

## Diurnal activity pattern of the black rhinoceros (*Diceros bicornis* (L.)) in Ngorongoro Crater, Tanzania

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### Summary

The diurnal activity of the black rhinoceros was studied in Ngorongoro Crater, Tanzania, from December 1980 to May 1982. From fourteen individuals of different sex and age classes, data were collected for a total of 656 and 473 observation hours in wet and dry seasons respectively. The rhinoceros were most active in early morning and late afternoon, and inactive at midday. In both seasons, the rhinoceros spent almost half of the day time lying down. Walking and feeding comprised the other major activities. Results from this study were similar to those of Goddard (1967) attained between 1964 and 1966, from the same population (which was then four times larger) and from the rhinoceros of Olduvai Gorge. Nocturnal studies were not feasible, because the rhinoceros retreated into the Crater forests at night where they presumably spent much of the time feeding since they fed little during the day time.

### Résumé

L'activité diurne du rhinocéros noir au cratère du Ngorongoro (Tanzanie) de décembre 1980 à mai 1982. De quatorze individus de sexes et d'âges différents, les données sont dérivées de 656 et 473 heures d'observations en saison sèche et saison des pluies respectivement. Les rhinocéros sont plus actifs en début de matinée et en fin d'après-midi et sont inactifs à la mi-journée. Quelle que soit la saison, le rhinocéros passe presque la moitié de la journée couché. La marche et l'alimentation constituent les autres activités majeures. Les résultats de cette étude sont similaires à ceux de Goddard (1967) récoltés entre 1964 et 1966 sur la même population (qui était alors quatre fois plus importante) et sur celle de la Gorge d'Olduvai. L'étude nocturne ne fut pas réalisable car les rhinocéros se retirent dans les forêts du cratère la nuit où ils passent probablement la majeure partie du temps à manger car ils se nourrissent peu de jour.

### Introduction

During the period 1964-1966, Goddard identified 108 rhinoceros (*Diceros bicornis* L.) in the Ngorongoro Crater, Tanzania. By the time of this study (December 1980 to May 1982), the population had decreased to twenty-five animals. The project was intended to compare the present status of the population with its previous status in the hope of providing information that could be of value in conservation of the species in the Crater as well as in other parts of Africa.

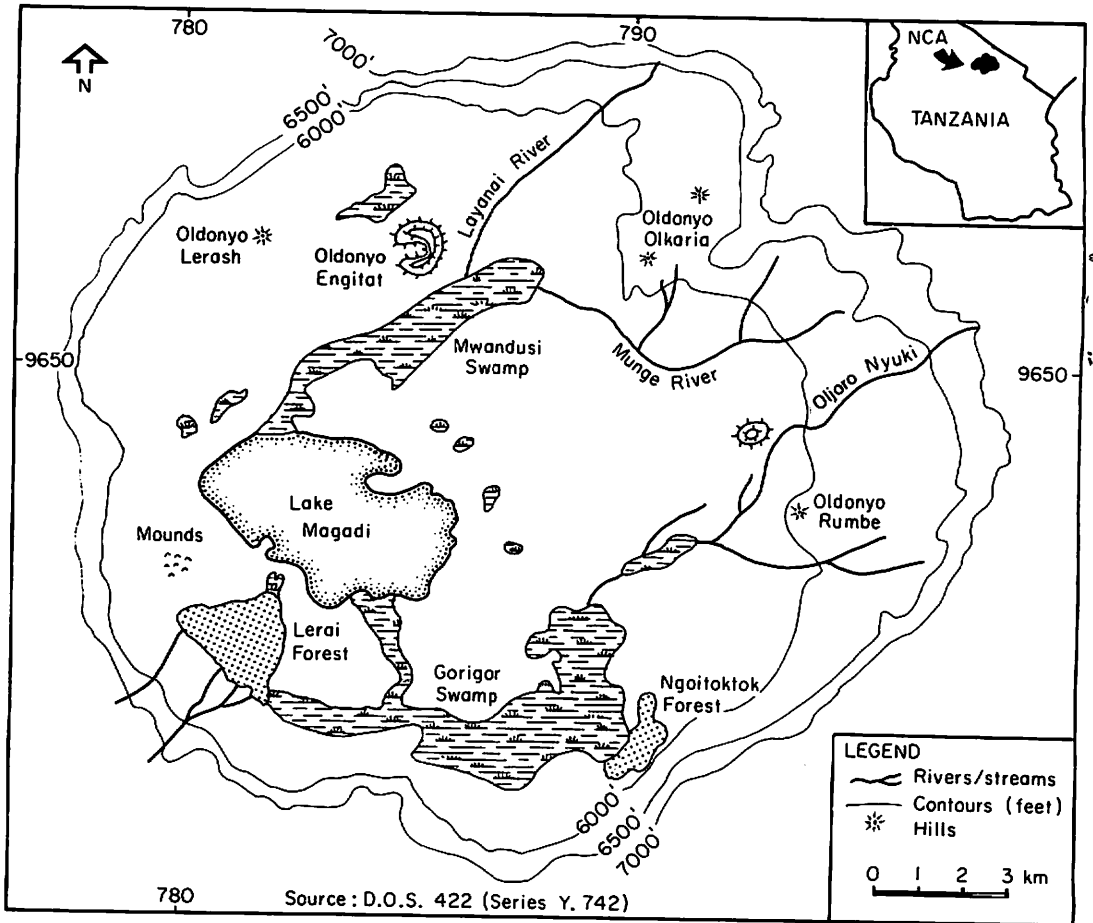


Fig.1. Ngorongoro Crater (study area) and location of Ngorongoro Conservation Area (N.C.A.) in Tanzania, East Africa.

There are very few published data on the activity of the black rhinoceros, with only Goddard (1967) providing quantitative information. Schenkel & Schenkel-Hullinger (1969) gave a qualitative account of the daily activity of rhinoceros in the Tsavo National Park, Kenya. Few attempts have been made to conduct such studies because, except in Ngorongoro Crater and Amboseli National Park, Kenya, most black rhinoceros are very shy and inhabit dense thickets or broken terrain making the animals very difficult to follow. In the Crater, the rhinoceros occur in open grassland, and are used to tourist vehicles so that continuous observations are possible.

#### Study area

The Ngorongoro Crater ( $35^{\circ}25'E$ ,  $3^{\circ}5'S$ ) is in Northern Tanzania and covers about 4% of the Conservation Area (Fig. 1). It has an area of about  $310 \text{ km}^2$  of which the floor occupies  $250 \text{ km}^2$  and the steep sloping wall the remainder. The lowest point on the floor (Lake Magadi) is at  $1737 \text{ m a.s.l.}$  and the highest point on the rim wall stands at  $2136 \text{ m a.s.l.}$  (Anderson & Herlocker, 1973).

The Geology of Ngorongoro Crater is summarized by Fosbrooke (1972) and Anderson & Herlocker (1973). Drainage is completely internal, with water flowing into the Crater through permanent rivers and some seasonal streams from a series of springs in the wall. All this water collects into a salt lake (Lake Magadi) at the centre of the Crater and into a series of permanent and seasonal swamps, which are interconnected by the lake during rains.

Most of the Crater floor is grassland, with small areas of forest (Lerai and Ngoitokitok) and swamps (Gorigor and Munge), which have been described in detail by Pratt, Greenway & Gwynne (1966), Herlocker & Dirschl (1972) and Anderson & Herlocker (1973). The study began in December 1980 and the first 8 months were spent in surveying the area, taking photographs to identify individual rhinos and assessing techniques. Collection of activity data began in August 1981 and continued to the end of May 1982, with no breaks longer than 15 days.

### Methods

The method used to record the daily activity of the rhinoceros in the field follows that of Rollinson *et al.* (1956), for qualitative studies on Zebu cattle in East Africa. The method is referred to as the 'Instantaneous Sampling Method' and is defined by Altman (1974) as a technique in which the observer records an animal's activity at a preselected time interval. This method has been widely used with success in wild ungulate studies in Africa by amongst others with warthog (*Phacochoerus aethiopicus*, Cretzshmer), Spinage (1982) with waterbuck (*Kobus defassa*, Heller), with elephant (*Loxodonta africana* (Blumenbach)) and Jarman & Jarman (1973) with impala (*Aepyceros melampus*, Lichtenstein).

The rhinoceros daily activity was studied by following known animals and recording their activity at intervals of 5 min. Observations were made from a vehicle in the open grasslands, on foot, from trees and tree stumps in Lerai forest and from the roof of the vehicle near the swamps. Most animals could be observed from a distance of about 50 m without causing apparent disturbance. Closer approaches caused the rhinoceros either to run away or to cease activity and stare at the observer. Sometimes they would charge the vehicle. When disturbance occurred accidentally, for instance due to sudden changes of wind direction, observations were abandoned and the vehicle was driven away for 100 m or so to wait for the animals to resume normal activity, before driving back to a safe position. It took roughly 5 min before the rhinoceros settled down after minor disturbance. Follows on shy individuals (especially sub-adults and temporary floor visitors) were often terminated because they ran off for long distances even after minor provocations.

Data were mostly collected during shifts either from 06.00 to 13.00 or from 13.00 to 19.00 h each day, but due to various practical circumstances, the daily observation periods ranged from 1 h to 10 h. It was sometimes possible to keep two rhinoceros groups under observation at a time, especially when these groups were lying down or feeding close by.

The behaviour of the rhinoceros was classified into six categories: (i) feeding: picking and ingesting a food plant; (ii) lying (a) lying in lateral or sternal recumbency, (b) lying with head raised; (iii) standing; (iv) walking; (v) social behaviour: all intraspecific interactions; (vi) comfort behaviour: wallowing. In

this study lying and wallowing were combined because normally rhinoceros lay down in the mud or dust depressions after rolling in them. Defaecation and urination were recorded whenever observed. If a rhinoceros picked or was chewing a food plant while walking, the activity was categorized as feeding. As it was not always possible to identify what the rhinoceros were selecting from the ground, feeding included both grazing and browsing.

Only the diurnal activity of the black rhinoceros is considered here. Data on nocturnal activity could not be obtained because the animals retreated at night into the Crater forest, swamps or thickets at the Crater wall, making observations impossible.

## Results

The data were analysed to show the differences and/or similarities in activity within each sex and age class, together with their seasonal variations. Within each season, no difference in activity was observed between the various sex and age classes. Thus data for all sex and age classes were combined and the results shown in Fig. 2 and Table 1.

During the wet season, the rhinoceros spent significantly more time feeding than during the dry season (Table 1), with peaks observed in early morning and late afternoon hours (Fig. 2a). The time spent lying down increased significantly during the dry season (Table 1). The pattern for the two seasons were similar, but values for the wet season were lower. In both seasons, peaks were observed at 10.00–11.00 hr and 15.00–16.00 h (Fig. 2b).

Standing was a minor activity in the rhinoceros daily life, with a peak of 20% reached at 13.00–14.00 h in both seasons (Fig. 2c). The animals stood up for about 10 min at rather regular intervals during the lying down phase. Instantaneous sampling is not the best method to use in recording social behaviour (Altman, 1974), but data collected using this method showed social activities to have been performed significantly more often during the wet season (Fig. 2e). In both seasons, rhinoceros walked during the 06.00–09.00 h and 18.00–19.00 h periods while in the middle of the day the animals were virtually stationary.

## Discussion

A comparison is made in Fig. 3 between the present results and those obtained by Goddard (1967). In both studies the rhinoceros were categorized as being 'active' when they were feeding or walking and 'inactive' when lying down or standing. Social behaviour was added to the first category in the present study, but since very little time was spent on this activity, the classifications remained essentially the same. There were differences, however, in the method of data collection as Goddard mainly recorded the activity of the rhinoceros when first sighted.

For the purpose of comparison the data on males and females compiled by Goddard (1967) in his Tables 1 and 2 were combined so as to give one graph for each rhinoceros population. The basic trends of the activities in the three studies correspond closely. Rhinoceros in the present study appear to be slightly less active, but the difference is not significant ( $\chi^2 = 36.13$ ,  $df = 24$ ,  $P > 0.05$ ). The

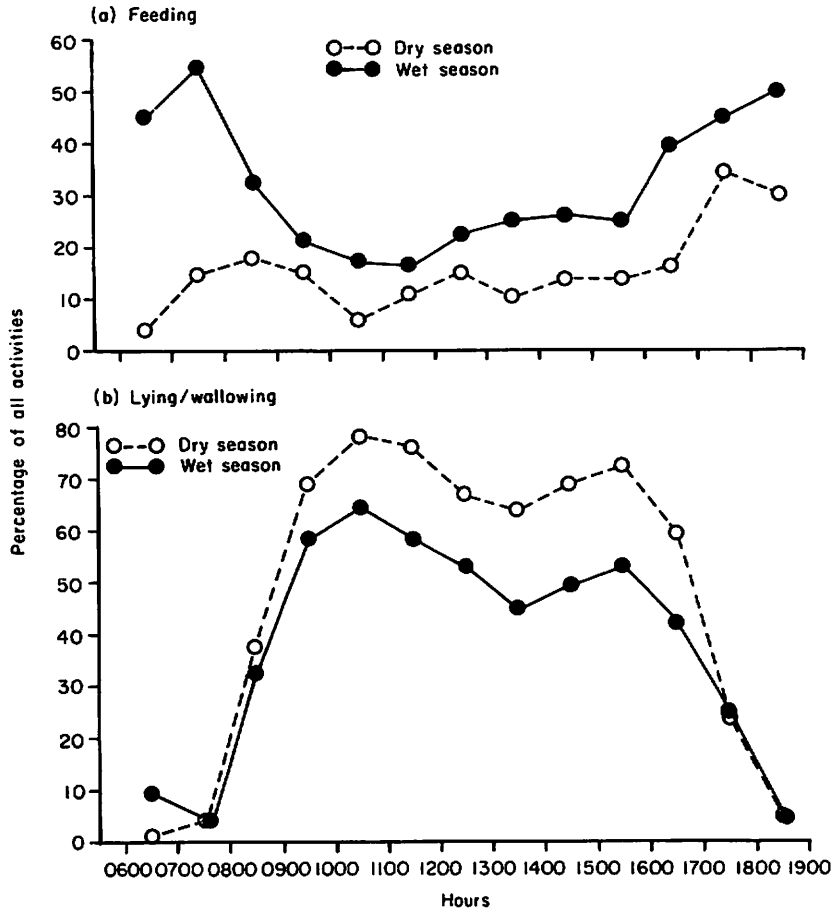
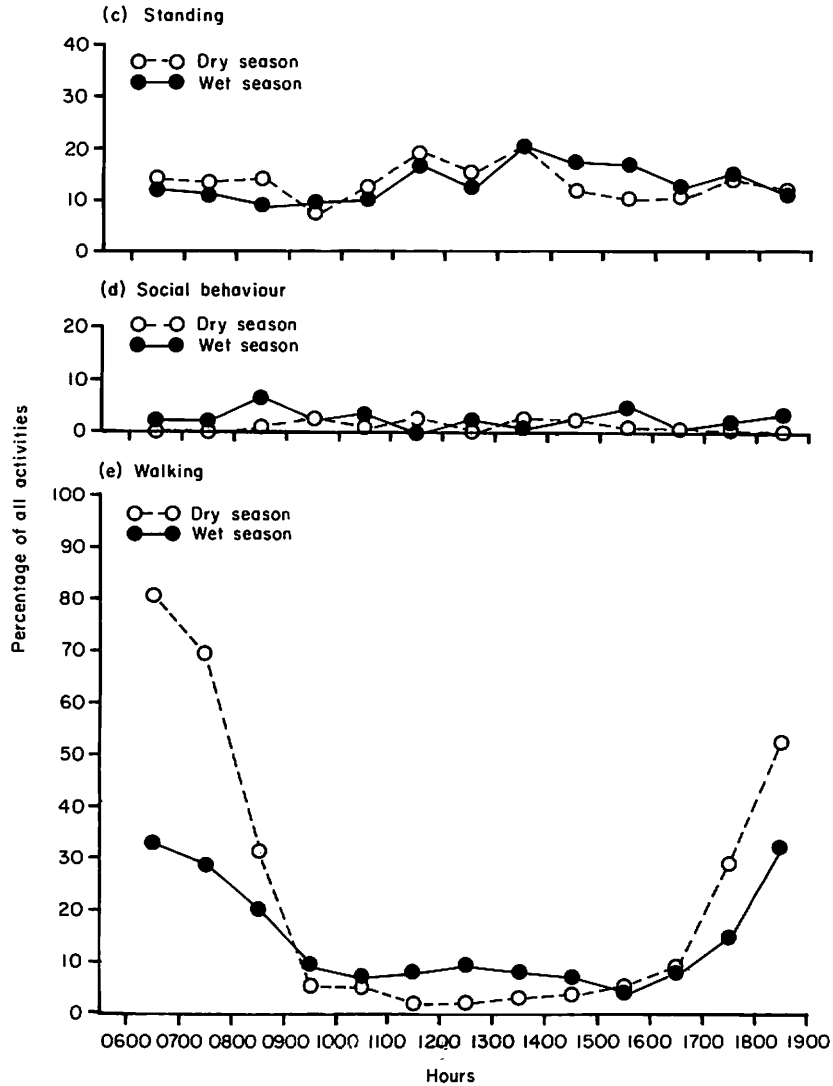


Fig. 2. The mean time spent in each activity in each hour during the day-time (data pooled from observations on fourteen rhinoceros); (c), (d) and (e) overleaf.

Olduvai Gorge population appears to be more active at 09.00–10.00 h and 15.00–16.00 h probably because the Gorge is more arid (Goddard, 1968) so that the rhinoceros have to walk longer distances to get their daily requirements of food and water.

The daily activity of the black rhinoceros in the Crater can broadly be divided into three distinct phases. In the early morning, the rhinoceros emerge from the Crater floor forests or thickets on the wall and feed while walking into the open grasslands or swamps; at midday they lie down and in late afternoon they feed while walking back into the forests or thickets, where they spend most of the nights. More time is spent feeding than actual walking during these journeys in the wet season, due to the availability of green food plants. In the dry season, they feed very little on the way.

During the wet season, a green flush of palatable herbs, shrubs and grasses appears in the open grasslands of the Crater floor, on which the rhinoceros spend



about one-third of the day time feeding. Green vegetation disappears completely from these areas in the dry season and the animals feed in and around the swamps where the vegetation remains green. However, since the rhinoceros spend very little time feeding during the day time, they probably have to feed more at night in the Crater forests.

Lying predominates over all the other activities in both seasons, with the animals spending almost half of the day time on this activity. They lie down in dust or mud depressions, and as also noted by Goddard (1967), they do not seem to be affected by the heat as they do not seek shade. This is contrary to observations made by Schenkel & Schenkel-Hullinger (1969) in the Tsavo National Park rhinoceros, which seek shade under trees and bushes in hot sunshine. The

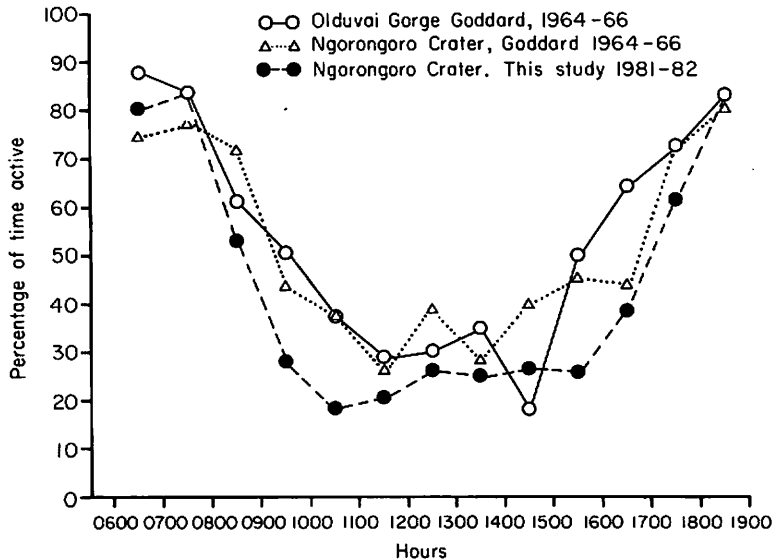
**Table 1.** The seasonal mean percentage time spent in each activity by the black rhinoceros in Ngorongoro Crater

	Wet season	dry season	<i>P</i> *
Feeding	31.7	15.8	<i>P</i> < 0.01
Lying/wallowing	38.9	48.7	<i>P</i> < 0.05
Standing	13.8	12.6	<i>P</i> > 0.05†*
Walking	14.2	22.1	<i>P</i> < 0.01
Social behaviour	2.0	1.0	<i>P</i> < 0.05

Five adult males, four lone adult females, three females with calves and two sub-adults.

\*From *F* ratios (Sokal & Rohlf, 1969).

†Not significant.



**Fig. 3.** Comparison of the results obtained by Goddard (1967) on the diurnal activity of the black rhinoceros in Ngorongoro Crater and Olduvai Gorge, with the results of the present study in the Crater (all sex/age classes combined).

significantly more time spent lying down in the dry season was probably due to the disappearance of green food plant in the open areas.

More time is spent walking in the dry season, but this difference is not related to the total areas covered because most individuals use larger areas in the wet season (Kiwia, 1983). The difference appeared because of the recording method, whereby an animal which is moving while ingesting a food plant is categorized as feeding—a behaviour observed most in the wet season when food plants are abundant along the rhinoceros movement routes.

In general, very little time was devoted to social interactions by the black rhinoceros during the day time. This is partly because the animals mostly lead a solitary life (Goddard, 1967; Kiwia, 1983) and partly because they are inactive most of the time. The general observation that most wild ungulates are active (feeding/walking) in the early mornings and late afternoons with a long period of inactivity (lying/standing) in the middle of the day (Leuthold, 1977) holds for the black rhinoceros in Ngorongoro Crater (Goddard, 1967 and present study) and Olduvai Gorge (Goddard, 1967).

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### References

- ALTMAN, J. (1974) Observational study on behaviour: Sampling methods. *Behaviour*, **49**, 227–267.
- ANDERSON, G.B. & HERLOCKER, D.J. (1973) Soil factors affecting the distribution of the vegetation types and their utilization by wild animals in Ngorongoro Crater, Tanzania. *J. Ecol.* **61**, 627–651.
- CLOUGH, G. & HASSAM, A.G. (1970) A quantitative study of the daily activity of the warthog in Queen Elizabeth National Park, Uganda. *E. Afr. Wildl. J.* **8**, 19–24.
- FOSBROOKE, H. (1972) *Ngorongoro: The Eighth Wonder*. Andre Deutsch, London.
- GODDARD, J. (1967) Home range, behaviour and recruitment rates of two black rhinoceros. *Diceros bicornis* L. populations. *E. Afr. Wildl. J.* **5**, 133–150.
- GODDARD, J. (1968) Food preferences of two black rhinoceros populations. *E. Afr. Wildl. J.* **6**, 1–18.
- GUGGISBERG, C.A.W. (1966) *S.O.S. Rhino*. Andre Deutsch, London.
- HERLOCKER, D.J. & DIRSCHL, H.J. (1972) *Vegetation of the Ngorongoro Conservation Area, Tanzania*. Canada Wildlife Service Report Service No. 19, Ottawa.
- JARMAN, M.V. & JARMAN, P.A. (1973) Daily activity of impala. *E. Afr. Wildl. J.* **11**, 75–92.
- KIWIA, H.Y.D. (1983) *The Behaviour and Ecology of the Black Rhinoceros Diceros bicornis L. in Ngorongoro Crater*. M.Sc. Thesis, University of Dar es Salaam, Tanzania.
- KLINGEL, H. & KLINGEL, U. (1966) The rhinoceros of Ngorongoro Crater. *Oryx* **8**, 302–306.
- LEUTHOLD, W. (1977) *African Ungulates: A comparative review of their Ethology and Behavioural Ecology*. Springer-Verlag, New York.
- PRATT, D.J., GREENWAY, P.J. & GWYNNE, M.A. (1966) A classification of East African rangelands, with an appendix on terminology. *J. appl. Ecol.* **3**, 369–382.
- ROLLINSON, D.H.I., HARKER, K.W., TAYLOR, J.J. & LEECH, F.B. (1956) Studies on the habits on Zebu cattle. IV Errors associated with recording technique. *J. Agric. Sci. Cambridge*, **47**, 1–5.
- SCHENKEL & SCHENKEL-HULLINGER, L. (1969) *Ecology and Behaviour of the Black Rhinoceros (Diceros bicornis L.) A Field Study. Mammalia depicta*. Verlag Paul Parey, Berlin.
- SOKAL, R.R. & ROHLF, F.J. (1969) *Biometry*. W.H. Freeman and Company, San Francisco.
- SPINAGE, C.A. (1982) *A Territorial Antelope. The Uganda Waterbuck*. Academic Press, London.
- WYATT, J.R. & ELTRINGHAM, S.K. (1974) The daily activity of the elephant in the Rwenzori National Park, Uganda. *E. Afr. Wildl. J.* **12**, 273–289.

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