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Black rhinoceros (*Diceros bicornis* (L.)): population size and structure in Ngorogoro Crater, Tanzania

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Summary

A study on the black rhinoceros population in Ngorongoro Crater, Tanzania, was carried out from December 1980 to May 1982 and, later, for three weeks in September 1982. The total population size, determined by recognition of individual rhinos, was twenty-five and the density was 0·08 km^{-2}.

Although the population size has declined by 77% since 1966, the population structure has not changed significantly. The sex ratio was 1:1·2 for all age classes combined and 1:1·8 for adults. The former value did not differ significantly from those of ten other studies in Tanzania and Kenya. In addition, a cow:calf ratio of 100:45 showed no difference from four other studies in Tanzania and Kenya. The birth rate was 13·6% and the mortality rate was 8%.

Résumé

On a mené une étude sur la population de rhinocéros noirs du cratère du Ngorongoro, Tanzanie, de décembre 1980 à mai 1982, plus encore trois semaines en septembre 1982. La population totale s'élève à vingt-cinque individus dénombrés individuellement, et la densité de population s'élève à 0·08 km^{-2}. Bien que la population ait baissé de 77% depuis 1966, sa structure n'a pas changé significativement. Le sex-ratio était de 1:1·2, toutes classes d'âge confondues et de 1:1·8 pour les adultes. La première valeur ne diffère pas significativement de celle de dix autres études en Tanzanie et au Kenya. De plus, le rapport femelles: jeunes de 100:45 ne montrait pas de différence avec quatre autres études en Tanzanie et au Kenya. Le taux de natalité était de 13·6% et celui de mortalité de 8%.

Introduction

The black rhinoceros (*Diceros bicornis* (L.)) in Ngorongoro Crater, Tanzania, are relatively sedentary (Klingel & Klingel, 1966; Goddard, 1967a; Kiwia, 1983), but a few individuals move between the floor and the Northern Highland Forest Reserve, where they possibly intermix with other rhinos residing there. According to Frame (1980), the Crater population is probably continuous in distribution with those of Olduvai Gorge, Serengeti National Park and Masai-Mara Game Reserve, so that the Crater is not a closed ecological unit for rhinos. This study was made about sixteen years after those of Klingel & Klingel (1966) and Goddard (1967a) on the same population, with the aim of updating their findings following the decline of the population due to poaching.

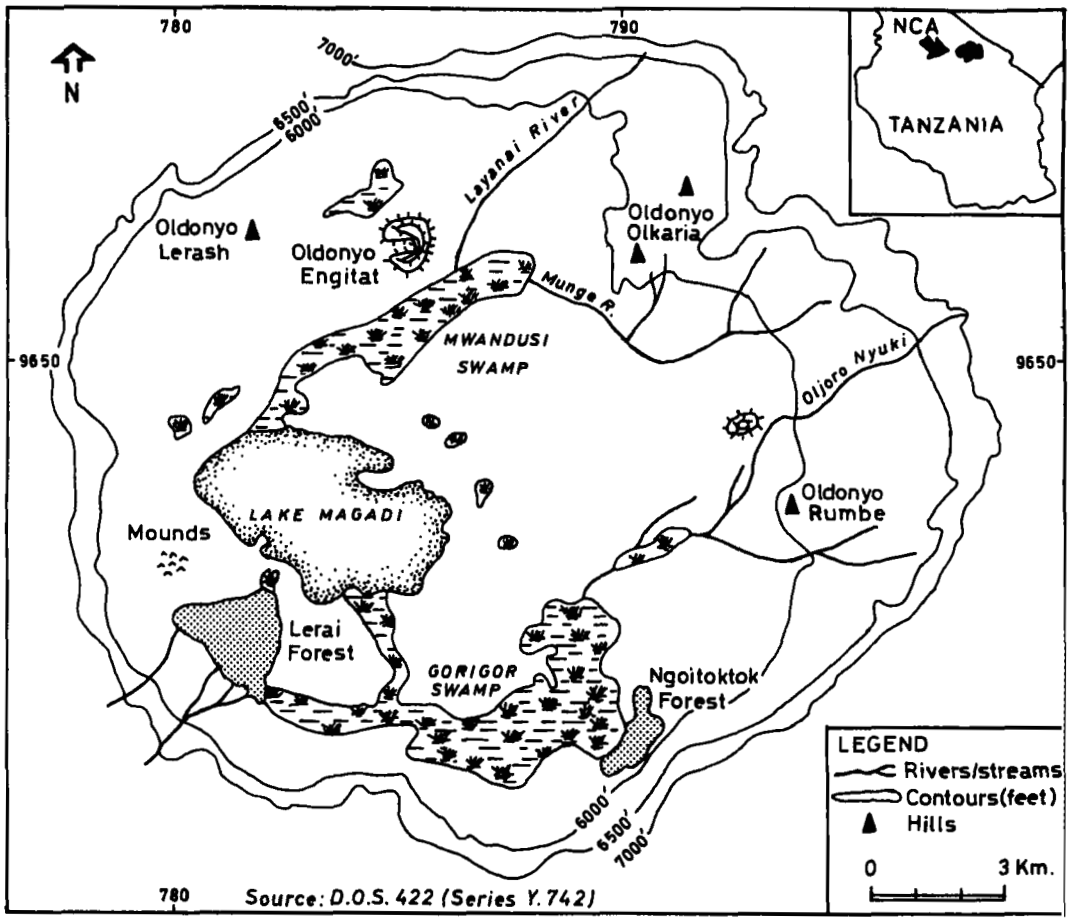

Fig. 1. Ngorongoro Crater (study area) and location of Ngorongoro Conservation Area (NCA) in Tanzania, East Africa.

Study area

The study was confined to Ngorongoro Crater (35°25'E, 3°5'S), which has an area of about 310 km^2, with the floor occupying 250 km^2 (Fig. 1). The geology of the Crater is summarized by Fosbrooke (1972) and Anderson & Herlocker (1973). Drainage is completely internal and the water collects into a salt lake (Lake Magadi) at the centre of the Crater floor. The vegetation of the area is as described in detail by Pratt, Greenway & Gwynne (1966), Herlocker & Dirschl (1972) and Anderson & Herlocker (1973).

Methods

All individual black rhinoceros in the Crater were photographed at close range, on both sides, and identified using various morphological characteristics. The photographs of each individual were mounted on an index card, below which a detailed description of the individual was written. Some of the features used for

Table 1. Past and present population size and structure of Black Rhinoceros in Ngorongoro Crater, Tanzania (n = number of rhinos; *residents; †temporary visitors)

	1964–1966 (Goddard, 1967)		1981–1982 (Author)			
Age/Sex class	n	% of total pop.	*	†	n	% of total pop.
Adult males	37	34·3	3(2)	3	6	24·0
Adult females	29	26·9	7(1)	4(1)	11	44·0
Sub adult males	9	8·3	2	1	3	12·0
Sub adult females	12	11·1	1	—	1	4·0
Male calves	10	9·3	1	1	2	8·0
Female calves	8	7·4	1	—	1	4·0
Unsexed calves	3	2·8	—	1	1	4·0
Totals	108	100·1			25	100·0
Densities	0·43			0·10		
Residents	78	72·2	15			60·0
Temporary visitors	30	27·8		10		40·0

Note: Numbers in brackets are animals killed by poachers.

identification were: sex (external genitalia), age class, horn structure, ear marks and permanent scars. The same method was used with success by Klingel & Klingel (1966), Goddard (1966), Mukinya (1973, 1976) and Frame (1980). The characteristics for horns proved very useful for identifying individuals in the field especially when they were at a distance or lying down.

The population size and structure of rhinos found in the Crater were compared with results obtained by Goddard (1967a) and the age and sex ratios were compared with populations elsewhere in Tanzania and Kenya. The former findings were tested statistically using χ^2-test for 'k' independent samples (Siegel, 1956) while the latter were tested by χ^2-test for proportions from 'm' independent samples (Fleiss, 1973). Dates for all births and deaths of rhinos in the area during the study were recorded and the data used for calculating the birth and mortality rates (birth rate = percentage of adult females producing calves each year; mortality rate = percentage of the population dying each year). Exact dates of parturition were not known because near-term females retired to thick cover, coming into the open only when calves were old enough to walk (about 3–4 weeks old).

Results

A total of twenty-five rhinos were counted in the area during the study (Table 1). Of the twenty-five rhinos, fifteen were permanent residents of the Crater floor and the remaining ten were temporary visitors. The sex ratio (male:female) for rhinos of all age classes combined was 1:1·2 and for adults 1:1·8 (Table 2). Three calves (two

Table 2. Sex and age ratios of Black Rhinoceros in Tanzania and Kenya (all individuals known by observer)

Location	Sample size	Sex ratio Male:Female	Age ratio Cow:Calf	Source of information
Ngorongoro Crater	24	1:1·2	100:45	This study
	105	1:1·1	100:72	Goddard, (1967a)
Serengeti Plains	63	1:1·0	100:79	Frame, (1980)
Olduvai Gorge	74	1:0·8	100:79	Goddard, (1967a)
Masai Mara	97	1:0·8	—	Mukinya, (1973)
Tsavo medium density	52	1:1·2	—	Goddard, (1970)
Tsavo high density	124	1:1·0	100:79†	Goddard, (1970)
Tsavo high density	89	1:0·8	—	Goddard, (1970)
Tsavo high density	119	1:0·9	—	Goddard, (1970)
Tsavo high density	77	1:1·0	—	Goddard, (1970)

Note: All unsexed calves not included. †All Goddard's data combined.

males and one female) were born in the area, whereas four adults (two males and two females) were killed by poachers (three were shot and one speared) leaving twenty-one individuals by the end of the field work.

Discussion

Black rhinoceros populations have declined rapidly in number (by up to 70–80%) over the past decade in most parks and reserves in Africa (African Rhino Group, 1981). In the Crater the population size decreased from 108 to 25 rhinos in a period of about sixteen years, a decline of 77%.

Records made on the Crater rhinos are incomplete, thus making it difficult to account for the fate of all the animals that once inhabited the area. The Ngorongoro Annual Report of 1977/78 mentions that serious poaching started in 1972. Because the number of carcasses counted did not tally with the missing rhinos, it was concluded that some animals had probably emigrated into the wall thickets and Northern Highland Forest Reserve.

Makacha, Mollel & Rwezaura (1979) compiled data to show the trend of the rhino population in the Crater since 1958. However, since three different census methods were included in the compilation (aerial, vehicle and individual recognition), the data should be interpreted with caution because possible biases were not allowed for. Goddard (1967b) and (Western 1982), for example, found that aerial counts consistently under-estimated the actual number of rhinos in an area. Single-day vehicle or foot count methods also under-estimate the population size of rhinos in the Crater. Throughout the study period, rarely could more than ten individuals be located in a single day despite the fact that each rhino's locality in the field was roughly known to the observer. In fact, on some days no rhinos were seen. The Ngorongoro staff use vehicles once or twice a year to conduct total animal censuses in the Crater. In September 1981, I participated in one such census and not a single rhino was spotted by the five groups involved in the exercise. Thus, it seems likely that the best method for counting rhinos in any area is that of individual recognition. This method was feasible here because the Crater floor is

relatively small with good visibility, the rhinos were relatively sedentary and few in number, and the observer had enough time to conduct the study. Although the population size has declined by 77% since 1966, the population structure has not changed significantly ($\chi^2 = 0{\cdot}99$, $P > 0{\cdot}05$) (Table 1). The sex ratio also does not differ significantly from those observed in ten other studies ($\chi^2 = 3{\cdot}13$, $P > 0{\cdot}05$) (Table 2). Likewise the cow:calf ratio did not differ significantly from those recorded in four other studies ($\chi^2 = 0{\cdot}91$, $P > 0{\cdot}05$) (Table 2).

The birth rate of the present population was 13·6%, compared to one of 24·1% reported for the period 1964–1966 by Goddard (1967a). However, during my second visit to the area, a year later (December 1983), five more calves had been born, thus raising the birth rate to 24·2%, a value very close to that recorded by Goddard. The intercalving interval of two known females in the area was observed to be 27–28 months. Goddard (1967a) reported an intercalving interval of 27 months. By September 1982, the mortality rate was 8% and the natality rate (number of births per year as a percentage of all rhinos) was 6%, showing a decline in the population of 2%. However, by December 1983, the natality rate changed to 10·7% resulting in a population increase of 2·7%.

To date, information on the Minimum Viable Population (MVP) for vertebrates is mostly theoretical and controversial (Soulé, 1987). No attempt has been made to calculate the MVP for the rhino, for since the animal is long-lived, it will take time before a viability analysis for the species is possible. However, from a genetic perspective, a population of twenty-five individuals in the Crater is small enough for its viability to be doubted.

However, the Crater is not a closed ecological unit for the rhinos. Observations show that the temporary visitors interbreed with the floor residents and possibly with the Northern Highland Forest Reserve population, thus minimizing the effects of inbreeding. Given a proper protection from poaching, and if there is no significant change in the habitat, the present rhino population has the potential to increase in size.

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