

large and that the population in the reserve was low. Bertram (1982) recorded leopards killing spotted hyaenas. Wild dog kills were also infrequently encountered in his study on leopard ecology. Bertram (1982) considered wild Pienaar (1969) placed spotted hyaenas second to the lion in the rank of the African predator society. Eaton (1969) also ranks the spotted hyaena second to the lion. Bothma and Le Riche (1984) concluded that in the Kalahari Desert, the presence of large, aggressive male leopards and the frequent presence of small groups of spotted hyaenas may result in the leopard being ranked second to the lion in that area. Scott (1985) suggested that, based on observations from Mara, the lion and the spotted hyaena dominate the predator hierarchy and that a leopard was able to defend its kill against one spotted hyaena but not against more than one spotted hyaena. The outcome of contacts between spotted hyaenas and leopards depended on the degree of hunger, numbers of spotted hyaenas involved and the original ownership of the kill (Scott 1985). The largest pack size of spotted hyaenas observed in the Klaserie Private Nature Reserve was one of 11 animals and the data suggest that in the Klaserie Private Nature Reserve, the leopard may well rank second to the lion in the interspecific rank of the larger African carnivores. In the Kröger National Park, wild dogs preyed mainly on impala and also killed a smaller number of prey types than the lion. Leopard And Wild Dog or the leopard. In the Serengeti, wild dogs preyed predominantly on Thomson's gazelle and blue wildebeest. Wild dogs were infrequently encountered in the Klaserie Private Nature Reserve. It is accepted that their ranges

were large and that the population in the reserve was low. Wild dog kills were also infrequently encountered. In his study on leopard ecology, Bertram (1982) considered wild dogs to be unimportant in the study area as they were so scarce, as did Henschel (1986) in the Kruger National Park.

In the Klaserie Private Nature Reserve, wild dogs were seen to be active during the early morning and late afternoon, and in contrast to the leopard, were not seen during hours of darkness (Fig. 11). Wild dogs in the reserve were known to kill and feed on impalas and bushbuck (Table 6), but not in any high numbers and the overlap of prey types killed by both predators was also small (Fig. 15). Of the prey types killed by wild dogs, seven were impala kills and one was a bushbuck kill.

Where age and sex of prey killed by wild dogs was estimated, two impalas were adult females, one was an adult male and one a subadult female. Three impala carcasses were neither sexed nor aged. The one bushbuck killed was an adult female. Prey was quickly consumed and little remained of the carcasses after the wild dogs had fed. Similarly, in the Kruger National Park, wild dogs preyed mainly on impalas and also killed a smaller number of prey types than the lion or the leopard. In the Serengeti, wild dogs preyed predominantly on Thomson's gazelle and blue wildebeest calves and have a preference for prey animals weighing 65 kg

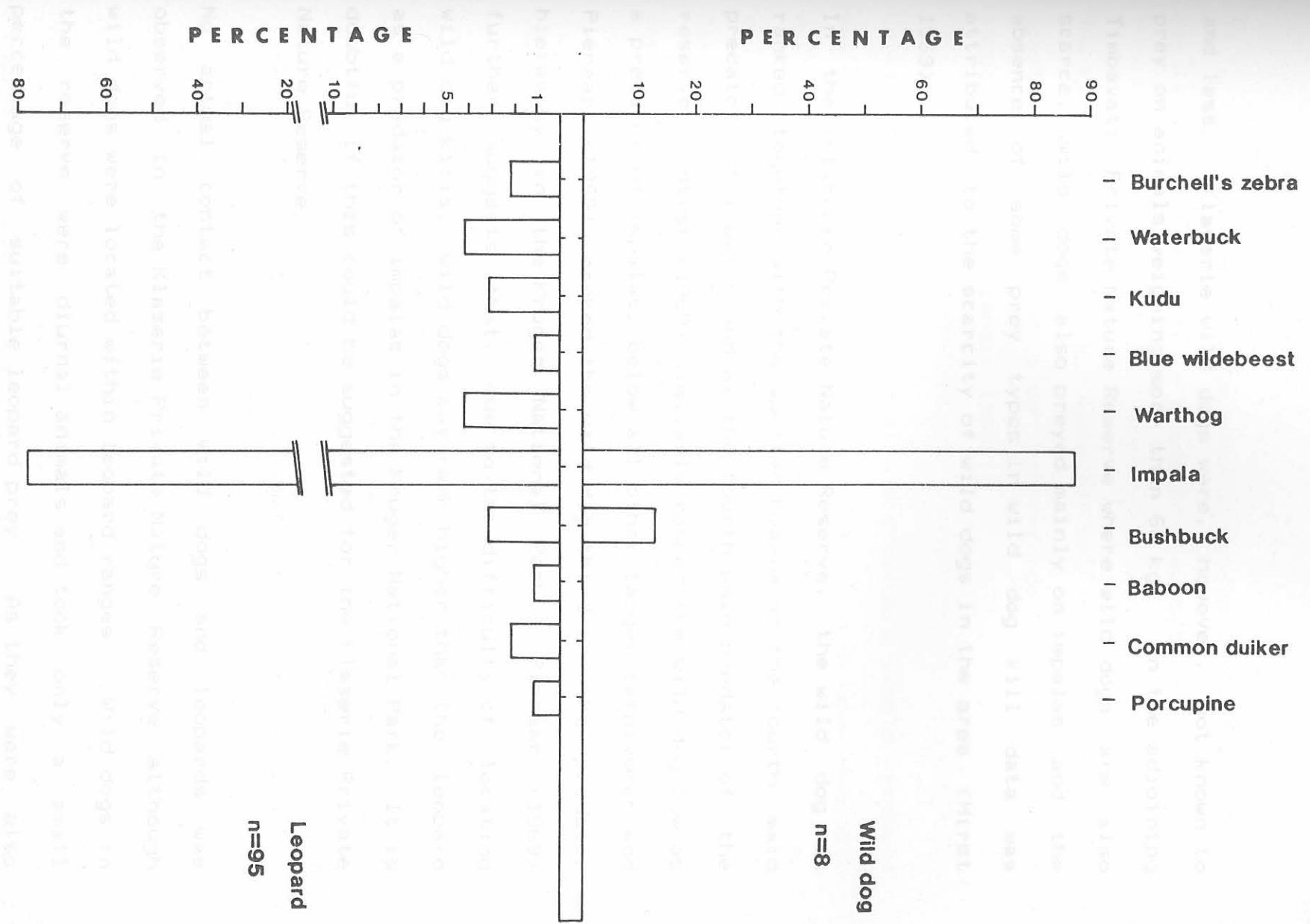


Figure 15: The percentage occurrence of different prey types in the diet of wild dogs and leopards in the Klasierie Private Nature Reserve, Eastern Transvaal Lowveld, February 1979 to October 1981.



and less. Klaserie wild dogs were, however, not known to prey on animals weighing more than 65 kg. In the adjoining Timbavati Private Nature Reserve where wild dogs are also scarce, wild dogs also preyed mainly on impalas and the absence of some prey types in wild dog kill data was attributed to the scarcity of wild dogs in the area (Hirst 1969).

In the Klaserie Private Nature Reserve, the wild dog is ranked together with the spotted hyaena as the fourth main predator of impalas and as the fourth main predator of the reserve. Hirst (1969) similarly ranked the wild dog low as a predator of impalas, below all other larger carnivores and Pienaar (1969) ranked the wild dog third in the predator hierarchy in the Kruger National Park. Pienaar (1969) further suggests that, due to the difficulty of locating wild dog kills, wild dogs may rank higher than the leopard as a predator of impalas in the Kruger National Park. It is doubtful if this could be suggested for the Klaserie Private Nature Reserve. Bothma and Le Riche (1984) did not note any contact between leopards of the same sex. No actual contact between wild dogs and leopards was observed in the Klaserie Private Nature Reserve although wild dogs were located within leopard ranges. Wild dogs in the reserve were diurnal animals and took only a small percentage of suitable leopard prey. As they were also rarely seen, the same conclusion as that of Bertram (1982)

is drawn: that wild dogs were so scarce as to be of no importance in the Klaserie predator-prey system.

The Kruger National Park, however, has records of wild dogs chasing leopards and also has records of them robbing leopards of prey (Pienaar 1969).

Eaton (1979) ranks a single wild dog below a single leopard but that wild dogs, which usually occur in groups, dominate the solitary leopard. In the present study, too little data on the interactions between wild dogs and leopards were obtained to either agree or contend Eaton's (1979) conclusion.

#### Leopard And Leopard

In the Serengeti National Park, Schaller (1972) observed two interactions between adult leopards: a courting pair and a male and female together at a kill. From 1052,1 km of tracks followed in the Kalahari Desert, Bothma and Le Riche (1984) did not note any contact between leopards of the same sex. From over 730 sets of tracks, Smith (1978) observed one clash between leopards over a range boundary. From Tsavo, Hamilton (1981) reported serious fighting between males on range boundaries and in areas of overlapping home range. He suggested there was more tolerance between adult males and subadult males. Muckenhirn and Eisenberg (1973)

outlined an incident where a subadult male leopard was confronted by an adult male leopard. The subadult male leopard did not leave the immediate vicinity but avoided the adult male. In both Tsavo and the Serengeti, females tended to avoid each other.

The literature shows that adult leopards are essentially solitary animals. Adults of the same sex avoid each other and the only prolonged contacts are between mating leopards and between a female with her cubs. Aggressive contacts between adults of the same sex have not often been recorded and take place mainly over range boundary disputes. Hamilton (1981) however, suggests that disputes between male leopards occurs more commonly than is believed and that conflicts between males may be a significant cause of mortality.

One leopard was found dead outside the study area in the Klaserie Private Nature Reserve during the study period, a subadult female. Death was from fighting but could not be conclusively proved whether the aggression was intraspecific or interspecific. The evidence, however, suggests that death was caused by a spotted hyaena. No further aggressive encounters were seen nor were any indications of aggressive encounters observed. Tracks and sightings throughout the reserve support the above data that leopards are predominantly solitary creatures. Non-aggressive suspected



contacts occurred between adults of the opposite sex, between an adult male and a subadult animal and between subadult siblings. An adult female and her one subadult offspring also showed non-aggressive contact. No territorial conflicts were known to occur in the Klaserie Private Nature Reserve during the study period and no leopard sightings indicated injured or maimed animals. This leads to the supposition that Klaserie leopards show a strong mutual avoidance of each other, particularly between adults of the same sex.

Prey size selection was similar in the leopard and the cheetah. The lion, however, selected for larger prey (Fig. 1). The known interactions Cheetah And Lion

recorded between lions and cheetahs have been of lions robbing cheetahs of their prey but the prey size selection. Conflicts between cheetahs and lions have been recorded in by each predator and the difference in activity times Africa and is not an uncommon occurrence. Pienaar (1969) enhanced the co-existence unit of the lion and the cheetah and Labuschagne (1979) observed that lions often robbed cheetahs of their prey and even preyed on cheetahs (Pienaar 1969). It is postulated that cheetah interactions between lions and cheetahs are further reduced by both predators having larger prey and also killed them (Schaller 1972). Pettifer (1981) observed that released captive-bred male cheetahs showed a strong respect for lions and always retreated hastily when confronted by lions.

Evidence that cheetahs may use areas not frequented by lions at a particular time was not found. No known contacts were made between cheetahs and lions in the Klaserie Private Nature Reserve although they shared the same range and lions were not observed robbing cheetahs of prey in time but not so in space. In the Serengeti, the five

their prey. The closest association observed was on two occasions when the tracks of lions and cheetahs were together for a short distance on a road.

Interactions between lions and cheetahs in the Klaserie Private Nature Reserve are less likely to occur than between leopards and cheetahs. Leopards and lions were both predominantly nocturnal, the cheetah predominantly diurnal. The difference comes in when the prey size selection by the three predators is considered. Prey size selection was similar for the leopard and the cheetah. The lion, however, selected for larger prey (Fig. 16). Most known interactions recorded between lions and cheetahs have been of lions robbing cheetahs of their prey but the prey size selection by each predator and the difference in activity times enhances the co-existence unit of the lion and the cheetah.

It is postulated that chance interactions between lions and cheetahs are further reduced by both predators having larger ranges than the leopard. The chances of cheetahs making contact with lions are less as the areas used are larger. The cheetah is more likely to make contact with a leopard in its smaller range. Evidence that cheetahs may use areas not frequented by lions at a particular time was not found.

Klaserie cheetahs and lions were separated to a large extent in time but not so in space. In the Serengeti, the five

*Nature Reserve, Eastern Transvaal District, February 1979 to October 1981*



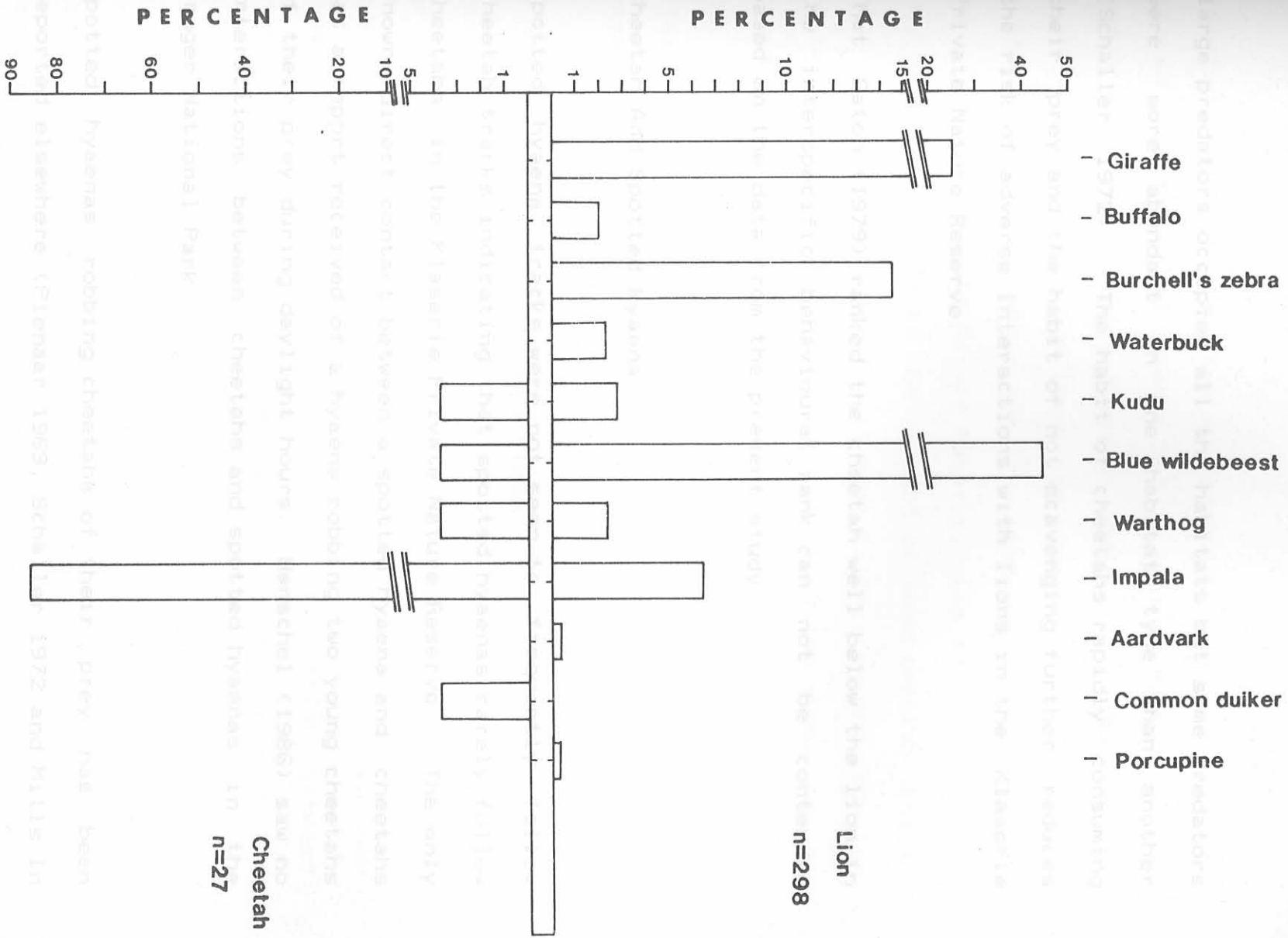


Figure 16: The percentage occurrence of different prey types in the diet of Lions and cheetahs in the Klaserie Private Nature Reserve, Eastern Transvaal Lowveld, February 1979 to October 1981.

large predators occupied all the habitats but some predators were more abundant in one habitat type than another (Schaller 1972). The habit of cheetahs rapidly consuming their prey and the habit of not scavenging further reduces the risk of adverse interactions with lions in the Klaserie Private Nature Reserve.

That Eaton (1979) ranked the cheetah well below the lion in the interspecific behavioural rank can not be contended based on the data from the present study.

#### Cheetah And Spotted Hyaena

Spotted hyaena tracks were not seen to frequently follow cheetah tracks indicating that spotted hyaenas rarely follow cheetahs in the Klaserie Private Nature Reserve. The only known direct contact between a spotted hyaena and cheetahs was a report received of a hyaena robbing two young cheetahs of their prey during daylight hours. Henschel (1986) saw no interactions between cheetahs and spotted hyaenas in the Kruger National Park.

Research elsewhere has shown that interactions between spotted hyaenas robbing cheetahs of their prey has been reported elsewhere (Pienaar 1969, Schaller 1972 and Mills In press) and spotted hyaenas may even prey on cheetahs (Pienaar 1969). Observing three relocated cheetahs,

Pettifer (1981 b) saw them successfully defend a carcass against seven spotted hyaenas but on another occasion, one hyaena appropriated the carcass of their prey. The presence of vultures has attracted lions and hyaenas to cheetah kills in the Serengeti (Schaller 1972). What was of interest in the Klaserie Private Nature Reserve, was the presence of only eagles and kites at the remains of some cheetah kills. While vultures were present at some kills, on one occasion the presence of a tawny eagle *Aquila rapax* led observers to a cheetah kill. On another two occasions, the presence of one bateleur *Terathopius ecaudatus* and two yellow-billed kites *Milvus migrans parasiticus* respectively revealed cheetah kills.

Of the prey animals killed by both cheetahs and spotted hyaenas, only the impala features significantly in each of the predator's kills (Fig.17). The spotted hyaena was, however, not considered a highly active predator in the Klaserie Private Nature Reserve and competition between hyaenas and cheetahs for live impalas as a food source was so slight as to be unimportant. n=27

Research elsewhere has shown that interactions between spotted hyaenas and cheetahs mainly occur when hyaenas rob cheetahs of their prey. Schaller (1972) observed a female cheetah in the Serengeti to make two kills in quick succession both of which were taken over by the same spotted



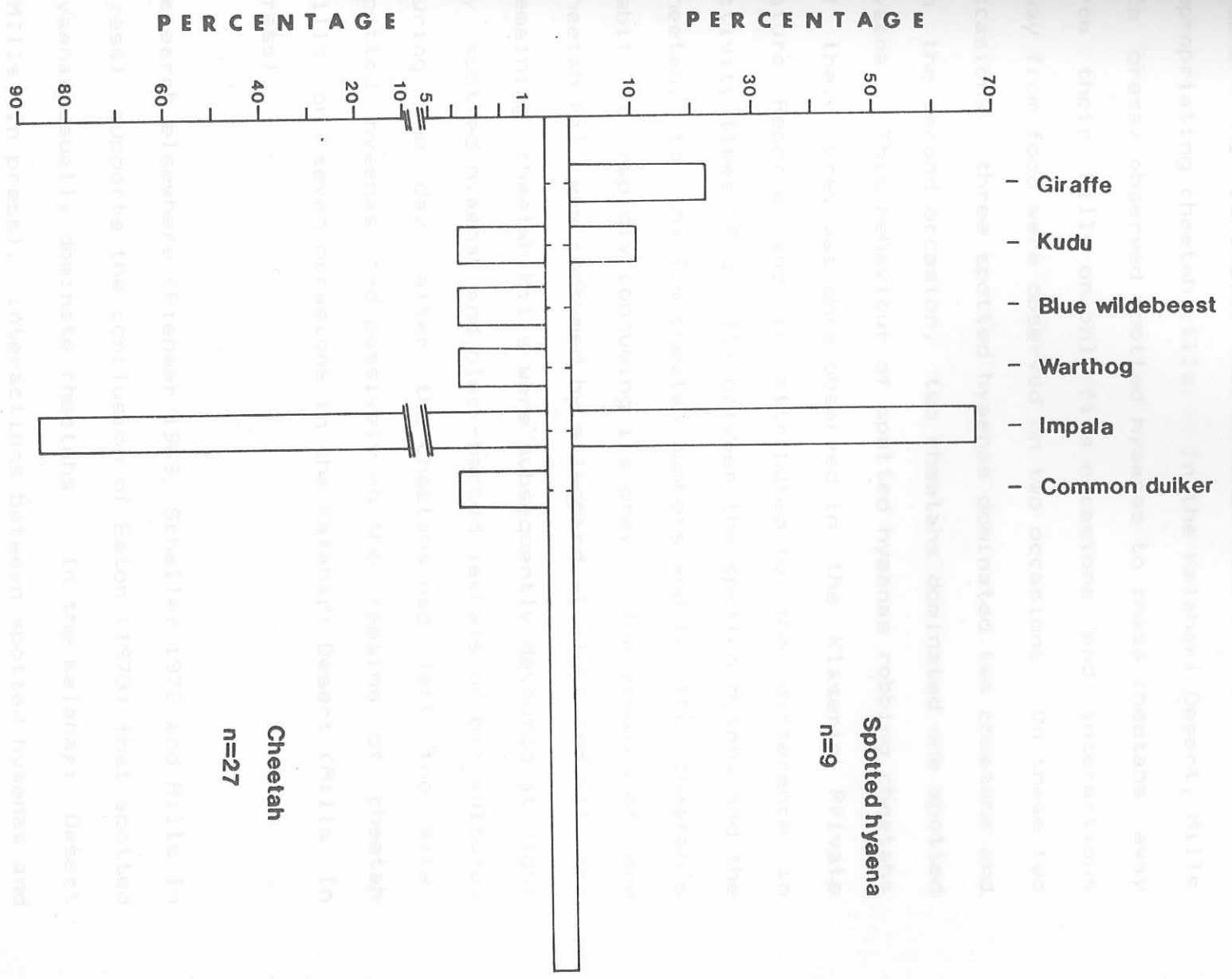


Figure 17: The percentage occurrence of different prey types in the diet of spotted hyaenas and cheetahs in the Klaserie Private Nature Reserve, Eastern Transvaal Lowveld, February 1979 to October 1981.

hyaena. He concluded that hyaenas have little trouble in appropriating cheetah kills. In the Kalahari Desert, Mills (In press) observed spotted hyaenas to chase cheetahs away from their kills on only five occasions and interactions away from food were observed on two occasions. On these two occasions, three spotted hyaenas dominated two cheetahs and on the second occasion, two cheetahs dominated one spotted hyaena. This behaviour of spotted hyaenas robbing cheetahs of their prey was once observed in the Klaserie Private Nature Reserve and is attributed to the difference in activity times (Fig. 11) between the spotted hyaena and the cheetah, to the low cheetah numbers and to the cheetah's habit of rapidly consuming its prey. The remains of one cheetah kill was consumed by a leopard at night and all the remaining cheetah kills were subsequently devoured at night by spotted hyaenas and black-backed jackals or by vultures during the day, after the cheetahs had left the site. Spotted hyaenas fed passively on the remains of cheetah kills on seven occasions in the Kalahari Desert (Mills In press).

In the Klaserie Private Nature Reserve both the cheetah and the wild dog were predominantly diurnal and both preyed Research elsewhere (Pienaar 1969, Schaller 1972 and Mills In press) supports the conclusion of Eaton (1979) that spotted hyaenas usually dominate cheetahs. In the Kalahari Desert (Mills In press), interactions between spotted hyaenas and cheetahs are reduced through the low density of spotted hyaenas in that area.

In a woodland habitat such as the Klaserie Private Nature Reserve and with abundant prey, spotted hyaenas are likely to reach high densities (Bearder 1977, from Mills 1978). It is suggested here that the chance of interactions between spotted hyaenas and cheetahs in the Klaserie Private Nature Reserve is reduced, not by low densities of spotted hyaenas, but by low densities of cheetahs, a difference in activity times and the cheetah's feeding behaviour.

#### Cheetah And Wild Dog

Eltringham (1979) wrote that the most significant factor preventing competition (defined as "one species, by its presence, preventing another from obtaining an essential resource") between cheetahs and wild dogs is the low population density of both animals and that the presence of one of the predators is unlikely to affect the other's chances of getting food.

In the Klaserie Private Nature Reserve, both the cheetah and the wild dog were predominantly diurnal and both preyed mainly on impalas (Fig. 18). However, the population size of both animals appeared to be so low that the chances of interactions between them was the least likely to occur in the Klaserie Private Nature Reserve and it is assumed that these two predators had little effect on each other.



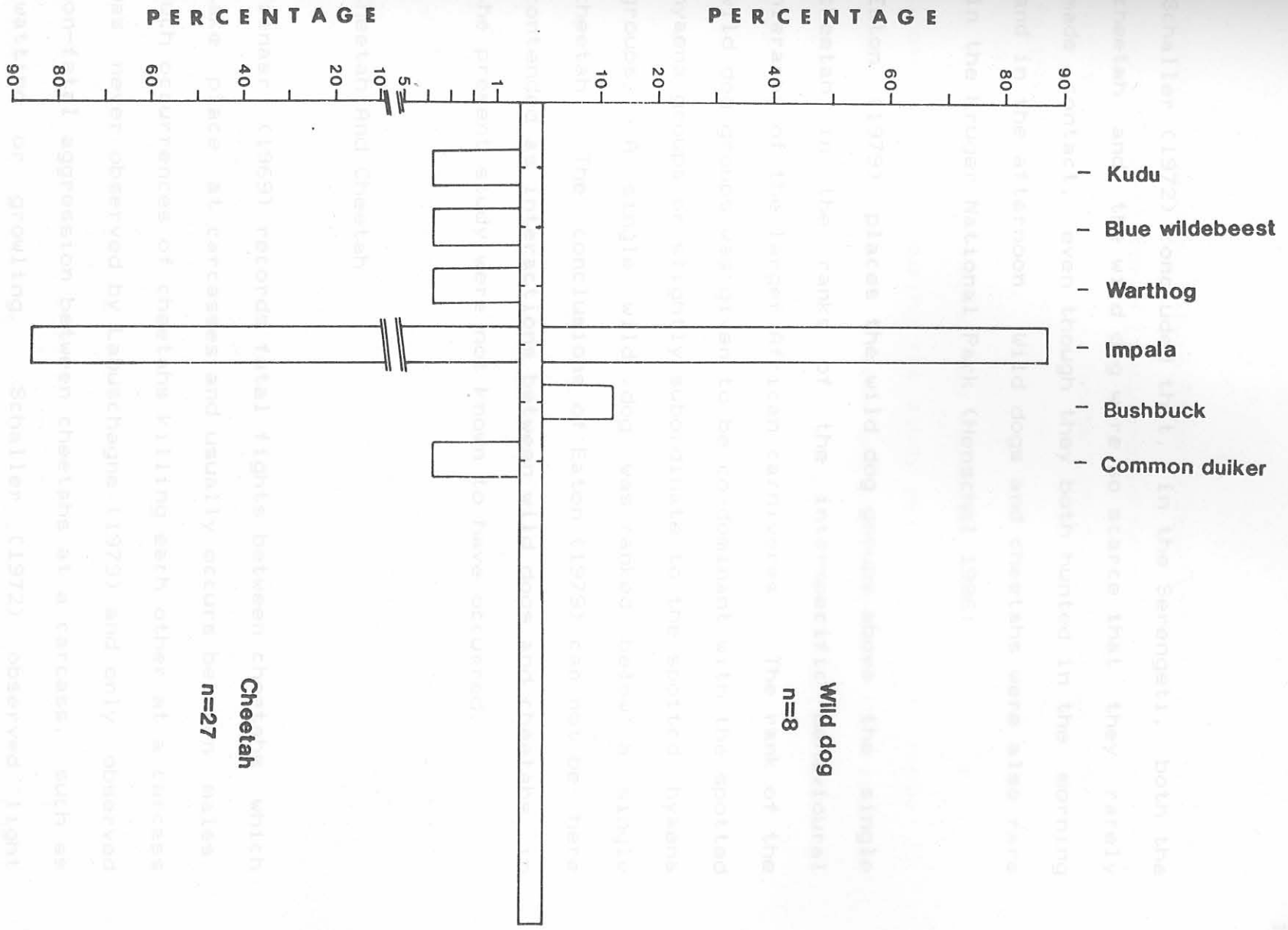


Figure 18: The percentage occurrence of different prey types in the diet of wild dogs and cheetahs in the Klaserie Private Nature Reserve, Eastern Transvaal Lowveld, February 1979 to October 1981.

Schaller (1972) concluded that, in the Serengeti, both the cheetah and the wild dog were so scarce that they rarely made contact, even though they both hunted in the morning and in the afternoon. Wild dogs and cheetahs were also rare in the Kruger National Park (Henschel 1986).

Eaton (1979) places the wild dog groups above the single cheetah in the ranks of the interspecific behavioural hierarchy of the larger African carnivores. The rank of the wild dog groups was given to be co-dominant with the spotted hyaena groups or slightly subordinate to the spotted hyaena groups. A single wild dog was ranked below a single cheetah. The conclusions of Eaton (1979) can not be here contended as interactions between wild dogs and cheetahs in the present study were not known to have occurred.

Cheetah And Cheetah

Pienaar (1969) records fatal fights between cheetahs which take place at carcasses and usually occurs between males. Such occurrences of cheetahs killing each other at a carcass was never observed by Labuschagne (1979) and only observed non-fatal aggression between cheetahs at a carcass, such as swatting or growling. Schaller (1972) observed light clashes between adult males, between females and cubs and between cubs. A fight with resident cheetahs in the

Timbavati Private Nature Reserve resulted in the serious injury of one of three captive-bred released males (Pettifer 1981 b) and this may indicate territoriality in cheetahs (Smithers 1983).

(1972) observed Serengeti lions to be aggressive towards other lions, both toward strange lions. One dead young cheetah was found in the Klaserie Private Nature Reserve during the study period but the cause of death was unknown. Tracks and sightings in the reserve during the study period revealed no conflict between cheetahs.

In the Serengeti, cheetahs avoided each other by visual and olfactory means and concentrated their activity in an area little used by others at that time. There was no evidence of territoriality (Schaller 1972). No evidence of territoriality was found in Klaserie cheetahs besides an adult male cheetah squirting against a tree trunk. This behaviour, however, also occurs in cheetahs which do not exhibit territoriality (Schaller 1972).

#### Other Interactions

Only contacts between predators which were known to occur are here given. Otherwise, no interactions were witnessed between other predators and have subsequently been omitted, but this does not mean that they do not occur and that they are not important in the lives of other carnivores.



During this study one adult male lion was killed in a fight with another lion/s and one lioness was also injured but not fatally in another fight. Two lion cubs were also killed by lion/s. Schaller (1972) observed Serengeti lions to be aggressive towards other lions, both toward strange lions and toward members of a pride at a kill. Different prides of Kalahari Desert lions (Eloff 1973) and different prides of Kruger National Park lions (Aiken 1987) tended to avoid each other although confrontations between prides was known to occur. Bertram (1973) found dominant males in a pride to be forcibly replaced by stronger, or more, males and these clashes can be fatal (Eltringham 1979). In the present study, one adult male lion kept his adult male lion companion away from a blue wildebeest kill until he had finished feeding while, in another instance, three lionesses fed on a giraffe carcass showing no aggression towards each other. Hungry lions show different social behaviour when feeding on a small kill than when feeding on a large kill (Bertram 1973). The larger the kill, the more sociable the lions are. Lion kills during this study were mostly found after lions had fed and left the kill site, or on observers coming upon feeding lions, the lions retreated.

Between lions and spotted hyaenas because of the low Lions in the Klaserie Private Nature Reserve appeared to be intolerant towards spotted hyaenas as they are in the Serengeti (Schaller 1972), the Kruger National Park (Henschel 1986 and Aiken 1987) and the Kalahari Desert

(Eloff 1973 and Mills In press). Lions have been known to kill spotted hyaenas for no apparent reason at all (Eloff 1973 and Aiken 1987). In the present study, tracks revealed a spotted hyaena to be chased by a lion at a lion kill and tracks further showed where, away from food, one of two lions had chased a spotted hyaena for 15 m. Another spotted hyaena was injured in a conflict with lions away from food and subsequently died in a nearby waterhole. The carcass was not eaten. On a separate occasion a second spotted hyaena was found dead but the cause of death is unknown as the carcass was partly decomposed when found. Lions in the Klaserie Private Nature Reserve were not directly seen to disturb feeding spotted hyaenas nor were spotted hyaenas directly seen to disturb feeding lions. Lion tracks were at times followed by spotted hyaena tracks, with contact between lions and spotted hyaenas most likely to occur at a carcass. (Mills In press)

Similarly, in the Kalahari Desert (Mills In press), most food scavenged by spotted hyaenas from lions was done so passively after the lions had left a kill site. However, in the Kalahari Desert, interference competition is rare between lions and spotted hyaenas because of the low densities of both predators (Mills In press). In the Klaserie Private Nature Reserve, interference competition between lions and spotted hyaenas is likely to occur more often than in the Kalahari Desert because of the expected

higher densities of both carnivores in Klaserie and because of the spotted hyaena's scavenging habits in Klaserie.

In the Kruger National Park, Henschel (1986) observed that contacts between lions and spotted hyaenas was most likely to occur at a carcass but that spotted hyaenas tended to avoid lions. In half the interactions observed did lions show aggressive behaviour towards spotted hyaenas and sometimes too were spotted hyaenas aggressive towards lions. The aggressiveness of spotted hyaenas towards lions, however, depended on group size (Henschel 1986).

The true interrelationships between lions and spotted hyaenas in the Klaserie Private Nature Reserve are expected to be more like interrelationships in the Kruger National Park (Henschel 1986) than in the vastly different habitat of the Kalahari Desert (Mills In press).

Black-backed jackals were at time associated with leopard tracks but black-backed jackals were not known to be killed (Scott 1985 and Henschel 1986) and eaten (Bertram 1982 and Bothma and Le Riche 1984) by leopards. The evidence here does not support the statement by Eltringham (1979) that the interactions between leopards and jackals is simply a predator-prey relationship.

E.P. Leibnitz, Warden, Klaserie Private Nature Reserve, P.O. Box 150, Hoedspruit, South Africa, 1380. November 1986



Scott (1985) noted that the sight of a leopard would illicit an immediate response from black-backed jackals, such as a mobbing response and barking, and in the Kruger National Park, spotted hyaenas twice found leopards through alarm-calling black-backed jackals (Henschel 1986). In the present study, two black-backed jackals called close to a feeding leopard and on another occasion, one black-backed jackal followed a satiated leopard. The latter incident suggests that leopards may well cause a response amongst black-backed jackals, and not alone the presence of a carcass. The presence of vocalizing black-backed jackals are killed by leopards as such a response would surely reveal the position of a leopard.

Carnivores And Man

Eighty-eight privately owned camps are found within the 60 000 ha Klaserie Private Nature Reserve. On the average each camp owner employs one male camp-guard who lives in the reserve and maintains the camp site in the owner's absence. Most camp guards have at least their wives staying with them. The 1985 figure was 375 guards and family members living within the reserve boundaries (Leibnitz pers. comm.)

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 E.P. Leibnitz. Warden, Klaserie Private Nature Reserve, P O Box 150, Hoedspruit, South Africa, 1380. November 1986.

and man, as an interactor with the five larger carnivores, should be noted.

This occurrence of predators being robbed of their prey and drawn by vultures, kills of the larger carnivores are scavenged and predators are even chased from their kills by these people. Even vulture nests are robbed of eggs (Leibnitz pers. comm.). The following are three examples of how man interacts with the predators in the reserve: At night, lions had killed an adult giraffe and by early the following morning had eaten only parts of the hind limbs. When the carcass was visited that afternoon it had been cut up and taken away in wheelbarrows leaving only the intestines, the backbone, the neck and head.

A report was once received of two cheetahs on an impala carcass. On immediately visiting the site, the carcass had been neatly stripped of meat. Before reporting the sighting, the concerned guard had first chased the cheetahs away and then he removed the remaining fleshy parts.

On a third occasion, the freshly-killed carcass of a young giraffe was found alongside a road and on returning one hour later, was found to have been moved by a lion. The drag marks were followed with two guards to where a lactating lioness was found feeding. Unnoticed, a guard standing to the rear, picked up a rock and hurled it at the lioness with a shout. The lioness fled. The motive was to appropriate

the kill.

with impala males being the favoured target. On an average, permits for a total of 1 500 impalas and 50 blue wildebeest. This occurrence of predators being robbed of their prey and being chased from carcasses would surely force the predators to hunt again thereby increasing the predators killing frequency and the numbers and types of prey killed. Extra unnecessary energy would thus have to be expended by the predator. Probably most affected would be reproducing females, cubs, pups, and the low ranked cheetah. Hyaenas and black-backed jackals, having less food available, would have to find nourishment elsewhere even though the bones could be utilized. On not all occasions are predators robbed of their prey or chased from their prey carcass but it certainly does occur.

Snaring, primarily for meat, is another activity which occurs in the reserve. It is unselective and potential prey animals die in snares or are maimed by them. Maimed prey animals are then more susceptible to predation. Where this activity would more directly affect Klaserie predators is where the predator itself is maimed. During the study period, one adult lioness and one adult male lion had to be destroyed as a result of snaring.

Limited hunting by the owners is also permitted in the Klaserie Private Nature Reserve, with quotas based on yearly census figures. The most common animal hunted is the impala



with impala males being the favoured target. On an average, permits for a total of 1 600 impalas and 60 blue wildebeest for the whole reserve are issued yearly of which 70 to 80 per cent of the animals are shot each year. Hunting is permitted throughout the year but most hunting occurs during the cold dry months. No hunting at night is allowed.

Man has, however, been interacting with predators since historical times. From a study on hominid fossils in the Sterkfontein valley caves, South Africa, Brain (1981) concluded that australopithecines were preyed on and dominated by leopards, false sabre-tooths *Dinofelis* sp. and hunting hyaenas *Euryboas* sp. With the disappearance of australopithecines, which was hastened by the predators, the first men appeared. Probably aided by the discovery of fire and the making of crude weapons, these first men were probably amateur hunters and survived largely by scavenging food from predator kills. Man now began dominating the predators. Progressive development then changed man from a scavenger into an active and dominant hunter (Brain 1981).

On the ecological separation of predators. Schaller (1972)

Pets are rare in the reserve and cause no undue disturbance. One dog was killed by a leopard during the study period and one female leopard was chased by a dog when it ventured too close to a camp. Leopards, lions and spotted hyaenas are bolder at night and walk into camps. They are sometimes driven away by camp guards as a result of this. If not



safely stored, carcasses of shot animals stand the chance of being eaten by lions and spotted hyaenas.

Different predators taking different sizes of prey is another factor. Camp guards and their families move freely about the reserve on foot, mostly during daylight hours. Resting carnivores have been disturbed in this way. Most carnivores will flee when disturbed while others will watch the disappearing person/s. But the degree of competition is reduced by several factors: abundant prey, different range of prey types taken.

The actions considered most disturbing are those of removing carcass remains and the chasing of predators off their kills. The former action occurs more often as the Klaserie carnivores, besides cheetahs and wild dogs, are predominantly nocturnal. Efforts are being and have been made to stop these actions, together with snaring, but still remains extremely difficult to control. The exact effect of these actions on Klaserie carnivores is unknown and the study on this topic should yield interesting results. Nature Reserve, ecologically separating the carnivores and reducing competition and conflict.

On the ecological separation of predators, Schaller (1972) concluded that the predators occupying different habitats or using the same habitat at different times, is one way in which competition between predators is reduced. He added that the predators are not totally separated in time and space and that clashes are not totally unavoidable. Further, it is important to find out to what degree

predators use the same resource as the Serengeti predators appear to view each other as competitors. Different predators taking different sizes of prey is another important separating factor given by Schaller (1972). As the prey of predators do overlap, Eltringham (1979) concluded that competition between predators in Africa is likely, but the degree of competition is reduced by several factors: abundant prey, different range of prey types taken by carnivores, low densities of some predator types, predator behaviour, and the separation of predators in time. Direct competition occurs when one predator type robs another type of its kill and this action is more like kleptoparasitism rather than competition except that with some carnivores the relationship is not always one-sided. Competition between predators, Eltringham (1979) concluded, appears to be relatively rare. The factors mentioned by Eltringham (1979) were also found to operate in the Klaserie Private Nature Reserve, ecologically separating the carnivores and reducing competition and conflict.

The spotted hyaena is not an active predator in the Klaserie Private Nature Reserve but mainly a nocturnal scavenger.

**CONCLUSIONS**

The Klaserie leopard is also a scavenger and close contact between these two animals is not infrequent and occurs predominantly at a feed site. Two spotted hyaenas are nocturnal animals sharing the same range to the extent that capable of dominating a Klaserie leopard but the reverse is the same paths are followed but at different times.

Klaserie lions are important predators of blue wildebeest, giraffe and Burchell's zebra in the reserve. The leopard is the most important predator of impalas in the reserve. Co-existence between these two predators is enhanced by the animals feeding on different sizes of prey. Lions and leopards in the Klaserie Private Nature Reserve are not largely separated in time and space and how actual contact is avoided is not known. Interactions between these two active carnivores is reduced by the availability of suitable sizes of prey for both.

The cheetah ranks second to the leopard as a predator of impalas in the Klaserie Private Nature Reserve. All prey types killed by the cheetah are also killed by the leopard but co-existence between these two predators in the Klaserie Private Nature Reserve is enhanced by the different activity times of the animals and by the feeding behaviour of the cheetah. It is evident that little contact occurs between Klaserie cheetahs and Klaserie leopards.

The spotted hyaena is not an active predator in the Klaserie Private Nature Reserve but mainly a nocturnal scavenger. The Klaserie leopard is also a scavenger and close contact between these two animals is not infrequent and occurs predominantly at a feed site. Two spotted hyaenas are capable of dominating a Klaserie leopard but the reverse is also true. A Klaserie leopard can also defend a carcass



against three spotted hyaenas and it is possible that the Klaserie leopard ranks second to the lion in the behavioural hierarchy.

The wild dog is not an animal often encountered in the Klaserie Private Nature Reserve. Although prey types and size overlaps that of the Klaserie leopard it is not regarded as a contender with the Klaserie leopard. The chance of a contact occurring between these two animals is further reduced by the difference in activity times of these two predators. The wild dog, together with the spotted hyaena, is the fourth most important predator of impalas and the fourth main predator in the reserve.

Although both predators hunt by day and both prey Contact between adult leopards of the same sex in the Klaserie Private Nature Reserve is infrequent. Klaserie leopards are solitary, nocturnal creatures and non-aggressive contacts occur between adults of the opposite sex, between an adult male and a subadult animal and between subadult siblings. Non-aggressive contacts also occur between females and subadult offspring.

Although Klaserie lions and Klaserie cheetahs largely share the same range, separation of these two predators occurs through different activity times of each, feeding largely on different types of prey and different size classes of prey. The chances of interactions occurring are reduced by the



cheetah's feeding behaviour. It is accepted that the cheetah ranks well below the lion in the larger African carnivore behavioural rank.

Spotted hyaenas are not important competitors with cheetahs for live prey. Contact between these two animals is reduced by the spotted hyaena, unlike the cheetah, being predominantly nocturnal and by the cheetah's feeding behaviour. It is supported, although without sufficient evidence, that the cheetah is usually dominated by the spotted hyaena. Birds of prey and not only vultures, indicate cheetah kills.

Although both predators hunt by day and both prey predominantly on impalas, Klaserie cheetahs and Klaserie wild dogs are both so scarce that interactions between these two predators are the least likely to occur of all the interactions between the larger carnivores and that these two predators had little effect on each other. Without supportive evidence, the wild dog group is accepted as being dominant over a cheetah or cheetah group.

Clashes between resident cheetahs of the Klaserie Private Nature Reserve are infrequent, and no evidence of territoriality was found in Klaserie cheetahs.

Clashes between lions in the Klaserie Private Nature Reserve

are sometimes fatal, as can be clashes between lions and Klaserie spotted hyaenas. Klaserie lions are intolerant towards Klaserie spotted hyaenas. Evidence suggests that some such clashes occur as a result of spotted hyaenas following lions, but mostly at carcasses.

The relationship between the black-backed jackal and the leopard is not purely a predator-prey one but rather a predator-scavenger-prey relationship.

The effect of the interactions between man and the Klaserie carnivores is not known but two human actions are considered important: that of robbing carnivores of their prey and that of scavenging from predator kills.

The overall conclusions here drawn support those of Schaller (1972), Seidensticker (1976), Eltringham (1979) and Bertram (1982). Predators are ecologically separated and interactions and competition is reduced by a combination of factors including mutual avoidance, prey availability, different ranges of prey killed, different activity times, predator behaviour and low densities of some predators. These combining factors enable the lion, the leopard, the cheetah, the spotted hyaena and the wild dog to co-exist as they have for years gone by.

The Klaserie Private Nature Reserve is a sanctuary for a

variety of African wild animals where the lion, leopard, cheetah, spotted hyaena and wild dog can be found co-existing in a natural environment. As are other big-block single management areas, the Klaserie Private Nature Reserve is vital in the preservation of large African carnivores.

## INTRODUCTION

Few national parks or game reserves can be regarded as forming an ecological unit and as such be capable of looking after themselves. In conservator areas, the main problem of management is not preventing animal populations from dying out, but preventing animal populations from becoming too large (Eltringham 1979). As with the adjacent Tlokweng Private Nature Reserve (Hirst 1969), the Klaserie Private Nature Reserve is bounded by a game fence precluding the movement of ungulates to surrounding areas. The Klaserie Private Nature Reserve can not be regarded as an ecological unit and this, together with the artificial water supplies, requires that ungulate populations be scientifically monitored and managed.

What is reported on here is a situation where ungulate populations, in the presence of predators, were allowed to increase without interference, apart from limited sport