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THE EXPERIMENTAL RELEASE OF CAPTIVE-BRED CHEETAH (ACINONYX JUBATUS) INTO THE NATURAL ENVIRONMENT

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ABSTRACT: Three captive-bred cheetah males were experimentally released into natural areas after the prior determination of their killing ability. The initial release into a small nature reserve confirmed that cheetahs can catch and kill prey without previous experience. The cheetahs were then tested in unlimited space. Differences in cheetah kill intervals between the 2 study areas was ascribed to the greater distances covered in the latter study area while familiarizing with their new environment, the comparative difficulty in locating potential prey and a fight which developed between the introduced cheetahs and resident wild cheetahs. The behavior of the captive-bred cheetahs was similar to that of wild cheetahs, with the exception that they spent considerable time at their kills.

The cheetah (Acinonyx jubatus) is listed as an endangered species in South Africa (Skinner et al. 1977). Due to mounting concern about the dwindling numbers of cheetahs in the wild, the South African National Zoological Gardens initiated the De Wildt Cheetah Breeding Station near Pretoria, where considerable breeding success of cheetahs has been attained with 170 births occurring over the past 5 yr (D. Meltzer, pers. comm.).

Although the supply of captive-bred cheetahs to zoological gardens throughout the world undoubtedly alleviates the pressure on wild cheetah populations, the possibility of relocating captive-bred cheetahs to areas where they have been exterminated, or augmenting depleted wild populations would be of advantage for the conservation of this species.

Several references to a cheetah having to be taught to kill by it's dam exist. For example, Denis (1964) states that captive-bred cheetahs could catch but not pull down prey. Shortridge (1934) in discussing the use of cheetahs for sport hunting states that it is essential to capture

adult cheetahs for this purpose since cubs need to be taught by their dam to hunt. Yet, when observing captive-bred cubs at play, numerous behavioral patterns emerge which are identical to those of wild cheetahs, including the stimulus to chase small running animals (A. van Dyk and D. Meltzer, pers. comm.). Encke (1960) also observed captive-bred cheetahs to use the typical knockdown technique of wild cheetahs when at play. It was therefore decided to test the hunting ability of captive-bred cheetahs.

Live barbary sheep (Ammotragus lervia) were presented to a number of captive-bred cheetahs at De Wildt. The cheetahs immediately gave chase, tripped and killed the sheep by the typical throat bite of wild cheetahs. This experiment took place in a small enclosure. This paper reports on a 1-mo study on the release of 3 male captive-bred cheetahs into a small nature reserve, and thereafter, a 65-day study in an area where their movements were unrestricted.

STUDY AREAS

The study areas are in gently undulating country within close proximity to each other at an altitude of about 400 m above sea level in the Eastern Transvaal Lowveld. Annual rainfall is from 300 - 500 mm and is largely confined to the summer months of November - March. The vegetation is heterogeneous bushveld varying from dense woodland (particularly riparian) to open grassland. Summers are hot to very hot and winters are temperate.

Suikerkop - Hoedspruit Air Force Base

Suikerkop is a small nature reserve comprising 1,100 ha and forms part of the Hoedspruit Air Force Base. The reserve is game-fenced and supports most of the common game species found in the area, these species having been described in detail in relation to the vegetation types of the region by Hirst (1975). The reserve is bisected by a seasonally flooded dry river bed. Four artificial dams provide water for the game.

Timbavati and Klaserie Private Nature Reserves

The Timbavati Private Nature Reserve is about 60,000 ha in extent and is enclosed by a 2 m high veterinary fence. The Klaserie Private Nature Reserve is some 65,000 ha in area and adjoins the Timbavati P.N.R. in the Northwest and reaches as far as the Olifants River in the north. The Timbavati P.N.R. is longitudinally bisected by the seasonally flooding Hlarlarumi River, whereas the Timbavati River cuts through the southern section of the reserve in a more-or-less west-east direction. The Klaserie River bisects the Klaserie P.N.R. and joins the Olifants River in the north. Water supply in both reserves is supplemented by numerous artificial dams. Kempiana, the point of release of the cheetahs, is situated in southern Timbavati P.N.R. approximately 5 km from the Orphen Gate to the Kruger National Park.

MATERIALS AND METHODS

Three male 2.5-yr-old captive-bred cheetah litter mates were selected from the De Wildt Cheetah Breeding Station and named Rogers, Gouws, and Jan. Each cheetah was collared with a radio-transmitter on frequencies ranging from 148.40 - 148.60 MHz. Two 4 x 4 vehicles were equipped with 2-way radio systems and omni-directional vehicle-mounted whip antennae. AVM LA 12 receivers (AVM Instrument Company, Illinois) and hand-held 4-element yagi directional antennae were used as aids in maintaining a 24-hr continuous surveillance on the cheetahs.

Where possible, the cheetahs were kept within observational distance provided no undue disturbance was caused by the observers. At night, a Lunatron 303-2 night-viewing telescope was used. The cheetahs' movements were plotted directly on 1:50,000 topocadastrial maps. Behavior, hunting attempts, prey selection, inter- and intraspecific relationships, weather data, light conditions, habitat descriptions, etc., were recorded.

At Suikerkop, observer shifts were changed at 0200 hr and 1400 hr (during the inactive period of the cheetahs). At Kempiana, it was found that changing shifts at 0200 hr was extremely difficult due to locating faint tracks in thick bush in the dark. Twenty-four hour shifts with 2

observers were thus instigated, and shifts changed at 1300 hr.

Activity, as described in this paper, represents all forms of activity where at least 2 of the cheetahs were not sleeping, lying down and resting, lying down alert and lying down social grooming. Sitting was included in the active period, as was feeding.

The mass of each prey animal killed by the cheetahs was estimated by determining the sex and approximate age and calculated from growth curves given by Hirst (1975). Estimating the mass consumed by the cheetahs of the smaller prey species was affected by weighing the remains with a spring balance and subtracting this from the estimated live mass. In cases of larger prey species, i.e., giraffe, kudu and waterbuck, where time did not allow for the weighing of remains, the portions of the body that were consumed by the cheetahs were recorded. Mass estimates for giraffe buttocks, forelegs, neck and remainder of carcass were estimated from data from Hall-Martin et al. (1977). The estimated mass consumed for kudu and waterbuck was derived from dressing percentages given by von La Chevallerie (1970).

RESULTS AND DISCUSSION

Quarantine

On 11 September 1979, the cheetahs were radio-collared and transported to Suikerkop, where they were quarantined in a 30 m x 30 m enclosure for 1 mo. During this period, the cheetahs were fed whole impala ram carcasses. Initially, these carcasses were opened with difficulty; however, after receiving their 4th carcass, they were capable of opening a carcass quickly and efficiently - normally from the anal region and behind the shoulder. During the quarantine period, the cheetahs persistently marked conspicuous objects within the enclosure.

Movements After Release - Suikerkop

On 8 October 1979, the cheetahs were released from the quarantine enclosure on Suikerkop. In the ensuing 31 days, the cheetahs ranged over the whole reserve. They frequently made use of the roads and tracks and

spent considerable time pacing the boundary fence, particularly in the southern section of the reserve.

Reproduction of a detailed map of the routes followed by the cheetahs would be difficult due to certain routes being repeatedly used. Consideration of the time spent in each section of the reserve gives a more realistic picture of habitat use. Figure 1 portrays the amount of time spent in each section of the reserve on a grid system. It is clear that 2 areas were utilized more heavily than others - the northern corner and the southeastern corner. The other grids of high utilization are localities in which the cheetahs either made a kill or spent the night sleeping. The high utilization of the northern corner is interesting in that the quarantine enclosure was situated in this area. The cheetahs repeatedly re-entered the enclosure and marked their old marking sites, but never slept therein.

Two parameters that influenced the activity of the cheetahs were temperature and diurnal length. The cheetahs were predominantly diurnal (Figure 2) with a steep incline in activity at 1st light and an equally steep decline at the onset of darkness. Also from this figure it can be seen that the cheetahs were relatively inactive between 1000 hr and 1600 hr. Figure 3 shows the daily maximum and minimum temperatures, the daily maximum temperature being frequently above 30° C and as high as 41.1° C during October and November. During the heat of the day, the cheetahs took refuge in the shade of bushes.

Table 1 gives the total daily distances covered by the cheetahs, the period between last feed and the following kill and the prey species killed. From this table, it can be seen that the cheetahs move small distances when sated, and that these distances increase as the animals become more hungry. Invariably, the movements on the day following a kill were to the nearest watering point. The average daily distance covered was 7.4 km (range 1.1 km - 18.0 km).

Movements After Release - Timbavati

The same 3 cheetahs were released on the farm Kempiana in the south of the Timbavati P.N.R. on 28 February 1980 after having been held in

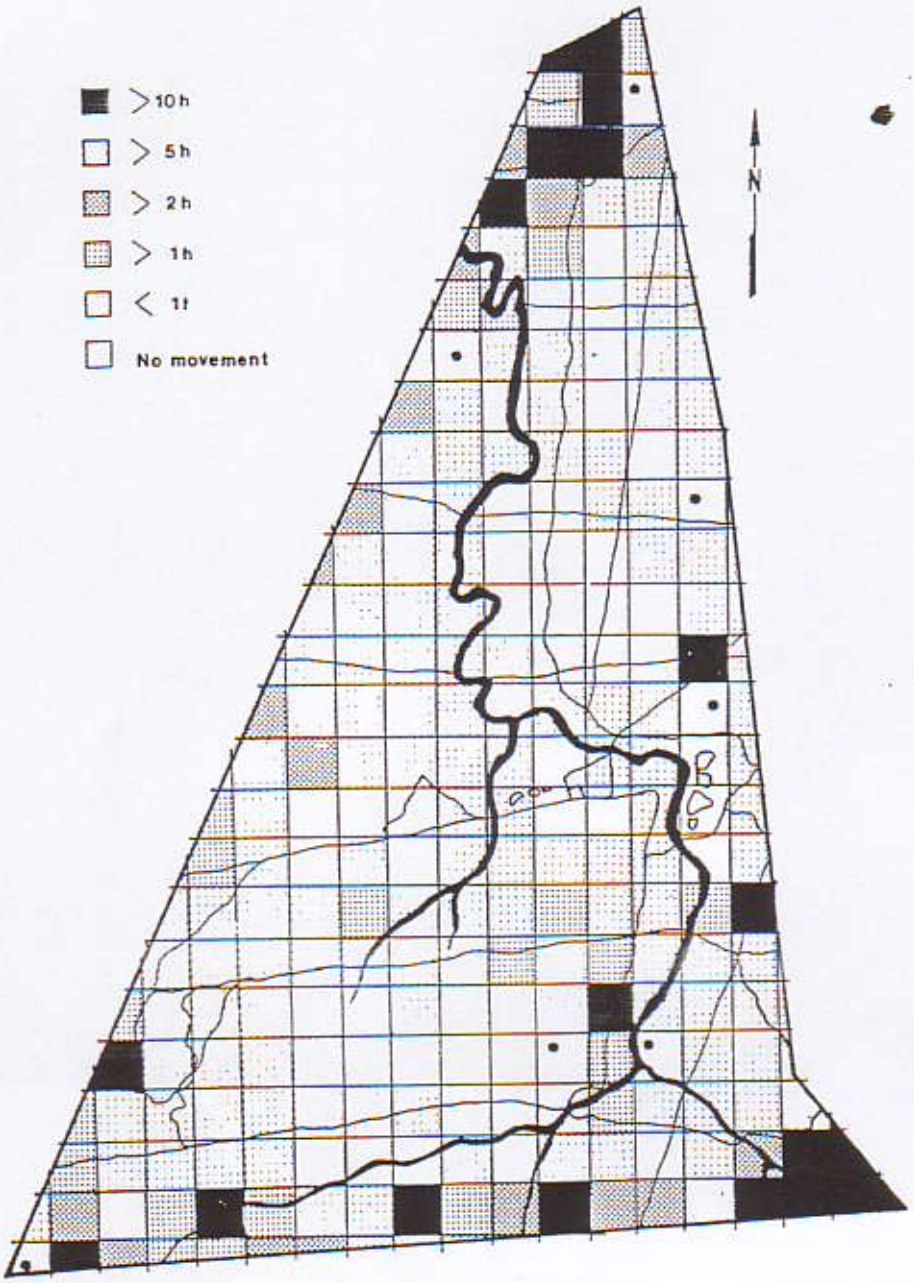

Figure 1. The time-based utilization of Suikerkop, Hoedspruit Air Force Base, by 3 captive-bred cheetahs. Each block = 4 ha.

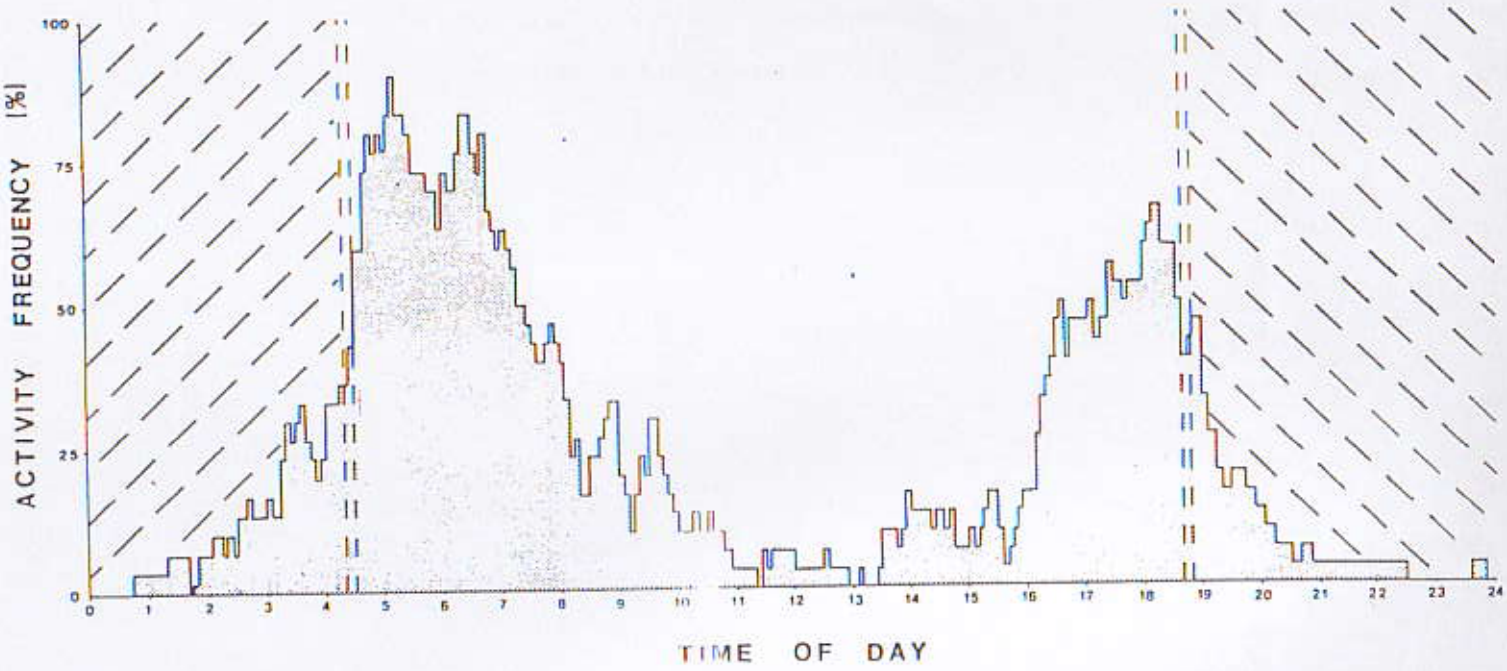

Figure 2. Activity frequencies of 3 captive bred cheetahs at Suikerkop, Hoedspruit Air Force Base. Activity intervals were recorded to the nearest 5 min for 31 days.

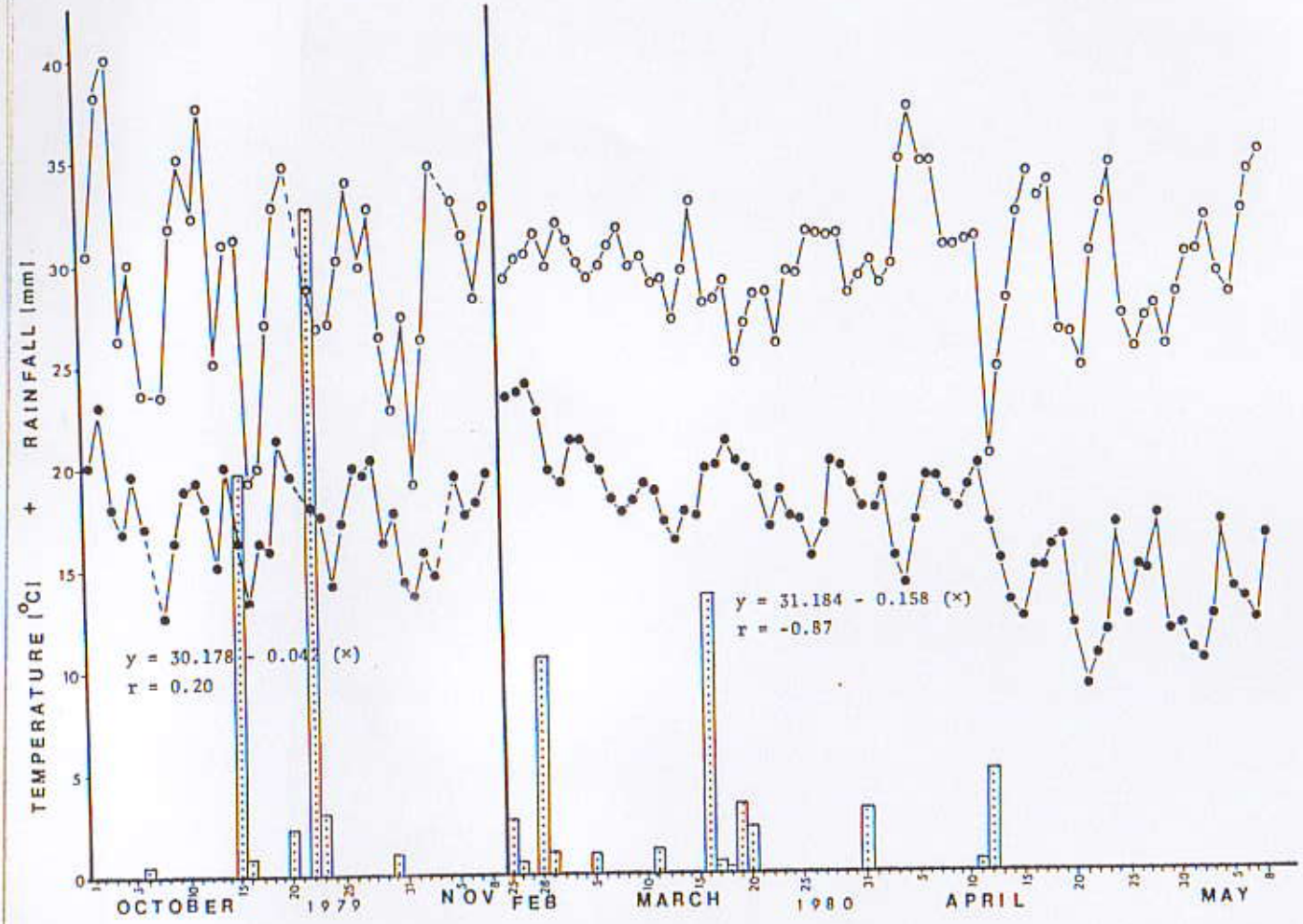

Figure 3. Daily maximum and minimum temperatures and rainfall recorded at the Hoedspruit Air Force Base for both study periods. (Data from Weather Bureau, Department of Transport, Pretoria.)

Table 1. The daily distances covered, kill frequency and prey species taken by 3 captive-bred cheetahs on the portion Suikerkop, Hoedspruit Air Force Base.

Date	Distance Covered (km)	Kill	Period between last feed and next kill (days)
8 Oct 1979	8.0	Giraffe (Giraffa camelopardalis)	-
9 Oct 1979	2.8	(feed)	
10 Oct 1979	6.7		
11 Oct 1979	3.9	Kudu (Tragelaphus strepsiceros)	2
12 Oct 1979	7.1		
13 Oct 1979	10.2		
14 Oct 1979	8.3		
15 Oct 1979	1.1	Impala (Aepyceros melampus) 2x	4
16 Oct 1979	1.4	(feed)	
17 Oct 1979	14.4		
18 Oct 1979	11.0		
19 Oct 1979	9.2		
20 Oct 1979	9.9	Duiker (Sylvicapra grimmia) Waterbuck (Kobus ellepsiprymnus)	5
22 Oct 1979	4.2		
23 Oct 1979	5.8		
24 Oct 1979	12.8		
25 Oct 1979	12.9	Giraffe (Giraffa camelopardelis)	5
26 Oct 1979	2.1		
27 Oct 1979	3.2		
28 Oct 1979	14.8		
29 Oct 1979	3.6	Impala (Aepyceros melampus)	3
30 Oct 1979	1.6		
31 Oct 1979	11.8		
1 Nov 1979	0.7	Impala (Aepyceros melampus) 2x	3
2 Nov 1979	0.9	(feed)	
3 Nov 1979	2.6		
4 Nov 1979	11.1		
5 Nov 1979	13.1		
6 Nov 1979	18.0		
7 Nov 1979	a	Impala (Aepyceros melampus)	5
Total Distance Covered	223.3		
Average Daily Distance	7.41		

[a]Project terminated, distance not included in calculations.

quarantine for 1 mo. Over the 65-day study period, the cheetahs covered 338.4 km with an average daily distance of 5.21 km (range 0 - 22.0 km), the distances are given in Table 2. The route followed is illustrated in Figure 4. They moved northwards into the Kruger National Park, and made a large circle through the upper 3rd of the Timbavati P.N.R. back towards Kempiana. From there, they again moved northwards through the center of the Timbavati P.N.R., along the outside of the western boundary into the Klaserie P.N.R., and circled north of the Timbavati P.N.R. back into the Timbavati P.N.R. They started to settle down on the farm Addger, but were involved in a serious fight with 3 resident cheetah males. On recovery from the fight, they moved westwards into the Klaserie P.N.R., where they began to settle down in the northern section of the Klaserie P.N.R. along the Klaserie River just south of the Olifants River. The project was terminated at this stage.

It can be clearly seen from Table 2 that the cheetahs again moved shorter distances when sated. The activity peaks of the cheetahs were not as pronounced in Timbavati/Klaserie (Figure 5) as they were at Suikerkop (Figure 2). This difference can be ascribed to temperature. It can be seen (Figure 3) that there was a gradual decline in the daily minimum temperatures ($t = 8.58$, $p < 0.01$) as winter progressed. As a result, the cheetahs spent more time huddled together or sunning themselves in the early morning, particularly in the latter stages of the study, showing a significant decline in activity frequency between the 2 study periods at 1st light ($\chi^2 = 14.29$, $p = 0.01$) and 1 hr after 1st light ($\chi^2 = 34.38$, $p = 0.01$). In days where the daily maximum temperatures were reasonably low, the cheetahs roamed at intervals throughout the day, showing a significant increase in activity frequency during the latter study period at 1300 hr ($\chi^2 = 23.0$, $p = 0.01$). Once again, the cheetahs were predominantly diurnal. Most of the nocturnal activities took place when the cheetahs were feeding, particularly during the latter part of the dark phase (Table 3). No nocturnal hunting attempts were made.

A fight which developed between wild cheetahs in the Timbavati P.N.R. influenced the movements of the study cheetahs greatly. One of the study cheetahs was so badly injured that he was incapable of moving any great distance for nearly a week. This incapacity lowered the mean

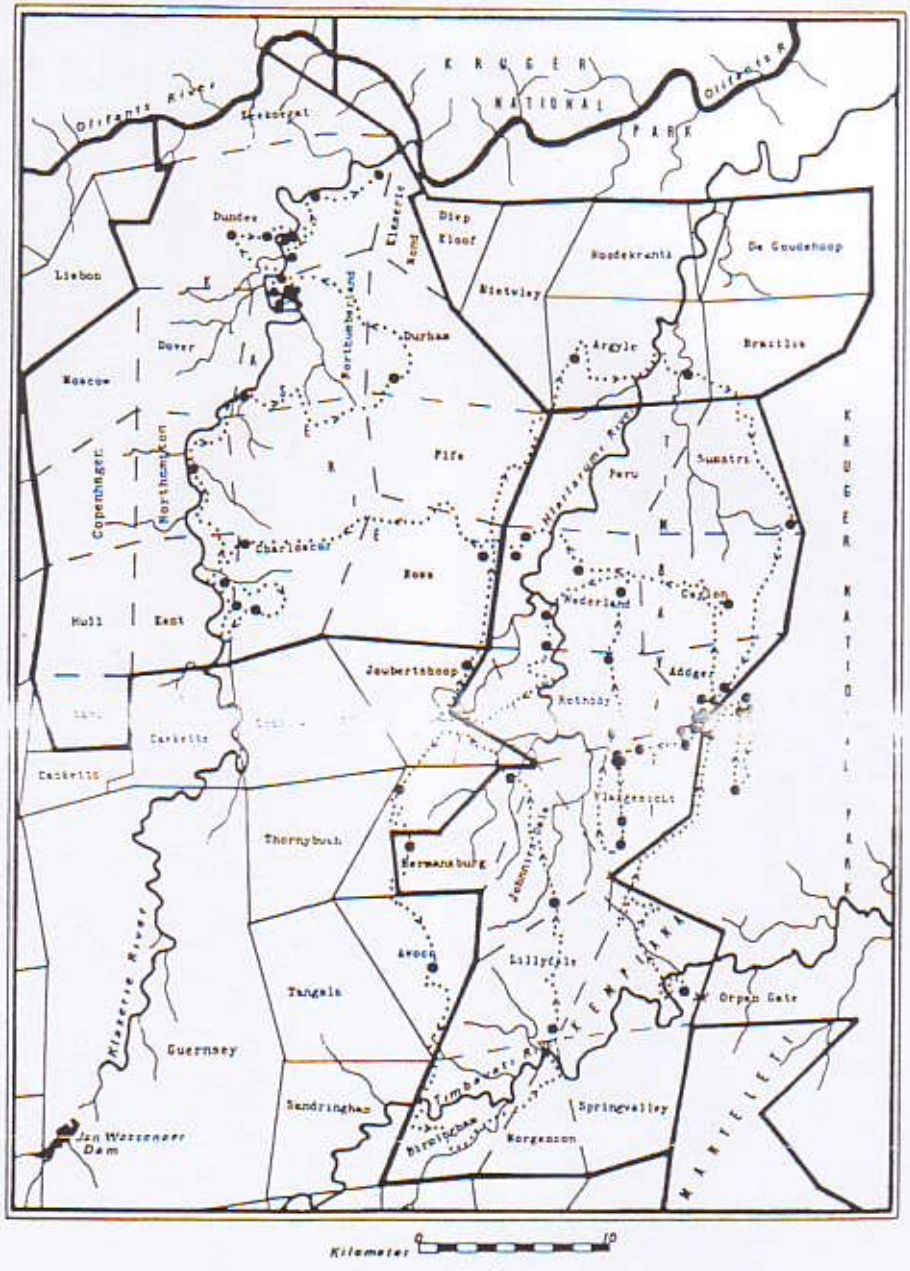

Figure 4. The route followed by 3 captive-bred cheetahs released on Kempiana in southern Timbavati Private Nature Reserve. Dots represent noctural sleeping sites. Duration of study was 65 days.

Table 2. The daily distances covered, kill frequency and prey species taken by 3 captive-bred cheetah in the Timbavati and Klaserie Private Nature Reserves.

Date	Distance Covered (km)	Kill	Period between last feed and next kill (days)
28 Feb 1980	19.0		
29 Feb 1980	7.5		
1 Mar 1980	17.0		
2 Mar 1980	9.0	Giraffe (F) (Calf)	4 (feed)
3 Mar 1980	5.0		
4 Mar 1980	-		
5 Mar 1980	4.0		
6 Mar 1980	8.0		
7 Mar 1980	22.0		
8 Mar 1980	15.5		
9 Mar 1980	9.0		
10 Mar 1980	17.0		
11 Mar 1980	9.0		
12 Mar 1980	11.0		
13 Mar 1980	10.0		
14 Mar 1980	3.5	Giraffe (M) (Calf)	10 (feed)
15 Mar 1980	2.0		
16 Mar 1980	-		
17 Mar 1980	2.0		
18 Mar 1980	4.5		
19 Mar 1980	5.0		
20 Mar 1980	9.0	(fight)	
21 Mar 1980	7.5		
22 Mar 1980	1.5		
23 Mar 1980	1.5		
24 Mar 1980	1.0		
25 Mar 1980	1.0		
26 Mar 1980	-		
27 Mar 1980	1.0		
28 Mar 1980	3.5	Impala (M) (Adult)	11
29 Mar 1980	1.5		
30 Mar 1980	-		
31 Mar 1980	1.0		
1 Apr 1980	6.0		
2 Apr 1980	1.0		
3 Apr 1980	2.0		
4 Apr 1980	4.0		
5 Apr 1980	4.5		
6 Apr 1980	5.0		

Table 2. (Cont'd.).

Date	Distance Covered (km)	Kill	Period between last feed and next kill (days)
7 Apr 1980	4.0	Giraffe (Calf)	8 (feed)
8 Apr 1980	-		
9 Apr 1980	0.5		
10 Apr 1980	2.5		
11 Apr 1980	15.0		
12 Apr 1980	4.5		
13 Apr 1980	6.0		
14 Apr 1980	3.0	Chickens	5
15 Apr 1980	3.0		
16 Apr 1980	10.0		
17 Apr 1980	5.5		
18 Apr 1980	9.5		
19 Apr 1980	10.5		
20 Apr 1980	3.0		
21 Apr 1980	3.0	Waterbuck (M) (Yearling)	(6)11[a] (feed)
22 Apr 1980	-		
23 Apr 1980	1.0		
24 Apr 1980	0.5		
25 Apr 1980	8.0	Impala (Calf)	2
26 Apr 1980	[illegible]	Chickens	[illegible]
27 Apr 1980	3.0		
28 Apr 1980	2.0	Kudu (M) (Yearling)	(2)3[a] (feed) (feed)
29 Apr 1980	-		
30 Apr 1980	1.0		
1 May 1980	1.0		
2 May 1980	6.0		
3 May 1980	3.0	Terminated project	
Total Distance Covered	338.5		
Average Daily Distance	5.21		

[a]Chickens not considered a full meal.

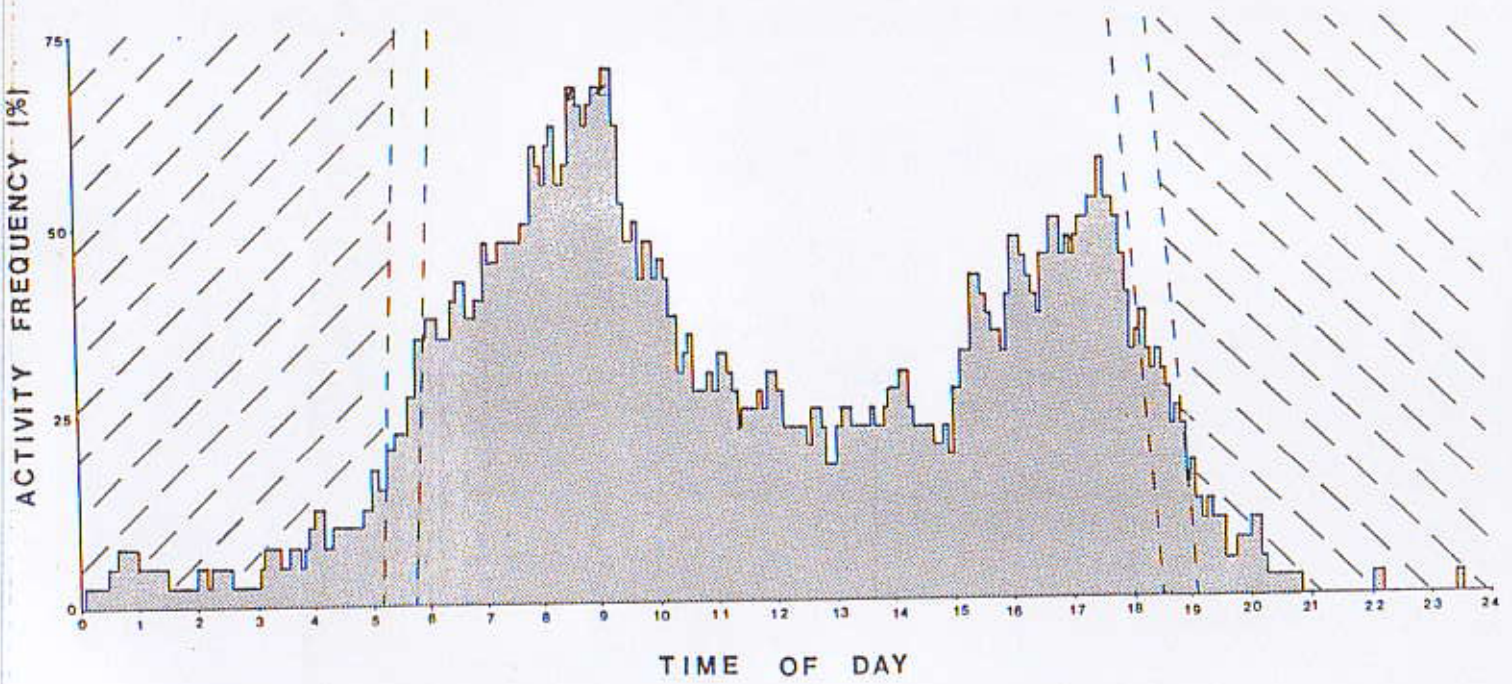

Figure 5. Activity frequencies of 3 captive-bred cheetahs released on Kempiana, southern Timbavati Private Nature Reserve. Activity intervals were recorded to the nearest 5 min. Duration of study was 65 days.

Table 3. The species, sex, approximate age, estimated live mass, estimated mass consumed and the time spent at each kill affected by 3 captive-bred cheetahs during a 31-day and 65-day study period.

Date	Time of Kill (hr)	Species	Sex	Approximate Age	Estimated live mass (kg)	Estimated Mass Consumed (kg)
8 Oct 1979	1625	Giraffe	(M)	2 mo	150	45
11 Oct 1979	0515	Kudu	(F)	11 mo	75	40
15 Oct 1979	0515	Impala	(M)	Adult	60	35
15 Oct 1979	0745	Impala	(M)	Adult	60	30
20 Oct 1979	0657	Duiker	(F)	Adult	14	8
20 Oct 1979	0912	Waterbuck	(M)	2 yr	170	40
26 Oct 1979	0445	Giraffe	(M)	3 mo	180	50
29 Oct 1979	0620	Impala	(M)	Adult	60	40
1 Nov 1979	0455	Impala	(M)	Adult	60	35
1 Nov 1979		Impala	(F)	Adult	45	25
7 Nov 1979	0715	Impala	(M)	Adult	60	30
3 Mar 1980	0655	Giraffe	(F)	4 mo	200	70
15 Mar 1980	0703	Giraffe	(M)	4 mo	220	100
29 Mar 1980	1215	Impala	(M)	Adult	60	40
7 Apr 1980	0720	Giraffe	(F)	2 wk	100	60
21 Apr 1980	1040	Waterbuck	(M)	10 mo	80	30
25 Apr 1980	1445	Impala	N/D	4 mo	15	12
28 Apr 1980	1005	Kudu	(M)	15 mo	130	60

Table 3. (Cont'd.).

Date	Time of Kill (hr)	Species	Sex	Approximate Age	Total Time Spent at Carcass (hr:min)[a]	Total Time Spent Feeding (hr:min)[b]
8 Oct 1979	1625	Giraffe	(M)	2 mo	12:10	7:45
11 Oct 1979	0515	Kudu	(F)	11 mo	23:15	2:07
15 Oct 1979	0515	Impala	(M)	Adult	1:55	1:23
15 Oct 1979	0745	Impala	(M)	Adult	22:29	2:33
20 Oct 1979	0657	Duiker	(F)	Adult	0:28	0:27
20 Oct 1979	0912	Waterbuck	(M)	2 yr	24:11	3:30
26 Oct 1979	0445	Giraffe	(M)	3 mo	23:40	3:39
29 Oct 1979	0620	Impala	(M)	Adult	22:15	3:01
1 Nov 1979	0455	Impala	(M)	Adult	23:35	5:27
1 Nov 1979		Impala	(F)	Adult		
7 Nov 1979	0715	Impala	(M)	Adult	Carcass used to retrap cheetahs	
3 Mar 1980	0655	Giraffe	(F)	4 mo	23:52	6:54
15 Mar 1980	0703	Giraffe	(M)	4 mo	70:50	8:28
29 Mar 1980	1215	Impala	(M)	Adult	0:45	0:40
7 Apr 1980	0720	Giraffe	(F)	2 wk	26:03	8:55
21 Apr 1980	1040	Waterbuck	(M)	10 mo	31:05	0:40
25 Apr 1980	1445	Impala	N/D	4 mo	2:05	1:05
28 Apr 1980	1005	Kudu	(M)	15 mo	71:00	8:36

[a] This includes resting periods between feeding in the vicinity of the carcass.

[b] Where at least 1 of the cheetahs was feeding.

daily distance traversed by the whole group. In addition, 1 of the study cheetahs died of a snakebite in the terminal stages of the study. The remaining 2 cheetahs remained in the vicinity of the dead cheetah for 3 days searching for him.

There is little quantitative information on cheetah movements. Wrogemann (1975) states that cheetahs normally travel 3 - 5 km per day, whereas Eaton (1969) gives an average ground distance of 7.8 km (8,500 yd) for a female accompanied by cubs. On the Suikerbosrand Nature Reserve on the Highveld near Johannesburg, maximum straight-line distances between daily diurnal resting sites can be as great as 13.8 km with a record of a female covering 26 km in 8 hr (Pettifer 1981). Even large nature reserves such as the Klaserie P.N.R. and Timbavati P.N.R. are therefore small enough for the cheetahs to traverse them in a short period of time.

Prey Selection

Table 3 gives the prey species, the sex and age classes of the prey taken, the estimated mass of prey taken and the time spent at each carcass for both study periods. The mean interval between last feed and the following kill was 3.86 days at Suikerkop, compared to that of the 2nd release of 7.14 days. Several factors have influenced this wide difference in the interval between kills. Suikerkop, being a small area with a high density of prey animals, ensured the chances of the cheetahs locating potential prey within a short period of time, whereas in the Timbavati P.N.R. and Klaserie P.N.R., the cheetahs often went for 2 - 3 days without sighting potential prey. Probably an equally important factor was that the cheetahs were less restricted by fences in the Timbavati and Klaserie P.N.R. and spent more time and energy exploring their new environment. This appears evident from the data where towards the end of the study period, they were more successful in hunting, probably because they had started to settle down. This is confirmed in that they spent 13 nights in the vicinity of the Klaserie River in northern Klaserie P.N.R. prior to the termination of the study (Figure 4).

Unfortunately, few continuous studies have been conducted on cheetahs in

order to determine kill frequency in relation to prey size. From Table 3, it can be seen that the study cheetahs spent considerable time feeding on large carcasses. Schaller (1968) recorded 24 Thompson's gazelle (Gazella thompsoni) killed over a 26-day period by a female cheetah with cubs. Wrogemann (1975) states that solitary cheetahs killed less frequently than females with cubs, the kill interval was between 2 and 3 days.

At Suikerkop 11 kills with an estimated total live mass of 934 kg were made by the study cheetahs. Of this mass approximately 378 kg were consumed giving a figure of 4.06 kg per cheetah per day over the 31-day study period (Table 3). In contrast only 7 kills were made during the 2nd study period of 65 days with an estimated total live mass of 805 kg of which approximately 372 kg were consumed. Taking into account that only 2 cheetahs fed on the last 3 carcasses (1 cheetah died) the daily consumption per cheetah would then be 2.17 kg, about 1/2 the amount at Suikerkop.

From Table 3 the mean time spent by the cheetahs at each carcass at Suikerkop was 17 hr 11 min of which the mean time spent feeding was 3 hr 32 min; whereas, in the Timbavati and Klaserie P.N.R. the mean time spent at each carcass was 32 hr 24 min of which 5 hr 5 min were spent in feeding, being significantly higher than for Suikerkop (χ^2 of means (minutes) = 40.8, $p = 0.01$). This can be attributed to the fewer kills in the Timbavati and Klaserie P.N.R. as well as the cooler days during the 2nd study period resulting in the carcasses remaining fresh for longer periods.

This behavioral pattern where the study cheetahs remained at their kills for long periods differs from what would be expected from wild cheetahs (Eaton 1974, Wrogemann 1975, Pettifer 1981). It can, however, be explained in that the study cheetahs had never been subjected to competition from other predators or scavengers while in captivity.

Eaton (1974) calculates the daily required food intake of cheetahs at 10 percent of the body mass of the cheetah. From the present study, it was noted that the cheetahs engorged themselves on large quantities of meat, the distended bellies showing for up to 4 days after a feed. Likewise,

it was demonstrated that cheetahs are capable of going long periods without food with no obvious adverse effects. On weighing the 2 surviving cheetahs at the end of the study, it was found that they both had a mass loss of 2 kg, which can be expected as most captive cheetahs appear to be overweight due to lack of exercise and being fed on meat with a high fat content.

Data on prey selection by cheetahs in various parts of Africa are given by Eaton (1970b, 1974), Kruuk and Turner (1967), Kruuk (1972), Mitchell et al. (1965), Pienaar (1969), Hirst (1969), Schaller (1968, 1972), Pettifer (1981) and in various popular articles. Thompson's gazelle appear to be the most important prey species of cheetahs in East Africa, whereas impala (Aepyceros melampus) rank as the most frequent prey species taken in the Transvaal Lowveld. Other than giraffe (Giraffa camelopardalis), all the prey species listed in Table 3 have been recorded as prey species of cheetahs in the Kruger National Park (Pienaar 1969).

Impala are the most abundant ungulate species in the Transvaal Lowveld (Hirst 1975). During the present study, 97 hunting attempts on impalas were made, of which only 9 (9.3 percent) were successful. The poor hunting success on impalas can be chiefly ascribed to the freely impalas heading for thick bush when sighting the cheetahs and the fact that the cheetahs very seldom stalked impalas, but gave chase spontaneously.

Conversely, 5 out of 12 hunts on giraffes were successful (41.7 percent). Giraffes are inquisitive animals and invariably approached to within 100 m - 200 m of the cheetahs. On most occasions, the cheetahs ignored the giraffes except when a calf was present. Four out of the 5 giraffe kills were witnessed at 1st hand, and all followed the same pattern. The cheetahs chased the giraffe group and selected a calf. One of the cheetahs (Jan) would continue chasing the giraffe group while the other 2 concentrated on the calf. One of the cheetahs (Rogers) would then hook his dew claws into the rump of the calf and pull downwards, while the other (Gouws) charged the calf high on the shoulder, their combined efforts thus bringing it to the ground. On all these occasions, Gouws gave the strangulation bite high on the throat under the jaw bone where the trachea was most exposed. On 1 occasion, Rogers also kept a strangle-hold alongside Gouws. The cheetahs always lay behind

the giraffe when strangling (possibly to avoid the thrashing legs of the victim).

Eaton (1970a) states that specialization on different prey species by cheetahs, even in the same area, has occurred. He observed that cheetah groups very seldom cooperated in hunting, other than holding the prey at "bay". He does, however, mention that the same individual in a group would knock down and kill the prey. Kruuk and Turner (1967) suggest that cheetahs can almost entirely be classified as solitary hunters, while Bourliere (1963), on the other hand, suggests that cheetahs may hunt in organized groups. During the present study, cooperative hunting only occurred when hunting giraffes and on 1 occasion a waterbuck (Kobus ellipsiprymnus), although on several occasions simultaneous hunting took place, twice resulting in a double kill on impalas.

Twenty-one unsuccessful hunting attempts on wildebeest (Connochaetes taurinus) and 13 on zebra (Equus burchelli) were recorded. On 2 occasions, 1 of the cheetahs was injured by wildebeest and once by a zebra. One cheetah was also injured while hunting buffalo (Syncerus caffer). No further attempts on buffalo occurred.

Most kills were affected in the early hours of the morning. All the study animals had captured and killed on their own, although Rogers was undoubtedly the best hunter. Prey was dispatched efficiently except with the 1st giraffe caught, which began to recover before being killed. All prey was killed by the typical cheetah strangle-hold on the throat.

The cheetahs only occasionally came into contact with lions (Panthera leo). They showed an instinctive respect for lions, and always beat a hasty retreat. Interactions with spotted hyaenas (Crocuta crocuta) were more frequent, the cheetahs on 1 occasion defending their giraffe kill from 7 hyaenas. On another occasion, however, a single large hyaena confiscated their kill when only 1/2 eaten. Black-backed jackals (Canis mesomelas) were observed to follow the cheetahs on occasion, but always patiently waited for the cheetahs to leave a carcass before scavenging their share. On most occasions, the cheetahs would drag the carcass into the shade of low bushes and spend 1 - 2 days at a carcass, depending on the size of the prey (Table 3).

Social Behavior

The 3 study cheetahs remained together throughout the study period and demonstrated an extremely strong group cohesion. When 1 of the cheetahs was separated during a hunt, intensive vocalization from all 3 individuals would reunite them. Perhaps the best illustration of this strong bond was shown after the fight with wild cheetahs. Jan was so badly injured that he was hardly capable of moving, yet the other 2 would not leave him behind even though this meant not hunting for a week and remaining without food for 11 days. Further evidence of this bond was shown when 1 of the cheetahs (Gouws) died of snakebite. The carcass was removed for autopsy. The other 2 cheetahs remained in the vicinity for 3 days searching for him before moving on.

Social dominance among the 3 cheetahs could not be identified. All took turns in determining direction and leading the way when walking or initiating a hunt. This is in contrast to Eaton's (1969, 1970c, 1974) findings where the "leader" of a group played a significant role. Aggressive behavior among these cheetahs only occasionally occurred while feeding on a carcass, but these outbursts were never serious.

Face-licking among the study animals was frequent and often accompanied by deep purring. These cheetahs also frequently licked each others wounds, but otherwise, allogrooming on the other parts of the body was rare. Eaton (1969, 1974) feels that face-licking in cheetahs plays an important part in group cohesion.

At Suikerkop the cheetahs frequently and persistently urine-marked conspicuous objects. This can probably be attributed to the presence of other cheetahs in this small area. In the Timbavati P.N.R., urine marking was only noted the day before the fight on the farm Addger where the cheetahs had spent a number of days and appeared to be settling down. Towards the end of the study, the cheetahs on occasion urine-marked in the Klaserie P.N.R., again when it appeared that they had selected an area. In the present study tree-scratching occurred frequently, both at Suikerkop and in the Timbavati P.N.R. and Klaserie P.N.R. On the other hand, Eaton (1970c) states that tree-scratching in cheetahs is rare and probably a form of stretching.

Defecation was normally preceded by scratching the ground with their hindlegs. Eaton (1970c) only records this behavior from 1 of his study groups. The fact that the study animals frequently defecated on high ground and spent much time smelling previous feces, would indicate that scent-marking in cheetahs as advocated by Eaton (1970c, 1974) as a spacing system could be affected by both urine and fecal marking. Only 1 record of female cheetahs urine marking is documented (Pettifer 1981).

CONCLUSIONS

Although this study has shown some promising results, particularly in demonstrating that catching and killing prey is instinctive, certain shortcomings are evident - the most important being the lack of fear for humans in captive-bred animals and an inability at times to select suitable prey (e.g., buffalo). The cheetahs on 2 occasions entered rest-camps and consumed chickens belonging to the local inhabitants. In both cases, the cheetahs would no doubt have been dispatched with well-aimed spears had we not have been there to dissuade the irate owners. Likewise, these cheetahs showed no fear for vehicles nor their owners and were vulnerable to being fed, thus, once again, becoming dependent on humans for food.

Another less obvious problem is encountered when relocating cheetahs to areas where cheetahs already occur, even in small numbers as in the Timbavati and Klaserie Private Nature Reserves. With the vast distances that the relocated cheetahs roam, fights with resident groups cannot be avoided.

Thirdly, in areas where bush encroachment is on the increase, such as in most parts of the Eastern Transvaal Lowveld, the habitat makes hunting more difficult for cheetahs. This would be particularly true for inexperienced captive-bred cheetahs that would, out of necessity start selecting for larger clumsier prey such as giraffes, waterbuck and reedbuck. These species are normally assigned a higher aesthetic value than the more common species and kills would thus cause consternation among landowners. This project certainly warrants further research. Additional experiments with captive-bred cheetahs reared in the absence of human contact and the experimental release of a single adult female are

needed in order to verify the findings of this study. In terms of the future conservation of the species, the results are highly encouraging.

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