisses der afrikanischen Nashörner. Zentralbl. Min. [illegible] 1942(B) : 2[illegible]7-30[illegible].

Dietrich, W.O. 1945 Nashornreste aus dem Quartär Deutsch-Ostafrikas. Palaeontographica [illegible] (A) : 4[illegible]-[illegible]

Dietrich, W.O. 1949 Nashornreste aus dem Quartär Deutsch-Ostafrikas. [illegible]

80. Dixon, J.E.[illegible] 1964 Preliminary Notes on the Mammal Fauna of the Mkuzi Game Reserve. Lammergeyer 3 (1) : 40 - 53

81. Dixon, J.E.M. 1966 Notes on the Mammals of Ndumu Game Reserve. Lammergeyer 6 : 24 - 40

82. Dollman, [illegible] 1937 Mammals which have recently become extinct and those on the verge of extinction. J. Soc. Pres. Fauna Em., n.s. 30: 67 - 74.

83. Drummond, [illegible] 1875 The Large Game and Natural History of South and South-East Africa. Edinburgh: Edmonston and Douglas.

84. Drummond, [illegible] 1876 On the African Rhinoceros. P.Z.S., 1876 : 109 - 114

85. Ellerman, J.R., Morrison-Scott, T.C.S., and Hayman, R.W. 1953 Southern African Mammals 1758-1951: a reclassification. Brit. Mus. (Nat. Hist.) : 1-363, [illegible] maps.

86. Ennouchi, E. 1948 Sur la présence de Rhinoceros simus dans le sud marocain. C.R. Soc. Geol. France. 1948: 239 - 241.

87. Ennouchi, E. 1949 Répartition paléogéographique des Proboscidiens et des Rhinocérides au Maroc. C.R. Congrès. Internat. Zool. Paris 1948 : 559-560.

88. Ennouchi, E. 1957 Nouvelles pièces d'Hippopotames, de Rhinocéros et d'Eléphants marocains. Bull. Soc. Sci. nat. Maroc. 36: 307-31[illegible] 5 pls. 3 figs.

89. Feely, J. 1962 Miscell. notes... on Square-lipped Rhinoceros. Lammergeyer, 2 (2) 45 - 49.

90. Ferguson, [illegible] 1949 The Carr Hartley Expedition. Sudan Wild Life 1 (2): 27-31, 1fig.

91. Flower, [illegible] 1929 List of Vertebrate animals exhibited in the Gardens of the Zoological Society of London 1828-1927. 1 : 254. London: Zoological Society.

92. Flower, W.H. 1876 On some cranial and dental characteristics of the existing species of rhinoceroses. P.Z.S. 1876 : 443 - 457

93. Flower, W.H. and Lydekker, R. 1891 Introduction to the study of mammals, living and extinct. London: Macmillan.

94. Fock, G.J. [illegible] Distribution of animals on rock-engravings in the [illegible]

96. Frenchkop, S. 1947 Animaux protégés au Congo belge. Bruxelles : I... C.B.

97. Freund, L. 1930 Beiträge zur Morphologie des Urogenital-systems der Säugetiere. Z. Morph.Ökol-Tiere Berlin 17: 417 - 440, 8figs.

98. Gibbons, A. St.H. 1904 Africa from north to south through Barotseland 2: 221 London : John Lane.

99. Glynn, H.T. 1929? Game and Gold. Memories of over 50years in the Lydenburg District. London : Dollman Printing Co.

100. Gowers, W. 1950 The classical Rhinoceros. Antiquity Glos. 24 : 61-71, Figs.

101. Gowers, W. 1952 Early rhinocers in Europe. Ctry. Life, Lond. 111 : 258-260, 4 figs.

102. Grassè, P.P. 1955 Mammifères. Traité de Zoologie 17 (1) : 1124 Paris, Masson.

103. Gray, J.E. 1821 London Medical Repository 15 : 300.

104. Gray, J.E. 1853 Notice of a presumed new species of Rhinoceros from South Africa. P.Z.S., 1853 : 46-47

105. Gray, J.E. 1867 Observations ..... the description of three new species. Proc. Zool. Soc. Lond. 1867 : 1003-1032.

106. Griffith, E. 1827 Cuvier's Animal Kingdom V : 740

107. Grzimek, B. 1958 Die gegenwärtige zahl der Nashörner auf der Erde. Säugetierk Mitt. 6 : 117-120 1pl.

108. Grzimek, B. 1960 Die gegenwärtige Zahl der Nashörner zuf der Erde (Teil2). Säugetierk. Mitt. 8: 21-25,2figs.

109. Guggisberg, C.A.W. 1963 The sanctuaries of the south. Africana 1, 5 : 3-11, 8pls.

110. Guggisberg, C.A.W. 1964 An appreciation of African Rhinoceroses. Animal Kingdom 67: 115 - 21.

111. Guggisberg, C.A.W. 1966 S.O.S. Rhino. London: Andre Deutsch.

112. Harris, W.C. 1838 Narrative of an Expedition into Southern Africa during the years 1836 and 1837. 1st Ed. London.

113. Harris, W.C. 1840 Portraits of the Game and Wild Animals of Southern Africa. London.

114. Harris, W.C. 1852 Wild Sports of Southern Africa 5th.Ed. London, Henry G. Bohn. VI + 359.

115.

116. Hayman, R.W. 1956 The rhinoceros. Zoo Life 11: 2-6, 4figs

117. Heller, E. 1913 The White Rhinoceros. Washington D.C. Smithson. Misc. Collect. 61 : 1 - 77, 30 pls.

118. Heppes, J.B. 1958a The White Rhino. Uganda Wild Life 1 (4) : 29 - 35, 3 figs.

119. Heppes, J.B. 1958b The White Rhinoceros in Uganda. Afr. Wild Life 12 :273-280, 6 figs.

120. Heuglin, von. 1869 Reise in das gebiet des Weissen Nil und seiner westlichen Zuflusse in den Jahren 1862-64.

121. Hewitt, J. 1931 A guide to the Vertebrate Fauna of the Eastern Cape Province 1 Mammals and Birds. Grahamstown, Albany Museum. 256

122. Hill, J.T. and Carter, T.D. 1941 The Mammals of Angola, Africa. Bull. Am. Museum nat. Hist. 78:1-211.

123. Hilzheimer, M. 1925 Rhinoceros simus germano-africanus n. sub.sp. zus Oldoway. Miss. Ergebn. Oldoway-Exp. 1913 new series 2 : 45-79

124. Hitchens, P. 1967 Personal Communication. Umfolozi Game Reserve, P.O. Mtubatuba

125. Hobley, C.W. 1931 The Rhinoceros. J. Soc. Pres. Fauna Emp. (N.S.) 14: 18-23.

126. Holland, W.J. 1901 The Carnegie Museum. Pop. Sci. Monthly 59(1) :14 New York

127. Hooijer, D.A. 1959 Fossil rhinoceroses from Limeworks Cave, Makapansgat. Palaeont. Africana 6 : 1-13, 4 figs. 4 tabs.

128. Hooijer, D.A. and Singer, R. 1960 Fossil rhinoceroses from Hopefield, South Africa. Zool. Meded. 37: 113-128, 1pl., 3 tabs.

129. Hopwood, A.T. 1951 in Leakey, Olduvai Gorge. Cambridge University Press.

130. Hopwood, A.T. 1954 Notes on the fossil and recent mammalian faunas of Africa. Proc. Linn. Soc, London, 165: 46-47.

131. Hutchinson, G.E. and Ripley, S.D. 1954 Gene dispersal and the ethology of the Rhinocerotidae. Evolution 8 : 178 - 179.

132. Hvass, H. 1962 Mammals of the world (trans, by G. Vevers). London. Methuen & Co. 212.

135. Jeannin, A. 1951 Les mammifères sauvages du Cameroun. Encycl. biol. No.16 : 1-252.

136. Jentink, F.A. 1890 Notes Leyd. Mus. xii: 241-245.

137. Joleaud, L. 1931 Études de Géographie Zoologique sur la Berbérie. Les Périssodactyles. 1. Les Rhinoceros. Arch. Zool. Torino 16: 636-666.

138. Junor, F. 1967 Personal Communication. Rhodesian Parks Board, Salisbury.

139. Keay, R.W.J. 1959 Vegetation Map Of Africa. Oxford: Oxford University Press.

140. Kirby, F.V. 1896 In haunts of Wild Game. Edinburgh,

141. Kirby, F.V. 1899 Sport in East Central Africa. London.

142. Kirby, F.V. 1926 The White Rhinoceros with special reference to its habits in Zululand. Annals of the Durban Museum 1926: 223-242.

143. Kirk, J. 1864 List of Mammalia met with in Zambesia, East Tropical Africa. P.Z.S. 1864: 656

144. Kluge, E. 1956 The white rhinoceros of the Umfolozi Game Reserve. Afr. Wild Life 4 : 155-159, 3 figs.

145. Lang, H. 1926 The White Rhinoceros of the Belgian Congo. Zool. Soc. Bull. New York, 29, : 65-72.

146. Lang, H. 1923 Recent and historical notes on the square-lipped rhinoceros (Ceratotherium simum). J. Mammal 4 : 199-102, 1 l., map, fig.

147. Lang, H. 1924 Threatened Extinction of the White Rhinoceros. J. Mammal V (3): 173-1

148. Lang, H. (Umfolozi) -undated) The southern white rhinoceros. Durban: Wild Life Protection Society, Natal Branch.

149. Lavauden, L. 1937 La diminution et la protection nationale de la faune africaine. Brazzaville: 1-38, 2 maps.

150. Lesson, R.P. 1827 des Mamm. et Oiseaux :401.

151. Letley, C.P. 1962 Foods and feeding of the square-lipped rhinoceros, Ceratotherium simum. Lammergeyer, 2(1): 67

152. Livingstone, D. 1857 Missionary Travels and Researches in South Africa. London.

153. Lönnberg, E. 1926 En brit noshörning från 1845 uppstoppad i Riksmuseet. Fauna och flora Uppsala 15 : 193-203 fig.

155. Lydekker, R. 1898 Horns and Hoofs, or chapters on Hoofed Animals. London.

156. Lydekker, R. 1907 A one horned White Rhinoceros. Field, London, 110 : 119

157. Lydekker, R. 1908 The White Rhinoceros. Field, London, 111 : 319

158. Lydekker, R. 1911 Skulls of the Southern White Rhinoceros. Field, London, 117.

159. Matthew, W.D. 1931 Critical observations on the phylogeny of the Rhinoceros. Univ. Calif. Pub. Geol. 20 :1-9,2figs

160. Malbrant, R. 1952 Faune du Centre Africain francais (Mammifères et Oiseaux). 2nd Edit. Encycl. Biol. No.15 : 1-616.

161. Micha, M. 1958 De Witte Neushoorn. Zoo.Antwerp 23 (4) : 111-115, 4 figs.

162 Millais, J.G. 1893 Note on R. simus Proc. Zool. Soc. Lond. 1893 : 614

163. Millais, J.C. 1895 A Breath from the Veldt. London.

164. Nehring, A. 1901 Ein Schädel des Rhinoceros simus im Naturhist Museum zu Hamburg. ?T.c.: 225-228. Zool. Anz., 24:225-228.

165. Neuville, H. 1927 Remarques et comparsisons relative aux phanères des Rhinoceros. Arch. Mus. Paris (6) 2 : 179-208 3pls., 11figs.

166. Newton, A. 1903 Photographs of the White Rhinoceros. Proc. Zool. Soc. Lond. 1903:222-22[illegible]

167. Nicholls, J.A. and Eglington, W. 1892 The Sportsman in South Africa. London: Simpkin, Marshall, Hamilton and Kent & Co.

168. Noll, F.C. 1873 Zool. Gart. : 47-55, 81-87,130-144.

169. Offerman, [illegible] 1952 Contribution à l'étude écologique de la region de Gangala na Bodio. Bull. Serv. Eaux Forêts Congo belge 2 (10).

170. Osborn 1921 Men of the Old Stone Age. New York 3rd. Ed.

171. Oswell, W.C. et al 1894 Big Game Shooting. The Badminton Library. 2 vols. London.

172. Owen, T.R.H., Hook, L. and Mackenzie, F.I. 1949 White Rhinoceros. Field, London 194:324-325, 3 figs

173. Parisi, B. 1925 le rinoceronte camuso. Natura Milano 16 : 133-139.

174. Parsons, J. 1743 The Natural History of the Rhinoceros. Phil. Trans. 42 :

1848 ausgeführt. Berlin.

176. Philipps, T. 1956 Discoveries in an African nature reserve. Ctry. Life, Lond. 119: 146-148, 5figs.

177. Pienaar, V de V. 1963 The large mammals of the Kruger National Park - their distribution and present day status. Koedoe 6: 1-37, 36figs.

178. Pitman, C.R.S. 1931 A game warden among his charges. London: James Nesbet & Co., Ltd.

179. Pitman, C.R.S. 1934 Report on a faunal survey of Northern Rhodesia. Livingstone, Government Printer.

180. Pitman, C.R.S. 1949 Uganda Game Department report for the year ended 31st. December 1947. 65p. Entebbe.

181. Pitman, C.R.S. 1950 Annual report of the Game Department, (Uganda Protectorate) for 1949. Entebbe, 1-73.

182. Pitman, C.R.S. 1954 in Edmond-Blanc, F.(Ed) Le grand livre de la faune africaine et de sa chasse. Zurich:Schmidt.

183. Pitman, C.R.S. 1956 Weapons of the two African Rhinoceroses. Oryx 3 : 195-196.

184. Player, I.C. and Feely, J.M. 1960 A preliminary report on the square-lipped rhinoceros Ceratotherium simum simum. Lammergeyer 1(1): 3-22. 2pls. 3maps.

185. Player, I.C. 1962 Foods and feeding: of the Square-lipped Rhinoceros Ceratotherium simum Lammergeyer, 2 (1) :61

186. Player, I.C. 1963 Rhino in trouble. Natal Wild Life 4 (2) :22.

187. Pocock, R.I. 1945 Some cranial and dental characters of the existing species of Asiatic rhinoceros. Proc. Zool. Soc. Lond. 114 : 437.

188. Potter, H.B. 1949 Rhino as we know them. Afr. Wild Life. 3 : 128-138, 2figs.

189. Potter, H.B. and Mitchell, D.E. 1947 Rhino - Black or White. Field, London 190 : 304-305.

190. Potter, 1967 Personal Communication. Natal Parks Board, P.O. Box 662, Pietermaritzburg.

191. Powell-Cotton 1907 Geogr. Journ. 26 : 371-384.

192. Reid, E.T.M. 1952 Game notes from Yei and Meru districts Sudan Wild Life 2 (3): 29-39.

194. Rieu, 1868 Vernandl. Schweiz. ntrf. Gesellsch. : 80.

195. Ripley, S.D. 1958 Comments on the black and square-lipped rhinoceros species in Africa. Ecology 39: 172-174.

196. Ritchie, A.T.A. 1963 The black rhinoceros (Diceros bicornis L.). E. Afr. Wild J. 1 : 54-62, 2 figs.

197. Roberts, A. 1913 Ann. Transvaal Mus., iv

198. Roberts, A. 1951 The Mammals of South Africa. Johannesburg: Trustees of The Mammals of South Africa Book Fund.

199. Roedelberger, F.A. and Groschoff, V.I. 1964 African Wildlife. trans. by Cleary and Paulet. London, Constable 224pp.

200. Roosevelt, T. 1910 African game trails. New York.

201. Rooseveld, T and Heller, E. 1914 Life Histories of African Game Animals 2 volumes.

202. Rushby, G.G. and Swynnerton, G.H. 1946 Notes on some Game animals of Tanganyika Territory. Tanganyika Notes and Rec. No22: 14-26.

203. Ryder, M.L. 1962 Rhinoceros horn. Turtox News 40: 274-277, 2 figs.

204. St. Croix, C.n. de 1962 The white rhino of Umfuluwe. J. Bombay nat. hist. Soc. 58: 321-331, 2pls.

205. Salmon, T.R.P. 1939 Annual Report. Rep Game Dep. Kenya, 1938.

206. Savidge, J. 1961 The introduction of white rhinoceros into the Murchison Falls National Park, Uganda. Oryx 6: 134-139.

207. Schack, W. 1947 Ein Weisses Nashorn gelangt in den Tiergarten von Pretoria (Südafrika). Natur v. Volk 77: 71-76, 3figs.

208. Schack, W. 1950 Ein zweites Weisses Nashorn im Tiergarten von Pretoria(Südafrika). Natur. v. Volk 80 : 49-51, 1 fig.

209. Schack, W. 1956 Ich jagte das Weisse Nashorn. Frankfurt a.M., Umschau-Verlag.

210. Schaumburg, S. 1953 Comparative studies of the Black and the White Rhinoceros. Afr. Wildlife 7 : 124-127.

211. Schaurte, W. 1960 Vom südafrikanischen Breitmaul-Nashorn, Ceratotherium simum simum.

213. Schouteden, H. 1911 Le Rhinocéros Blanc (Rhinoceros Simus cottoni). Rev. Zool. Africaine Bruxelles, 1: 113-124.

214. Schoutenden, H. 1927 Les Rhinocèros congolais. Bul. Cerc. Zool. Congo (Rév.Zool. Afr.) 4 : 19-30, 3photos

215. Schoutenden, H. 1946 De Zoogdieren van Belgisch-Congo en van Ruandz - Urundi. 111 (2) Ann. Mus. Congo belge. C. Zoologie. (11) 3 (3) : 333-575.

216. Schulz and Hammer 1877 The New Africa. London.

217. Sclater, P.L. 1871 Proc. zool. Soc. Lond. 1871:8-11.

218. Sclater, P.L. 1880 Note on the external characters of Rhinoceros simus. Proc. zool. Soc. Lond. 1880 : 143-144

219. Sclater, P.L. 1890 Nature, London, 42: 520 & 521.

220. Sclater, P.L. 1900 Mammals of South Africa. Vol.1. London : R.H. Porter.

221. Sclater, P.L. 1900 Note on a rhinoceros. Proc. zool. Soc. Lond. 1900 : 949.

222. Sclater, P.L. 1903 Exhibition of a Rhinoceros horn. Proc. zool. Soc. London: 1903 (2) 194 & 195.

223. Scott, W.B. and Osborn, H.F. 1883 On the Origin and Development of the Rhinoceros Group. Nature, xxviii : 579.

224. Selous, F.C. 1881 On the South African Rhinoceroses. Proc. zool. Soc. Lond. 1881 : 725 - 734.

225. Selous, F.C. 1895 A hunter's wanderings in Africa ((4th. Ed). London: Richard Bentley & Son. xviii & 455.

226. Selous, F.C. 1899 The White or Square-mouthed Rhinoceros (Rhinoceros simus), sometimes called Burchell's Rhinoceros. in 'Great and Small Game of Africa', ed. H.A. Bryden. London : Rowland Ward Ltd.

227. Shortridge, G.C. 1934 The Mammals of South West Africa. Vol. I London : Wm. Heinemann Ltd.

228. Sidney, J. 1965 The past and present distribution of some South African ungulates. Trans. Zool Soc. Lond., 30 : 1-397.

South Africa. Vol 1 (Mammalia) London.

233. Simpson, G.G. 1945 The principles of Classification and a classification of mammals. Bull. Amer. Mus. nat. Hist. 85:143.

234. Spinage, C.A. 1962 Animals of East Africa. London : Collins 160pp.

235. Steele, N. 1967 Personal Communication. Umfolozi Game Reserve. T.C. Mtubatuba.

236. Stevenson-Hamilton, J. 1917 Animal Life in Africa II In vegetations. London: Heinemann. xii + 170

237. Stevenson-Hamilton, J. 1919 Field notes on some mammals in the Jur-el-Gebel, Southern Sudan. Proc. zool. Soc. Lond. 1919: 341-345

238. Stevenson-Hamilton, J. 1950 Wild Life in South Africa. London : Cassell and Co.

239. Stott, K. 1963 As different as black and white. Zoonooz 36 : 11-15, 1 map, 4pls.

240. Thom, W.S. 1943 A few notes about the five Rhinoceros of the world. J. Bombay nat. Hist. Soc. 44: 257-274

241. Thomas, O. 1900 The White Rhinoceros on the Upper Nile. Nature, Lond. 62: 599

242. Thomas, O. 1901 Notes on the type specimen of Rhinoceros Oasiotis Sclater, with remarks on the generic portion of the living species of rhinoceros. Proc. zool. Soc. Lond. 1901 (2):154.

243. Tinley, K.L. 1967 Personal Communication. Ntosha Game Reserve, Okaukejo, via Outjo.

244. Travassos Santos Dias J.A. 1961 A propósito do extinto Rhinoceronte do Maputo. Causa e consequências da sua desaparicão. Mocambique No 105: 14-24. 4figs.

245. Trouessart, E.L. 1908 Le Rhinocéros blanc retrouvé au Soudan est la Licorne des anciens. C.R. Acad. sci., 147: 1352-1355.

246. Trouessart, E.L. 1909 Le Rhinocéros blanc du Soudan (Rhinoceros simus cottoni) Proc. zool. Soc. Lond. 1909: 191-200.

247. Ulmer, F. 1941 The Living Rhinoceroses. Fauna, 3 : 3-10

248. Van den Berge 1952 Nos rhinoceros blancs. Zoo, Anvers, 18 : 6-26

249. Van den Berge,H 1955 Nos Rhinocéros Blancs (Ceratotherium

250. Van den Bergh, W. 1959 'Encore une fois: les Rhinocéros blancs.
Zool. Gart. Lpz. 24: 285, 1 fig.

251. Verschuren, J. 1958 Ecologie et biologie des grands Mammifères (Primates, Carnwores, Ongulés).
Exploration du Parc National de la Garamba. Fasc. 9.
Inst. Parcs. Nation. Congo Belge, Brussels: 1-225, 2pls, 93figs.

252. Vialli, V. 1955 Su una anomalia nella dentura di un rinoceronte africano.
Natura, Milano 46 : 131-134,1fig.

253. Vincent, J. 1962 The distribution of ungulates in Natal.
Ann. Sum. Cape. Prov. Mus. 2: 116-117.

254. Walker, E.P. 1964 Mammals of the World. 3 Vols.
Baltimore : Johns Hopkins Press.

255. Wilhelm, J.H. 1933 Das Wild des Okawangogebietes und des Caprivizipfels.
Jour. S.W. African Sci. Soc., 6 : 51-74.

256. Willcox, A.R. 1956 Rock Paintings of the Drakensberg.
London. M. Parrish.

257. Williams, E.H. 1961 Ajzi's Island.
Wild Life and Sport 2 (2): 33-37.

258. Wood, H.E. 1941 Trends in Rhinoceros evolution.
Trans. New York Acad. Sci,(2), 3 93-96.

259. Wood, H.E. 1949 Evolutionary rates and trends in Rhinoceros. in: Jepson,G.L., & Simpson,G.G.
Genetici, paleontology and Evolut
Princetown N.J. pp 185-189.

260. Wurst, E 1922 Beiträge zur kenntnis der diluvial Nashörner Europas.
Centralb. Min. Stuttgart :641-650, 688-688, 5figs.

261. Young, E. 1965 Lesions in the vicinity of the eye of the white rhinoceros.
Int. Zoo. Yearbook 5 : 194-195.

262. Zeuner, F. 1934 Die Beziehungen zwischen Schädelfo und Lebensweise bei den rezenten und fossilen Nashörnern.
Ber, naturf. Ges. Freiburg 34 : 21-80, 21figs.

263. Zukowsky, L. 1924 Beitrag zur kenntnis der Saugetier der nördlichen Teile Deutsch-Südwest-Afrikas unter besonderer Berucksichtigung des Grosswildes.
Archiv. f. Naturg., 90(A) 1:29-10

264. Zumpt, F. 1961 Parasites of the White and Black

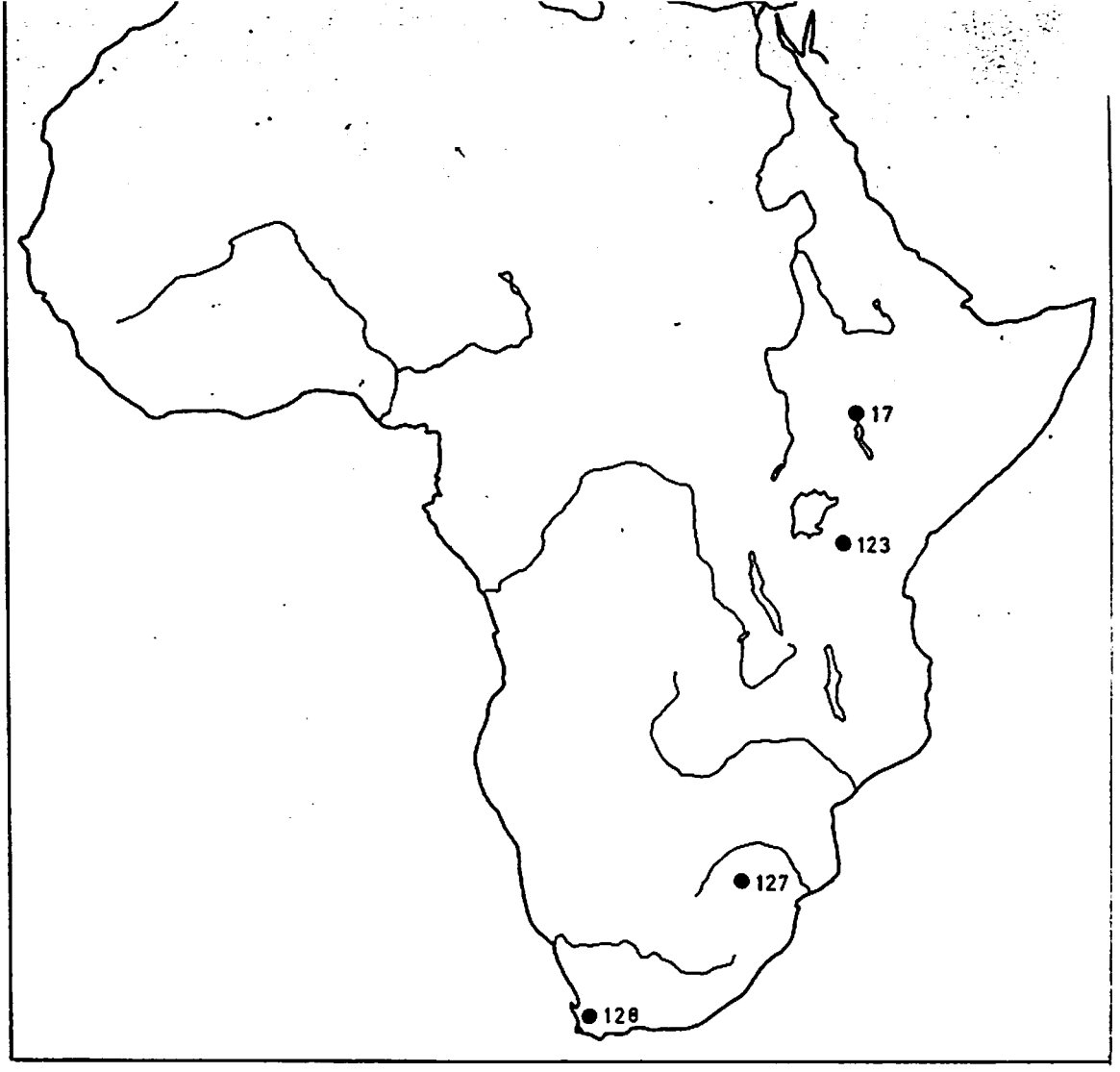

Fig. 1: Pleistocene distribution of Ceratotherium simum

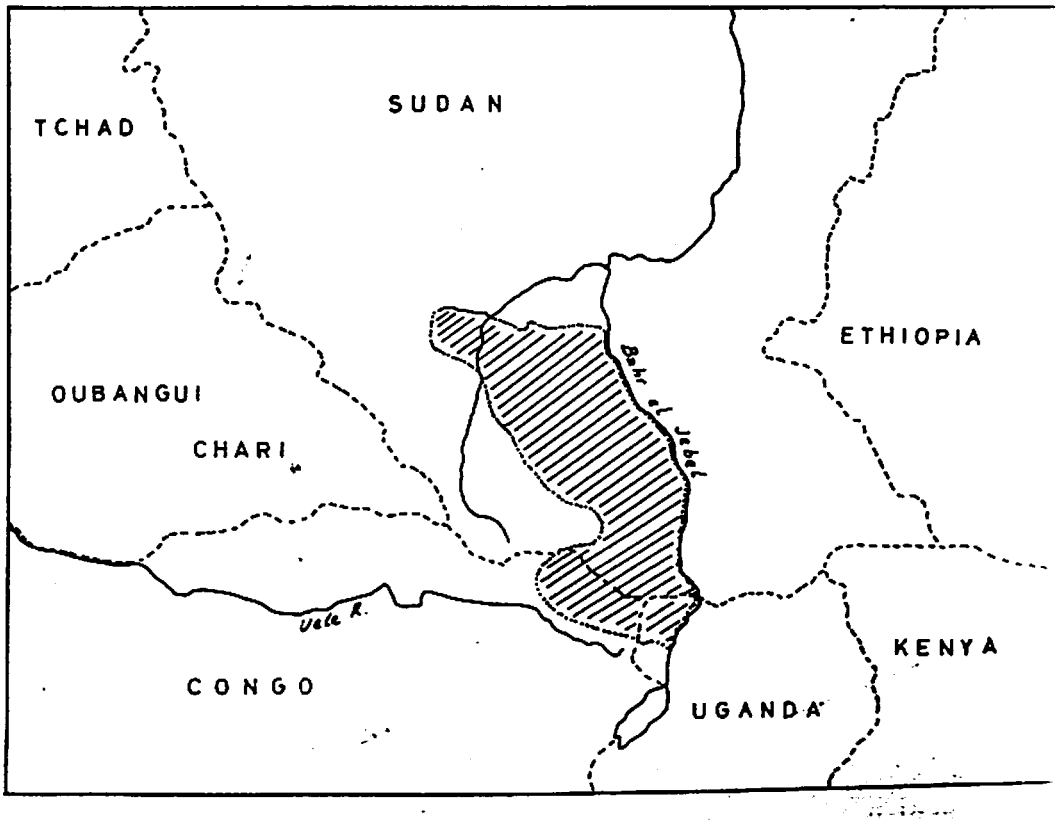

Fig. 3: Present distribution of Ceratotherium s. cottoni.
(After Sidney, 1965)

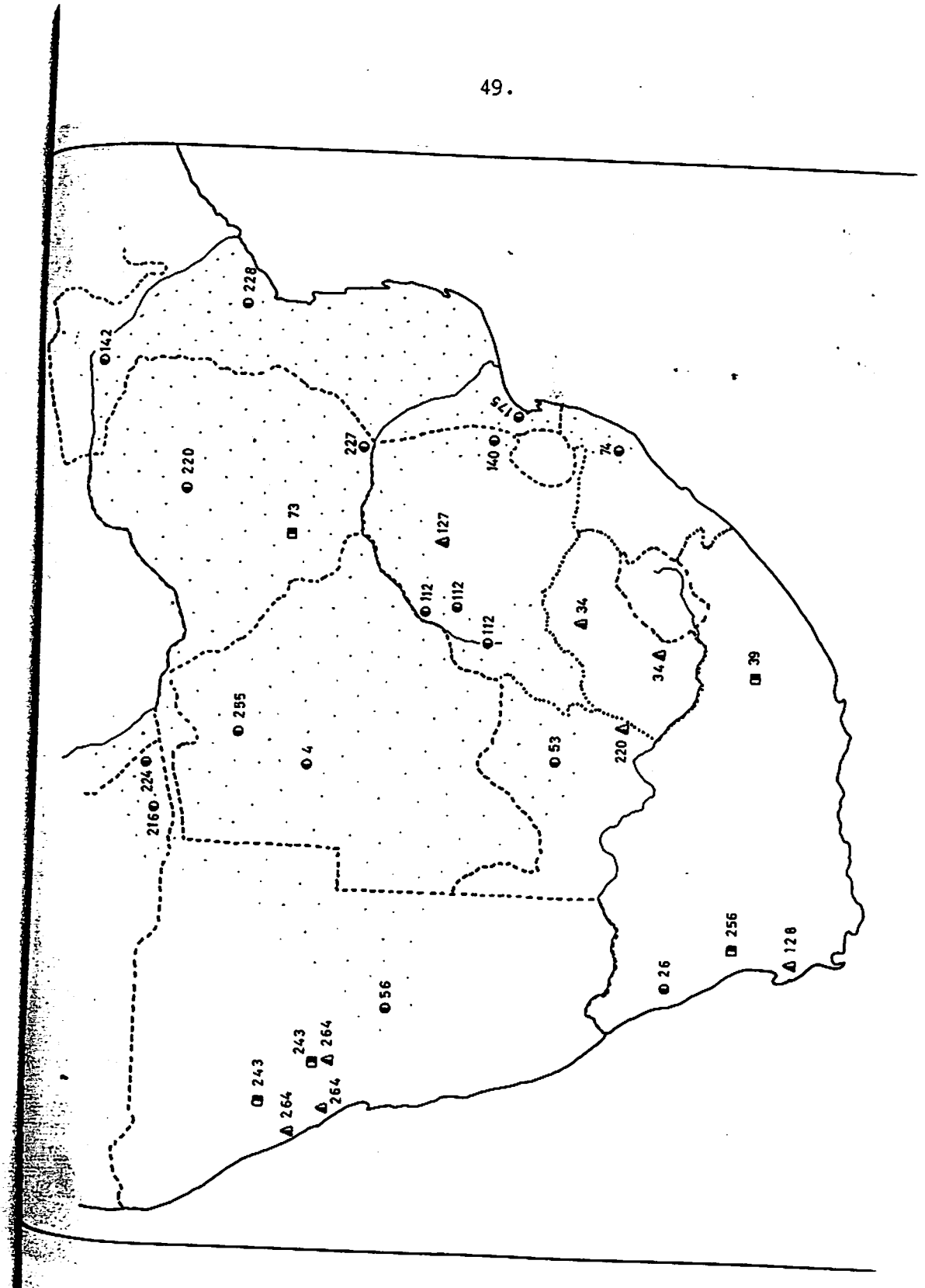

FIG. 2: Distribution of Ceratotherium s. simum in Pleistocene ▲, Holocene ■, and historic ●, times. Putative distribution c. 1800 indicated