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Population, distribution, and behaviour of giraffe in the Arusha National Park, Tanzania

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The Arusha National Park in northern Tanzania, with an area of only 119 km², barely covers the summit and crater of Mt. Meru at its west end, the Momela Lakes in the northeast, and Ngurdoto Crater in the southeast. This elevated complex, including a forest reserve adjoining the Park, is surrounded by plains and stands about 40 km west of Mt. Kilimanjaro. Its elevations range from 1400 to 4565 m, its annual rainfall for different regions varies from 600 to 2400 mm, and its habitats include lakes, swamps and grassland, bush, forest, heath, volcanic ash and sheer rock precipice. Vesey-Fitzgerald published a number of papers on the Park's flora, and Beesley's (1972) account of the birds contains a valuable summary of the Park's many habitats, gleaned from a comprehensive but unpublished manuscript of the Park's vegetation by Vesey-Fitzgerald (ms).

In mammalian fauna, the Park is notable for the great numbers of buffalo (*Syncerus caffer*) and the paucity of large predators. There are leopards (*Panthera pardus*) and some spotted hyenas (*Crocuta crocuta*) but no resident lions (*Panthera leo*). The giraffe population (*Giraffa camelopardalis*), whose numerical strength was not known, is cut off from other populations; the Mt. Meru-Ngurdoto massif is isolated and there is no immigration or emigration across the agricultural lands surrounding it. Many giraffe populations throughout the species' current range in central, east, and southern Africa are similarly isolated. We studied this population from July 15, 1979 to June 28, 1980, focusing on the size and structure of the population, distribution and movements of individuals, and social behaviour.

Methods

The uneven terrain, heavy vegetation, and the impossibility of offtrack driving in most areas make the study of giraffe in this Park difficult. Our weekly schedule consisted of daily observations on six days in the northeast section and parts of three days and one night in the area south of that. We made occasional but not systematic observations in the forested areas of Mt. Meru and Ngurdoto, where giraffe are scarce. A drawing of the markings on the neck of each giraffe was made at first sighting and was used to identify the individual on subsequent sightings.

We classify an immature giraffe as a calf as long as it regularly accompanies its mother; when (usually between the ages of one and two years) it leaves its mother, it is classed as a juvenile. When it attains the size of an adult female, at about five years (Backhaus 1961, Dagg and Foster 1976), it is classed as a cow or a bull. Bulls continue to grow for about two more years. On a subjective basis, we recognized three classes of bulls: A, B, and C. As an individual matures from Class C to Class B, it increases in stature, the neck becomes heavier and the horns longer and thicker. Bulls of Class A tend to be larger than Class B bulls, but their main distinctions are the stouter neck,

the massive horns, and the addition of bone and knobs and even extra horns to the skull. We estimated the ages of calves born before our arrival by criteria developed in studying calves in the Serengeti (Pratt and Anderson 1979); after the first week of life (when the horns become erect), the principal features useful in age determination are shapes and proportions of head, neck and chest, and the estimate is subjective.

Results

Population size and structure

Our effort in identifying new individuals was constant over time, and at the end of the study the number of known individuals was 462 and still increasing slowly. The cumulative first sightings of giraffe were tallied for the period of study. The resulting curve was fit by a generalized logistic model

$$y = \frac{K}{1 + \exp(a + bx + cx^2 + dx^3 + ex^4)}$$

using an iterative nonlinear least squares technique. For this we are indebted to Talbot Murray. The estimate of total population size thus derived is 471 individuals. The lower limit is known by observation to be 462, and the upper limit is 497 (95% upper confidence limit).

The numbers of individuals identified are shown in table 1; their division into North and South subpopulations will be discussed below. Combining all age categories, there were 242 females and 220 males. There was a consistent preponderance of females among the calves and juveniles, but among the adults sex ratios differed greatly in the two major subpopulations. In the North, bulls outnumbered cows 1.39 : 1; in the South the ratio was skewed the other way, 1 : 1.68. Immature stages (calves, juveniles) comprised 24% of the population.

During the year, we recorded the births of 12 calves in the North and 10 in the South. In this small sample, there was no evidence of seasonality in calving. At the end of the study all but one of the new calves in the North were still alive. The new South calves had not fared as well: four of these were certainly dead (their mothers consistently seen without them), and four of them together with their mothers had not been seen for seven to nine months and were presumed dead, so that only two of the ten were known to be alive.

Table 1. Numbers of known individual giraffe, by age, sex, and region.

	<i>North</i>	<i>South</i>
calves		
female	17	19
male	13	7
juveniles		
female	20	14
male	15	9
cows	93	79
bulls	129	47
	287	175

Distribution

The Park's giraffe are segregated into two subpopulations, North and South (table 1, fig. 1). Fourteen bulls, or 3% of the total population, were seen in both the North and the South (eight of them making round trips). No other giraffe are known to have crossed the North-South boundary.

The North part of the Park is divided into four areas each with its own group of individuals. The individuals that were seen more often in Area A than elsewhere were 5 calves, 12 juveniles, 15 cows and 35 bulls. Area B was the home of nearly half of the northern subpopulation: 13 calves, 12 juveniles, 40 cows and 73 bulls. The individuals characteristic of Area C were 11 calves, 9 juveniles, 23 cows and 8 bulls. Area D contained a small but distinct group, 1 calf, 2 juveniles, 15 cows and 13 bulls; only three of these were ever seen elsewhere and these extraterritorial sightings were all in Area B. There were eighty-four individuals seen in the North on 20 or more days. The percentages of these with 60–100% of their sightings in any one area are shown in table 2. It will be seen that 63% of the cows and immatures were in a given area in 90% of their sightings. The bulls tended to move about somewhat more; nevertheless, 88% of them were confined to single areas in 60% of their sightings. Seven of these 59 cows and immatures typically occurred in Area A, 36 in Area B, and 16 in Area C. Six of the bulls were regularly seen in Area A, 19 in Area B, and none in Area C; compared with the cows and immatures, they tended to avoid the Momela

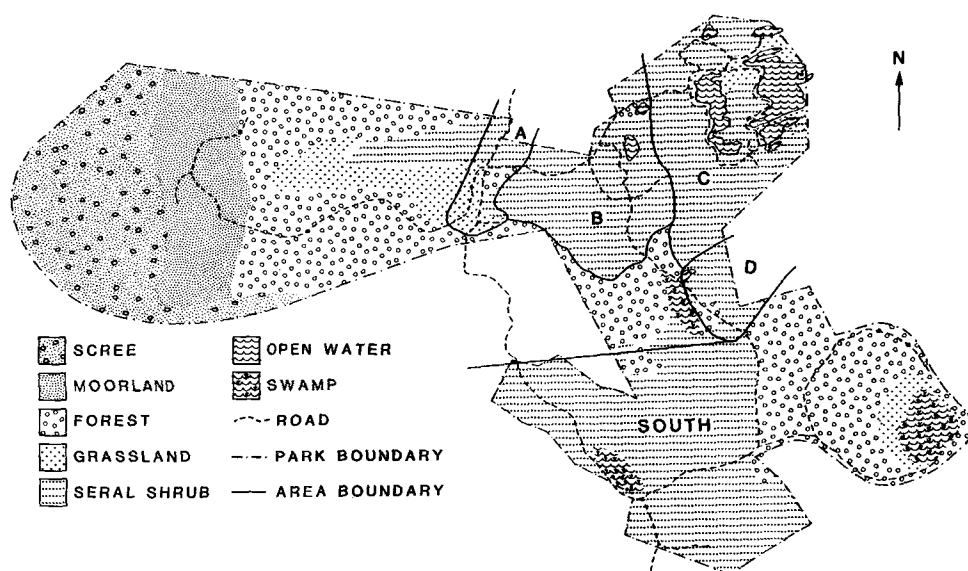


FIG. 1. Arusha National Park, after Vesey-FitzGerald 1973 and Vesey-FitzGerald Ms.

Table 2. Percentages of (a) cows and immatures and (b) bulls seen on 20 or more days with 60, 70, 80, 90 and 100% of their sightings in any one area of the North.

	60	70	80	90	100
(a) cows and immatures ($n=59$)	93	90	80	63	17
(b) bulls ($n=25$)	88	76	64	48	8

Lakes and to favour the forest and the approaches to Mt. Meru. The restriction of range of these North giraffes, totalling 287 individuals, can also be seen in the fact that only eight of them (2.8%) were seen in three of the areas and only one in all four.

In general and throughout the Park, bulls were seen less often relative to their numbers than were cows. In the North the average number of sightings per cow was 23; for bulls it was 11. South cows were seen, on average, twelve times, while the figure for South bulls is only four. These consistent differences are measures of the degree to which bulls frequent parts of the Park not visible from the roads. It seems likely that they spent more time in the forest than did the cows. Foster (1966) noted the higher proportion of bulls in wooded parts of the Nairobi National Park. Apparently the habit of wandering into such areas is established long before males have become adult: average sightings per female juvenile in the North were 23 and for males 13; in the South for female juveniles 8, for males 3. (Average sightings for female and male calves were nearly equal: in the North, females 34 and males 31; in the South, females 5 and males 6.)

Near the road that enters the Park from the South and also where it leaves the Park in the North there is often an exodus of giraffe from the Park around sundown, rarely involving more than 15 individuals, males and females of all ages. In the North they are known to move as far as 7 km from the Park boundary during the night, in the South only about 2 km. They re-enter the Park about sunrise. This movement, which occurs more regularly in the South than in the North, is conspicuous but involves an insignificant fraction of the population.

Food

We are indebted to Audax Matoju, a Park Warden, for the following incomplete list of plants eaten by giraffe in the Arusha National Park: *Acacia abyssinica*, *A. sieberiana*, *A. xanthophloea*, *Carissa edulis*, *Croton macrostachyus*, *Dodonaea viscosa*, *Euclea divinorum*, *Lantana* spp., *Lippia javanica*, *Ocimum suave*, *Olea africana*, *Psidium arabica*, *Rhamnus prinoides*, *Syzygium guineense*, *Thunbergia alata*, *Turraea obusta*. We recorded only two of these species being eaten by giraffe in the Seronera area of the Serengeti, *Acacia sieberiana* and *A. xanthophloea*. Acacias are quantitatively dominant in the Serengeti diet but insignificant in the Arusha Park diet. Here the plant most commonly eaten appears to be *Croton macrostachyus*.

Mother-calf relationships

We witnessed only 49 suckling acts. Their mean duration (59 s) was only slightly less than in the Serengeti (66 s) (Pratt and Anderson, 1979). As in the Serengeti, unsuccessful attempts by calves to suck outnumbered successful attempts. Suckling was initiated as often by the mother as by the calf but the great majority of bouts were terminated by the mother, and a substantial number of suckling acts were prematurely terminated because other calves tried to join in the sucking. The oldest calf we saw being suckled in the Arusha Park was nine months, in the Serengeti 22 months.

Calves were usually seen with their mothers. Neonates (calves less than one month old) were seen without their mothers in only six of 90 sightings. Only one calf was known to 'lie out' in isolation in the manner described by Langman (1977) as characteristic of the giraffe in the Timbavati Private Nature Reserve bordering the Kruger National Park in South Africa. The Arusha Park calves tended to follow their mothers. The individual often seen lying out disappeared at age three months, and

since we often saw its mother alone during the next three months, the calf was presumed dead.

Calves were rarely left unattended as they frequently are in the Serengeti, perhaps because water is plentiful and well distributed in the Arusha Park whereas in the Serengeti the mothers must travel far to find it, especially in dry seasons. Of the 15 calves over one month old that were seen on 20 or more days, 12 were with their mothers in 54–89% of their sightings.

Calf-calf relationships

Associations of calves were remarkably consistent in membership. Analysis of the associations of the 15 calves over one month old and seen on 20 or more days shows that for each calf there was a particular group of one to four peers with which the calf was seen in 48–92% of its sightings, and 75% of the calves were with the same one to four individuals in 70% or more of their sightings.

While the constancy of these calf associations was surely influenced by the associations between their mothers, the calves' behaviour demonstrated, in different ways, a mutual attraction and attachment quite aside from their mothers' affiliations. First, 12 of these 15 calves spent a higher proportion of their time with other calves than with their mothers. Second, in 69 hours of recording the activities of and distances between individuals at five-minute intervals, the calves were consistently closer to one another than to their mothers: 56% of the calf-calf distances but only 37% of the calf-mother distances were less than 10 m, while 34% of the calf-mother distances but only 16% of the calf-calf distances were greater than 50 m.

A third indication of the calves' relating to one another is the amount of deliberate physical contact and play that occurred between them: nosing, rubbing, sniffing, licking, kicking, gamboling, and 'naso-frontal greeting' (Pratt and Anderson 1979). In 1012 calf-hours of observation we recorded 164 instances of such behaviours. The frequency of these activities was not significantly different between male and female calves, but declined steadily from a mean of 0.65/hour in the first week of life to 0.17/hour in the second month and to 0.08 after one year.

Associations and interactions of bulls

Table 3 itemizes the associations of bulls with other giraffe. The associations of A bulls and B bulls were very similar. Class C bulls differed sharply from those of the other classes in two respects: only a very few were solitary, and a much greater percentage of them associated with other bulls and cows and immatures. For Class A and Class B bulls the largest percentage of sightings was with cows and immatures but without other bulls, while the smallest percentage was with other bulls and cows/immatures. This indicates that A and B bulls shun other bulls in the presence of cows and immatures. The same is not true of C bulls.

We recorded 221 groups of two or more bulls (ranging up to eight bulls), with or without cows/immatures present. Table 4 compares the frequencies of occurrence of A, B, and C bulls with bulls of each age class. When individual A Class bulls were seen in company with other bulls, many fewer of them occurred with A Class bulls than chance alone would have allowed. The same is true of B and C Class bulls: bulls of each age class occurred less frequently with individuals of their own class and more with other age classes of bulls than would be expected. Apparently A Class bulls avoided one another. We never sighted a bull group consisting only of A Class bulls

Table 3. Sightings of bulls, by class, alone or associated with other individuals.

	A bulls sightings %		B bulls sightings %		C bulls sightings %	
Solitary	78	26.7	124	22.1	42	5.7
With other bulls but not cows/immatures	67	22.9	140	24.9	225	30.6
With cows/immatures but not other bulls	129	44.2	249	44.3	275	37.4
With other bulls and cows/immatures	18	6.2	49	8.7	193	26.3
	292	100.0	562	100.0	735	100.0

χ^2 values: A bulls *vs.* B bulls, 3.66. Not significant.
A bulls *vs.* C bulls, 126.66. Significant at $\alpha=0.001$.
B bulls *vs.* C bulls, 126.45. Significant at $\alpha=0.001$.

Table 4. Frequencies of occurrence of A, B, and C class bulls with bulls of each age class.

		With As	With Bs	With Cs
A bulls	observed	4	49	62
	expected	24.51	38.41	52.07
	$(o-e)^2/e$	17.1628	2.9198	1.8937
B bulls	observed	56	50	141
	expected	52.65	82.51	111.84
	$(o-e)^2/e$	0.2132	12.8094	7.6029
C bulls	observed	141	216	224
	expected	123.84	194.08	263.08
	$(o-e)^2/e$	2.3778	2.4757	5.8053

$\chi^2=53.2606$. Significant at $\alpha=0.001$.

(whereas we recorded 10 all B groups and 46 all C groups), and in all of the 221 groups there were only four that contained two A Class bulls, and no group contained more. Giraffe bulls spar with one another by swinging the neck and striking with the head. They test the sexual readiness of cows by flehmen, and in their courting of a cow they follow her closely and persistently for hours or days. The frequencies of these behaviours in A, B, and C Class bulls are shown in table 5. In 71 recorded bouts of sparring, the participants were 5 juvenile males, 33 C Class bulls and 9 B Class bulls, but no A bulls. Of these 71 bouts, only 17 involved B bulls and only 4 bouts were between B bulls. Sparring emerges as an activity characteristic of young bulls. Participants in sparring matches were often quite different in size, and when this was the case it was usually the the smaller individual that initiated the bout. Sometimes more than two bulls, even five, sparred with each other. We saw only one violent bout: after receiving three or four vigorous blows that landed solidly, a C bull ran from a B bull. The older bulls were more attentive to cows. Relative to the number of

Table 5. Frequencies of sparring, testing of cows, and courting of cows by A, B, and C Class bulls. (Sparring frequencies computed from observations on groups of two or more bulls, testing and courting frequencies computed for bulls seen in the presence of cows.)

	Sparring	Not sparring	χ^2 values for paired classes
A bulls	0	85	
B bulls	21	168	10.2176†
C bulls	126	292	25.6867‡
	Testing	Not testing	
A bulls	50	97	
B bulls	62	236	9.1151†
C bulls	37	431	26.9304‡
	Courting	Not courting	
A bulls	13	134	
B bulls	13	285	3.5909
C bulls	4	464	10.3365†

† significant at $\alpha=0.01$.

‡ significant at $\alpha=0.001$.

times they were seen with cows, A bulls tested cows four times as often as C bulls did and courted cows more than ten times as often.

A dominance hierarchy grows out of the interactions of bulls as they mature. The relative positions of individuals are established before they attain A Class. The outcome of disputes is settled in advance and potentially injurious conflicts are avoided. Social standing is manifested when a dominant individual obliges a subordinate, by walking toward him or by merely staring at him, to move away from cows. We saw A bulls thus displace A bulls 5 times, B bulls 12 times and C bulls 20 times. Three times a B bull displaced a B bull, 3 times a C bull, and once a B bull displaced an old and thin A bull. In all but one of these 43 instances, cows were present. We never saw a C bull displace any other bull.

Discussion

A census of the Park's giraffe by Parks personnel with the help of Tanzanian Police Airwing helicopters in December, 1973, yielded a count of 178 (Mwenera *et al.*). A series of estimates made by students from the College of African Wildlife Management (Mweka) between 1972 and 1978, by synoptic total counts and by road-strip sampling, gave numbers ranging from 161 to 178 (Mohammed 1978). Two road-strip samplings by C.A.W.M. students in May, 1980, gave estimates of over 800 and over 1000. Neither of these methods is suited to the highly irregular and heavily vegetated terrain. An attempted synoptic total count cannot succeed because at any one time so many of the animals will be hidden. Road-strip sampling assumes an even distribution of giraffe throughout the Park, whereas in fact their distribution is extremely spotty. Our method can be used only on species whose individuals can all be accurately recognized and it may, as in the case of this giraffe population, require

a long time, but it does yield a minimum number that cannot be questioned and a population estimate with confidence limits.

The degree of segregation of the Park's giraffe into subpopulations is surprising. There are no physical barriers to movement between North and South. These two major regions are joined by a continuous band of what appears to be excellent giraffe habitat that connects Area C, through Area D, with the South. The forest itself does not present an actual barrier: bulls frequent it, and if for some reason it deters cows and immatures, they can at least follow the roads through it. Nevertheless, in 6836 sightings of cows and immatures, we never saw a North individual in the South nor a South individual in the North.

The age structure of the population, with 76% adults, differs sharply from that of the Nairobi National Park population, described as stable over seven years, with about 56% adults (Dagg and Foster 1976). The Arusha Park giraffe are an ageing group that is not replenished fast enough to maintain its numbers. In the South this low rate of recruitment can be explained in part by the high mortality during the first year of life. The average calving interval for giraffe is usually considered to be 20 months (Dagg and Foster 1976). On this basis, the Park's 172 cows should be expected to produce 103 calves per year. During the year of our study, 22 calves were produced—a very low birth rate, that retarded recruitment, even allowing for some possible additional births (and early deaths) of calves that went undetected. While the giraffe population of the Park as a whole is senescent, the South subpopulation is affected more seriously than the North by the combination of low birthrate and high calf mortality. Regardless of causes, the observed age distribution, birthrate and calf deathrate foretell a decline in numbers, especially in the South subpopulation.

Summary

In a year's study of the giraffe population of the Arusha National Park we identified 462 individuals. The cumulative first sightings of individuals were fitted to a logistic model that gave an estimated total population of 471. Immatures accounted for only 24% of the population. Twenty-two calves were born during the period of study.

The giraffe of the Park are divided into 'North' (more precisely northeastern) and 'South' (southeastern) subpopulations, and although there is no barrier between them, only 3% of the population (all bulls) were ever seen in both the northern and southern parts of the Park. The northern region is further divided into four areas, each with its own assemblage of individuals, which were seldom seen elsewhere. Bulls and male juveniles were seen less often relative to their numbers than were cows and female juveniles. This indicates that they spend a greater proportion of the time in the forest than do the females.

A partial list of plants eaten by giraffe in the Park is given. Acacias are an insignificant component of the diet.

Calves were usually accompanied by their mothers; typically they did not lie out. Each calf was usually seen in the company of the same few individual peers. Calves spent a higher percentage of the time with calves than with their own mothers, they were closer to one another than to their mothers, and there was much physical contact between them.

Bulls of each age class occurred less frequently with individuals of their own class and more frequently with bulls of other age classes than would be expected. Young bulls were frequently seen in the company of other bulls, cows and immatures, and

they often engaged in sparring: Older bulls were more solitary, tended to avoid other bulls in the presence of cows and immatures, and instead of sparring they tested and courted cows.

The inadequate recruitment of this senescent population is attributed mainly to low birth rate and, in the South, high mortality in the first year. A decline in numbers is anticipated.

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References

- BACKHAUS, D., 1961, *Beobachtungen an Giraffen in Zoologischen Garten und freier Wildbahn*. Inst. des Parcs Nationaux du Congo et du Ruanda-Urundi. Imprimerie Hayez, Bruxells, pp. 202.
- BEESLEY, J. S., 1972, Birds of the Arusha National Park, Tanzania, *Journal of the East Africa Natural History Society and National Museum*, **132**, 1-30.
- DAGG, A. I., and FOSTER, J. B., 1976, *The Giraffe: its Biology, Behavior, and Ecology*. Van Nostrand and Reinhold, New York, pp. 210.
- FOSTER, J. B., 1966, The giraffe of Nairobi National Park: home range, sex ratios, the herd, and food, *East African Wildlife Society Journal*, **4**, 139-148.
- LANGMAN, V. A., 1977, Cow-calf relationships in giraffe (*Giraffa camelopardalis giraffa*), *Zeitschrift für Tierpsychologie*, **43**, 264-286.
- MOHAMMED, A., 1978, *Censusing techniques on big game in a forested area—Arusha National Park, Tanzania*. Ms., College of African Wildlife Management, Mweka, Tanzania.
- MWENERA, R. J. P., KESSY, F. E., and LYOGELLO, L. (undated), Arusha National Park Management Plan. Mimeographed, Arusha National Park, pp. 26.
- PRATT, D. M., and ANDERSON, V. H., 1979, Giraffe cow-calf relationships and social development of the calf in the Serengeti, *Zeitschrift für Tierpsychologie*, **51**, 233-251.
- VESEY-FITZGERALD, L. D. E. F., 1973, The dynamic aspects of the secondary vegetation in Arusha National Park, Tanzania. *East African Agricultural and Forestry Journal*, **38**, 314-327.
- VESEY-FITZGERALD (undated), *The utilization of the environment by buffalo in the Arusha National Park*. Ms., Arusha National Park.