

Foster JW. The induction of estrus in the cheetah.

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Abstract: Little is known about the cheetah's estrous cycle. The duration of estrus is, on the average, no more than two weeks with an interestrus period of at least two weeks. The female will recycle if the litter is lost shortly after birth. In this research observations were made of 3 cheetahs: 2 female, 1 male. Oestrus behavior of male and female were recorded. The study indicates the PMSG will provoke estrous behavior in the cheetah. Since copulation and resulting pregnancy did not occur, without laparotomy or radioimmunoassay we can not only speculate as to whether a true heat or physiological estrus had been induced.

## THE INDUCTION OF ESTRUS IN THE CHEETAH

James W. Foster

In the past little has been done with the large Felidae in the area of artificial control of reproduction. This was no doubt in part due to the lack of emphasis on captive reproduction and to the difficulty in restraining the animals so that the accepted techniques might be employed. Today, with the advent of safe anesthetics, we can immobilize an animal with relative confidence for procedures that would not have warranted the risk just a few years ago.

There are still a number of problems that remain before artificial insemination is a reality in felids, one of which is the determination of estrus in certain species, such as the cheetah (*Acinonyx jubatus*). It would seem that if estrus could be induced artificially it would then not only be possible to inseminate the female at the appropriate time, either artificially or by natural mating, but to observe female reproductive behavior at a greater degree of intensity. It was under this premise that an attempt was made to induce estrus in a cheetah here at Woodland Park Zoo.

The induction of ovulation in the African lion (*Panthera leo*) with exogenous hormones was reported by Sadleir in 1968, and the induction of estrus in the bobcat (*Lynx rufus*) and jungle cat (*Felis chaus*) by Colby in 1974. Sadleir demonstrated success in all three instances by necropsy and histopathological techniques while Colby used laparotomy and radioimmunoassay. At this time it would be impossible to use laparotomy under zoo conditions and radioimmunoassay would require immobilization of the animal prior to collecting the blood samples. It was decided that an attempt would be made to evaluate the animal's ovarian response to hormones using behavioral criteria.

Little is known about the cheetah's estrous cycle. Eaton and Craig (1973) observed that mating activity is most frequent during July, August and September in the northern temperate zone. At the San Diego Wild Animal Park most sexual activity has occurred in July-August and December-January (Herdman, 1972). The duration of estrus is, on the average, no more than two weeks with an inter-estrus period of at least two weeks (Eaton and Craig, 1973). Females have conceived at 21 months of age (Herdman, 1972). The female will recycle if the litter is lost shortly after birth (W. Higgins, pers. comm.).



## Materials and Methods

The three cheetahs used in this experiment were:

Male - named "Jim" - WD-1 - arrived at Woodland Park Zoo, February 1972, at an estimated age of two years. No personal history was received from the animal dealer on arrival except that he was wild-caught. When introduced to the two females he was dominated by the older female (WD-2). We assumed he was sexually inexperienced. He is a large attractive animal and has had no medical problems.

"Cheena" - WD-2 was born in 1964 and was received at Woodland Park Zoo in 1964. No other history is available. She has been housed with three successive males, and was observed copulating on several occasions with the first male but with no resulting pregnancy. The last copulation was reported in 1967. She was treated for acute pancreatitis on two occasions and for lung worms in 1973.

"Pet" - WD-3 was born in 1967 and arrived at Woodland Park Zoo in 1968. She had been kept as a personal pet by an animal dealer and was tractable. She showed a strong social relationship with Cheena (WD-2), lying next to one another, and social grooming between the two was frequently observed. She was treated for an abscessed carnassial tooth in 1971 and for lung worms in 1973. She has shown no signs of estrus during her six years at Woodland Park Zoo.

At the time of this study the above three animals were housed in an outside grotto previously used for tigers. The back portion of the grotto is overhung providing protection from rain and one of several gulleys under this protected area contains radiant heat for additional warmth. On the right central part of the grotto there is a tree with an artificial stream and pool below it while a moat separates the foremost portion from the public area.

The cheetahs were brought into the Feline House at 1530 hours each afternoon and during this experiment the two females were housed and fed separately from the male. The females were released into the grotto at 800 hours and the male was entered with them an hour later.

Behavioral observations were made for 30 minutes after the male was introduced to the females. The male was removed from the two females each night in an effort to stimulate activity and interaction during the observation period.



Observations commenced on 4 December 1973. A tape recorder was used and all behavioral activity was recorded. After the first week's observations, a check sheet was prepared so that the reproductive behavior data could be more readily isolated and tabulated. Separate sheets were kept on the male and female for comparison (Figure 1 and Figure 2).

The male check sheet consisted of behavior associated with a male's response to estrus: following the female (Figure 3); approaching the female, the flop response (Eaton and Craig, 1973); allo - and auto-grooming (Figure 4); investigative behavior (Figure 5), *Flehmen* (Leyhausen, 1956) (Figure 6); encountering the female, vocalization, urine marking and defecation.

The term investigative behavior was used to describe the male's examination of the various areas of the grotto where the female had urinated, defecated, or otherwise left her scent. There were three postures that were used while these areas were visually examined, sniffed and sometimes licked: (1) the standing posture; (2) front crouch; and, (3) full crouch. They were recorded separately on the check sheet to see if there might be a direct correlation between the posture and intensity of the behavior.

An encounter was differentiated from an approach in that an encounter was required to demonstrate physical contact. This was usually in the form of pawing or boxing, mouthing or perineal investigation.

An attempt was made to categorize vocalizations as to "eeow", stutter call, growl or chirp, after Eaton and Craig (1973). This proved to be difficult because of the acoustics of the grotto and the distance between animals and observer. In the final summation only the "eeow" vocalization had been recorded.

The female check sheet consisted of rolling, flop response, head and neck rubbing, vocalizations, investigative behavior, grooming, *Flehmen*, encounters male, approaching male, following male, urination and defecation.

Pregnant Mares Serum Gonadin (P.M.S.G., Cutter Laboratories) was selected as the hormone of choice for the induction of estrus because of its known effects in stimulating follicle development. The dosage selected was arbitrarily based on that recommended by the manufacturer for the domestic dog with the



Figure 1. Woodland Park Zoological Gardens

Check Sheet for Male's Response to Estrus.

Date:

Weather:

Time observation begun:

Time observation completed:

SOCIAL:

1. Follows female
2. Approaches female
3. Encounters female (physical contact is made)
  - a. Pawing (foot to body contact)
  - b. Mouthing or nipping
  - c. Perineal investigation
  - d. Attempt to mount
4. Vocalization
  - a. Growl
  - b. Eeow
  - c. Other
5. Flop response (lateral recumbency while orienting toward female)
6. Grooming
  - a. Grooms WD-2
  - b. Grooms WD-3
  - c. Auto-grooming

SOLITARY:

1. Marking
  - a. Treading back feet
  - b. Treading front feet
  - c. Tail-flagging
2. Defecation
3. Investigative behavior
  - a. Upright position
  - b. Front crouch
  - c. Full crouch
4. *Flehmen*
5. Time inactive

COMMENTS:



## Figure 2. Woodland Park Zoological Gardens

### Check Sheet for Female Estrous Behavior

Date:

Weather:

Time observation begun:

Time observation completed:

Observer: \_\_\_\_\_

#### SOCIAL:

1. Follows male
2. Approaches male
3. Encounters male (physical contact is made)
  - a. Pawing (foot to body contact)
  - b. Mouthing or nipping
  - c. Perineal investigation
4. Vocalization
  - a. Growl
  - b. Eeow
  - c. Other
5. Flop response (lateral recumbency while orienting toward male)
6. Grooming
  - a. Grooms male
  - b. Grooms female
  - c. Auto-grooming
  - d. Ano-genital grooming
7. Rolling

#### SOLITARY:

1. Head and neck rubbing
2. Urinating
3. Defecation
4. *Flehmen*
5. Investigative behavior
6. Rolling
7. Time inactive during observation period

#### COMMENTS:



Figure 3. Male cheetah showing following behavior during estrus.

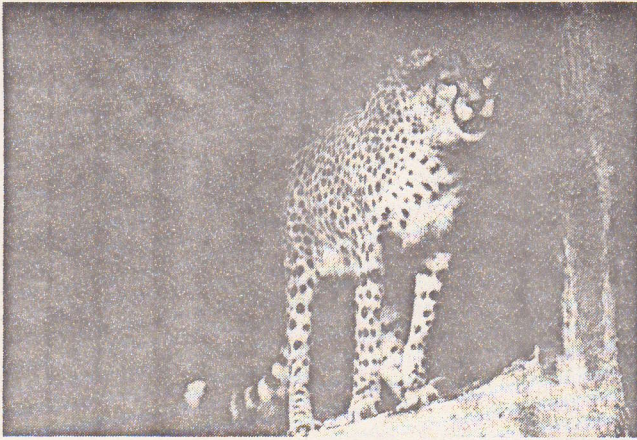


Figure 4. Allo-grooming between male and female (right) cheetahs.



Figure 5. Male cheetah showing investigative behavior in front crouch.

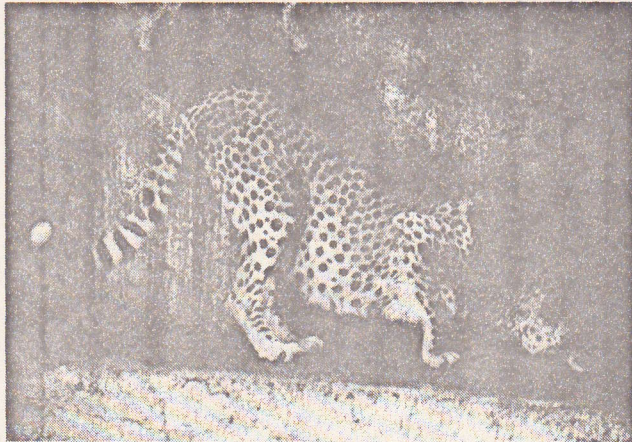


Figure 6. Male cheetah showing *Flehmen* following investigative behavior.

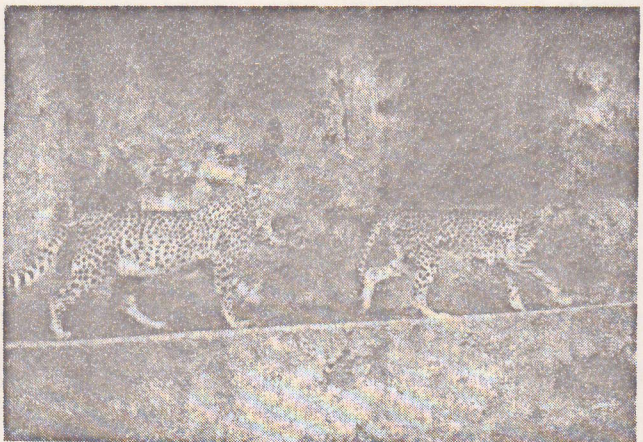
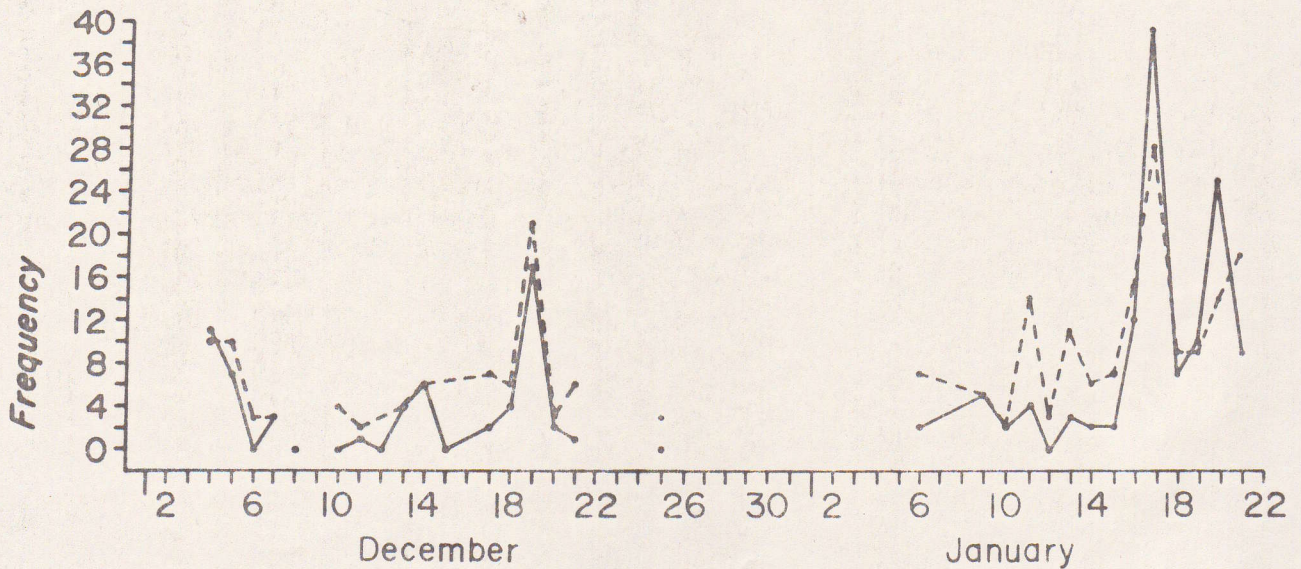


Figure 7. Point totals of male and injected female (solid line) from daily check





exception that the physiological approach (Colby, 1974) requiring a series of small daily doses after the initial injection was used.

"Cheena" (WD-2) was selected as the subject and injections were begun on January 8, 1974. The following dosage schedule was used:

January 8, 1974	500 IU	PMSG
January 9, 1974	250 IU	"
January 10, 1974	250 IU	"
January 11, 1974	250 IU	"
January 12, 1974	250 IU	"

All injections were given subcutaneously in the para-lumbar area while the animal was restrained in a squeeze cage.

### Results and Discussion

Analysis of the data collected indicated that four criteria -- approaching and following female, flop response and grooming -- were significant in evaluating the male's response to estrus (Table 1 and 2). The other items on the check sheet showed either no correlation or, as in marking, investigative behavior, and *Flehmen*, an inverse correlation. The decrease in these three behavior patterns would appear to be the result of the increase in time spent following, approaching and interacting with the female as she came into estrus. *Flehmen* was noted most often following investigative behavior of marking areas, so a reduction in that activity would naturally decrease the frequency of the other. In the future it would be wise to record male *Flehmen* following anogenital investigation separately as it would have greater significance in that context.

When the female data were evaluated it was evident that all behavior patterns listed on the check sheet showed close correlation with estrus (Tables 1 and 2). Rolling, flop response, head and neck rubbing, showed the strongest correlation, with the "eeow" vocalization, investigative behavior and auto-grooming also showing a dramatic increase in frequency. Following the male, urination and defecation were infrequent, but since a correlation was noted they were included in the list of estrous behavior; their points were also used in tabulating the final graph (Figure 7). They do not appear to be primary criteria for estrus.

A single point value was assigned to each behavior pattern used and the totals were then plotted against time (Figure 7).



Table 1. Frequency of Behavioral Patterns Recorded on Check Sheets, December, 1973.

Criteria for Male Cheetah's Response to Estrus

DECEMBER	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
Follows Female	5	1	1							1	1					4								
Approaches Female	4	6	2	2			4	1		2	5			4	3	12	2	3						3
Flop Response	1	1	1						1					2	2	3	1	3						
Grooming		2						1						1	1	2								
Sub-Total	10	10	3	3			4	2	4	4	6			7	6	21	3	6						3
Investigative Behavior	3	4	7				10	7	4	8				9	11	18	4	13						14
Encounters Female	3	5	3	4			1	1	5	3				1	1	5	2	2						1
Vocalizations	3	4	7	1			4	2	3	10				8	8	8	5	3						8
Marking	1	1	1						1	1				1	1	1	1	1						1
Defecation	1	2	1	2			5	4	5	8				1	7	10	3	7						3
Fleehen	18	25	19	17			24	16	22	36				27	34	63	16	32						30

Criteria for Cheetah Estrous Behavior

DECEMBER	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
Rolling																								
Flop Response																								
Head and Neck Rubbing														2	2	2		1						1
Vocalizations	4	2		2					1	1	3				1	3	1							
Investigative Behavior																								
Grooming	1	1																						
Fleehen	4	1	5	1			1	1	5	5	5			2	6	17	1	4						5
Encounters Male	4	1	1						1	1	2					9	1							
Approaches Male																								
Follows Male																								
Urination	2	1																						
Defecation	15	8	5	4			1	2	9	11				4	10	34	3	5						6
TOTAL	15	8	5	4			1	2	9	11				4	10	34	3	5						6



Table 2. Frequency of Behavioral Patterns Recorded on Check Sheets, January, 1974.

Criteria for Male Cheetah's Response to Estrus

JANUARY	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Follows Female				4	1	7	4	2	5	6	2	3	6	7
Approaches Female		3	1	4				2	5	12	3	4	5	7
Flop Response		1	1	6	2	4	1	1	1	9	2	2	3	3
Grooming		1		4			1	2	4	1	2			1
<u>Sub-Total</u>	<u>5</u>	<u>2</u>	<u>14</u>	<u>3</u>	<u>11</u>	<u>6</u>	<u>7</u>	<u>15</u>	<u>28</u>	<u>9</u>	<u>9</u>	<u>14</u>	<u>18</u>	<u>18</u>
Investigative Behavior		14	10		3	15	4	2	5	2	2	11	9	1
Encounters Female		3	3		6	8	1	5	5	3	3	2	6	3
Vocalizations				3										
Marking		6	6	6	3	7	5	2	2	3	2	4	5	2
Defecation		1	1	1		1	1			1			2	2
<i>Flehmen</i>		3	5	2	2	8	4	1	2	1	2	2	7	2
<u>TOTAL</u>	<u>32</u>	<u>27</u>	<u>26</u>	<u>17</u>	<u>50</u>	<u>21</u>	<u>15</u>	<u>29</u>	<u>38</u>	<u>16</u>	<u>28</u>	<u>43</u>	<u>26</u>	<u>26</u>

Criteria for Cheetah Estrous Behavior

JANUARY	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Rolling									2	14	2		8	
Flop Response				1		1			1	1	2			
Head and Neck Rubbing									6	6	1	1	2	6
Vocalizations		3	1		2		1		4	6	1	1	1	2
Investigative Behavior		2	1	3			2	1	2	1	1	2	1	1
Grooming									3	8		3	11	
<i>Flehmen</i>										1	1			
Encounters Male			1			8		5	5	21	4	1	9	8
Approaches Male										1	1	2		
Follows Male										1			1	
Urination													1	
Defecation													1	
<u>TOTAL</u>	<u>0</u>	<u>5</u>	<u>3</u>	<u>4</u>	<u>0</u>	<u>11</u>	<u>2</u>	<u>7</u>	<u>17</u>	<u>60</u>	<u>13</u>	<u>10</u>	<u>34</u>	<u>17</u>



It would appear that Cheena (WD-2) was showing signs of estrus during the early observations. On the 19th of December a high point count occurred as a result of following behavior by the male and a high frequency of approaches by both animals. The flop response was noted by the male on three occasions and by the female once. The next day, 20 December, activity was greatly reduced by heavy rain during the entire observation period.

The first signs of estrus resulting from the PMSG were on January 12th. The male was inadvertently let into the grotto 25 minutes before the observer arrived, thus seriously influencing the point total for that day. I entered the grotto with them to stimulate activity and observed almost continuous following of the female by the male, plus numerous "eeow" vocalizations and a flop response by the female. The male was also exhibiting a penile erection while following the female. The frequency of estrous behavior reached its peak on January 17th and then tapered off over the next few days. It is interesting to note that heavy rain occurred on the 18th of January and the point count was reduced considerably. The male and female had also been left together overnight for the first time since observations had begun in hope of promoting copulation. This, too, could have reduced frequency of activity during the observation time.

In the management of captive felids, the detection and control of estrus are extremely important to successful reproduction. This is especially true in the cheetah which, until recently, has had an incredibly poor reputation as a captive breeder. The above study indicates the PMSG will provoke estrous behavior in the cheetah. Since copulation and resulting pregnancy did not occur, without laparotomy or radioimmunoassay we can only speculate as to whether a true heat or physiological estrus had been induced.

I would conclude, however, that a behavioral check sheet can be used as a valuable management tool in determining estrus in the female and response to estrus by the male cheetah.

#### Acknowledgements

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