THE CHEETAH

Short introduction to species

Cheetahs are classified in the family Felidae, subfamily Acinonychinae as the genus Acynonyx, and species jubatus. The genus contains a single living species.

Cheetahs, one of the bigger free-living cats but at the bottom of the pecking order, are unique animals under threat of extinction because of the increasing loss of their habitat and access to prey species.

They generally appear to have a very limited genetic pool and this genetic uniformity is believed to be the result of at least two population bottlenecks followed by natural inbreeding. The first and most extreme bottleneck possibly occurred in the late Pleistocene (circa 10,000 years ago), while the second was more recent (within the last century) and led to the development of the current South African populations.

Compared to other mammalian species including felids, cheetahs have low levels of MHC (major histocompatibility complex proteins) diversity, but this phenomenon does not seem to influence its immunocompetence and resistance to diseases of free-ranging cheetahs. Additionally, carnivores in general exhibit significantly lower levels of genetic variation than other mammals do, and several carnivore species for which data are available, exhibit lower levels of heterozygosity and polymorphism than cheetahs do. There is speculation though that this limited genetic variation may be responsible for the perceived vulnerability of cheetahs in captivity and in the wild.

There is a belief that cheetahs, as a consequence of their restricted genetic diversity, tend easily to develop clinical signs of inbreeding depression. These are characterised by high neonatal mortality rates that are partially attributed to their perceived increased susceptibility to infections, the difficulty of breeding them in captivity, and the high frequency of spermatozoal defects in captive, and free-ranging cheetah males.

Many of the phenotypic effects that can be attributed to inbreeding depression, such as infertility, reduced litter sizes, and increased susceptibility to disease are, however, normally limited to captive individuals and this phenomenon may be explained as being physiological or behavioural artefacts of captivity, often as a result of inadequate diets and exposure to stress. Usually, however, the survival of cubs in the wild too is poor and there is an expected high attrition rate because of a number of factors, predation being one of the more important ones.

Cheetahs, as a consequence of this perceived inbreeding, also developed metabolic patterns that are substantially different from those of other cats. These variations provide major challenges when attempting to compile balanced diets for cheetahs in captivity as their needs differ substantially from those of the other cats. Nutritional deficiencies and imbalances because of inadequate diets in captivity result in increased neonatal mortalities, poor breeding performance, and various fatal conditions in adult animals.

The current contention is that the genetic constitution of cheetahs does not compromise its survival in the wild and plays a limited role in the poor performance of cheetahs in captivity. Currently the genetic diversity of a metapopulation managed across small resereves is more diverse than that of the free-living population. It is thus important to have genetic information of groups of cheetahs available to allow population management of this threatened species in conservation areas and in small game farms to sustain as much of the genetic variation as is possible.

The extent and geographic patterns of molecular genetic diversity of the largest remaining free-ranging cheetah populations reflect limited differentiation among regions and a generally panmictic population (panmixia or panmixis means random mating). This assumes that there are no mating restrictions, neither genetic nor behavioural, upon the population, and that therefore all recombinations are possible. Where the genetic diversity has been assessed, measures of genetic variation are similar in cheetahs in all regions of Namibia and they are comparable to Eastern African cheetah populations.

In the small and fragmented South African populations, genetic analyses indicate that cheetahs on reserves would not benefit from cross-breeding with the free-roamers but that the free-roamers would benefit. As the reserve population approaches its overall capacity, mating suppression will be required to avoid selling wild cheetah into captivity. Genetic information should continue to be utilized for management of meta-populations, in order to further increase the population’s biological fitness over the long term.

Physical characteristics

Male and female

Cheetahs are tall and slender animals, with their bodies high off the ground and with long thin legs. Their long tails that may have circular black markings, are distinctive. They have relatively small rounded heads, short muzzles and round ears, and a distinctive black stripe (tear mark) from the inner aspects of the eyes to the corner of their mouthes. Males are larger than females with an average weight of 54 kg in males and 43 kg in females. Their total length (including the tail) varies between 2060 cm and 1900 cm in males and females, respectively. Their coat is rough and contains numerous round to oval black spots. The background colour is buffy-white but it varies in intensity according to the region and habitat in which they occur. In desert areas, their colour may be quite pale causing them to blend into the colour of the desert sand.

Cheetah cubs are distinctly different in appearance from the adults. They are less distinctly spotted, and have a rug of long lighter hair on the back, sometimes said, to mimic the coat pattern of honey badgers (Mellivora capensis) who are known to be very aggressive animals. This is considered a form of crypsis (crypsis is the use of anatomy and behaviour to hide from potential predators. Cryptic animals are often otherwise palatable to their predators so would never survive if obvious).

The cheetah is an atypical and the most cursorial (having limbs adapted for running) felid. Generally, to maximize its speed, an animal must rapidly swing its limbs (to increase stride frequency) and support its body weight by resisting large ground reaction forces. As a predator, the cheetah also uses its forelimbs for prey capture and they must therefore also be adapted for this function. Its claws are somewhat dog-like both in shape and the diminished degree of retraction that is intermediate between that of other felids and of wolves. They are well known, with the exception of the dew claw (the first digit which is also retractile), for having blunt, only slightly curved, partly retractile claws, considered to be an adaptation for high-speed locomotion.

Some of the morphological differences in the middle phalanges of the cheetah’s front feet can be associated with its distinctive hunting behaviour (see below). The reduced manipulative capabilities of the forelimb associated with the evolution of cursorial adaptations seem to have limited the roles of the forepaws in both subduing its prey and feeding. Cheetahs lack the strength of other felids and they are unable to fight their prey to the ground. Instead they must trip or pull them off balance by hooking the rump of its prey and pulling them off balance with their dew claw while running at high speeds.

Cheetahs make various sounds depending on the situation in which they find themselves. When challenged they make a sudden spitting sound reflecting aggression. Normally they communicate with chirping sounds used to locate cubs and members of coalitions. They purr like domestic cats when pleased.

Running ability and speed

In nature predator–prey interactions are fundamental in the evolution and structure of ecological communities and within this context cheetahs have evolved the ability to run at speed to capture their prey. Although cheetahs and racing greyhounds are of a similar size and gross morphology, cheetahs are able to achieve far higher top speeds. They are the best sprinters on earth and are capable of accelerating at a rate of up to 7.5 m/s, and to reach speeds in excess of 28 m/s, which is about double that of grey hounds that are considered to be excellent sprinters.

The cheetah is capable of a top speed of about 29 m/s (1749,40 m/min) compared to the maximum speed of 17 m/s achieved by racing greyhounds, and they sprint at speeds that may exceed 100 km/h. However, most cheetah hunts involve only moderate speeds. During a sprint heat production due to muscular activity escalates by about 60 times the rate of heat production at rest. Most of this heat (70%) is stored, the normal evaporative heat loss mechanism not being activated while running. Cheetahs stop running when their rectal body temperature reaches 40.5 C. It thus appears that their body temperature determines the distance that they run after which they abandon the chase, if not successful, after a few hundred metres. Females and trained individuals reach significantly higher speeds compared to males and untrained individuals, respectively.

The cheetah possesses several unique adaptations for high-speed locomotion and fast acceleration, when compared to racing greyhounds. Their hind limb bones are proportionally longer and heavier than in grey hounds, enabling the cheetah to take longer strides. It has a smaller volume of hip extensor musculature than the greyhound, suggesting that the cheetah powers acceleration by using its extensive back musculature. This contention is supported by the presence of extremely powerful psoas muscles that could help to resist the pitching moments around the hip associated with fast acceleration. There is also a proximal to distal reduction in muscle mass on the long bones of the legs, with many of the distal muscles being in series with long tendons. This configuration reduces the inertia of the limb and thus the amount of muscular work required to swing the limb.

It is assumed that these high speeds enable cheetahs to run down slower prey, with failed hunts being attributable to exhaustion and/or overheating. However, their running pattern during a chase reflects a different hunting strategy. The chase involves alternating between forward and lateral acceleration the extent of which varies according to the prey species. Thus during a chase, they first accelerate to decrease the distance to their prey, before reducing speed 5–8 s from the end of the hunt to enable them to turn rapidly to match prey escape tactics that can involve sudden directional changes and that are difficult to accommodate with an increasing velocity. Moreover, turns at higher speeds lead to greater forces on animals' limbs and muscles, particularly when turn angles are acute, and increase the risk of injury. Thus, while the ability to hunt at high speed may enable cheetahs to outrun their prey, they may not always choose to run at maximum speed, especially when chasing prey species that attempt evasion by sudden changes in direction. These hunting strategies require specific anatomical configurations to allow them to generate speed, and to deal with the torque forces generated by the high speed and sudden changes in direction caused by the typical evasive actions of their prey.

The ability of cheetahs to run very fast is the result of a number of anatomical and physiological parameters including:

- **Stride length**
  Cheetahs have an abnormally long stride that contributes substantially to the speeds achieved when running fast. The configuration of its skeletal and muscle structures increases the large, angular movements of the limb joints that, with bending and straightening of the spine, prolong their stride length. The back muscles, because of their inherent muscle fibre composition, have the ability to produce a strong and quick extension of the spinal column and to increase its rigidity during locomotion thus adding to the force of the forward surge when running.

- **Stride frequency**
  Increasing stride frequency by swinging the limb rapidly and thereby decreasing swing time, also allows quadruped sprinters to reach faster speeds. Cheetahs, however, generally use a lower stride frequency than greyhounds at any given speed and it appears that stride frequency does not contribute substantially to the high speeds reached by cheetahs.

- **Gait characteristics**
  Mammals use two distinct gallops referred to as the transverse (where landing and take-off are contralateral) and rotary (where landing and take-off are ipsilateral). The transverse gallop is characteristically that of the horse, while cheetahs use the rotary gallop. The fundamental difference between these gaits is determined by which set of limbs, fore or hind, initiates the transition of the centre of mass from a downward–forward to upward–forward trajectory that occurs between the main portions of the stride when the animal makes contact with the ground.

  During a stride when their feet are in contact with the ground, animals support their body weight by resisting joint torques caused by the impact. Quadrupeds typically support a greater proportion of their body weight with their forelimbs during steady state locomotion. At high speed, however, such as in cheetahs running at speed, the hind limbs support the majority of an animal's body weight, and within this context, cheetahs support 70% of their body weight on their hind limbs at speeds of 18 m/s. The hindquarters thus generate most of the muscular activity required for propulsion. It is assumed that supporting a greater proportion of body weight on a particular limb is also likely to reduce the risk of slipping during propulsive efforts.

  When travelling at top speed the cheetah’s forelimbs also experience very high peak forces, and they too must be able to cope with large joint torques but they do not contribute substantially to generating the superior speed of cheetahs.

- **Muscle structure and conformation**
  The distribution of skeletal muscle along the legs plays a role in animals that have the ability to reach high speeds and have to accommodating high impact pressures during

a chase. In cheetahs the proximal limbs contain many, large, PCSA (physiological cross-sectional area) muscles. This configuration provides the limbs with the ability to resist and absorb large impacts. The legs, because of these muscle masses that can absorb some of the impact, do not merely function as simple struts and, because of the muscle distribution, they can absorb much of the force of impact while running. This conformation also provides cheetahs with the ability to control and stabilise their legs during high-speed manoeuvring such as is needed during a chase. The large digital flexors and extensor muscles characteristic of the cheetah's forelimb, allow it to dig its digits into the ground, providing the required traction when galloping and manoeuvring at speed.

- **Muscle fibre composition and characteristics**

  Muscle consists of muscle fibres (Type I and Type II fibres) that have different functional and metabolic characteristics. The characteristic species-specific variations in fibre composition reflect the physiological needs of individual animal species, and in felids generally the fibre type composition of hind limb muscles matches their daily activity patterns. Roaming tigers, for instance, walk long distances, while cheetahs have requirements for speed and power over short distances. There is a relationship between the amount and type of activity, and the myosin heavy chain (MHC) isoform composition of a muscle in that tigers have a high combined percentage of the characteristically slower-twitch fibre isoforms required for sustained activity (MHCs I and IIa).

  Cheetah locomotory muscles contain a high proportion of fast-twitch fibres, needed for rapidly swinging their limbs and reducing limb swing-times required for running at speed over short distances. In their hind limb muscles there is a higher percentage of Type II (Type IIa + IIx) fibres than in the forelimb muscles further confirming that the propulsive role of the hind limb is greater than the forelimb.

  Enzyme activity in cheetah muscle reflects a high capacity for glycolysis in anaerobically based exercise required for sprinting during high-speed chases for hunting purposes. The fibre type composition, mitochondrial content, and glycolytic enzyme capacities in the locomotory muscles of cheetahs operate at the extreme range of values for other sprinters bred or trained for this activity including greyhounds, thoroughbred horses and human athletes.

King cheetahs

The iconic and spectacular king cheetah has become a well-known feature of the cheetahs at HESC.

The first recorded description of the king cheetah was from the Macheke district in Zimbabwe in 1927 where it was thought to be a hybridisation of a leopard and a cheetah. There the local indigenous population, who had known of its existence for a long time, referred to it as nsuifisi, the hyena-leopard, and told many tales of its fierceness. At a time, they seemed to be more common in parts of Zimbabwe where the colonists in the then Rhodesia referred to them as Mazoe leopards.

Now it is known that what was once considered a separate species (Acinonyx rex), is but one of many colour variants that have been described in cheetahs. Other such variants include albinistic, melanistic, cream (isabelline), black with ghost markings, and red (erythristic) with dark tawny spots on a golden background. Blue (or grey) cheetahs have been described as white cheetahs with grey-blue spots (chinchilla) or pale grey cheetahs with darker grey spots (Maltese mutation). Some desert region cheetahs are unusually pale probably because it provides a better camouflage in the like-coloured desert (http://messybeast.com/genetics/mutant-cheetahs.html)

King cheetahs are infrequently seen in the wild. The last recorded sighting of a king cheetah in the wild was in 1986 in the Kruger National Park. They occur naturally in a localised area that covers adjoining portions of Botswana, Zimbabwe, and South Africa (northern and eastern regions of the Limpopo Province).

During the 1980s, a number of litters born in captivity contained king cheetah cubs, and since then it has become customary for some of the breeding facilities (De Wildt and HESC) to focus on sustaining blood lines with the intention of breeding king cheetahs at will. The gene appears to be carried at a low frequency in the wild, and its occurrence is localised.

The king coat colour pattern is the consequence of a mutation at the tabby locus inherited as a single, autosomal, recessive allele.

Distribution – historical and current

Cheetahs were originally found throughout Africa outside of the Sahara, and in Asia. Today only about 7500 cheetahs remain worldwide and they have disappeared from much of their formal range because of habitat loss due to land-use changes, and disappearance of its prey species. Dense human populations at the interface with conservation areas and the proliferation of small-scale farming, additionally play important roles in the decline of cheetah numbers in conservation areas and are the causes of ever-declining numbers of cheetahs. The illegal trade in captured free-ranging cheetahs and the consequences of inbreeding also have a negative effect on cheetah numbers in the wild.

Currently they occur in fragmented populations particularly in Tanzania, Namibia, Botswana, and in South Africa, and are listed as vulnerable by the IUCN.

Status

Cheetahs are considered a vulnerable species and are under threat of extinction should current trends persist. Success for an animal species does not only mean that it survives, but that it survives to reproduce. When a species is unable to reproduce enough offspring to sustain the population numbers, extinction is the result.

Vertebrates are specialized in their reproductive habits and a great deal of energy is spent in assuring the most optimal conditions for survival of the young. Various conditions affect cheetah cub survival in the wild. To cope with these events, and a notoriously low cub survival rate in the wild, cheetahs with their iteroparitic reproductive pattern, breed year after year thus increasing with every brood the likelihood that the species will persist. (http://www.encyclopedia.com/doc/1G2-3400500202.html)

Modelling indicates that extinction risk is highly sensitive to both adult survival and juvenile survival. In the wild, lions are the major predator of cheetah cubs and a high and average lion abundance result in extinction of nearly all cheetah populations in 50 years' time, whereas with low lion abundance most cheetah populations remain extant. It appears that the conservation of cheetahs can not only rely on their protection inside national parks, but that it is also dependent on their protection in natural areas outside national parks where other large predators are absent.

Habitat

Although cheetahs in general appear to be adaptable to various types of habitat, they are in certain respects considered to be savannah specialists. Cheetahs possess a degree of behavioural flexibility since they can hunt successfully in thicket vegetation, sometimes in darkness, and they are not restricted to killing small to medium-sized prey. Across a range of African savannahs cheetahs, however, show a distinct preference for open savannah habitat, although females occupy areas with thicker bush more often than males, probably because this is the preferred habitat of their main prey.

Habitat preferences vary according to social groups, their susceptibility to predation, and their needs for cover and water.

Cheetah population viability is greater in woodland savannahs than in grassland savannahs, particularly when dealing with small population sizes. The grassland savannah population is most affected by changes in juvenile mortality.

Threats

Population declines of free-ranging cheetahs are due to a number of factors. The main reasons for their decline include hunting, poaching, loss of habitat, lack of genetic heterogeneity, overstocking with livestock, range partitioning, the arrival of deep borehole technology, the erection of cordon fences, and the death of cubs due to natural predation by lions and leopards. Maximum annual litter size and female mortality rates have large impacts on population persistence. Outside of protected areas these animals, because of their perceived threat to livestock and game animals, are indiscriminatively live-trapped or killed, often in groups because of their group dynamics.

Natural enemies

The interaction between predators in ecosystems play an important role in biodiversity conservation and in determining predator numbers. Cheetahs always lose in direct competition with other predators that are attracted to large congregations of prey. In environments where competition with other predators plays a role in sustaining cheetah populations, an increased adult and cub survival rate is necessary to ensure survival of the local population, and this should be managed if success is to be attained in small reserves. Natural deaths due to predation should be expected but the effects will differ depending on prey resource availability, habitat complexity, and the complexity of the predator communities. For instance, cheetah cub survival on the Serengeti Plains (SP) is low because of lion predation. In the Kgalagadi Transfrontier Park, however, cubs' rate of survival is seven times higher than in the SP and, although predation was the most common cause of mortality, lions were not found to be involved.

Prey preference and hunting practices

Cheetahs prefer to kill prey in good condition and rarely scavenge. Depending on the region in Africa in which they occur, the cheetah's preferred prey species is determined by the local presence of specific species. The morphological adaptations of the cheetah appear to have evolved to equip them to capture medium-sized prey that can be subdued with minimal risk of injury. Coincidentally, these species can be consumed rapidly before kleptoparasites such as hyenas and other felids arrive.

Cheetahs prey preferentially on medium-sized ungulates and there is a strong effect of gender and group size on the behaviour of cheetahs. The size, availability and vulnerability of the prey species influence the food habits of cheetahs. Males kill significantly larger animals (55% of kills weighed more than 65 kg) than single female cheetahs (less than 2% of kills weighed more than 65 kg). Male coalitions tend to hunt larger animals than females.

Cheetah prey size range from birds and hares to large antelope, and they rarely prey on domestic stock. Due to their relatively small jaws and teeth, cheetahs find it difficult to subdue large prey species, unless two or more cheetahs attack at the same time. Usually they will select small species, or the young of the larger species such as wildebeest and zebra.

They kill the most available prey present at a site within a body mass range of 23–56 kg with a peak (mode) at 36 kg. Blesbok, impala, Thomson's and Grant's gazelles, and springbok are significantly preferred, whereas prey species outside this range are generally avoided. Various publications list a range of prey in various parts of the range distribution in which cheetahs occur. In the Serengeti 21 prey species were recorded, ranging in size from mole rats (Cryptomys spp.) to wildebeest (Connochaetes taurinus), with a strong bias towards Thomson's gazelles (Gazella thomsoni). Elsewhere in East Africa they had preferences for gazelles (Gazella spp.) and impala (Aepyceros melampus), amongst a diverse prey base. In northern Kenya, cheetahs were observed taking kudu (Tragelaphus strepsiceros), gerenuk (Litocranius walleri) and dik-dik (Madoqua kirkii) while kob (Adenota kob) and oribi (Ourebia ourebi) have been noted as prey in West Africa). Data from the Kafue National Park, Zambia, showed puku (Kobus vardoni) to be the favoured prey species while cheetahs in the Lowveld region of South Africa took a preponderance of impala amongst 15 species preyed upon. In the southern Kalahari cheetahs killed prey ranging from bat-eared foxes (Otocyon megalotis) to wildebeest, with springbok (Antidorcas marsupialis) as the favoured species. In the Valley Bushveld in South Africa, they have been reported to kill 15 species of animal but preferentially kudu, springbok, grey duiker and bushbuck. There they shunned impala but in the Kruger National Park impalas appear to be a preferential prey species. The summary to date, then, is that cheetahs predominantly kill medium-sized (10–35 kg) antelope, but will opportunistically take other prey if available.

The decision of cheetahs to hunt or not is influenced by the abundance of their main prey, the reproductive status of the cheetah and the presence of competitors and predators, but not by the hunger level of the cheetah. When the decision to hunt is taken, the time of year, the gender of the predator, the abundance of prey, and the presence of competitors then drive prey choice.

Cheetahs are not vary active and may spend much of the day lying in the shade of a tree or on a termite heap. At the start of a hunt cheetahs may walk towards their prey with no attemtp of concealment and they may make a number of short mock charges. They often select an animal from a small group of animals that is separate from the main herd to pursue. In approaching their prey, they may crouch, hold their head and body low and use the available cover, when stalking their prey over short distances of about a 100 metres. During the course of this approach, they may remain stationary in a crouching position for 10 minutes or more until the final assault is made. After this stalk, that may last up to 30 minutes, and when they are within about 30 metres of the intended victim, they will rush in for the kill usually when the target looks away from the cheetah. When the cheetah is close enough to its prey, it will slap it on either the hindleg, flank or rump to cause it to loose its footing and fall with the aid of its dew claw that often leaves a cut in the skin. Alternatively they may just run in from a distance of about 100 to 200 metres at which stage it will select and individual to pursue. After capture, the antelope is usually grabbed by the throat or sometimes with small animals, by the head or napeand strangled. The average chase distance varies substantially, and in successful hunts the distance is usually longer than in unsuccessful hunts. In the KNP the mean chase distance for successful hunts was 18l9 m and with unsuccessful hunts, 96 m. Cheetah hunting success was 20.7%, kleptoparasitism was 11.8%, the mean kill retention time was 165 min, kill rated averaged 1 kill per 4.61 days. The daily food intake of cheetahs varies between on average 5,3 kg/day for coalitions, and 8kg/day for females. Cases are on record where a single female killed 25 animals during the course of 26 days.

Successful kills are usually followed by an extended rest period of up to 30 minutes before the cheetah will start eating. Cheetahs characteristically will eat the meat from one flank and then off the abdomen and ribcage where they consume the soft part of the ribs. They drink some of the accumulated blood in the carcass. They eat rapidly because of the threat of kleptoparasitism and is alert and skittish most of the time. This behaviour is accentuated in females with cubs. Predators kill free-living cheetah cubs, thus the vigilance in cheetah mothers is a form of anti-predator behaviour. When cubs are older and can outrun predators, vigilance at kills decline.

All that typically remain of a carcass after cheetags have fed, are the articulated bones covered by skin, and the digestive tract. Small-, medium- and large-sized vultures, jackals, spotted hyenas and lions are more likely to be present at the carcasses of large-bodied than small-bodied prey where they compete with the animal killed by the cheetah. On average, lions and hyenas appropriate 12 per cent of the cheetah kills. The various rates of kleptoparasitism reported in the literature varies substantially and it is suggested that this is the consequence of the cover provided by the thicket vegetation and prey size, against the lack of cover in savannahs.

Various demographic, environmental, and prey-based factors influence the success of a hunt. The chase and overall hunting success are influenced by the age of the cheetah and the prey size, while the effect of habitat features are important in the stalk. Whether a stalk turns into a chase is dependent on prey size. Contrary to expectation, the cheetah's hunger level, the presence of cubs, and the type of habitat where the hunt took place, had no effect on hunting success. Different factors thus affect the success of individual hunt stages, and the predation risk of prey is influenced not only by its size, the habitat it is in, and the age of the its predator, but also by hunt stage.

Female cheetahs show temporal and spatial avoidance of lions by hunting at dawn and dusk and positioning their home ranges significantly farther from lions. Females are more active during the day while males hunted earlier and later in the day than female cheetahs, and 46% of their kills were made in darkness. In addition, their home range overlapped that of the lions and they show neither temporal nor spatial avoidance of lions.

Home range, migration and dispersal patterns

Cheetahs in the wild are usually solitary animals or they occur in small groups. Males may occur as small coalitions of two or three and up to 5, while single females are usually accompanied by their offspring that remain a cohesive group for up to 1.7 years after which they disperse following which the cubs may still remain together for a few months.

Patterns of territory ownership in male cheetahs inhabiting the Serengeti Plains Body size and age were factors influencing whether males became territorial, and single males usually had to join up with others in order to oust residents. Both size of male coalition and body size of its members were associated with length of tenure on territories. Limited data suggest that territory owners were probably no more likely to encounter females than were non-territorial males and breeding is thus quite random.

In the wild most adult females are capable of reproduction. Conceptions are more frequent during the wet season, possibly as a result of increased food availability. Cub mortality is usually extremely high and cheetah mothers produced new litters rapidly following the loss of an unweaned litter.

Cheetahs have extensive home ranges that vary according to gender and to whether females are attending to cubs or not. The reported home ranges of cheetahs in general, varies markedly depending on the region in which they occur, and the nature of the local habitat. Thus males have a home range that varies from 173 km2 to 850 km2. Male cheetah territory size appears not to be determined by female cheetah density.

Across African savannah ecosystems, female cheetah home range size is determined by the dispersion patterns and biomass of medium-sized prey. Home ranges for females similarly varies markedly between 105 and 833 km2 depending on whether they are dependent on migratory or sedentary prey. It increases as prey biomass decreases in areas with sedentary prey only. Generally females travel 2.16 km/day compared to 6.13 km/day that males travel. Females after cubs have left the den, travel about twice as far per day than those attending to cubs.

Reproduction and life history

Cheetahs generally have a panmictic reproductive pattern(panmixia or panmixis means random mating). This assumes that there are no mating restrictions, neither genetic nor behavioural, upon the population, and that therefore all recombinations are possible. They are seasonally polyoestrus and may breed at any time of the year.

Cubs born blind and helpless and are hidding after birth. Their eyes open after about 10 to 12 days. They can walk by three weeks and at six weeks of age start following the mother. During this time the mother frequently move them around so as to lessen the likelihood of predation. The weaning process starts at about 5 – 6 weeks of age.

Reproductive data may differ between populations but female cheetahs give birth to their first litter when they are approximately 2.4 years old. The average litter size at independence is 2.1 cubs and the inter-birth interval is usually 20.1 months. There is a significant difference between litter sizes at independence on reserves with lions (2.9 cubs) compared to those without (4.7 cubs). Age-specific mortality is higher in the first four years of life (40-70%) than year five to nine (0%) and increases after year nine. Mortality of adult cheetahs is higher on reserves with lions compared to those without and there was a significant positive relationship ($R2 = 0.56$; $P < 0.05$) between cheetah mortality and the density of large predators on reserves. The mortality of cubs and young adult cheetahs is elevated in the presence of lions and other carnivores.

Males normally have markedly lower survival rates than females. Females who survive to independence live on average 6.2 years while the male average longevity varies between 2.8 and 5.3 years. Although the cheetah routinely lives for more than 12 years in ex situ collections, females older than 8 years reproduce infrequently.

Cheetahs produce poor quality ejaculates. Raw ejaculates contain $69.0 \pm 1.1\%$ motile spermatozoa (mean ± s.e.m.) with $73.6 \pm 1.5\%$ of these cells containing an intact acrosome. Overall, $18.4 \pm 0.9\%$ of spermatozoa were morphologically normal, with mid piece anomalies being the most prevalent (~39%) defect. Juvenile cheetahs produced ejaculates with poorer sperm motility, forward progressive status, lower seminal volume and fewer total motile spermatozoa than adult and aged animals. Spermatogenesis continued unabated throughout the year and is minimally influenced by season. Proportions of sperm malformations are also not affected by season. Ejaculates from captive cheetahs had increased volume and intact acrosomes, but lower sperm density than wild-caught counterparts. The observed teratospermia (abnormal sperm) in the free-living cheetahs is mostly genetically derived. There is a significant effect of age on volume, which increased throughout the animal's lifetime except for a reduction between ages 10 and 12. Concentration was also significantly affected by age and increased from the age of 3 to the age of 10, then decreased. The sperm quality index revealed a significant effect of age as it increased from age 3 to age 8, and then declined, as the male grew older. Cheetahs do not reach peak semen production until age 8 and they continued to produce good quality semen for several more years. These data are somewhat unexpected, given the average cheetah life expectancy of approximately 7 years.

Cubs remain with their mother for an extended period of time as small family groups. The birth weight and the neonatal growth rate are reliable indicators of neonatal survival. Growth is expected to be linear during the first 40 days of life. Hand-raised cubs have a lower growth rate than those in the wild (45 vs. 27 g/day). On average, their age at independence is 17.1 months. Females produced on average only 1.7 cubs to independence in their entire lifetime, and their average reproductive rate is 0.36 cubs per year (or 0.17 litters per year) to independence. Large numbers of lions have an effect on litter size at independence, the lifetime reproductive success, and the reproductive rate (cubs/year). Thus cheetah reproductive success in the wild is lower during periods of high lion abundance than during times when relatively few lions occur in a specific environment. Cheetahs, when nearby prey are scarce, may also abandon their litters.

There is a negative association between recruitment and numbers of lions, demonstrating that high rates of predation have implications for the dynamics of cheetah populations. Within this context, sociality affected survival in two ways: adolescents living in temporary sibling groups had higher survival than singletons, particularly males with sisters, and adult males living in coalitions had higher survival than singletons in periods when other coalitions were numerous, yet they had lower survival when other coalitions were rare.

Relocation and re-introduction

Introduction of large predators into the wild is increasingly being attempted to restore ecological integrity and to enhance ecotourism. The re-introduction of captive cheetahs into the wild onto small and larger conservation areas remains a problem and it is often controversial because the carrying capacity of these properties is unknown, and because of their competition for space and prey species with other large predators in their environment. The introduction of captive-bred cheetahs also has other challenges: the lack of hunting ability and ability to fend for themselves. Orphaned large felids can successfully hunt after release using appropriate rehabilitation techniques but they face the same human-carnivore conflicts of their wild counterparts. Relocated cheetahs are also prone to injure themselves and often need veterinary attention. Often the efforts to reintroduce cheetahs, is met with comments of 'less successful'. Given these sentiments and in light of the low survival, significant financial costs and failure to reduce stock losses, it was recommended that the translocation of problem cheetahs in Botswana should no longer be conducted, and that conflict mitigation methods should focus on techniques that promote coexistence of predators and humans.

A poor reproductive rate is a very important reason for the limited success that has been obtained with the reintroduction of cheetahs into the wild. Factors that impact on the reproductive rate include breeding soundness and age of the female, and post-emergence cub survival in predator-free environments. In managing introductions, the reproductive activity and health of the cheetah females are determined by reproductive history and age rather than innate rhythms, captive stress, or lack of genetic diversity, and post-emergence cub survival under natural conditions in a predator-free habitat is high. Management practices of captive breeding and re-introduction programmes should encourage early reproduction in females to induce long-lasting and healthy reproductive performance. With this practice, re-introduction projects might increase their chances of success

Cheetah cub survival is a critical matter in the maintenance of populations after re-introduction. Naturally low cub survival is attributed to predation by lions that in certain areas cause most of the cub mortalities and for this reason re-introduction of cheetahs for conservation purposes into such areas, is not advised. Other predators may also play a significant role in cub predation.

The outcome of relocation exercises is often also negatively affected by the presence of large human populations at the interface, and changing land-use practices such as small-scale farming.

Reproductive activity and health of cheetah females is determined by reproductive history and age rather than innate rhythms, captive stress, or lack of genetic diversity, and that post-emergence cub survival under natural conditions in a predator-free habitat is high. Management practices of captive breeding and re-introduction programs should encourage early reproduction in females to induce long-lasting and healthy reproductive performance. With this practice, re-introduction projects might increase their chances of success. Post-release monitoring following rehabilitation remains a indispensable but commonly neglected activity.

Conservation efforts may be more effectively aimed at the real, immediate threat to the cheetah's future: the loss of its natural habitat.

Diseases

A substantial amount of information about the diseases of cheetahs is available, although most of it relates to captive cheetahs in zoological gardens or in breeding institutions. There does appear to be a substantial difference in the disease patterns seen in captive cheetahs, compared to those in the wild. These data are essential for breeding facilities where attempts are made to sustain the dwindling populations of free-ranging cheetahs. Furthermore, it is notoriously difficult to breed cheetahs in captivity and the survival rates of cubs born under those circumstances is, generally, equally poor. Artificial rearing of cubs similarly is not without major challenges, one being the compilation of diets that will sustain the cubs and allow them to thrive without developing simple or complex nutritional deficiencies.

What is HESC doing?

At HESC we managed to establish a large group of cheethas over time to create a source of diverse genetic material that can be utilised to manage the degree of inbreeding of captive groups of cheetahs and those on small reserves. Having access to this group of cheetahs allowed us to:

Develop expertise in the reproduction and breeding in captive populations of cheetahs.

Developed expertise in raising and managing captive-bred populations of cheetahs

Determine the nutritional requirements of captive cheetahs to compile balanced diets based on feeding beef

Creating a collection of cheetahs with a heterogeneous genetic pool

We have a genetic pool of king cheetah genes and can at will breed them

Develop expertise in managing health-related matters in captive cheetah

Create opportunities for research relevant to cheetahs

Allow exhibition of cheetahs to raise awareness in the local communities and general public about their role in ecosystems and the need for their conservation

Rehabilitation and re-location into the wild thus aiding the maintenance of the species in small reserves

Participate in the local and international trade in cheetahs

References and active links

Comprehensive information about cheetahs is available in:

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