

OESTROUS CYCLE OF THE ASIATIC ELEPHANT, *ELEPHAS MAXIMUS*, IN CAPTIVITY

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Summary. During the course of a programme to breed the Asiatic elephant, *Elephas maximus*, in captivity, the oestrous cycles of eleven adult females were studied. Two methods were used for detecting oestrus: (1) daily testing with a male elephant, and (2) urogenital smear cytology.

Overt signs of oestrus were not observed but 'standing' oestrus was detected in ten animals. The duration of oestrus ranged from 2 to 8 days with a mode of 4 days. Oestrous cycles in six animals ranged from 18 to 27 days with a mean of 22 days. Urogenital smear cytology failed to indicate accurately the onset of behavioural oestrus but increases in the number of cornified cells may occur before, during and slightly after behavioural oestrus. Considerable mating activity occurred during oestrus. A description of mating behaviour is presented.

The findings are discussed in relation to breeding elephants in captivity and to the phenomenon of temporal gland activity.

INTRODUCTION

In Ceylon, as in many other countries in South-East Asia, the Asiatic elephant, *Elephas maximus* has been kept in captivity since the earliest days of recorded history. Despite its close association with man, basic information regarding many aspects of reproduction (births in elephants in captivity are still not regularly observed) is surprisingly lacking for this mammalian species. In general, there have been few scientific studies on reproduction of the Asiatic elephant except for reports on incidental observations on mating and parturition (Slade, 1903; Anghi, 1962; Maberry, 1962; Buss & Smith, 1966; Dittrich, 1966; Krishne Gowda, 1969). With any species which has been closely associated with man, the untrained observer is likely to be anthropomorphic and much of the information on the Asiatic elephant has, therefore, been anecdotal in nature.

In 1969, a programme was undertaken to ascertain if elephants could be bred in captivity. During the course of this programme, observations on many facets of the reproductive physiology of the Asiatic elephant were made. Studies on the semen (Jainudeen, Eisenberg & Jayasinghe, 1971), and reproductive behaviour (Eisenberg, McKay & Jainudeen, 1971) of the Asiatic elephant were reported previously.

The purpose of the present paper is to furnish a description of the oestrous cycle of the captive Asiatic elephant, *E. maximus*, and deals with the following: (1) the procedure employed to detect oestrus; (2) duration of oestrus and the oestrous cycle; and (3) the diagnostic value of the urogenital smear in detecting behavioural oestrus.

ANIMALS AND METHODS

General considerations

The animals used in this study belong to a population of 532 captive elephants living in Ceylon (Jayasinghe & Jainudeen, 1970). All animals were captured at an approximate age of 3 to 5 years and after being trained to obey commands, they commenced working at the age of 12 to 15 years. Each animal is privately owned and has a keeper who is responsible for feeding, bathing and working the animal. At night, each animal is secured by chains either to a strong post or to a tree. There was very little opportunity for animals to

TABLE 1
EXPERIMENTAL DESIGN

<i>Exp.</i>	<i>Location</i>	<i>Male-female combinations</i>		
1	Hingula	♂1 (27)	♀1 (22)	♀2 (18)
2	Alawwa	♂2 (35)	♀3 (28)	♀7 (35)
		♂4 (22)	♀4 (30)	
		♂7 (25)	♀9 (30)	
3	Colombo	♂3 (18)	♀5 (26)	
4	Matale	♂5 (20)	♀6 (29)	♀8 (18)
		♂6 (12)*		
5	Kandy	♂8 (32)	♀10 (23)	♀11 (40)

Age of animals in years is given in parentheses.

* Animal discarded from experiment.

associate with one another either during the day or night. An analysis of fifty-two case histories of captive elephants revealed that keepers, though closely associated with their animals, could not recognize any overt signs of behavioural oestrus such as a change in behaviour or a change in the external genitalia.

Experimental animals

A breeding programme was established at five locations during the period January 1969 to February 1970. Eleven mature females (aged 18 to 40 years) and seven males (aged 12 to 35 years) were used in this study. The experimental design is presented in Table 1. Only one female (♀1) had given birth on a previous occasion. All males, with the exception of ♂3, ♂5 and ♂6, had a history of having been in 'musth', but no male showed any signs of 'musth' at the beginning of these experiments.

Detection of oestrus

Observations for oestrus were made daily during the morning hours by allowing a male access to a particular female. Elephant pairs were brought together in sequence in quiet, isolated surroundings. Observers and keepers stayed at some distance so that pairs were not distracted. At the end of the 60- to 90-min test period, pairs were separated and each animal followed its normal daily routine of bathing and feeding until the next day. 'Oestrus' was defined as the period during which the female stood to be mounted by the male. The 1st day of oestrus was regarded as Day 1 of the oestrous cycle. Each male was allowed to copulate with its mate on all days of oestrus.

Urogenital smears

The long urogenital canal in the female elephant made it very difficult to obtain smears from the vagina. Samples were, therefore, obtained from the upper half of the urogenital canal and are referred to in the text as 'urogenital smears'. Daily smears were obtained from each female before they were checked for oestrus. Animals were restrained in the standing or laterally recumbent position and a 45-cm disposable polystyrene bovine artificial insemination pipette with a 2-ml rubber bulb fitted at one end was introduced along the dorsal wall of the urogenital canal. The aspirated contents were smeared on two microscope slides, fixed in 90% alcohol-ether mixture and stained according to the method of Shorr (1940). Smears, examined microscopically, were scored for relative numbers of cornified epithelial cells, young epithelial cells, leucocytes and erythrocytes.

RESULTS

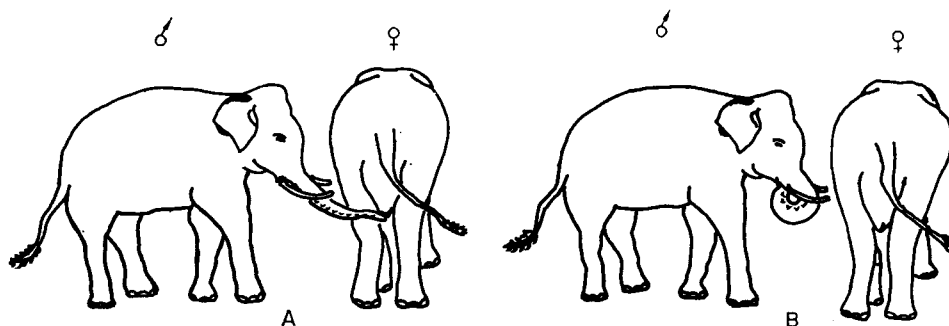
Oestrous cycle

Male-female encounters. Observations of sexual behaviour during male-female encounters indicated that the male played an active rôle in detecting oestrus. On initial contact, the male used the tip of the trunk to 'smell' the vulval orifice and/or the clitoris, and in some instances the female's urine; the tip of the trunk was then inserted into his mouth. We have termed this chain of events, the 'urine test' (Text-fig. 1). The frequency of urine testing altered significantly during various phases of the cycle. During dioestrus, after the initial urine test, the male paid no further attention to his partner for the rest of the observation period. In pro-oestrus, frequency of testing increased and in oestrus, the testing decreased considerably, followed by a dramatic increase in frequency as the females passed out of oestrus.

During oestrus, the male's behaviour changed immediately after the initial urine test. Instead of moving away from his partner, the male raised his head to 'reach over' her shoulder or flank with his trunk (Pl. 1, Fig. 1). Strongly correlated with reach over was the attainment of an erection (Pl. 1, Fig. 2). After a period of courtship, the male orientated himself and rested his chin and throat on her rump (Pl. 1, Fig. 3). Oestrous females responded to the chin-resting by 'standing' to be mounted (Pl. 1, Fig. 4), but non-receptive females responded by exhibiting antagonistic behaviour. Occasionally, males would

make unsuccessful attempts to mount females in dioestrus. There was, thus, very little opportunity for a male to copulate with a non-receptive female.

The duration of each mount ranged from 30 to 60 sec. Intromission was extremely brief (10 to 15 sec) and involved the engaging of the vulva by the upwardly curved distal end of the erect penis. Since pelvic movements or an ejaculatory thrust were not evident, it was difficult to determine if ejaculation occurred at every intromission. On each day of oestrus, three to eight mountings were recorded during the 60- to 90-min observation period, but intromission was achieved in less than 20% of the mountings.



TEXT-FIG. 1. Sequence illustrating 'urine testing' to detect oestrus. The male 'sniffs' the female genitalia with the tip of his trunk (A) and immediately inserts the tip of his trunk into his mouth (B).

Signs of oestrus. Females in oestrus did not display any overt signs of oestrus. For example, behavioural changes, swelling and discharge from the vulva were absent. The only indication of oestrus was the willingness of the female to stand for the male to mount her.

Duration of oestrus. Oestrus was observed in ten of the eleven females during the 1st month of the observation period. Female 6 exhibited antagonistic behaviour and did not permit the male to mount her even though he showed

TABLE 2
DURATION OF OESTRUS AND THE OESTROUS CYCLE IN THE
ASIATIC ELEPHANT

♀	Observations commenced	First oestrus		Second oestrus		Oestrous cycle (days)
		Day 1	Duration*	Day 1	Duration*	
1	Jan 1	Jan 5	5	Feb 1	16	27
2	Jan 16	Jan 19	7	Feb 7	12	19
3	Sep 1	Sep 19	5	Oct 7	4	18
4	Sep 1	Sep 11	4	Oct 5	3	24
5	Sep 4	Sep 4	2	—	—	—
6	Oct 4	—	—	—	—	—
7	Oct 4	Oct 26	3	—	—	—
8	Oct 20	Nov 19	8	Dec 8	3	19
9	Oct 14	Oct 16	4	Nov 11	3	26
10	Feb 1	Feb 6	4	—	—	—
11	Feb 1	Feb 8	4	—	—	—

* Consecutive days of 'standing' oestrus.

PLATE 1



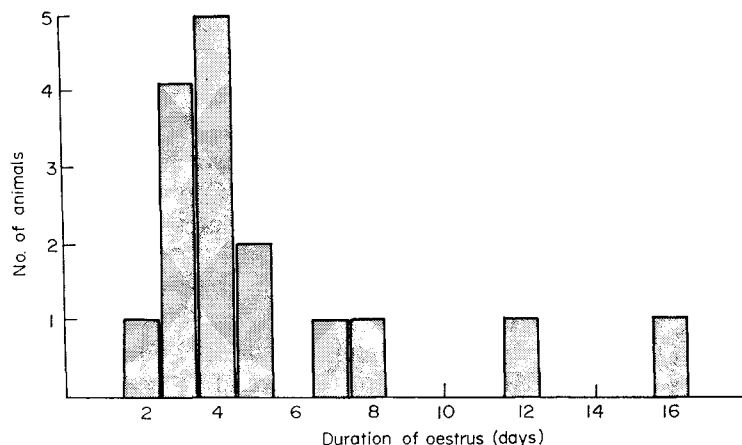
Figs. 1 to 4. Mating behaviour of the Asiatic elephant. Fig. 1 illustrates 'reach over'. The first expressions of male behaviour towards a sexually receptive female. Fig. 2. Male next responds with an erection. Fig. 3. Female in oestrus showing an 'immobility response' to chin-resting pressure by the male. Fig. 4. Female in 'standing' oestrus.

sexual interest. Out of a total of sixteen oestrous periods, fourteen lasted from 2 to 8 days with a mode of 4 days (Table 2 and Text-fig. 2), but the second oestrous period of ♀1 and ♀2 lasted 16 and 12 days, respectively.

Length of the oestrous cycle. The length of the oestrous cycles of six females ranged from 18 to 27 days with a mean of 22 days (see Table 2). One female (♀5) did not show a second period of oestrus. Observations on ♀7, ♀10 and ♀11 had to be terminated prematurely as ♂7 and ♂8 came into 'musth' and were intractable.

Urogenital smear

The cell types found in the urogenital smear of the elephant were classified on the basis of their morphology and their affinity for the 'Shorr stain'. Fully cornified cells were characterized by dark staining pycnotic nuclei with orange-red stained cytoplasm; they usually occurred in clumps. Partially cornified



TEXT-FIG. 2. Frequency distribution showing duration of oestrus in the Asiatic elephant.

cells and non-nucleated cells were also observed. Uncornified cells were of two types: a small round cell with a large centrally placed nucleus and a narrow rim of blue to green cytoplasm, and a large angular or round cell with a comparatively small nucleus. A few leucocytes and erythrocytes were also present.

Marked variations existed in the general appearance of the smears studied. Wide fluctuations in the percentage of cornified cells were seen in smears on successive days in a given animal. Female 5 yielded very few cells during behavioural oestrus; the smear contained cellular débris which stained orange-red. Rhythmic fluctuations in the percentage of cornified cells with pycnotic nuclei were observed in the smears of six animals, but there was considerable individual variation as to the extent and exact time in the cycle at which this occurred. For example, the highest percentage of cornified cells were observed during behavioural oestrus in ♀1, ♀2 and ♀3; but increases in cornified cells occurred a few days preceding or following behavioural oestrus in ♀4, ♀7 and

♀9. Neither leucocytes and erythrocytes which were occasionally observed, nor the uncornified cells exhibited any cyclic pattern. Thus, the onset of oestrus in the captive elephant could not be clearly identified by the urogenital smear, although increases in the numbers of cornified cells were noted on or about the time of oestrus.

DISCUSSION

Certain important differences exist between the techniques used for breeding elephants in foreign zoos and captive elephants in Ceylon. In zoos, elephants are kept together for long periods with no competing demands on their time but, in Ceylon, it is very uneconomical to keep elephants away from work for long periods. Precise determination of biological events and the optimum time to breed each female is, therefore, necessary to minimize the time taken from regular work. Thus, the approach made in the present study resembles more the highly controlled breeding practices adopted for domestic animals rather than the wild/tame matings of elephants in India and Burma or the time consuming techniques adopted in zoos.

There are several reports on successful breeding of the Asiatic elephant in zoos (Anghi, 1962; Maberry, 1962; Dittrich, 1966; Krishne Gowda, 1969), but no information is available on the duration of oestrus or the oestrous cycle. According to Asdell (1964), the Asiatic elephant is polyoestrous and in captivity, oestrus lasts for 3 to 4 days. The results of the present study confirm this view.

External manifestations of oestrus, especially in domestic animals, are well known. In no instances did captive elephants in the present study show external signs of oestrus, confirming previous reports (Slade, 1903; Evans, 1910; Benedict, 1936; Ferrier, 1948). A feature that could be utilized for detecting oestrus is the sexual interest of the male towards a female in oestrus. Olfactory stimuli play an important rôle in the male's ability to detect oestrus, probably from a specific odour emanating from the female genitalia. After 'sniffing' and/or touching the genitalia or the urine of his partner, the male inserts the tip of his trunk close to an orifice located on the roof of his mouth. We have termed this 'urine testing' (Eisenberg *et al.*, 1971) and consider it to be comparable to the 'flehmen' reaction shown in ungulates. Jacobson's organ possessing olfactory epithelium is present in the foetal elephant (Eales, 1925); if this organ is functional in the adult, it could well be involved in discrimination of oestrus.

Detecting oestrus by noting mating activity may, at times, be laborious and could be a limiting factor in breeding elephants in captivity. If, however, oestrus could be predicted without resorting to daily teasing with a male, then the time taken from regular work could be minimized.

Changes occur in the vaginal smear of several mammalian species during the oestrous cycle. It is most valuable, however, in laboratory rodents and the bitch (Nalbandov, 1964) for in them, vaginal cytology reflects ovarian events most accurately. In domestic animals, e.g. the cow (Hansel, 1959), mare (Berliner, 1959), and ewe (Robinson, 1959), vaginal smears are less reliable

indicators of ovarian events. In the elephant too, no characteristic patterns in the urogenital smears were observed and the onset of oestrus could not be clearly identified.

In this study, it was not possible to determine if ovulation occurred in each of the cycles studied but at least in the African elephant, *Loxodonta africana*, ovulation probably occurs at every oestrous cycle (Short, 1966).

The relationship of temporal gland activity to reproduction in the elephant remains obscure. In the African elephant, temporal glands are active at all ages in both sexes and may also be related to reproductive activity (Perry, 1953). However, in the Asiatic elephant, the gland is sexually dimorphic and the secretory activity is observed only in adult males.

The results of the present study show that the temporal glands in the female Asiatic elephant do not secrete during oestrus. A similar observation has been reported for the African elephant (Short, 1966). By contrast, there are numerous allusions to a possible connexion between male sexual behaviour and 'musth' in the Asiatic elephant. 'Musth' in captive males is characterized by episodes of aggressive behaviour and discharging temporal glands. In the present study, no male was in 'musth' at the time of mating, confirming previous observations (Slade, 1903; Hundley, 1922; Wilson, 1922; Anghi, 1962; Maberry, 1962; Dittrich, 1966) that, in captivity, the Asiatic elephant is capable of mating when not in 'musth'. An interesting finding in the present study was the unexpected occurrence of 'musth' in five males within 1 to 2 months of mating. It seems possible that sexual activity, or perhaps prolonged contact with an oestrous female, might be an important factor inducing 'musth' in the male Asiatic elephant. Further studies are needed, however, to confirm this view.

This study has necessarily been short-term due to unavoidable circumstances and to the occurrence of musth in male elephants. It was not possible to establish if females in this study experienced several sterile oestrous cycles before conceiving as has been observed in the African species (Perry, 1953; Short, 1966). The number of animals that conceived is not known since there are no reliable signs of pregnancy nor any accurate method of diagnosing pregnancy in the elephant. The success of these matings can only be ascertained on the birth of calves.

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