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Ranging patterns of the black rhinoceros (*Diceros bicornis* (L.)) in Ngorongoro Crater, Tanzania

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Summary

Annual and seasonal ranges of nine known resident black rhinoceros (*Diceros bicornis* (L.)) consisting of one adult male, six adult females and two sub-adults, in Ngorongoro Crater, Tanzania were determined from observations made from January, 1981 to May, 1982. Range sizes were influenced by density and quality of the habitat.

The adult male had the largest annual range of 69·0 km^2, the six adult females' ranges were between 12·5 and 47·3 km^2, the sub-adult male's range was 22·8 km^2 and the sub-adult female's 25·0 km^2. Seasonal ranges of all resident individuals overlapped extensively. The annual range of the male overlapped slightly with those of other males at the Crater wall. The annual ranges of the resident male and females overlapped extensively.

Individuals of all sex and age classes defaecated more on preformed dung piles. The densities of dung piles in sample areas of Lerai forest and open grassland were 78·5 and 9·3 km^{-2}, respectively, and most of these piles were deposited within a metre of the main rhino tracks. Rhinos of all sex and age classes scraped dung piles and all sub-adult males and bulls spray-urinated.

Résumé

Les domaines vitaux annuels et saisonniers de neuf rhinocéros noirs (*Diceros bicornis* (L.)) – un mâle et six femelles adultes, deux subadultes – dans le cratère du Ngorongoro, en Tanzanie, furent établis par des observations entre janvier 1981 et mai 1982. La dimension des domaines est influencée par la densité et la qualité de l'habitat. Le mâle adulte a le domaine vital le plus grand avec 69 km^2, celui des six femelles adultes varie entre 12·5 et 47·3 km^2, celui du mâle subadulte est de 22·8 km^2 et celui de la femelle subadulte, de 25 km^2. Les domaines vitaux saisonniers de tous ces individus se superposent dans une large mesure. Le domaine annuel du mâle se superpose légèrement à ceux des autres mâles du cratère. Les domaines annuels du mâle et des femelles suivies se superposent largement. Les individus de toutes classes d'âge et des deux sexes défèquent davantage sur les anciens amas de crottes. Les fréquences de ces amas dans la zone-échantillon dans la forêt de Lerai et dans la savane ouverte sont respectivement de 78·5 et 9·3 par km^2; la plupart de ces amas sont disposés à moins d'une mètre des principales pistes des rhinos. Les individus des deux sexes et de toutes classes d'âge grattent les amas de crottes et les mâles subadultes et adultes vaporisent leur urine.

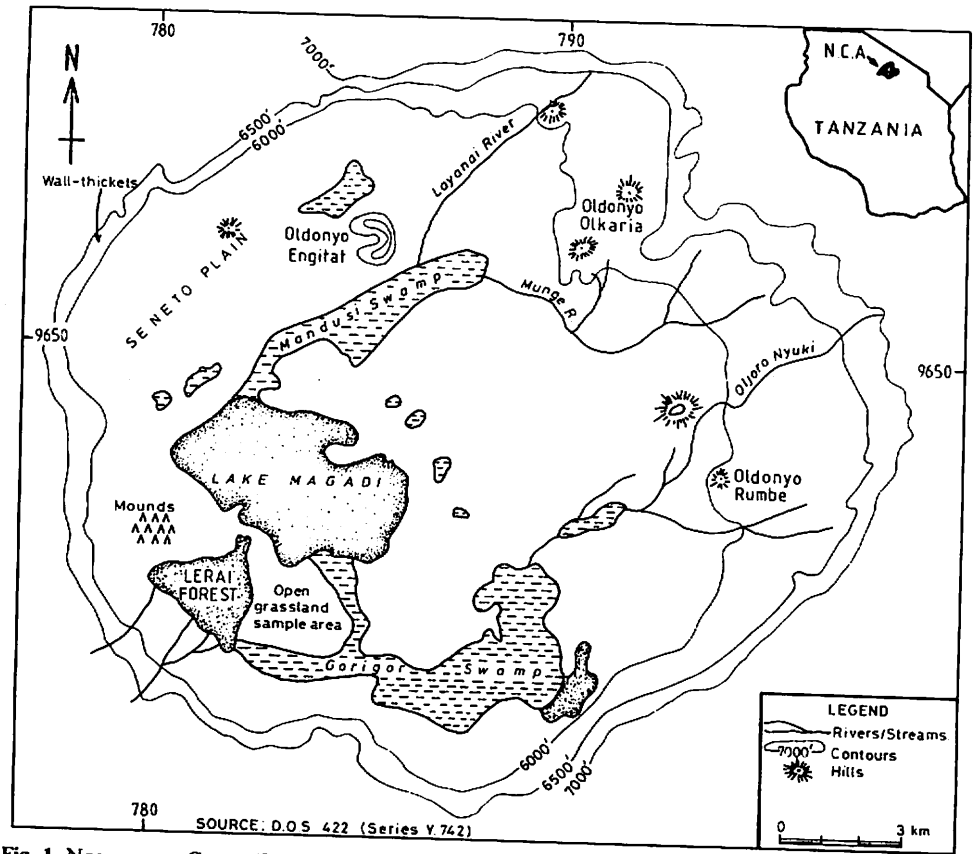

Fig. 1. Ngorongoro Crater (Study area) and the location of Ngorongoro Conservation Area (N.C.A.) in Tanzania, East Africa.

Introduction

The ranging pattern of the resident black rhinoceros (*Diceros bicornis* (L.)) in Ngorongoro Crater (Fig. 1), was first studied by Goddard (1967) during the period 1964–1966. At that time there were seventy-eight resident rhinos on the Crater floor. During the present study from 1981 to 1982 only fifteen resident rhinos were found. Three adult males (A, E & F), seven adult females (G, H, I, J, K, L & M), one sub-adult male (J_2), one sub-adult female (J_1) and three calves. The rest of the resident rhinos were either killed by poachers or had possibly emigrated to the Crater wall and Northern Highland Forest Reserve. Out of the fifteen resident rhinos on the floor, eleven occupied the Lerai-Gorigor area and four occupied Seneto plain. The non-resident population comprised ten rhinos consisting of three adult males (B, C & D), three adult females (N, O, P & Q), one sub-adult male (N_1) and two calves. During the present study, two males (E & F) and two females (G & P) were killed by poachers.

The principal objective of this study was to determine the ranging pattern of the remaining resident individuals and find out if there have been changes due to the decline in population size. The significance of the use of dung piles and ritualized urination were also examined and comparisons made with results from observations on the white rhinoceros, *Ceratotherium simum* (Burchell) by Owen-Smith (1974).

Methods

Individual rhinos were identified using methods described by Klingel & Klingel (1966), Goddard (1966) and Mukinya (1973, 1976). Individuals were classified as adults, sub-adults or calves to accord with the technique used by Goddard (1967).

Data for range size determination were collected concurrently with those for other studies (Kiwia, 1983) and not systematically. Location points for nine resident rhinos of different sex and age classes were plotted on 1:50,000 maps with grids of 1 × 1 cm, each equivalent to an area of 0·25 km^2. The Crater floor is flat and open so that it was fairly easy to pinpoint the locations of the rhinos on the maps.

The 'Minimum Area Method' (Hamilton, 1976) was used to determine range sizes. An area was calculated from a polygon obtained from connecting the peripheral location points of each individual. Wet (January–June) and dry (July–December) season location points were marked differently so that seasonal ranges could be calculated and the extent to which these ranges overlapped could be determined. Annual ranges were calculated from the polygon obtained by connecting all peripheral location points of each individual, regardless of the season.

Various data on dung piles were collected in the field. They include the density, distribution, size (length × width) and distance of piles from the nearest main rhino track. In both sampled areas, systematic transect lines, 100 m apart were used. In Lerai forest twenty-four transect lines were run 25°E/205°W and in the open grassland the transects ran parallel with the forest edge up to Gorigor swamp and the lake. Any rhino track found was followed for 15 m on both sides and information on all piles encountered was recorded.

During the daily observations of the rhinos, the following information was noted: each time an individual was seen to defaecate, date, whether defaecation was on a pre-formed dung pile or not, location of the pile and number of times the individual scraped the pile before and after defaecating. The intervals between spray-urinating by the bulls were also recorded.

Results

Adult male A occupied the largest annual range (69·0 km^2) in the Crater, followed by the females and sub-adults in that order (Table 1), but the sample size was too small for any differences in range size to be tested statistically. Wet season ranges for most individuals appear to be larger than the dry season ranges (Table 1), but the difference was not significant (Wilcoxon matched pair signed-rank test $t = 19$, $n = 9$, $P < 0{\cdot}05$).

Seasonal ranges for the nine individuals overlapped extensively by values ranging from 46 to 100%. Apart from males E and F, which were seen together most of the time, male annual ranges overlapped only slightly and any overlap was due to occasional forays by male A. Female annual ranges overlapped with those of other females by 27–100% and ranges for males and females overlapped by 67–100% (Table 2).

Densities of dung piles in Lerai forest and in the open grassland sample area were 78·5 and 9·3 km^{-2} respectively (Fig. 2a & b). Eighty-two per cent of the piles in the forest and 97% in the grassland were deposited within a metre of the main rhino tracks (Fig. 3a & b). Over 60% of all defaecation by individuals of all sex & age classes was on pre-formed dung piles. Eight recorded piles were shared by

Table 1. Annual/seasonal range sizes (km²) and seasonal range overlaps (%) of nine resident rhinos in Ngorongoro Crater (January 1981 to May 1982).

	Adult male range		Adult female range					Sub-adult range: Male	Sub-adult range: Female
	A	E & F	G	H	I	J	K & L	M	N
Annual range	69·0	—	27·8	33·0	12·5	20·8	47·3	22·8	25·0
Wet-season range (Jan–June)	43·0	26·0	26·0	31·8	9·8	19·8	28·5	21·5	22·0
Dry-season range (July–Dec)	59·6	—	18·0	16·6	11·8	14·0	41·3	14·0	21·8
Seasonal range overlaps (%)	74·0	—	80·0	61·0	84·0	76·0	46·0	76·0	84·0

E & F were shot on 2 June 1981.

Table 2. Annual range overlaps (%) between individual black rhinoceros in Ngorongoro Crater.

	A	B*	C*	D*	E & F	G	H	I	K & L
A									
B*	+								
C*	+	0							
D*	0	0	0						
E & F	39	+	0	0	100				
G	100	0	0	0	0				
H	100	+	0	0	+	72			
I	100	0	0	0	0	60	57		
K & L	67	+	0	0	50	39	47	27	100

A, G, H & I—Lerai-Gorigor resident rhinos,
E, F, K & L—Seneto Plain resident rhinos,
E, F & G—Killed by poachers in 1981,
*Non-residents,
+—overlap due to forays.

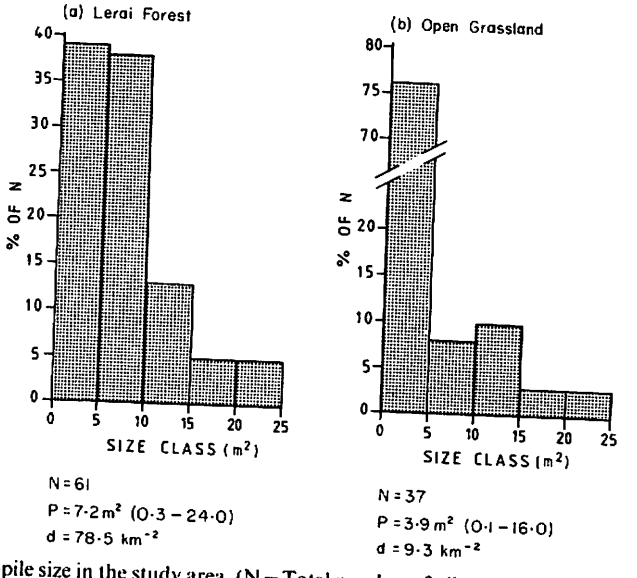

Fig. 2. Rhino dung-pile size in the study area. (N = Total number of piles, P = Mean pile size, d = Density.)

individuals of all sex and age classes. All individuals, including calves scraped dung piles before and after defaecating. The mean number of scrapes by adults was four before and eight after defaecating. Values for sub-adults and calves were generally lower but the data were not sufficient for statistical analysis.

Sub-adult males and bulls spray-urinated when walking from one station to the other and especially when bulls were courting females.

Discussion

Two of the factors which determine the range size of black rhinoceros in the Crater are density and habitat quality.

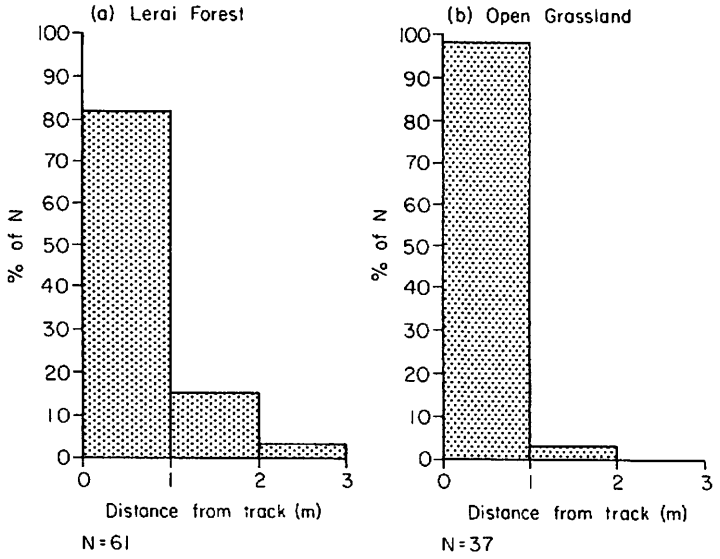

Fig. 3. Distance of dung-piles from rhino main tracks. (N = Total number of piles.)

Table 3. Comparison of mean annual-range size (km²) of black rhinoceros in Ngorongoro Crater during periods 1964–1966 and 1981–1982.

	1964–1966 (Goddard, 1967)			1981–1982 (This study)		
Sex/age class	*n*	mean	range	*n*	mean	range
Adult males	16	15·8	2·6–44·0	1	69·0	—
Adult females	13	15·0	2·6–26·2	6	31·5	12·5 47·3
Sub-adult males	2	36·0	13·9–58·0	1	22·8	—
Sub-adult females	7	27·7	14·2–58·0	1	25·0	—

n = number of rhinoceros.

Rhino density

The density of the resident rhinos on the Crater floor in 1982 was 0·06 km^{-2} a decline of 80·6% since 1966. Table 3 shows that adult rhinos in this study occupy larger ranges than in the previous study, suggesting that adults have increased their range sizes with the decrease in their density. At the Lerai-Gorigor area, where the present resident rhino density is 0·39 km^{-2}, the mean annual-range size for individuals is smaller at 21·8 km^2 (range 0·8–31·8 km^2; $n = 6$), whereas at Seneto Plain, where the density is 0·12 km^{-2} the mean annual-range size is much larger averaging at 36·8 km^2 with a range of 26·0 to 47·3 km^2; $n = 4$.

Habitat quality

The distribution of food, water and shelter also determines range sizes. At the Lerai-Gorigor area where the three resources are close together, the resident rhinos have much smaller ranges compared to the Seneto Plain rhinos, where resources are more widely spaced. This was also found to be the case with the Masai-Mara rhino population (Mukinya, 1973).

The higher values for seasonal range overlap of the Lerai-Gorigor rhinos indicate that they were more sedentary than those of Seneto Plain. The probable reason is that food was available at the Lerai-Gorigor area throughout the year. The Seneto rhinos on the other hand moved to the Lerai-Gorigor area during the dry season, presumably to seek food and water.

Space utilization in the black rhinoceros

Owen-Smith (1974) found white rhinoceros bulls to be territorial, although they foray outside their territories to look for water in the dry season. Territorial borders are marked by large hollowed-out dung piles. Ritualized urination is most pronounced when bulls are patrolling the border regions. Subordinate bulls reside in these territories and use the same dung piles as the territorial bulls but they neither scatter their dung nor spray-urinate.

The interpretation of results obtained from field studies as to whether the black rhinoceros occupy home ranges or territories are controversial. Goddard (1967), working in Ngorongoro Crater, found that home ranges of the black rhinoceros overlap extensively, with no evidence of territoriality. Klingel & Klingel (1966), working on the same rhino population, suggested that males may establish true territories because bulls stayed within well-defined home areas from which they never dispersed. Schenkel & Schenkel-Hullinger (1969) concluded from studies in Tsavo East National Park—Kenya, that the black rhinoceros was not territorial, whereas Frame (1980), in a brief study of black rhinoceros on the Serengeti Plains, concluded that '... the overlap in home ranges of males and tolerance between others suggest that the rhinos could have a territorial system similar to that described for the white rhinoceros'.

Unfortunately the situation in the Crater at the time of the study did not offer a good opportunity for the study of territoriality, mainly because only male A inhabited the floor permanently after males E and F were killed at Seneto Plain. The other three males (B, C & D) were non-residents and rarely came onto the floor.

Male A's core area is the Lerai-Gorigor region, which is the best rhino habitat in the Crater and where most females reside. The fact that the Crater wall males do not enter this area possibly indicates that male A is dominant. Contact between males was seen only once when male B from the Crater wall, on his way to Mandusi swamp, met males E and F at Seneto Plain and chased each one separately for 0·5 km or so. Otherwise, each male (except A) restricted his movements to within their own range. Male A patrolled two-thirds of the Crater floor and was occasionally seen in the ranges of males B and C probably looking for females. Encounters with these males were not observed.

Space utilization by females shows a clearer pattern. They occupied ranges which overlapped extensively. No physical conflicts were observed between them

and whenever they met, they greeted each other before parting peacefully (Kiwia, 1983).

Although data on defaecation and urination by the species provide no evidence of territoriality as in the white rhinoceros, some observations of interest were noted.

The density and size of dung piles in Lerai Forest are larger than those in the open grassland (Fig. 2). This suggests that the forest is the best rhino habitat on the Crater floor for resident rhinos to retreat into during the night to feed (Kiwia, 1986). As most piles were deposited within a metre of the main rhino tracks and since individuals sniff and scatter the piles on encountering them, it appears that scent associated with the dung is used for orientation and communication in the species, which is both myopic and solitary (Schenkel & Schenkel-Hullinger, 1969; Goddard, 1967).

Bulls spray-urinate more often when courting females than when engaged in other activities. Also when courting, male A was twice observed scraping dung piles very vigorously using both hind legs and horns. It seems these activities have some social role within the species.

Overlap of ranges and the occasional forays by males provide no conclusive evidence for or against territoriality in the Crater rhinos.

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