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Movement Patterns And Home Range Sizes Of The Rothschild's Giraffes (*Giraffa camelopardalis Rothschildii*) Translocated To Ruma National Park, Kenya.

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----------ABSTRACT----------
The need for management of small, wild populations has been given limited attention. The Rothschild's giraffe is poorly represented in East Africa, therefore, it is important that its populations and environments should be carefully managed to permit its survival. The objective of this study was to determine the movement patterns and home range sizes of the translocated Rothschild's giraffes in Ruma National Park. Using binoculars, the giraffes were located, aged and sexed. Individuals were recognized by variations in their skin pattern. When a herd was sighted, the direction of movement was observed and the location plotted on a field map using a six-digit code of eastings and northings. The most peripheral points were joined resulting in polygons. Using a planimeter, home range sizes were computed as the polygon areas. Thirty recognizable giraffes exhibited well-defined movement patterns. The extent of movement varied from one vegetation community to another. The home range sizes were small with high percentage overlap values. There were no significant differences in the home range sizes (Mann-Whitney 'U' test = 15, df = 4,5, P>0.05) and in the longest linear distances covered by males and females (Mann-Whitney 'U' test = 13, df 4,5, P>0.05). Apparently, vegetation distribution and disturbance by poachers affected the movement patterns and home range sizes of the giraffes in the study area.

KEYWORDS: *Home ranges, Movement patterns, Translocation.*

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I. INTRODUCTION

The Rothschild's giraffe has been classified as endangered [1, 2] and is now a protected species in most of its range. All populations in Kenya are now confined to managed conservation areas where they are exerting pressure on the environments that support them, leading to increasing tree mortality and consistent failure to recruit young [3]. In 1983, the former Kenya Game Department captured and translocated 28 Rothschild's giraffes from Lewa Downs Farm (Soy) to Ruma National Park. Translocation refers to the moving of wild-captured animals for release into the wild at a second site where they can establish themselves and breed [4].

The range of the Rothschild's giraffes in Soy had been greatly reduced due to the spread of human settlement coupled with poaching and hunting. This led to a great decline in their numbers and severe browsing pressure on woody plant species resulting in stunted growth forms [5]. Ruma National Park represented a suitable habitat because it contained much of the right food plants and did not have other races of giraffes with which the Rothschild's giraffes would crossbreed thereby loosing or diluting their unique characters. Populations of conservations interest will increasingly need to be monitored and managed to ensure their long-term survival [6]. This study was initiated to improve on the ecological baseline data on the translocated Rothschild's giraffe in Ruma National Park.

II. STUDY APPROACH

2.1 Study area

Ruma National Park covers an area of 120 Km^2 within Lambwe Valley in Homabay County, Kenya. The park lies 17 Km South West of Homabay town within latitudes 0^030^0 and 0^045^0 South and longitudes 34^01` and $34^010$`East. The park is essentially Savannah grassland dissected by the Olambwe River which is largely subterranean and runs the whole length of the park. It carries surface water during the wet season only. Along

the Olambwe river valley, a riverine thicket forms a distinct vegetation type dominated by several species of *Acacia* and *Rhus natalensis* bushes. The rest of the park falls under wooded grasslands dominated by *Balanites aegyptiaca* and *Acacia drepanolobium* and woodlands dominated by *Acacia seyal* and *Rhus natalensis* bushes. Dominant grass species are *Themeda triandra* and *Setaria sphacelata* in the wooded grasslands and *Hyparrhenia filipendula* in the woodlands. On the hill slopes of Kanyamwa Escarpment, there is a coniferous forest with the oldest trees planted in 1964 [7].

2.2 MATERIALS AND METHODS

2.2.1 Individual identification of the giraffes

Using an 8 x 40 pair of binoculars, the giraffes were searched for and located by looking out for them from vantage points and following their tracks. The search was done on foot. After locating them, the giraffes were pursued continually between 6.00 a.m. and 6.00 p.m. for a total of 120 days during the study period. Observations were made for at least 5 days in a week. Individual giraffes were recognized on the basis of variations in their skin patterns using the method of Foster [8]. Whenever possible, photographs showing distinctive neck spot patterns were taken and carried to the field to aid in identification of individuals. A total of 17 males (9 adults and 8 sub adults) and 13 females (11 adults and 2 sub adults) were identified.

2.2.2 Sexing of the giraffes

Physical appearance is a reliable guide to the sex of a giraffe. The following criteria were used:

a) External genitalia: the male genital organ clearly protrudes from the ventro-posterior section of the animal. The ventro-posterior section of the female lacks a protuberance.

b) Character of the horn-like ossicones: this is the only subspecies to be born with five ossicones. Two of these are the larger ossicones at the top of the head. The third ossicone can often be seen in the center of the forehead and the other two are behind each ear. Females have one pair of visible short frontal ossicones on top of the head; males have an extra median ossicone [3].

c) Size and colour: Males are taller than females and tend to be darker in colour as they age [3], although this is not a guaranteed sexing indicator.

2.2.3 Ageing of the giraffes

Physical appearance is a reliable guide to the age of a giraffe. The following criteria were used:

a) Calves: these included all the individuals that were still suckling. The approximate age of this group was taken to be from newborns to l½ years old. By the age of 1½ years, the calves usually have separated from the mother [9].

b) Sub adults: these included all the individuals that were larger than the calves but were clearly smaller in size than adults. Males and females in this group have thin ossicones that display tufts of hair on top [3].

.c) Adults: these included all individuals that had reached full size. The ossicones of adult males end in knobs and tend to be bald from sparring [(3]. Males develop calcium deposits that form supplementary bony nodules on the upper surface of the skull as they age (10, 11). Females have thin ossicones that display tufts of hair [3].

2.2.4 Determination of movement patterns

Data on movement patterns of the giraffes were obtained from observations of known individuals [12, 9, 5]. Records of giraffe movements were made during day light hours only. When a herd of giraffes was encountered, its composition by sex and age classes and known individuals present were recorded. The directions of movement were marked on field maps of Ruma National Park on a scale of 1:100,000 which were divided into grids of 1 Km^2. It was therefore possible to accumulate data on movement patterns and vegetation communitiestraversed.

2.2.5 Determination of home range sizes

Data on home range sizes of the giraffes were obtained from observations of known individuals [12, 9, 5]. Home range sizes were established by recording locations of giraffes on field maps of Ruma National Park on a scale of 1:100,000 which were divided into grids of 1 Km^2. Each of these grids was further sub-divided into 10 equal parts. These sub-divisions were then used to plot the actual location of a herd using a six-digit code. The first three digits represented the eastings and the last three the northings. After plotting all the locations, the

most peripheral points were joined resulting in a polygon. Using a planimeter, the sizes of the home ranges were computed as the area of the polygons [12, 9, 5, 13].

2.3 Statistical analyses

Mann-Whitney 'U' test was used to test for any significant differences in the longest linear distances covered and home range sizes of the male and female giraffes. All tests were interpreted at 0.05 level of significance[14].

III. RESULTS

3.1 Movement patterns

The results described in this section are based on 120 days, each of 12 hours of continuous observation. Figure 1 shows the movement patterns and vegetation communities traversed by the giraffes. Around the release point (opposite the airstrip), the movements of the 2 commonly sighted adult male giraffes (M1 and M2) conformed to consistent patterns. They exhibited a north - south movement pattern in the *A. seyal* woodland and the fringes of the riverine vegetation community.

The movements of the rest of the giraffes in the northern part of the park tended to be circular in pattern. They moved away from the riverine vegetation community towards the *A. drepanolobium* wooded grassland, then towards the *B. aegyptiaca* wooded grassland and finally there was a general movement towards the riverine vegetation community. Although well-defined movement patterns existed around the riverine vegetation community, the giraffes confined their movements along the edges of this community. They appeared to move repeatedly along the same routes in each vegetation community although the extent of movement varied from one community to another. Usually the giraffes were observed moving as they fed early in the morning up to about 0900 - 1000 hours then resting or just walking during most of the day until about 1600 - 1700 hours when they resumed feeding again.

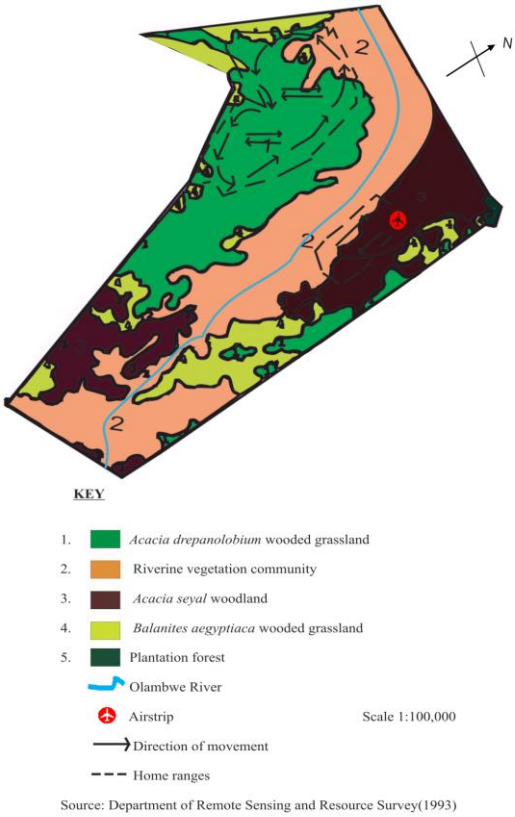

Figure 1: Home ranges and movement patterns of the giraffes and vegetation communities traversed in Ruma National Park

3.2 Home ranges

Table 1 shows the sex, age, number of sightings, longest linear distance, home range size, home range overlap area and percentage overlap of 17 recognizable males and 13 recognizable females commonly sighted in Ruma National Park. Figures 2 to 5 show the home ranges of 30 recognizable individuals (17 males and 13 females). 10 of the 13 recognizable females had calves which were often in the company of their mothers. The largest home range recorded was 16.21 Km^2 (M3, M10 and M11) and 12.08 Km^2 (Sub adults FI and F12) for males and females respectively. M10, M11, M12, M13, M14, M15, M16 and M17 were sub adult males.

Female F10 had the smallest home range of 3.03 Km^2. Males M1 and M2 had the smallest home range recorded for males measuring 8.07 Km^2. However, the home range sizes of males was not significantly different from that of females (Mann- Whitney 'U' test =15, d.f= 4, 5, $P > 0.05$). A significant feature of these home ranges was that they were considerably smaller than those recorded for giraffes elsewhere except in Soy. Another outstanding feature was the percentage overlap of the home ranges which was as high as 100% in some cases. The giraffes always moved in herds. Occasionally these herds split into two or more groups with the males moving further than the females. They later regrouped into the original herds. For research purposes, a "group" has been defined as "a collection of individuals that are less than a kilometre apart and moving in the same general direction" [8,15].

The highest value for the longest linear distance between two observations was 8.0 Km for males M7, M8, M9, M14, M15, M16 and M17 who were members of a bachelor herd. The highest value for the longest linear distance for females was 5.7 Km for F1 and F12 and the shortest distance recorded was 3.1Km for F10. The shortest distance recorded for male giraffes was 4.2 Km for M1 and M2. However, there was no significant difference in the longest linear distances traveled by the males and females (Mann-Whitney 'U' test = 13, df = 4,5, $P > 0.05$). All the home ranges were characterized by woody vegetation cover. Giraffes were not sighted in the southern part of the park throughout the study period. The number of times an animal was sighted had little influence on the home range size. Some animals with few sighting records had large home ranges while others with many records had smaller home ranges.

Table 1: Sex, age, number of sightings, longest linear distance, home range size, home range overlap area and percentage overlap of 17 recognizable males and 13 recognizable females.

Individual Giraffes	Age	Number of sightings	Longest linear distance (Km)	Home range size (Km^2)	Overlap area (Km^2)	Percentage overlap
M1	Adult	103	4.2	8.07	8.07	100.00
M2	Adult	94	4.2	8.07	8.07	100.00
M3	Adult	92	5.6	16.21	10.76	66.38
M4	Adult	91	5.6	16.21	10.76	66.38
M5	Adult	91	4.6	8.36	5.94	71.05
M6	Adult	90	4.6	8.36	5.94	71.05
M7	Adult	86	8.0	12.05	5.41	44.90
M8	Adult	87	8.0	12.05	5.41	44.90
M9	Adult	86	8.0	12.05	5.41	44.90
M10	Sub-A	92	5.6	16.21	10.76	66.38
M11	Sub-A	92	5.6	16.21	10.76	66.38
MI2	Sub-A	88	4.6	8.36	5.94	71.05
M13	Sub-A	89	4.6	8.36	5.94	71.05
M14	Sub-A	84	8.0	12.05	5.41	44.90
M15	Sub-A	84	8.0	12.05	5.41	44.90
M16	Sub-A	84	8.0	12.05	5.41	44.90
M17	Sub-A	87	8.0	12.05	5.41	44.90
Fl	Sub-A	90	5.7	12.08	11.07	91.64
*F2	Adult	95	5.4	10.68	10.68	100.00
*F3	Adult	88	3.3	5.47	5.47	100.00
*F4	Adult	89	3.3	5.47	5.47	100.00
*F5	Adult	96	5.4	10.68	10.68	100.00
*F6	Adult	89	3.3	5.47	5.47	100.00
*F7	Adult	89	3.3	5.47	5.47	100.00
*F8	Adult	97	4.8	5.45	5.45	100.00
*F9	Adult	97	4.8	5.45	5.45	100.00
*F10	Adult	91	3.1	3.03	3.03	100.00
*F11	Adult	97	4.8	5.45	5.45	100.00
F12	Sub-A	92	5.7	12.08	11.07	91.64
FI3	Adult	98	4.8	5.45	5.45	88.01
M=17 F=13		M=17 F=13				
Mean M=6.19 F=4.44		M=11.69 F= 7.09				
Range M= 3.80 F= 2.60		M= 8.14 F= 9.05				

Legend
*F- female with a calf
M- Male
F- Female
Sub-A –Sub adults

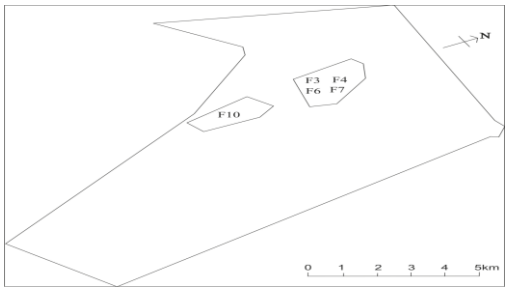

Figure 2: Giraffe home ranges of 5 females commonly sighted in Ruma National Park

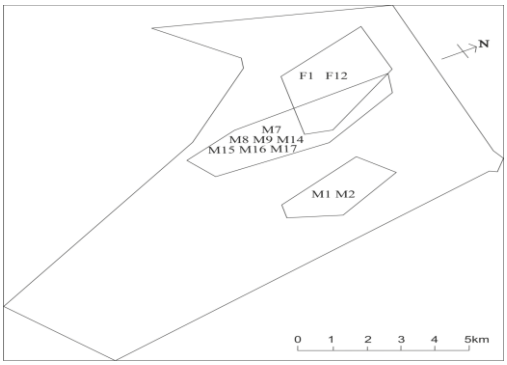

Figure 3: Giraffe home ranges of 2 females and 9 males commonly sighted in Ruma National Park

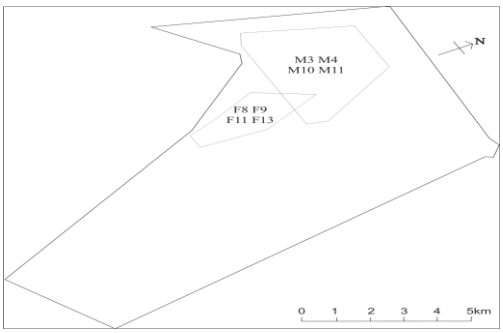

Figure 4: Giraffe home ranges of 4 females and 4 males commonly sighted in Ruma National Park

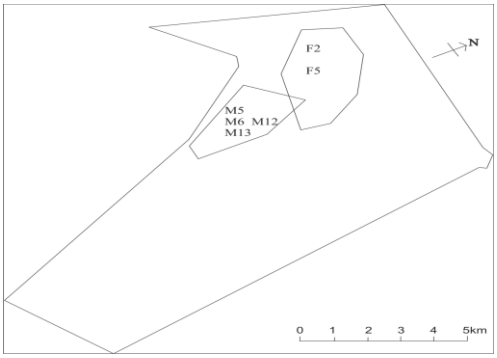

Figure 5: Giraffe home ranges of 2 females and 4 males commonly sighted in Ruma National Park

IV. DISCUSSION

The giraffes were released in the *A. seyal* woodland, opposite the airstrip. They moved westwards, across the Olambwe River towards the far north of the park where they established their home ranges (Figure 2). Apparently two males remained in the vicinity of the release point. There are several proximate factors that could have caused these settlement patterns. First, the vegetation at the point of release was denser than that across the Olambwe River towards the North-Eastern part of the park where the vegetation communities were more open comprising of A. *drepanolobium* and the *B. aegyptica* wooded grasslands. Heavy concentration of shrub creates access problems to potentially grazeable areas [16]. The release point probably offered less food and the trees were old and very tall. In Lake Nakuru National Park the giraffes seemed to avoid very old pure stands of *Acacia* trees [17]. The more open vegetation communities in the North Eastern part of the park were mainly made up of young plants which the giraffes appeared to prefer. Giraffes prefer to browse on immature *Acacia* trees [18], lending credence to this observation.

Second, in Soy, the giraffes interacted with a few animal species and the sudden appearance of strange species in Ruma may have forced them to move west of the release point in an attempt to avoid the strange animals. Third, poachers set up snares in the dense vegetation communities (Unpublished Report by Department of Wildlife Management, Moi University, 1993). Therefore, the giraffes may have moved from this area to avoid being ensnared. Fourth, the North Eastern part of the park across the Olambwe River offered good visibility because of the short and scattered vegetation. The giraffes could feed and at the same time survey their surroundings for any imminent danger. Females with calves tend to feed in open areas, presumably to make it easier to detect predators, although this may reduce their feeding efficiency [19]. In Lake Nakuru National Park giraffes moved southwards from the release point towards the bush land, which offered more food and water sources. This area was also far away from human disturbance, which was more prevalent in the north. Consequently the giraffes exhibited well-defined movement patterns. In Soy, the giraffes wandered around with no apparent consistency in an attempt to avoid traffic, domestic animals and people on foot [5].

Giraffes are not territorial but they have home ranges [3]. After establishing their home ranges, giraffes in Ruma exhibited well-defined movement patterns associated with the availability and distribution of food plants and the avoidance of the disturbing presence of snares in the dense vegetation communities. Male giraffes occasionally wander far from areas that they normally frequent [20]. Mothers with calves will gather in nursery herds, moving or browsing together [20]. Both the quantity and quality of food available influences the distribution of animals. Plants, unlike animals have tissues which are largely composed of indigestible cellulose and lignins and contain widely variable concentrations of nutrients like amino acids and attractant, repellent and toxic chemicals [17]. Therefore, the distribution of giraffes in Ruma National Park may be influenced by low quality vegetation in the southern half despite an apparent abundance of suitable food. It is true that all that is green is not food [18]. The giraffe requires less food than many other herbivores, because the foliage it eats has more concentrated nutrients and it has a more efficient digestive system [21, 22]. Feeding is at its highest during the first and last hours of daytime. Between these hours, giraffes mostly stand and ruminate [3].

Giraffes in Ruma National Park shared the same home ranges to a large extent. A similar pattern was reported in Lake Nakuru National Park where 17 of the 18 translocated giraffes shared one home range characterized by woody vegetation cover [5]. The giraffe is exclusively a browser and woody cover is therefore an important factor influencing its distribution. Home ranges of giraffes in Ruma National Park showed a very high degree of overlap. In Soy, a similar pattern was observed [5]. Moore-Berger [23] found a high degree of overlap between home range positions of individuals at El Karama Ranch which was partially fenced, traversed by tracks and had a high degree of human activities. While giraffes are usually found in groups, the composition of these groups tends to be open and ever-changing [24]. The most stable giraffe groups are those made of mothers and their young [15], which can last weeks or months [25]. Social cohesion in these groups is maintained by the bonds formed between calves [15, 20]. Mixed-sex groups made of adult females and young males are also known to occur. Sub adult males are particularly social and will engage in play fights [15]. All these observations are consistent with previous reports that giraffes are gregarious. However, as they get older, males tend to become more solitary [25].

The home ranges of giraffes in Ruma National Park were much smaller than those reported in other areas. The mean home range size was 11.7 km^2 for males and 7.1 km^2 for females. Nesbit-Evans [26] noted that the small area the giraffes covered in Soy may not have represented what their range would have been under completely natural conditions. One possible reason for the small home ranges in Ruma National Park was that the giraffes probably got all their basic survival requirements from the small area. The fence surrounding the park was another factor which may have contributed to the small home ranges.

The giraffes were not free to move outside the fence hence the only few suitable areas had to be shared by all the individuals. Kingdon [21] observed that during the wet season, food is abundant and giraffes are more spread out, while during the dry season, they gather around the remaining evergreen trees and bushes.

Another factor that may have contributed to small home range sizes was the presence of the riverine vegetation community that cut across the park along the whole length of Olambwe River. This vegetation community was dense and wet in the rainy season and probably acted as a physical barrier to the giraffes' movements. The giraffes only fed at the edges of the riverine vegetation community. The giraffes may have also avoided this area because of the disturbing presence of snares set up for game poaching (Unpublished Report by Department of Wildlife Management, Moi University, 1993). Whether or not this vegetation "barrier" had an effect on giraffe distribution in Ruma National Park is conjectural. Giraffes prefer drier, more open habitats and are uncommon in denser woodlands and when present tend to spend most of their time on the fringes [10]. Leuthold and Leuthold [27] noted that giraffes showed a general preference for the most densely wooded vegetation and a relative avoidance of the most open one in Tsavo East National Park. A similar pattern was observed in Lake Nakuru National Park [5, 17]. Thus factors that affect the spatial distribution of giraffes may be more complex than these reports have found.

Animals often inhabit restricted environments while chance and inherent aggregation may lead to restricted dispersion [28]. Special habitat requirements are likely to be the major cause of patchy distribution of higher vertebrates. Giraffes usually inhabit savannas, grasslands and open woodlands. They prefer *Acacia*, *Commiphora*, *Combretum* and open *Terminalia* woodlands over denser environments like *Brachystegia* woodlands [(20]. The four vegetation communities in Ruma National Park were not equally utilized. The giraffes preferred the *B. aegyptiaca* and the *A. drepanolobium* wooded grasslands which provided abundant browse resource. The microspatial dispersal of animals is influenced by the availability of food [29, 30, 31]. Availability of drinking water may also affect the distribution of giraffes but its influence is difficult to separate from that of vegetation type and condition [27]. When it has access to water, a giraffe drinks at intervals no longer than three days [3]. Giraffes are capable of surviving without water for relatively long periods [10]. Therefore, it is unlikely that it played a crucial role in the distribution of giraffes in Ruma National Park. The giraffes may have avoided the *A. seyal* woodland and the riverine vegetation community because they would end up spending more time trying to find their way and less time would be spent on feeding. Optimal foraging theory postulates that animals should feed in such a way as to gain the most calories per unit time spent feeding [32]. Discrimination in choice of habitat is one means of optimal foraging.

V. CONCLUSIONS

Ruma National Park is a “terrestrial island” in the sense that it is surrounded by farmlands and dense human settlements. The management of “island” populations requires close monitoring of the ecological effects and habitat requirements of the animal species in question. Central to the study of animal ecology is the usage it makes of its environment, specifically the kinds of habitats it occupies and the dietary composition. The northern part of the park had a much higher intensity of use by the giraffes than the south. Under such circumstances, the giraffes may themselves affect their food supply adversely by favouring and overutilizing preferred food plants in the small area where they established their home ranges and within which they confined their movements.

REFERENCES

[1] Fennessy, J.; Brown, D. (2008). “Giraffa camelopardalis ssp. peralta”.IUCN Red List of Threatened Species. International Union for the Conservation of Nature.
[2] Fennessy, J. & Brenneman, R. (2010). “Giraffa camelopardalis ssp. rothschildii”. IUCN Red List of Threatened Species. International Union for Conservation of Nature.
[3] Estes, R. (1992). The Behavior Guide to African Mammals: including Hoofed Mammals, Carnivores, Primates. University of California Press. pp. 202–07.
[4] Stanley-price, M.R. (1989). Animal introductions: The Arabian Oryx in Oman.New York: Cambridge University Press.
[5] Kakuyo, K. (1980). The effects of translocation on the rothschild's giraffe (Giraffa camelopardalis rothschildii) from Lewa Downs Farm to Lake Nakuru National Park. M.Sc. Thesis. University of Nairobi.
[6] Conway, W. (1995). Altered states: population viability analyses, planning and caring for wildlife in parks. In Ballou, D.J; Gilpin, M. and Foose, J., (1995) Population management for survival and recovery. New York: Columbia University Press.
[7] Muthuri, F.M. (1993). Ruma National Park Fence Environmental Impact Assessments. Report to Kenya Wildlife Service, Nairobi.
[8] Foster J.B. (1966). The giraffe of Nairobi National Park: home range, sex ratios, the herd and food. East African Wildlife Journal 4: 139-148.
[9] Leuthold, B.M. & Leuthold, W. (1978). Ecology of the giraffe in Tsavo East National Park, Kenya. East African Wildlife Journal 10:129-141.
[10] Kingdon, J. (1979). East African Mammals. An atlas of evolution in Africa. Volume 3, part B. London: Academic Press.

[11] Prothero, D. R. and Schoch, R. M. (2003). Horns, Tusks, and Flippers: The Evolution of Hoofed Mammals. Johns Hopkins University Press. pp. 67–72.
[12] Berry, P.S.M. (1978). Range movement of giraffes in Luangwa Valley, Zambia. East African Wildlife Journal, 16:77-83
[13] Waweru, F.K. (1985). Population status, ranging patterns and feeding strategies of the black rhinocerous (Diceros bicornis Linn 1758) in Nairobi National Park, Kenya. Msc. thesis University of Nairobi.
[14] Zar, H.J. (1984). Biostatistical Analysis. Printice-Hall International inc. U.S.
[15] Pratt, D. M. and Anderson, V. H. (1985). "Giraffe social behavior". Journal of Natural History 19 (4): 771–81.
[16] Ayeni, J.S.O. (1987). Big game utilization of natural mineral licks. In: Wildlife management in savannah woodlands (eds). Ajayi, S.S. and Halstead, L.B. London: Taylor and Francis Ltd.
[17] Kairu, J.K. (1993). Habitat utilization by the Rothschild's giraffe (Giraffa camelopardalis rothschildii) in Lake Nakuru National Park with some management implications. Report submitted to Deputy director, Scientific Services, Kenya Wildlife Service, Nairobi.
[18] Sinclair, A.R.E. (1975). The resource limitation of trophic levels in tropical grassland ecosystems. Journal of Animal Ecology 44: 520-597.
[19] Young, T. P. and Isbell, L. A. (1991). "Sex differences in giraffe feeding ecology: energetic and social constraints". Ethology 87 (1–2): 79–89.
[20] Kingdon, J. (1988). East African Mammals: An Atlas of Evolution in Africa, Volume 3, Part B: Large Mammals. University Of Chicago Press. pp. 313–37.
[21] Kingdon, J. (1997). The Kingdon Field Guide to African Mammals. Academic Press. pp. 339–44.
[22] Mitchell, G. and Skinner, J. D. (2003). "On the origin, evolution and phylogeny of giraffes, Giraffa camelopardalis". Transactions of the Royal Society of South Africa 58 (1): 51–73.
[23] Moore - Berger, E. (1974). Utilization of habitat by the reticulated giraffe (Giraffa camelopardalis reticulata Linnaeus) in Northern Kenya. M.Sc. Thesis. University of Nairobi.
[24] Van der Jeugd, H.P. and Prins, H.H.T. (2000). "Movements and group structure of giraffes (Giraffa camelopardalis) in Lake Manyara National Park, Tanzania" Journal of Zoology 251 (1): 15–21.
[25] Leuthold, B. M. (1979). "Social organization and behaviour of giraffe in Tsavo East National Park". African Journal of Ecology 17 (1): 19–34.
[26] Nesbit-Evans, E.M. (1970). The reaction of a group of Rothchild's giraffes to a new environment. East African Wildlife Journal, 8:53-62.
[27] Leuthold, B.M. & Leuthold, W. (1973). Ecological studies of ungulates in Tsavo National Park (East), Kenya. Mimeographed report, Kenya National Parks.
[28] Taylor, R.A. and Taylor, L.R. (1979). A behavioural model for the evolution of spatial dynamics. In: Population dynamics (eds). Anderson, R.M.; Turner, B.D. and Taylor, L.R. Oxford: Blackwell Scientific Publications.
[29] Duncan, P. (1983). Determination of the use of the habitat by the horses in a Mediterranean wetland. Journal of Animal Ecology 55: 93-109.
[30] Hart, J.A. and Hart, T.B. (1989). Ranging and feeding behaviour of okapi (Okapi johnstoni) in Ituri Forest of Zaire: Food limitation in a rain forest herbivore? In: Biology of large African mammals in their environment. The proceedings of a symposium held at the Zoological Society of London, 1988 (eds). PP 31-49. Jewell, P.A. and Malloiy, M.O. Clarendon Press, Oxford.
[31] Taylor, R.D. (1989). Buffalo and their food resources: The exploitation of Kariba Lake-Shore pastures. In: Biology of large African mammals in their environment. The proceedings of a symposium held at the Zoological Society of London, 1988 (eds). PP 51-69. Oxford: Jewell, P.A. and Malloiy, M.O. Clarendon Press.
[32] Melechek, J.C. and Balph, D.F. (1987). Diet selectivity by grazing and browsing livestock In: The nutrition of herbivores (eds). Sydney: Hacker, J.B. and Temouth, J.H. Academic Press.