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Feeding biology of a group of re-introduced cheetah on Kwandwe Private Game Reserve, Eastern Cape Province

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ABSTRACT

A group of re-introduced cheetah on Kwandwe Private Game Reserve was studied to establish their feeding biology in Valley Bushveld. Direct observations, scat analysis and continuous observations were used to avoid bias towards large sized prey found when only using direct observations. The cheetah's main prey was medium sized ungulates, although the 3 male cheetah coalition killed larger prey than females and females with cubs. The cheetah killed 15 species and 4 of the 5 most abundant species (kudu, springbuck, grey duiker and bushbuck) were hunted according to their abundance on the reserve, while impala the 5th most important prey species, was avoided by the cheetah. The daily food intake per cheetah per day was calculated to range from 5.6kg/cheetah/day for the coalition to 8.4kg/cheetah/day for a solitary female. The observations at Kwandwe illustrate that cheetah are adaptable and efficient hunters in Valley Bushveld and are not necessarily dependent on gazelle or impala-sized prey.

INTRODUCTION

The cheetah (*Acinonyx jubatus*) is Africa's most endangered large felid with the largest remaining population of free ranging cheetah found in Namibia (Marker-Kraus *et al.* 1996; Nowell & Jackson 1996; Marker & Schumann 1998). The feeding biology of cheetah has received extensive attention in the scientific literature with most studies focussing on diet, feeding behaviour and hunting patterns (Mitchell *et al.* 1965; Kruuk & Turner 1967; Schaller 1968; Pienaar 1969; Eaton 1974; Mills 1984; Durant *et al.* 1988; Fitzgibbon & Fanshawe 1989; Fitzgibbon 1990; Caro 1994; Nowell & Jackson 1996; Hofmeyr & van Dyk 1998; Hunter 1998; Purchase & du Toit 2000). This type of information is important in understanding the behaviour

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and ecology of cheetah and the potential impact that cheetah may have on their prey (Caro 1994). In general it appears that cheetah feed predominantly on the most abundant medium sized antelope in any one area, although they are also able to utilise both larger and smaller prey (Mills 1996). For example on the Serengeti Plains the cheetah's most important prey species is Thomson's gazelle (Caro 1994); in Kruger National Park impala are the most abundant and they formed a far greater proportion of the cheetah's diet than any other species (Mills *et al.* 2004); in Phinda Resource Reserve nyala are the most abundant species and the most common prey species in the cheetah's diet (Hunter 1998) and in the Kalahari springbuck are cheetah's most important prey species (Mills 1984).

Historical records show that cheetah occurred in the Eastern Cape Province and were last recorded 35km north of Grahamstown in 1888 (Skead 1987). In 2001, nine cheetah (4 adult males, 2 adult females with 1 and 2 cubs respectively) were reintroduced to Kwandwe Private Game Reserve (from here on referred to as Kwandwe) in the Eastern Cape Province. The habitat types on Kwandwe, referred to as Valley Bushveld (Acocks 1988), are quite different from those in any other area in which cheetah have been studied. Although there are some savannah-like vegetation types, these are not characterized by the long grass, which would usually offer the cheetah cover. Much of the rest of the reserve is covered by vegetation types, which are characterized by very thick, succulent, and thorny bush which is quite different from the type of habitat selected elsewhere by cheetah. Thus the aim of this study was to examine the feeding biology of cheetah in Valley Bushveld and to establish the extent to which their normal feeding behaviour (high speed chase in open areas to catch small to medium sized prey) was modified. In this paper the diet is described and discussed.

MATERIALS AND METHODS

Study Animals

At the onset of my study there were 12 cheetah on Kwandwe, which comprised a 3 male coalition and 3 females with cubs (1, 2 and 3 cubs respectively). Due to losses and births, and introductions of cheetah on Kwandwe the cheetah composition changed considerably throughout my study. Cheetah are asocial animals and for this reason the cheetah on

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Kwandwe were divided into the following groups for the purpose of analyzing the results: a 3 male coalition; females with cubs (5 females with 16 cubs between them); single females (4 females) and independent cubs (1 group of 2 siblings).

Data Collection

All cheetah on Kwandwe have been fitted with either a radio collar or an implanted radio transmitter. I collected data on feeding ecology by three means; the daily location of all cheetah and opportunistic observation of kills, scat analysis and continuous observation of selected animals.

Daily location of all cheetah

All cheetah were located each day and, where possible, I followed the cheetah for extended periods to observe kills as they were made. Cheetah which had already made a kill, were often located and in this case it was assumed that the cheetah on the carcass made the kill as cheetah very rarely scavenge. These direct observations are likely to artificially increase the contribution of large kills, because cheetah are more likely to spend more time on larger kills and thus large kills are more likely to be found than smaller ones. In an attempt to fill these gaps in the observations, I collected scats and undertook two-week continuous observations. It was hoped that the scat analysis would give a more accurate indication of the species killed by cheetah, while the continuous observations would give a better indication of kill frequency and daily consumption.

Scat Analysis

Cheetah scats were collected opportunistically, hairs were extracted, washed with water, filtered and air-dried and identified by examining the cuticle scale imprints and cross-sectional shape of the hairs. Cuticle scale imprints were made from the extracted hair samples using a method discussed in Keogh (1983). Gelatin (Royal) was added to hot water at a concentration of 5%. Clean slides were thinly coated with the gelatin solution and the hairs were placed in position using fine forceps. Six hairs were placed on each slide and 4 slides were made for each scat sample. The slides were allowed to dry for approximately 24 hours before the hairs

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were removed. Cross sections were made using a method proposed by Douglas (1989). A random selection of 10-20 hairs from each scat sample were placed in a disposable pipette and the tube was filled with molten wax. Once filled, the tubes were cooled rapidly in a beaker with ice cubes. The pipette was cut into sections of 1-2mm thick and ~ 8 of these sections were fixed onto microscope slides using molten wax. A reference collection was used, that was produced from hair samples collected from museum specimens (Amatola Museum, King Williams Town, Eastern Cape Province) and prepared following the same method mentioned above.

Continuous Observations

The various groups of cheetah were followed continuously for approximately two weeks at a time. From 19 January to 4 February and from May 1 to 15, 2004, the 3 male coalition was observed continuously and a single female was observed continuously from 28 February to 13 March, 2004. I usually followed the cheetah at a distance of about 100-200m in open regions and 40-50m in more dense areas, so as not to interfere with the hunt. For the 3 male coalition of cheetah, which did most of their hunting at night, I used a spotlight which I switched off when the cheetah encountered prey and waited until an attempt had been made before I relocated them again. If I lost the cheetah in thick bush and they remained stationary in the bush it often meant that they had killed. I determined the location of the kill using triangulation and attempted to walk into the site once the cheetah had left the area. In this way I often located fresh kill remains.

For all kills found the date, species, sex and, where possible, age (juvenile, sub-adult, adult) of the prey were recorded. The vegetation type in which the kill was made and the location and/or GPS readings for the carcass were recorded. The area was searched for drag marks in an attempt to ascertain precisely where the kill had been made. Using these three methods, kill lists for Kwandwe were recorded for a total of 18 months beginning in February 2003.

Data Analysis

Kills have been analyzed in terms of species of ungulate killed, age, sex and size in order to determine the preferences of the cheetah. Due to considerable variation in the assignment of

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ungulate species to size classes in the literature, species were assigned to a size class according to the age of the prey taken and categories used by Hunter (1998; Table 1). Kills made by the different groups of cheetah (coalition, females with cubs, single females & independent cubs) were analyzed separately so that comparisons could be made between the groups.

Prey Preference Index

To determine whether cheetah at Kwandwe selected certain ungulate species preferentially, a preference index was calculated for prey species (Pienaar 1969). The preference indices were determined as follows:

$$\text{Preference Index} = \frac{\text{kill frequency of prey}}{\text{relative abundance of prey}}$$

Kill frequency was calculated as the number of individuals of a particular species, killed by the cheetah, relative to the number of individuals of all species killed. The relative abundance of prey was based on game counts derived from an aerial census method and is the abundance of a particular species expressed as a percentage of the abundance of all prey species. A preference index of one indicates that the species was selected according to its abundance on the reserve. An index above one shows that the cheetah were preferentially selecting for the species and an index below one indicates that the prey species were not actively hunted and were avoided when they were encountered opportunistically. Prey preference indices were calculated for all cheetah on Kwandwe. Calculations were not made for prey species where adequate game count records were not available. Species such as forest dwelling ungulates like duiker and bushbuck tend to be underestimated using aerial game counts and this may result in an artificially elevated preference index.

Calculation of Daily Food Intake and Kill Rate

The total biomass consumed by all cheetah was calculated from the kill list. The edible biomass from a carcass was estimated from the categories suggested by Mills (1990) of carcass weight > 80kg = 67%, carcass weight 5-80kg = 90%, carcass weight <5kg =100%. The carcass

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weight was estimated for every kill, according to age, sex and species using published data on herbivore weights (Bothma 2002; Meissner 1982).

Because many kills were missed during the daily direct observations, average kill rates and daily intake rates (kg of meat/cheetah/day) were calculated from the two week continuous observations on the various groups of cheetah.

Statistical Analyses

To assess whether cheetah were selecting certain prey a Chi-squared test was used comparing the availability of prey species to the rate at which they were killed by the cheetah. Chi-squared tests were used to compare the size, age and sex of kills made by the various cheetah groups, with the availability of these categories of prey on Kwandwe.

RESULTS

General Analysis of Diet

A total of 224 kills were recorded over a period of 18 months for the entire cheetah population on Kwandwe. Fifteen species were preyed on (Table 2) at Kwandwe. 86% of cheetah kills were mammals and cheetah always ate from all species they killed. Five of the 15 species (kudu, springbuck, grey duiker, impala and bushbuck) preyed on by the cheetah at Kwandwe comprised 82.2% of the animals killed and 79.2% (7031.6kg) of the total edible biomass of the kills (Table 2). Analysis of both numbers of animals killed and their edible biomass is necessary since a small number of large kills may make a similar contribution to the cheetah's energetic and nutrient requirements as a larger number of smaller kills. Kudu formed a far greater proportion of the diet (42.9%; Table 2) than any other species and 77% of the kudu killed by the cheetah were juvenile.

In terms of size of the prey, more than half of the kills recorded over the study period by the entire cheetah population on Kwandwe, were of the medium size class, however there was a significant difference in the way in which male, female, female cheetah with cubs and independent cubs utilized prey of different size classes ($p < 0.001$; Figure 1). The male

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cheetah's (coalition) diet consisted of a greater proportion of larger prey items (Figure 1). Female cheetah and females with cubs preyed more on medium sized prey, whereas independent cubs concentrated on smaller prey items (Figure 1).

The number of kills where the sex was not known was high (Figure 2) and this was due to the high percentage of juveniles killed by the cheetah. A large number of juvenile kudu were killed and it is very difficult to determine the sex of kudu in this age class. Overall, there was no significant difference in the number of male and female prey killed. When comparing the different cheetah social groups, independent cubs killed significantly more males than females ($p < 0.005$), whereas the coalition and single females killed more female than male prey.

Overall, significantly more juvenile and adult prey were killed than sub adult ($p < 0.001$; Figure 3). When comparing the different cheetah groups the single female cheetah killed a higher proportion of juveniles than females with cubs, the coalition and independent cubs (Figure 3), however, these differences were not statistically significant ($p > 0.05$).

Scat Analysis

Ninety seven cheetah scats were analysed, of which 53% were from the coalition, 37% from females with cubs, 8% from single females and 2% from independent cubs. Twelve species of prey were found in the cheetah scats analysed. The composition of the scats was very similar to that found in the observed kills, with only two new additions to the kill list, an unidentified rodent and black backed jackal (Table 3). A higher percentage of kudu (63.9%), blesbuck (6.2%) and waterbuck (5.2%) were found in the cheetah scats compared to the observed kills (Table 3). Overall, the 5 most dominant prey species in the observed kills represented 80.5% of specimens in the cheetah scats analysed. Kudu was the most abundant species identified in the scats of the coalition (54.9%), followed by blesbuck (11.8%) and waterbuck (7.8%; Table 4). By contrast, in the scats of the female cheetah with cubs' kudu (75%) was the most abundant species identified, followed by impala (11.1%) and bushbuck (5.6%; Table 4). Hairs from 3 new species (rodent species, scrub hare & black backed jackal; Table 3) were found in the scats from the coalition; whereas only 2 new species were found in the scats of the females with cubs (black backed jackal & waterbuck; Table 3). The sample size of scats from single female cheetah and independent cheetah cubs was too low to draw any conclusions.

Prey Preference

The calculation of prey preference indices for all cheetah has generated values from a maximum of 4.53 for blesbuck to a minimum of 0.08 for blue wildebeest (Table 5). Values below 1 have been interpreted as indicating avoidance, values between 1 and 2 as indicating that the prey was being utilized according to its abundance on the reserve and values greater than 2 as indicating a preference for a particular species. In terms of preference ratings kudu, which was by far the most common prey item, was selected according to its relative abundance. By contrast, blesbuck which was not one of the top five prey species had the highest preference index, suggesting that it was hunted preferentially. However, high preference indices should be interpreted with caution since, while they may reflect true preference, they can be artificially elevated. For example, if the population of a prey species on a reserve is very small then single predation incidents will produce a very high preference rating. This may be the case with Blesbuck, which are present in low numbers on the reserve. Interestingly impala, which are the most common prey species of cheetah in other reserves (Kruger National Park, Pienaar 1969, Mills *et al.* 2004, Eaton 1974) and are abundant on Kwandwe, were avoided by cheetah on Kwandwe. Bushbuck, springbuck and grey duiker were hunted opportunistically. Chi-squared analyses of these data indicate a significant difference between observed kills and expected, assuming that the cheetah hunted at random ($p < 0.001$).

Calculation of Daily Food Intake and Kill Rate

In the first observation of the coalition (18 days), 7 kills were made: 2 blesbuck (1 adult male & 1 juvenile); 2 red hartebeest (1 adult male & 1 juvenile); 1 blue wildebeest (juvenile); 1 kudu (juvenile) and 1 Burchell's zebra (juvenile), giving a total edible biomass of 357 kg and a daily consumption of 5.6 kg per cheetah per day. The kill rate was one kill per 2.6 days. In the second observation of the coalition (16 days), 5 kills were made: 2 kudu (adult females); 2 gemsbuck (juveniles) and 1 impala (adult male), giving a total edible biomass of 342.8kg and a daily consumption rate of 6.5kg per cheetah per day. The kill rate was one kill per 3.2 days. In the observation of the single female (16 days), 6 kills were made: 5 kudu (all juveniles) and

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1 grey duiker (juvenile), giving a total edible biomass of 164.7kg and a daily consumption rate of 8.4kg per cheetah per day. The kill rate was one kill per 2.7 days. If the consumption and kill rates are calculated from the kills recorded opportunistically over a full year, the daily consumption rate for the coalition and the single female cheetah for year 1(2003) was 1.8kg meat/cheetah/day.

DISCUSSION

Overall, the cheetah on Kwandwe exhibited a similar diet to that which has been reported elsewhere. They selected a wide range of prey of all sizes, including non-mammalian species. However, as many other studies have shown, the majority of the diet was made up of only a few species (Caro 1994, Hunter 1998, Mills *et al.* 2004). The majority of the cheetah's diet comprised medium sized species (30-65kg) which is consistent with previous studies (Mills 1984, Caro 1994, Mills *et al.* 2004). However the different cheetah groups killed different sized prey. The co-operation in hunting of the three adult male coalition on Kwandwe has enabled them to kill large sized prey (>65kg), which is consistent with previous studies (Caro 1994, Mills 1998, Hunter 1998 & Mills *et al.* 2004). Male coalitions need a greater biomass of food than solitary cheetah (Caro 1994) and this need could be met by making more frequent kills or by killing larger prey. It has been suggested that large carnivores will resist changing kill frequency and that changes in group size are associated with change in the size of the prey (Caro 1994) and this appears to be the pattern at Kwandwe. More than a third of kills made by the coalition weighed more than a 100kg's and in most cases the cheetah remained at their kills until they were satiated. However, the continuous observations on the coalition showed that the cheetah did adjust the kill rate to meet their energetic needs as they killed twice on the same day on more than one occasion. Significantly, on these occasions the kills were juveniles which would explain the need to catch more than one prey item per day. Females with cubs preyed on more medium sized animals than single females and again this can be explained in terms of the increased needs of the group over a solitary female. However, unlike the coalition the groups of adult females and their cubs do not have the power to kill large prey. As expected, single females preyed upon more medium sized prey whereas independent cubs preyed on more small sized prey. These results are different from those from the Kruger

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National Park where females preyed mostly on smaller sized prey like grey duiker and steenbuck (Mills *et al.* 2004).

It has been suggested that direct observations of predators is likely to artificially increase the contribution of large kills (Mills 1996), because cheetah will spend more time on larger kills and thus large kills are more likely to be found than smaller ones. Results from the scat analysis have shown that small prey like rodents and scrub hares do not appear regularly in the cheetah diet on Kwandwe and only two new species (a rodent and black backed jackal) were added to the diet. Very few studies have shown black backed jackal to be part of cheetah's diet but the high concentration of black back jackal on Kwandwe could have led to the consumption of these lesser predators. Pienaar (1969) recorded cheetah killing jackal but they did not form part of the diet. I have seen cheetah chase black backed jackal on a number of occasions on Kwandwe but none of these chases resulted in a kill. The similarity between the results from the observations and scat analysis suggest that at Kwandwe the direct observations have given an accurate reflection of the diet.

When looking at the prey preferences of cheetah on Kwandwe, kudu were hunted according to their abundance on the property. This is to be expected as cheetah predominantly kill the most abundant species in an area (Mills 1984, Caro 1994 & Hunter 1998). Bushbuck, grey duiker and springbuck were hunted opportunistically further suggesting that the cheetah were not selecting prey. Interestingly, impala, which are the most common prey species of cheetah in other reserves (Purchase & du Toit 2000; Matusadona NP & Broomhall *et al.* 2003; Kruger NP) and are abundant on Kwandwe, had a preference rating of 0.77 indicating that they were avoided by cheetah. This was especially evident in the coalition as on a number of occasions they ignored nearby impala herds while hunting kudu.

Kill rates of cheetah have been shown to be affected by group size, presence of cubs, prey size and availability, habitat structure and competition with other predators (Pettifer 1981a, Caro 1994, Durant 2000, Mills *et al.* 2004). These probably explain the variations found in cheetah kill rate across African ecosystems. Three male coalitions were found to have very low kill rates of 95 and 51 kills per year in Suikerbosrand Nature Reserve (SNR) and Timbavati & Klaserie Nature Reserves (TNR; Pettifer 1981a & 1981b). However, the cheetah were estimated to have

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consumed approximately 4.1kg of meat/cheetah/day in SNR and approximately 2.2kg in TNR (Pettifer 1981b). Schaller's (1972) estimate that a female (with two cubs) consumed approximately 4kg of meat/cheetah/day is similar to that found by Pettifer (1981b) in SNR, although this female had a far higher kill rate of 341 kills per year. The high estimate of kill rate given by Schaller (1972) however was influenced by sample size, which was recorded once over six consecutive days. A three male coalition in the Kruger National Park had a comparatively low kill rate of 79 kills per year and consumed approximately 1.4kg of meat/cheetah/year (Mills *et al.* 2004). Cheetah on Kwandwe had much higher kill rates (~ 126 kills per year) and a higher consumption rate of ~ 6kg of meat/cheetah/day for a 3 male coalition and ~ 8.4kg of meat/cheetah/day for a single female cheetah. This could be because of the high concentration of prey on Kwandwe and the low numbers of lion and other competitors, therefore allowing the cheetah to catch more often and consume more meat at one sitting.

CONCLUSION

Cheetah are regarded as the most specialised of all felids, preferring small to medium sized prey, particularly in open grasslands where most studies have been undertaken (Caro 1994, Nowell & Jackson 1996). However, the patterns observed at Kwandwe illustrate that cheetah are adaptable and successful hunters in Valley Bushveld and are not necessarily dependent on gazelle or impala-sized prey. Indeed, impala are abundant at Kwandwe but were not selected by the cheetah.

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REFERENCES

- ACOCKS, J.P.H. 1988. Veld types of South Africa. (3e). Botanical Research Institute. South Africa.
- BOTHMA, J.DU P. 2002. Game Ranch Management. (3e). Van Schaik Publishers. Pretoria.
- BROOMHALL, L.S., MILLS, M.G.L. DU TOIT, J.T. 2003. Home range and habitat use by cheetahs (*Acinonyx jubatus*) in the Kruger National Park. *Journal of Zoology*. London 261: 119-128.
- CARO, T.M. 1994. Cheetah of the Serengeti Plains: Group living in an asocial species. The University of Chicago Press. Chicago.
- DOUGLAS, R.M. 1989. A new method of cross-sectioning hair of larger mammals. *S.Afr.J.Wildl.Res* 19: 73-76.
- DURANT, S.M., CARO, T.M., COLLINS, D.A., ALAWI, R.M. & FITZGIBBON, C.D. 1988. Migration patterns of Thomson's gazelles and cheetahs on the Serengeti plains. *Afr. J. Ecol.* 26: 257-268.
- DURANT, S.M. 2000. Living with the enemy: avoidance of hyenas and lions by cheetah in the Serengeti. *Behav. Ecol.* 11: 624-632.
- EATON, R.L. 1974. The Cheetah: The biology, ecology and behaviour of an endangered species. Van Nostrand Reinhold Company. New York.
- FITZGIBBON, C.D. & FANSHAWE, J.H. 1989. The condition and age of Thomson's gazelle killed by cheetahs and wild dogs. *J. Zool.* 218: 99-108.
- FITZGIBBON, C.D. 1990. Why do cheetah prefer hunting male gazelles? *An. Behav.* 40: 837-845.
- HOFMEYR, M. & VAN DYK, G. 1998. Cheetah introductions to two North West Parks: case studies from Pilanesburg National Park and Madikwe Game Reserve. In: Penzhorn, B.L. (Ed.); Cheetahs as game ranch animals. Proceedings of a symposium on cheetahs as game ranch animals. Onderstepoort. 23 & 24 October. pp. 60-71.
- HUNTER, L.T.B. 1998. The behavioural ecology of reintroduced lions and cheetah

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in the Phinda Resource Reserve. Kwazulu-Natal. South Africa. PhD. Thesis.
University of Pretoria.

KEOGH, H..J. 1983. A photographic reference system of the microstructure of the
hair of African Bovids. *S.Afr.J.Wildl.Res.* 13: 89-132.

KRUUK, H. & TURNER, M. 1967. Comparative notes on predation by lion, leopard,
cheetah and wild dog in the Serengeti area. *Mammalia* 31: 1-27.

MARKER-KRAUS, L. KRAUS, D., BARNETT, D. & HURLBUT, S. 1996. Cheetah
survival on Namibian farmlands. Cheetah Conservation Fund. Windhoek.

MARKER, L. & SCHUMANN, B.D. 1998. Cheetahs as problem animals:
management of cheetahs on private land in Namibia. In: Penzhorn, B.L. (Ed.);
Cheetahs as game ranch animals. Proceedings of a symposium on cheetahs as game
ranch animals. Onderstepoort. 23 & 24 October. pp. 90-99.

MARKER, L.L., MUNTIFERING, J.R., DICKMAN, A.J., MILLS, M.G.L. &
MACDONALD, D.W. 2003. Quantifying prey preferences of free-ranging
Namibian cheetahs. *S.Afr.J.Wildl.Res.* 33(1): 43-53.

MEISSNER, H.H. 1982. Classification of farm and game animals to predict carrying
capacity. In Farming in South Africa C3. Department of Agriculture and
Fisheries. Pretoria.

MILLS, M.G.L. BROOMHALL, L.S. & DU TOIT, J.T. 2004. Cheetah *Acinonyx*
jubatus feeding ecology in the Kruger National Park and a comparison across African
savanna habitats: is the cheetah only a successful hunter on open grassland plains?
Wildlife Biology 10(3): 177-186.

MILLS, M.G.L. 1984. Prey selection and feeding habits of the carnivores in the
southern Kalahari. *Koedoe supplement* 27: 281-294.

MILLS, M.G.L. 1990. Kalahari hyaenas: the comparative behavioural ecology of
two species. Chapman & Hall. London.

MILLS, M.G.L. 1996. Methodological advances in capture, census and food habits
studies of large African carnivores. In Carnivore Behaviour, Ecology and
Evolution. Volume II. (ed. J.L. Gittleman). Pp 223-242. Cornell University
Press. New York.

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MITCHELL, B. SHENTON, J. UYS, J. 1965. Predation on large mammals in the Kafue National Park. Zambia. *Zool. Afr.* 1: 297-318.

NOWELL, K. & JACKSON, P. 1996. Wild cats: status survey and conservation action plan. Burlington Press. Cambridge.

PETTIFER, H.L. 1981a. Aspects on the ecology of cheetah (*Acinonyx jubatus*) on the Suikerbosrand Nature Reserve. In Worldwide Furbearer Conference Proceedings. (ed. J.A. Chapman & D. Pursesly). pp.1121-1142. R.R. Donnelly & Sons, Co. Falls Church. VA.

PETTIFER, H.L. 1981b. The experimental release of captive-bred cheetah (*Acinonyx jubatus*) into the natural environment. In Worldwide Furbearer Conference Proceedings. (ed. J.A. Chapman & D. Pursesly). pp.1001-1024. R.R. Donnelly & Sons, Co. Falls Church. VA.

PIENAAR, U De V. 1969. Predator-prey relationships amongst the larger mammals of the Kruger National Park. *Koedoe* 12: 108-176.

PURCHASE, G. & DU TOIT, J.T. 2000. The use of space and prey by cheetahs in Matusadona National Park. Zimbabwe. *S. Afr. J. Wild. Res.* 30: 1-6.

SCHALLER, G.B. 1972. The Serengeti Lion: A study of predator-prey relations. The University of Chicago Press, Chicago.

SKEAD, C.J. 1987. Historical mammal incidence in the Cape Province: Volume 2. Chief Directorate of Nature and Environmental Conservation. Cape Town.

Table 1: Prey size categories (used by Hunter (1998)) and typical examples. Totals are the total number of kills (all cheetah for all months) in each size class.

Kill Size	Weight Range	Typical Examples	Total
Small	< 30kg	Grey Duiker, Steenbok, Scrub Hare and juvenile Springbuck, Bushbuck, Impala	47
Medium	30 – 65kg	Springbuck, Bushbuck, Impala and juvenile Kudu, Waterbuck, Ostrich, Gemsbuck, Blue Wildebeest, Red Hartebeest, Blesbuck	134
Large	> 65kg	Kudu, Waterbuck, Red Hartebeest, Blesbuck Burchell's Zebra and Eland	43

Table 2: Complete list and edible biomass of all prey species killed by cheetah. Mass of individuals is from Bothma (2002) and Meissner (1982). The edible biomass for all the individuals of each species is estimated from the categories suggested by Mills (1990) and takes into account the age of the kills.

Prey species	Kills		Mass of indiv. (kg)			Edible Biomass	
	No	%	Juvenile	Male	Female	Kg	%
Kudu	96	42.9	55	220	155	4836.2	54.5
Springbuck	28	12.5	12	41	31	721.7	8.1
Grey Duiker	27	12.1	8	17	21	403.4	4.5
Bushbuck	17	7.6	17	60	36	601.3	6.8
Impala	16	7.1	19	60	45	469	5.3
Blesbuck	11	4.9	23	75	67	550.9	6.2
Red Hartebeest	7	3.1	30	150	120	434.5	4.9
Burchell's Zebra	6	2.7	95	335	290	402.9	4.5
Steenbok	4	1.8	5	11	11	33.2	0.4
Ostrich	3	1.3	35	120	120	89.8	1.0
Waterbuck	3	1.3	50	260	180	107.2	1.2
Scrub Hare	2	0.9	0.5	4.5	3	8.5	0.1
Gemsbuck	2	0.9	55	240	210	81	0.9
Eland	1	0.4	160	650	460	107.2	1.2
Blue Wildebeest	1	0.4	51	200	160	30.9	0.3
Total	224	100				8877.7	100.0

Table 3: Results of the scat analysis showing the species found in the scat samples and the prey species recorded by direct observations.

Prey species	Obs.Kills		Scats	
	No	%	No	%
Kudu	96	42.9	62	63.9
Springbuck	28	12.5	6	6.2
Grey Duiker	27	12.1	2	2.1
Bushbuck	17	7.6	2	2.1
Impala	16	7.1	6	6.2
Blesbuck	11	4.9	6	6.2
Red Hartebeest	7	3.1	1	1.0
Burchell's Zebra	6	2.7	0	0.0
Steenbok	4	1.8	0	0.0
Ostrich	3	1.3	0	0.0
Waterbuck	3	1.3	5	5.2
Scrub Hare	2	0.9	1	1.0
Gemsbuck	2	0.9	0	0.0
Eland	1	0.4	0	0.0
Blue Wildebeest	1	0.4	1	1.0
Rodent	0	0.0	1	1.0
Black Backed Jackal	0	0.0	4	4.1
Total	224	100.0	97	100.0

Table 4: Results of the scat analysis showing the species found in the scat samples and the prey species recorded by direct observation of the various cheetah social groups on Kwandwe. (columns represent the percentages of the direct observation (Obs) and the scat analysis)

Prey species	Coalition		Females with cubs		Single Females		Independent Cubs	
	Obs	Scats	Obs	Scats	Obs	Scats	Obs	Scats
Kudu	40.0	54.9	47.6	75.0	48.1	75	21.4	50
Springbuck	6.7	9.8	19.0	0.0	13.5	12.5	7.1	0
Grey Duiker	0.0	0.0	11.9	2.8	19.2	12.5	35.7	0
Bushbuck	0.0	0.0	7.1	5.6	7.7	0	21.4	0
Impala	1.7	2.0	10.7	11.1	5.8	0	14.3	50
Blesbuck	18.3	11.8	0.0	0.0	0.0	0	0.0	0
Red Hartebeest	10.0	2.0	0.0	0.0	0.0	0	0.0	0
Burchell's Zebra	10.0	0.0	0.0	0.0	0.0	0	0.0	0
Steenbok	0.0	0.0	2.4	0.0	3.8	0	0.0	0
Ostrich	3.3	0.0	1.2	0.0	0.0	0	0.0	0
Waterbuck	3.3	7.8	0.0	2.8	1.9	0	0.0	0
Scrub Hare	0.0	2.0	1.2	0.0	1.9	0	0.0	0
Gemsbuck	3.3	0.0	0.0	0.0	0.0	0	0.0	0
Eland	1.7	0.0	0.0	0.0	0.0	0	0.0	0
Blue Wildebeest	1.7	2.0	0.0	0.0	0.0	0	0.0	0
Rodent	0.0	2.0	0	0.0	0	0	0.0	0
Black Backed Jackal	0.0	5.9	0	2.8	0	0	0.0	0
Total*	60	51	85	36	53	8	14	2

* Total is the number of kills made by the cheetah and the total number of scats analysed for each group

Table 5: Preference indices for species killed by all cheetah on Kwandwe.

(the total number is the number of species derived from the annual game count)

Species	Total No.	No. Killed	Preference Index	Size Category
Blesbuck Blue	44	11	4.53	L/M
Wildebeest Burchell's	213	1	0.08	L
Zebra	174	6	0.62	L
Bushbuck	185	17	1.65	S/M
Grey Duiker	287	27	1.68	S
Eland	89	1	0.20	L
Gemsbuck	149	2	0.24	M
Impala	370	16	0.77	S/M
Kudu	1512	96	1.14	M/L
Ostrich	84	3	0.64	S
Red Hartebeest	251	7	0.50	L/M
Springbuck	457	28	1.10	S/M
Steenbok	60	4	1.20	S
Waterbuck	104	3	0.52	M/L
TOTAL	3975	222		

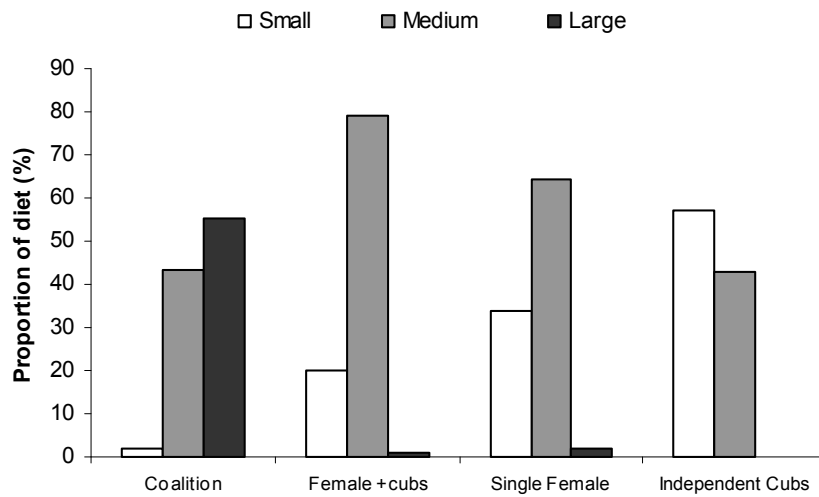


Figure 1: Proportion of small, medium and large prey found in the diet of the various groups of cheetah on Kwandwe.

Figure 2: Proportion of males, females and animals of unknown sex selected by all cheetah for all prey species.

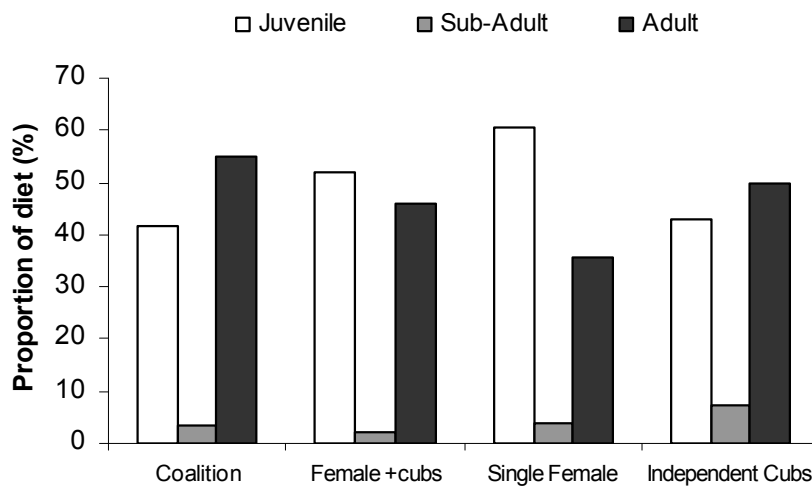


Figure 3: Proportion of each age class in the kills made by all cheetah on Kwandwe.