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Abstract: The British orientalist and jurist W. Jones (1746-94) says that the use of the cheetah for hunting originated with Hushing, King of Persia in 856 B.C. Despite this long association with man and his success with other animals, it is surprising to read in a report by the English naturalist W.I. Blandford, in 1888, that the cheetah had not been known to breed in captivity. It is only from 1956 that cheetahs are registered to be born in captivity. To answer the question of how and why it is so difficult to breed cheetahs in zoos, the author uses a 15 years period, during which 43 young were born, to search the common factors. Between several factors, he brought out the three probably most relevant ones like the improvement in standard diets, the separation of breeding pairs and the bringing together of only mature animals.

Captive Breeding of Cheetahs

V. J. A. Manton

The British orientalist and jurist Sir W. Jones (1746–94) wrote that the use of the cheetah for hunting originated with Hushing, King of Persia in 856 B.C. So popular did their use for this sport become with the Mongol emperors that many of the latter kept thousands of cheetah, all trained to the leash. Despite this long association with man and his success with other animals, it is surprising to read a report by the English naturalist W. I. Blandford, in 1888, that the cheetah had not been known to breed in captivity. This may in part be related to the methods of obtaining and training the animals. All were picked up at an "early age" and hand-reared in an atmosphere where man was the dominant factor.

Again in 1950 Dr. Hediger listed the cheetah as a non-breeder in zoological gardens. However, 6 years later the pair of animals at Philadelphia gave birth to three youngsters which unfortunately were not reared. Some 13 months later they produced a second litter whch were reared by hand but died from "distemper" at 3 months of age. In April 1960 the pair at Krefeld unexpectedly gave birth to four youngsters. All were unfortunately dead within 4 months and although a single birth occurred later this was "unsuccessful". In 1959 or 1960 and again in November 1962 two young were born in Oklahoma City, but all attempts to rear them failed and the longest survivor only lived 10 days. In January 1966, following the loan of two of Rome Zoo's males for mating, a tame female belonging to Signor Spinelli gave birth to a single youngster, and to three in December of the same year.

September 1967 saw the first of Whipsnade's four litters to date (1/2, 1/2, 1/1 and 0/3), of which only two females in the first litter have not been reared to maturity by the mother (see Fig. 1). Montpellier produced three young in December 1968 and four in May 1970, while the latest birth appears to be that of four young in Toledo Zoo, Ohio. Young have also been reported at Arnhem Zoo and at Longleat, but they either did not survive for long or were stillborn.

To summarize: over a period of 15 years, 43 young (19 males, 13 females and 11 of unidentified sex) have been born in nine collections to nine females. The question we should be asking ourselves is how and why. Firstly, I have

searched all the available records for common factors. Age of the parents does not seem to play a part once the cheetah are sexually mature. The Philadelphia pair had an age disparity of about 4 years—the male probably being the older. At Krefeld the female was about 5 or 6 years old and the male 4 or 5 at the time of birth of the infant. Signor Spinelli's female was just under 4 years old and the males were about 9. Whipsnade's female was just over 3 years old at the time of the first litter and the male was about 5. At Montpellier the female was 4 and the male 5, while at Toledo both parents were only $2\frac{1}{2}$–$3\frac{1}{2}$ years old.

The time of year does not seem to be important, since with 14 litters, births

FIGURE 1. The female cheetah Juanita with her first litter of three cubs (born 19 September 1967). This was the first litter of cheetah cubs born in the United Kingdom and one of the offspring was reared to maturity.

occurred in every month except June, August and October. Generally speaking, litters result from animals kept as pairs although Spinelli's female was introduced to two males and the Montpellier female was with a second barren female at the time of breeding. Size of cage does not appear to be important. The Philadelphia pair bred in small dens of 7·5 sq. m (though the proximity of the male may have adversely affected the rearing in this case), the Krefeld pair bred in a pen of 90 sq. m, Signor Spinelli's pen was 150 sq. m, Whipsnade's was 800 sq. m, Montpellier's three pens each covered 1200 sq. m, while the pen at Toledo covered about 1625 sq. m.

It is highly probable that improvement in the standard of diets, and knowledge of suitable nutrition gained since Ratcliffe (of Philadelphia) and Wackernagel (of Basle) highlighted the unsuitability of the diets initially provided, has helped

the species towards a fit breeding state in captivity. However, it is very hard to obtain detailed information on diets fed at cheetah breeding establishments. The recognition that carnivorous animals in the wild seldom feed entirely, or even mainly, on red meat (Ca: P ratio at least 1 : 12) has reminded cheetah keepers that small prey when caught live is often consumed entirely, thus ensuring a correct Ca: P ratio, plentiful supplies of vitamin A (or at least carotinoids) and the B complex vitamins. Instead of feeding whole or (from the animals' point of view, better still) live prey, supplementation is required and necessary for complete breeding and rearing success. At Philadelphia, the animals received horse meat varied with whole chickens or pigeons, but Ulmer (1957) states "it is doubtful if this helped for, in India, their (cheetah) owners have been feeding them natural (sic) food for centuries without any breeding taking place". This was altered shortly after the female arrived in the zoo to a compounded diet consisting basically of raw ground horse meat, powdered skim milk, a protein, mineral and vitamin B supplement, salt and a multivitamin powder. Oklahoma fed "mainly horse meat", while Krefeld fed horse meat and occasionally freshly killed rabbits. Here, however, 4 months before the first birth both parents received daily "20 cb (sic)" of a vitamin preparation containing 1 million i.u. vitamin A, 100,000 i.u. vitamin D_3 and 40 mg vitamin E per c.c. Signor Spinelli's female Beauty was fed apparently on donkey meat; the first youngster was also eating chicken heads at 4 months of age. All Whipsnade's cheetah were fed mainly on beef fit for human consumption dusted with steamed bone flour and alternating as often as possible (several times a week) with whole poultry and rabbits. They now receive on 3 lb of meat a 15 g supplement containing 20,000 i.u. vitamin A, 750 i.u. vitamin D_3, 40 i.u. vitamin E, 30 mg vitamin B_1, 45 μg vitamin B_{12}, 0·1 mg iodine, 4 g calcium and 2 g phosphorus (these last two as calcium dihydrogen phosphate). Montpellier feeds "meat" sprinkled "periodically" with powdered milk, brewer's yeast or vitamin mineral salts and a weekly whole chicken. Toledo feeds horse meat sprayed with vitamin supplements 6 days a week, with a whole rabbit once a week.

It is very difficult to discover the history of each breeding animal to ascertain if it was hand-reared from an early age or caught wild as an adult. Certainly the Oklahoma cheetahs were reasonably tame at the time of breeding since both were harnessed and exercised on a leash 3 days a week. The Krefeld animals do not appear to have been handled, whereas Signor Spinelli's Beauty was so tame that he "had prepared the teats for suckling . . . by sucking them in his mouth . . ." and after 2 weeks from the birth visitors were accepted by her into the den, though only "one at a time". At Whipsnade the female was never tamed and had always resented the too close approach of any human even to the wire of her quarantine quarters. She had been rescued from an attack by cape hunting dogs when two-thirds grown and artificially fed from then on, spending 18 months on her own before meeting any other cheetahs. The sire was "leash tame", having been hand-reared in Nairobi. The Montpellier animals were imported young although both were over 1 year old. No record of tameness is

available. The Toledo animals arrived in Ohio when between 2 and 3 years old, 5 months prior to breeding.

It is interesting to note that the sire at Philadelphia had been "observed to mate on several occasions" with a previous mate with whom he had lived for 4 years. Yet Ulmer (1957) felt that "psychological factors can be ruled out". Despite this, the close proximity of the male at parturition apparently caused unease in the female, who attacked and killed her offspring. At Oklahoma the male "ate the first cub" and was therefore removed. The same happened with the first litters at Krefeld. Spinelli's dam was kept separate, as was Whipsnade's (although by mistake the second litter was born not only in the presence of the sire but in a spare hut, on a busy weekend). At Montpellier the sire and the barren female were removed at the "moment of birth". In Ohio the female was separated and put into a run of some 46 sq. m where supplementary heating and observation windows were available. Joy Adamson, in "The Spotted Sphinx", quotes an area of 63 square miles covered by Pippa and her three cubs and if this example is typical of the wild, then wild-caught adults are not used to the close proximity of unrelated animals, except at breeding time. Indeed what zoo, or even safari park can hope to imitate the wild in keeping cheetah in this sort of area? I believe it is very important to realize that if males and females only come together for mating and the females only share a territory with a maturing family at other times, then pairs should not be kept together in the same enclosure throughout the year. Indeed one of the most obvious common factors amongst zoos who have successfully bred cheetah is the separation of the breeding pairs and the bringing together of animals only when mature. Breeding occurred at Philadelphia 6 months after a second female was obtained for the male. Oklahoma's animals were removed from the pens frequently for exercise, although it is not known if the animals were exercised separately. Krefeld's pair were not put together until less than 9 months before the birth. Signor Spinelli's female of course lived on her own and was introduced to the male at the onset of oestrus. At Whipsnade oestrus and/or mating has been recorded on four occasions and each time between 10 and 14 days of the reintroduction of the male to the female. Within 12 months prior to the births at Montpellier the breeding pair were selected after some "violent battles" and left alone. A similar selection took place at Toledo from four adult imports. In most of these cases, at least one parent was an adult or late juvenile import and not a youngster hand-reared with the rest of the litter or a group of animals of similar age.

Another factor which I believe to be important is the siting of the cheetah pen. These animals are well known for their ability to focus on objects in the distance even when tame and on a leash. Spinelli's pen is on a hill facing the sea, which is about 15 kilometres away. At Krefeld the pen, although at ground level, allows very good vision across the zoo paddock in which there is plenty of activity. At Whipsnade free-flying peafowl (*Pavo cristatus*) and turkeys (*Meleagris gallopavo*) often land in or near the breeding pen, while free-roaming Bennett's wallabies (*Protemnodon rufogrisea*) and muntjac (*Muntiacus* spp.) frequently pass

close to the pen on either side. Being on a slightly higher contour line, there is a good view across the main elephant lawn, the African buffalo (*Syncerus caffer*) and musk ox (*Ovibos moschatus*) paddocks in which there is plenty of movement. At Toledo, a paddock nearly 70 m long gives a good view beyond each end.

It is interesting to note that although Joy Adamson feels that cheetah are "not built for climbing" but only acquired this habit when "driven by man from . . . open plain, and forced into wooded country", and young animals at Whipsnade were seen climbing up a tree without the mother first setting an example, at three zoos symptoms of leg weakness have occurred. R. Bigalke, lately of Pretoria Zoo, found it common in young wild-caught cheetah that he had attempted to rear. At Philadelphia the cubs of the second litter developed, prior to 12 weeks of age, "some weakness in the carpal region of the forelegs". This apparently resolved without treatment. At Montpellier the four youngsters in the second litter (after being vaccinated for the first time against Carré's disease, leptospirosis and infectious hepatitis) became lame but the symptoms rapidly regressed on treatment with an "anti-rachitic vitamin (Sterogyl 15)". With the first litter at Whipsnade one cub was reported to be "carrying a hind leg" on 21 November when 2 months old. Careful observation showed the condition to clear up without treatment and no abnormalities could be felt when the cubs were handled for vaccination 6 days later. However, on 9 January 1968 a severe electrical black-out coupled with cold weather forced us to move the mother and her family to new quarters where an alternative form of heating could be supplied. They were all very nervous and highly suspicious of this new house, very different from the small dark kennel in which they were born. Ten days later the youngster already mentioned above was reported to be weak in her hind legs. When the animal was X-rayed at Regent's Park under phencyclidine sedation the picture revealed a "healing osteodystrophia, evidence of earlier calcium deficiency in the skeleton" and a healed fracture of the lower third of the left tibia. This latter could well have been a "greenstick" fracture and present on 27 November. Accepted back by her mother, this animal did not appear to recover completely from the sedation and collapsed and died (possibly after an epileptiform fit) on 10 February. The other two animals, having been seen to be "weak on their hind legs" since 1 February, were transferred to Regent's Park hospital on 12 February where their hind limb weaknesses were much exaggerated. The female youngster having died, the male was returned to Whipsnade on 23 April 1969, where he made a slow and prolonged but almost complete recovery. Indeed, when the female from the 1970 litter (see Fig. 2) with which he lived came into season in March 1972 he made two very concerted efforts and nearly served her, so strong are his hind legs now.

On reflection I cannot help feeling that the double disturbance in the life of this litter played a more important part in our failure to rear them than the level of nutrition or the lack of experience on the part of the dam with her first litter. However, experience at the other zoos confirms that rapidly growing young

FIGURE 2. Juanita with two cubs born on 20 February 1970 (her third litter), photographed at about 8 weeks of age. One cub is half-hidden but can be identified by the wet tail lying across the mother's right forelimb.

cheetah may be very susceptible to slight deficiencies or imbalances in their diet when it comes to the calcification of bones.

Any attempt to provide guidelines for an ideal cheetah breeding and maintenance programme makes one realize the depths of one's ignorance. It would seem that accommodation standards are not of overriding importance, but that the provision of dry bedding out of the wind and away from human interference is. Paddocks (see Fig. 3) should have a good view, preferably with plenty of

FIGURE 3. The new cheetah enclosure at Whipsnade Zoo (approximately 50 ft long and 32 ft deep). This is not a breeding enclosure and no cubs have been born in it so far (up to September 1974).

movement in the middle to far distance. The diet should certainly be as near as possible to that obtained by the animals in the wild and based on complete carnivore foods or whole animals. I would advise strongly against handling or attempting to tame any cheetah which is destined for breeding and the most important factor of all is to keep separating and reintroducing sexually mature animals, which should otherwise be kept in isolation (both from sight and sound) from one another, but still with good "views". Any house should be well ventilated to limit upper respiratory infections, but be free of draughts. I believe annual vaccination against feline infectious enteritis to be desirable, using a 3 ml dose.

I do not believe our knowledge extends to making proposals for a viable breeding unit, but a spare male should always be kept and young females should be retained to replace an older breeding animal. Once into the F_2 generation, dispersal of the group is an excellent idea provided that the new location understands cheetah husbandry. No thought should be given to sending captive-born stock back to the wild until at least six breeding units have progressed into the F_2 generation and cross-breeding has been satisfactorily carried out.

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