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Abstract: A six-year study aimed at determining the conditions under which the cheetah is most likely to reproduce. Comprehensive behavioural notes were taken and still and cine cameras and tape recorders were used in the collection of data. This paper summarizes the conditions and events leading to births and attempts to evaluate the factors involved. Main factors that have contributed to the success of the cheetah breeding programme include a quality commercially prepared diet, a large compound with wide field of vision and which excludes sensory awareness of other large carnivores, females of at least three years of age, predetermined sexual activity levels for males and the fighting, females was apparently courted and impregnated by one male alone.

## at the Lion Country Safari Parks: a summary

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A group of 18.6 cheetahs *Acinonyx jubatus* from South-West Africa received in May 1970 at the California Lion Country Safari has been the subject of a six-year study aimed at determining the conditions under which this increasingly threatened species is most likely to reproduce. During the first year of captivity the animals were under continuous observation (by S. J. Craig) for 8–10 hours a day and occasionally through the night. Comprehensive behavioural notes were taken and still and cine cameras and tape recorders were used in the collection of data. In the last three years, four of the ♀♀ have between them produced seven litters totalling 27 cubs, 22 of which were reared. Based on our preliminary findings, modified from their own experience, the LCS parks in Georgia and Texas have also established breeding programmes, which have resulted in 27 cubs in seven litters – a total for the three parks of 54 cubs. This paper summarises the conditions and events leading to these births and attempts to evaluate the factors involved.

The 18 ♂♂ all appeared to be fully adult. Of the six ♀♀, one was already past her prime, one was of breeding age and four were subadult (about 18 months old). The group was placed in a 1.6 ha grassed compound through which visitors could drive on a paved road in their own cars. The terrain was varied with shady trees, a pond, dead branches and rock outcrops, and overlooked another section of the preserve, separated by a 3.6 m high chain link fence, where roamed various species of African antelope. During this initial phase the animals were fed a diet of raw horsemeat, complete with bone and hide, sprinkled with a vitamin-mineral supplement. They adapted surprisingly quickly to their new environment and diet and within the first two weeks were to be seen, despite the sometimes heavy traffic, lying in amicable groups less than 2 m from the road.

## EARLY BEHAVIOUR

Female 1 died of old age after two years of captivity. She never demonstrated oestrous behaviour and was ostracised and persecuted by the rest of the group. Female 2, the younger of the two adults, came regularly into oestrus and was courted, usually by a single, established group of 3–5 ♂♂ who competed aggressively for her. Oestrus lasted 2–4 weeks, with 2–3 weeks inter-oestrous periods (Eaton & Craig, 1973). Copulation was observed on three occasions but no pregnancy resulted. In December 1970 she died from an adverse reaction to ketamine hydrochloride.

Female 3 displayed oestrous behaviour during 1970 and 1971, although not as frequently as ♀<sub>2</sub> and courtship, by the same active group, was not as intense. In June 1971 two adjoining compounds, each 2000 m<sup>2</sup>, were constructed in the remote hills behind the park. Female 3 was transferred to one of these, and two of the active courting ♂♂ to the other, tactile communication being possible through the chain link fence. When after three weeks the animals had still shown no great interest in one another, the two ♂♂ were given access to the ♀. She failed, however, to give any signs of oestrus, and after two months was returned to the main compound, where she was without difficulty received back into the group.

Female 4 was then put into the isolation enclosure and remained there for the next six months with no ♂♂ in proximity. In the meantime, in the main compound, the five active ♂♂ in January 1973 were observed in low intensity courtship – similar to that previously exhibited – around ♀<sub>3</sub>, and on 28 April the latter was seen to pass a small amount of blood from the vagina. Some mammary development also being visible, she was placed in isolation. Two days later it was clear that she was in some distress, and after immobilisation (with 300 mg ketamine hydro-

chloride) and X-ray, a single dead cub, weighing 0.9 kg and measuring 40 cm, was removed by caesarian section; it had been lying in the breach position. The ♀ recovered well from surgery. She had been about four years old at time of conception.

In June 1973 the animals were moved from the compound they had been occupying to a smaller 1.2 ha moated enclosure, surrounded by a 3.6 m fence, which visitors were able to drive around, but not through. Female 4 was returned to the main group at this stage. At the same time, the horsemeat diet was replaced by Zu/Preem, a commercially prepared feline diet, which was felt to be nutritionally superior.

#### REDUCTION OF ♂ : ♀ RATIO

A year later most of the ♂♂ were removed from the main display to a separate 2 ha drive-through section. Of the four left with the four ♀♀, only two had been part of the sexually active group, neither of the others having ever shown any interest whatsoever in an oestrous ♀. Although one of the latter suffered from partial paralysis of the foreleg, there was no discernible reason why the other, an apparently healthy animal, should have been inactive.

In October 1974, about four months after the reduction in ♂ numbers, ♀<sub>3</sub> and ♀<sub>4</sub> both appeared pregnant. Except on one occasion during the previous July when a single ♂ had been seen following ♀<sub>3</sub>, there had been no observations recorded of either courtship or copulation. The two animals were immobilised with 80 mg CI 744, an experimental drug that had previously been used with no ill effects for the relocation of the surplus ♂♂, and X-rayed. Pregnancy being confirmed, they were returned to the two adjacent hill enclosures, where each had a waterproof hut for shelter. Female 3 gave birth on 25 October to five cubs, two of which, left outside during the first night, died, while the remaining three were raised by the mother and are now healthy subadults. Female 4 produced a litter of four on 3 November, all of which she successfully reared. When the cubs were about 6-8 weeks old, the two ♀♀ were allowed access to one another, under close observation, and friendly from the outset, they established themselves and cubs as a single social unit, with the young suckling indiscriminately from either ♀.

The cubs were removed from their mothers in May 1975 and shipped to another LCS park. The ♀♀ were reintroduced into their former group, which, apart from the removal of one of the two breeding ♂♂, was of the same composition as before. In October they again showed symptoms of pregnancy, together with ♀<sub>5</sub>, and this time without prior X-ray, the three ♀♀ were isolated in the hill compounds under conditions similar to that of the previous year. Female 3 again had a litter of five, but two of these, which seemed sickly, were eaten within three hours of birth. Females 4 and 5 had litters of four and three respectively, all of which were healthy. The three births took place on 27 October, and 5 and 6 November. The mothers, separated from their cubs at approximately five months, were reintroduced into the breeding compound in March 1976.

At about this time the remaining ♀<sub>6</sub> also began showing signs of pregnancy, and similarly isolated in the cubbing compound, gave birth to five cubs on 3 April. Because we had been unable to entice her into the crate, immobilisation was necessary (with 85 mg CI 744), and this had given the veterinarian an opportunity for palpation and verification of her condition.

At the LCS parks at Georgia and Texas where breeding programmes based on our preliminary studies have been instituted, the chief innovations have been firstly, to introduce a regime of compulsory exercise; and secondly, to provide – in the form of the rhinoceroses with which the cheetahs share an enclosure – an additional source of psychological stimulus. To encourage the cheetahs to move about, the animals receive their rations in small amounts, for which they are whistled to the feeding station several times a day. Seven litters totalling 27 cubs altogether have so far been born in these two establishments.

#### CONCLUSION

The main factors that we believe have contributed to the success of our cheetah breeding programme include (1) a quality commercially prepared diet; (2) a large compound (*c.* 1.2 ha minimum), with a wide field of vision, which at the same time excludes sensory awareness of other large carnivores, such as lions (Schaller, pers. comm.); (3) ♀♀ of at least three years of age; (4) pre-determined sexual activity levels for ♂♂ and the

reduction of the originally high ♂ : ♀ ratio of 18 : 6 to a less competitive ratio of 3 : 1 or lower.

Perhaps just as significant as the positive requirements mentioned above, are elements which in the past had been thought detrimental to breeding, but which the authors have found to be of little or no consequence. It was, for example, never found necessary to augment the prepared diet with live food, even though it has been shown that this may stimulate sexual activity (Eaton & Craig, 1973). The close proximity of heavy visitor traffic and low-flying aircraft from a nearby military base did not appear to do any damage, nor the fact that over the six years the animals had been closely observed, photographed and fed on foot by several park personnel.

It has been suggested (Herdman, 1972; Eaton, 1972; Eaton & Craig, 1973) that competition between courting ♂♂ is necessary for successful copulation. Our data do not substantiate this theory. Indeed, not only was mating interrupted through over-competition between as few as five ♂♂, but our last four litters, from four different ♀♀, were fathered by a single sexually active ♂, with no other ♂♂ present except the two non-competitive animals which had never been observed participating in any sexual behaviour. Our experience is borne out by that at Whipnade (Manton, 1974), where conception took place with no inter-♂ competition, at the Beekse Bergen Safari Park in Hilvarenbeek (Tong, 1974), where on several occasions effective copulation had been thwarted by

fighting, and by Desmond Varraday (1964), whose tame, but free-roaming, ♀ was apparently courted and impregnated by one ♂ alone.

#### AUTHOR'S NOTE

Since the completion of this paper females 3 and 4 have again each produced a litter of three, on 31 August and 22 September 1976. Five of these six cubs are currently doing well at six and nine weeks of age and as before are being reared by the mothers.

#### PRODUCTS MENTIONED IN THE TEXT

**CI-744:** experimental drug containing 1 : 1 tiletamine and zolazepam, manufactured by Parke-Davis & Co, Detroit, Michigan 48232, USA.

**Zu/Preem Frozen Feline Diet:** manufactured by Hill's Division Riviana Foods Inc., Topeka, Kansas 66601, USA.

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