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Abstract: This paper summarizes the information on cheetah reproduction biology in the literature and data from a field study of cheetah ecology in Nairobi National Park and Masai Amboseli Game Reserve, Kenya. Data on the reproductive biology of endangered species such as the cheetah is important as an aid to breeding them in captivity.

Births appear to be seasonal relating to game concentrations and rainy seasons. Factors affecting hunting success that are related to seasonal changes, other than game concentrations, are vegetation growth and colour. Breeding success would be highest in those females that gave birth during the wet season so that food would be most easily available when the cubs required it.

Notes on the reproductive biology of the cheetah

Acinonyx jubatus

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Data on the reproductive biology of endangered species such as the cheetah *Acinonyx jubatus* is important as an aid to breeding them in captivity so that demands for these animals can be met without further removal of individuals from decreasing wild populations (Eaton, 1969a).

This paper summarises the information on cheetah reproductive biology in the literature and data from a field study of cheetah ecology in Nairobi National Park and Masai Amboseli Game Reserve, Kenya (Eaton, 1969a, b, c; in press, a, b).

RESULTS

Gestation period

Table 1 gives measurements and estimates of gestation periods in cheetahs. There is unfortunately little data on wild cheetahs.

Oestrus and anoestrus

Crandall (1964) describes a female in captivity that gave birth on 24 March 1956, and again on 25 April 1957. Assuming that gestation was about 90 days, this female was impregnated 10 months following parturition, an anoestrous period of 13

SOURCE	WILD OR ZOO CHEETAHS	GESTATION (DAYS)
Asdell (1964)	zoo	95
Ulmer (1957)	zoo	92
Burton (1962)	?	90-95
Wilhelm, in Shortridge (1934)	wild	90
Kenneth (1943), in Asdell (1964)	zoo	95

Table 1. Gestation periods in wild and captive cheetahs *Acinonyx jubatus*.

months. Graham and Parker (1965) describe an adult female and a three-quarters grown male, presumed to be her son, that were approached by an adult male. The adult male kept driving off the young male and kept very close to the female. In Nairobi National Park, Kenya, J. B. Foster (pers. comm.) observed a group of adult male cheetahs approach and mate with a female that was accompanied by cubs estimated to be one-half to three-quarters grown. Since females raise their young in isolation from other adults until the cubs reach sexual maturity at 14-16 months (Graham & Parker, 1965; Eaton, in press, a), then the three-quarters grown male was probably the female's cub, apparently about 10 months of age. The

cubs observed by Foster were roughly 10 months old also. In both cases anoestrus was about 13 months. Sterndale (1884) observed a female with two older cubs accompanied by an adult male. The female was probably in oestrus, but from Sterndale's description it is not possible to determine the age of the cubs.

In Nairobi National Park I watched one female with cubs from the time that the cubs were 5.5 months old until they were 10 months old. During this period adult males did not approach the family group although visual encounters occurred between adult groups of both sexes and between male groups and the family. Scent markings are critical for spacing of cheetah

CAPTIVE OR WILD CHEETAH	BIRTH TO BIRTH PERIOD (MONTHS)	BIRTH TO OESTROUS PERIOD (MONTHS)
Captive	13	10
Wild (Kenya)	—	10
Wild (Kenya)	—	10
Wild (Kenya)	—	12-14
Wild (Kenya)	12-14	9-11
mean	13	10

Table 2. Birth to birth and birth to oestrous periods in one captive and four wild cheetahs *Acinonyx jubatus*.

SOURCE	LOCATION AND/OR ORIGIN	NO LITTERS	WILD OR CAPTIVE	BIRTH-MONTH(S)
Hamilton (1912), in Asdell (1964)	Transvaal	—	wild	July-Dec.
Stevenson-Hamilton (1947)	Eastern Transvaal	—	wild	June-Dec.
Stevenson-Hamilton (1947)	Eastern Transvaal	—	wild	Aug.-Sept.
Shortridge (1934)	S.W. Africa	1	wild	Dec. or Jan.
Ansell (1960)	N. Rhodesia	2	wild	March or Apr.
Graham & Parker (1965)	Nairobi N.P.	2*	wild	May
Graham & Parker (1965)	Nairobi N.P.	1	wild	August, late
Eaton	Nairobi N.P.	1	wild	May, early
Eaton	Nairobi N.P.	1	wild	Apr.-June
Eaton	Nairobi N.P.	1	wild	November
Eaton	Masai Amboseli Game Reserve	1	wild	Apr.-June
Encke (1961)	Krefeld Zoo, Germany	1	captive	April
Ulmer (1957)	—	2	captive	late March to late April
Anonymous (1967)	Rome	1	captive	Apr.-June**

* One litter of three young was estimated to be about 8 months old when observed in January.

** No exact date available.

Table 3. Locations and dates of births in captive and wild cheetahs *Acinonyx jubatus*.

groups but they also communicate oestrous condition and serve to enable males to locate females (Eaton, in press, a). I observed a second female in Nairobi National Park that had an older litter of cubs. The female exhibited oestrus when her cubs were 12 to 14 months old. Hans Oppendorfer (pers. comm.) says that Joy Adamson's tame but free-living cheetah in northern Kenya gave birth to a second litter when the first litter was about 12 to 14 months old. In this instance oestrus and impregnation must have occurred 9 to 11 months following parturition.

Litter Sizes

There were no cases of birth in captivity recorded before 1946 (Hediger, 1950, 1952). The first litter born in captivity and raised by the mother was in Rome in 1966 and consisted of three cubs (Anonymous, 1967). Crandall (1964) records a litter of three cubs ($\delta\delta\varnothing$) and two cubs ($\delta\varnothing$) and two litters of two cubs (sex not given). Encke (1961) recorded four cubs born at the Krefeld Zoo, Germany. These litter sizes average 2.5 cubs.

In the wild, Denis (1964) found a litter of four cubs and refers to another of three, both litters estimated to be seven to eight weeks old. Shortridge (1934) tells of Wilhelm in S. W. Africa finding a litter of two cubs that were apparently four to six weeks old. But even litters of seven to eight weeks of age may not accurately reflect birth litter size since many probably die in early life. Of 15 wild litters estimated to be less than one month old by Graham & Parker (1965), six had four cubs; the average size was 3.7 cubs. The three largest litters recorded had eight cubs each. The same authors found that as cheetahs got older their litters became smaller.

It seems that the average cheetah litter in the wild is at least four cubs, assuming that some cub mortality occurs in the first six weeks, but the smaller litters in captivity may be due to physiological stress.

Season of Birth

The dates of cheetah births are summarised in Table 3. Hamilton (1912, in Asdell, 1964) and Stevenson-Hamilton (1947) do not provide numbers of litters for their estimates of birth seasons in the latter half of the year in the Transvaal.

All other birth-dates are based on specific

litters and are estimated within one to two specific months. The birth-dates in East Africa and in captivity suggest that births mainly occur from March to the end of June.

DISCUSSION

Selection for Timing of Birth

Births appear to be seasonal; 11 of the 15 more exact estimates of captive and wild births are from March to the end of June. The main rains for Masailand, which includes Nairobi Park and Masai Amboseli Game Reserve, are in March and April (Talbot & Talbot, 1963). Game is widely scattered over the plains once the rains come and large game concentrations are rare. When most litters are six to ten months old, from October to February, a second, less intense and often irregular rainy season occurs. The female raising cubs goes through three stages in rearing the young: (1) feeding the cubs, from birth to six months; (2) teaching the six to twelve month old cubs to hunt while still providing most of the food; and (3) hunting with the cubs, which are effective hunters, from the age of 12 months onwards. When these periods are plotted against the rainy seasons and game concentrations it is seen that the first step coincides with scattered game, the second step parallels higher game concentrations, and the third step parallels lower game concentrations again.

Factors affecting hunting success that are related to seasonal changes, other than game concentrations, are vegetation growth and colour. The height of vegetation appears to change little, and may not affect cheetah activities. The colour of vegetation, however, does change distinctly. Whether or not prey species possess colour vision, the camouflage of cheetahs is probably more effective in the dry season, and in the rainy seasons, in lush green grass, cheetahs should be more visible. The second phase of cub rearing coincides not only with higher game concentrations but also with better camouflage for the cheetahs. This phase is the most difficult period for the female rearing young for several reasons. The cubs are growing fast and demand ever increasing food which must be provided by the female until the cubs can hunt for themselves. During this period too the female is teaching the young how to hunt. This requires much time and is unproductive; the cubs contribute very little

to the family's food supply, they frequently scare away the prey and the female's time for hunting is cut short. As the cubs become increasingly active in learning how to hunt, they require increased energy from food and, of course, it is to be expected that natural selection will favour females that bear young at a time when they can best meet the energy requirements of the cubs. This contention is made in general by Lack (1954), and it is likely that breeding success would be highest in those females that gave birth during the wet season so that food would be most easily available when the cubs required it.

Robinette *et al* (1961) have demonstrated that reproduction in the puma *Felis concolor* is timed so that small cubs are born in the summer months. In this case the birth season appears to be an adaptation to prevent young from freezing while the female goes off to hunt.

Seasons of birth may vary in regions with different ecological conditions. Since relatively few cheetah data are available from other than East African areas, it is difficult to speculate on birth seasons elsewhere; however, in the Eastern Transvaal births appear to occur in the second half of the year. The abundance of young prey might also be expected to be related to birth seasons in cheetahs and, indeed, in East Africa most ungulates either drop their young throughout the year or at the onset of the rainy season. Since cheetah cubs are frequently preyed upon by other predator species (Eaton, in press, a) and the cubs remain sedentary until they are about eight weeks old, when they accompany the female, the availability of ungulates born at the onset of the rainy season could be an advantage to the female with very young cubs. The relationships between cheetah hunting success and susceptibility of prey classes (age, sex and condition) have been discussed by Schaller (1968) for the Serengeti area, Tanzania, and by Eaton (in press, b) for Nairobi National Park, Kenya.

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