# THE LENGTH OF THE OESTROUS CYCLE IN THE UNMATED NORMAL MOUSE: RECORDS OF ONE THOUSAND CYCLES

By A. S. PARKES,

Beit Memorial Research Fellow.

(From the Department of Physiology and Biochemistry, University College, London.)

(*Received 5th January* 1928.)

(With Three Text-figures.)

CONTENTS.

| | | PAGE |
|---|---|---|
| 1. | Introduction | 371 |
| 2. | Methods and material | 372 |
| 3. | Total length of the cycle in the unmated female | 373 |
| 4. | Length of meta-oestrus and dioestrus combined | 374 |
| 5. | Length of pro-oestrus and oestrus combined | 375 |
| 6. | Summary | 376 |

## 1. INTRODUCTION.

In an earlier paper (4) a variety of aspects of the oestrous cycle of the mouse was dealt with, but comparatively little attention was paid to the length of the cycle in the unmated normal mouse. The records of more than 1000 cycles in normal unmated female mice are now available, and it is hoped that this material, which is analysed in the present paper, will serve as a standard for the colony, and will make possible the easy comparison of experimental and control material.

Accurate investigation of the oestrous cycle of the mouse has only been possible since the application to this animal by Allen (1) of the vaginal smear technique first elaborated by Stockard and Papanicolaou (6) on the guinea-pig. Earlier observers mated the females in order to detect oestrus, and in cases where the matings were sterile, the interval between copulations was considered as the length of the cycle. Using this method, Lataste (2) placed the length of the cycle at 10 days. Other workers, starting their observations at the immediate post-partum oestrus, were led to put the length of the cycle at 20 ± days.

The application to the mouse, however, of the vaginal smear technique very soon showed that for the length of the oestrous cycle in the normal unmated mouse neither of these results was correct. Allen (1) found that the peak of the frequency curve for length of cycle in the unmated female fell at 4–5 days. Since the curve is, however, skew in the direction of long cycles, the mean length is somewhat greater

than this, though Allen does not give the figure or the data required for its calculation.

In an earlier paper (Parkes (4)) the data for 56 cycles in unmated females were given and the average length was found to be 5·7 days. Sterile copulation, however, was found to prolong the cycle as in the case of the rat (Long and Evans (3)) and the average length in these circumstances was found to be 11·0 days. A second point of similarity with the rat was also observed in that after the immediate post-partum period, no further signs of oestrus are observed until the end of the normal lactation period (about 21 days). These results readily explained the excessive time given by earlier observers for the length of the cycle.

The data which are now available are only very briefly summarised in the present note. It is hoped later to attempt a complete statistical survey of the material, which would throw light on:

(*a*) Individual idiosyncrasy in the length of cycle and in the length of its phases.

(*b*) Relation between the length of dioestrus and the duration of the succeeding oestrous symptoms.

(*c*) Influence of season on the length of cycle and its phases.

## 2. METHODS AND MATERIAL.

*Detection of oestrus*. The detection of the oestrous cycle has in all cases been carried out by means of the vaginal smear technique mentioned above (Allen (1) and Parkes (4)). No attempt is made in this paper to distinguish pro-oestrus from oestrus, or meta-oestrus from dioestrus, the former pair are considered together as "oestrus" and the latter pair as "dioestrus." In all cases a cycle is considered as running from the beginning of dioestrus to the end of oestrus.

*Material.* 1000 cycles were observed in 189 fully adult normal mice of the colony, in each of which in the majority of cases some 5–10 cycles were observed.

One important point is that except in cases where the cycle was obviously being influenced by pathological factors, no selection of the material whatsoever has been made, the data representing the first 1000 cycles (as defined above) observed in definitely normal unmated animals since the 56 previously reported. In a few cases cycles with long dioestrous intervals almost certainly associated with ill health of the animal (diarrhoea, chill, etc.) have been omitted.

It has, however, been found impossible to incorporate in these data one type of unusual cycle, *i.e.* the apparent absence of any real cycle. Two types of this anomaly occur: (*a*) absence of any periodic cornification of the vagina; (*b*) persistent and almost uninterrupted cornification. Both of these conditions, when occurring in otherwise healthy animals, may be correlated with interesting abnormalties of the ovary. A number of these cases are now being collected, and it is hoped that they will throw considerable light on the mechanism of the oestrous cycle.

*Statistical methods*. The comparatively great variability of the oestrous cycle emphasises the obvious fact that the reliability of any mean value arrived at depends

on the amount and constancy of the data from which it is derived. For this reason any comparison of the cycles in normal and experimental animals is facilitated by the calculation of a probable error. The method adopted here is to work out the frequency distribution, calculate $\sigma$, and then the probable error in the ordinary way. The validity of this method as applied to this type of data has been discussed elsewhere (Parkes (5)) and need not be referred to here beyond stating that neither of the possible objections to the course, *i.e.*:

(*a*) The skewness of the distribution;

(*b*) The possible idiosyncrasy in length of cycle of an individual animal;

are sufficiently pronounced to disturb the method.

## 3. TOTAL LENGTH OF THE CYCLE IN THE UNMATED FEMALE.

Owing to the amount of tabular matter involved, it is not proposed to give here the cycle formulae for individual animals; only the frequency distributions will be dealt with. Table I gives the distribution for total length of cycle.

Table I. *Frequency distribution for length of whole cycle.*

| Length in days | No. of cycles | Total days involved |
|---|---|---|
| 2 | 4 | 8 |
| 3 | 29 | 87 |
| 4 | 158 | 632 |
| 5 | 293 | 1465 |
| 6 | 218 | 1308 |
| 7 | 122 | 854 |
| 8 | 60 | 480 |
| 9 | 31 | 279 |
| 10 | 18 | 180 |
| 11 | 22 | 242 |
| 12 | 14 | 168 |
| 13 | 6 | 78 |
| 14 | 7 | 98 |
| 15 | 2 | 30 |
| 16 | 3 | 48 |
| 17 | 5 | 85 |
| 18 | 1 | 18 |
| 19 | 1 | 19 |
| 20 | 2 | 40 |
| 21 | — | — |
| 22 | 3 | 66 |
| 28 | 1 | 28 |
| Total | 1000 | 6213 |

For this distribution the following values are found:

Mean = 6·213 days — s.d. of mean = 0·0822

$\sigma$ = 2·598 — p.e. of mean = $\pm$ 0·0554.

This table gives a rather higher mean value than that found for the 56 cycles previously reported, but the difference is only half a day. The table shows the range in length of cycle to be from 2 to 28 days, the most common length of cycle being 5 days.

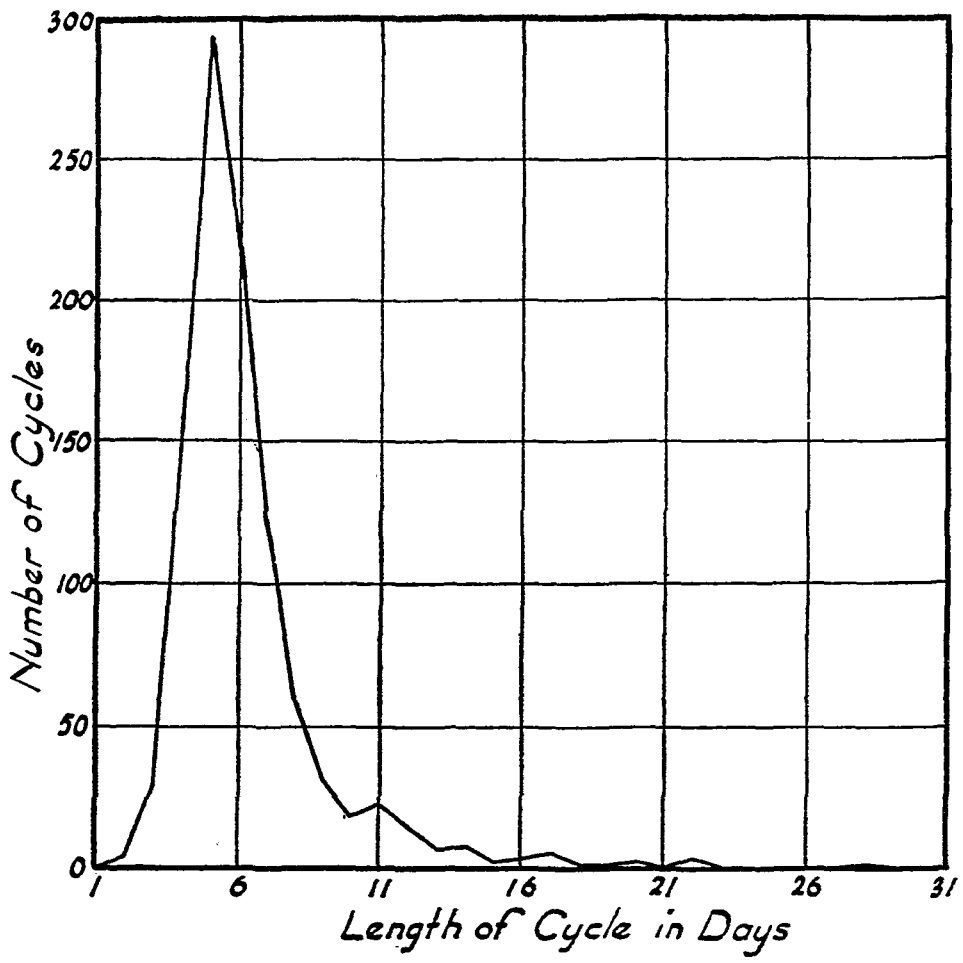


Fig. 1. Frequency polygon for length of whole cycle.

4. LENGTH OF META-OESTRUS AND DIOESTRUS COMBINED.

The frequency distribution for length of dioestrus is given in Table II.

Table II. *Frequency distribution for length of dioestrus.*

| Length in days | No. of intervals | Total days occupied |
|---|---|---|
| 1 | 11 | 11 |
| 2 | 232 | 464 |
| 3 | 386 | 1158 |
| 4 | 196 | 784 |
| 5 | 76 | 380 |
| 6 | 24 | 144 |
| 7 | 14 | 98 |
| 8 | 13 | 104 |
| 9 | 14 | 126 |
| 10 | 11 | 110 |
| 11 | 3 | 33 |
| 12 | 6 | 72 |
| 13 | 1 | 13 |
| 14 | 3 | 42 |
| 15 | 3 | 45 |
| 16 | 2 | 32 |
| 17 | 0 | — |
| 18 | 1 | 18 |
| 19 | 0 | — |
| 20 | 3 | 60 |
| 25 | 1 | 25 |
| Total | 1000 | 3719 |

The values given by this frequency are as follows:

Mean = 3·719 days — s.d. of mean = 0·0744

$\sigma$ = 2·356 — p.e. of mean = ± 0·0502.

This table shows that in this material the length of meta-oestrus—dioestrus varies from 1 day to 25 days, the most frequent length, however, being 3 days.

The frequency polygon for length of dioestrus is given in Fig. 2.

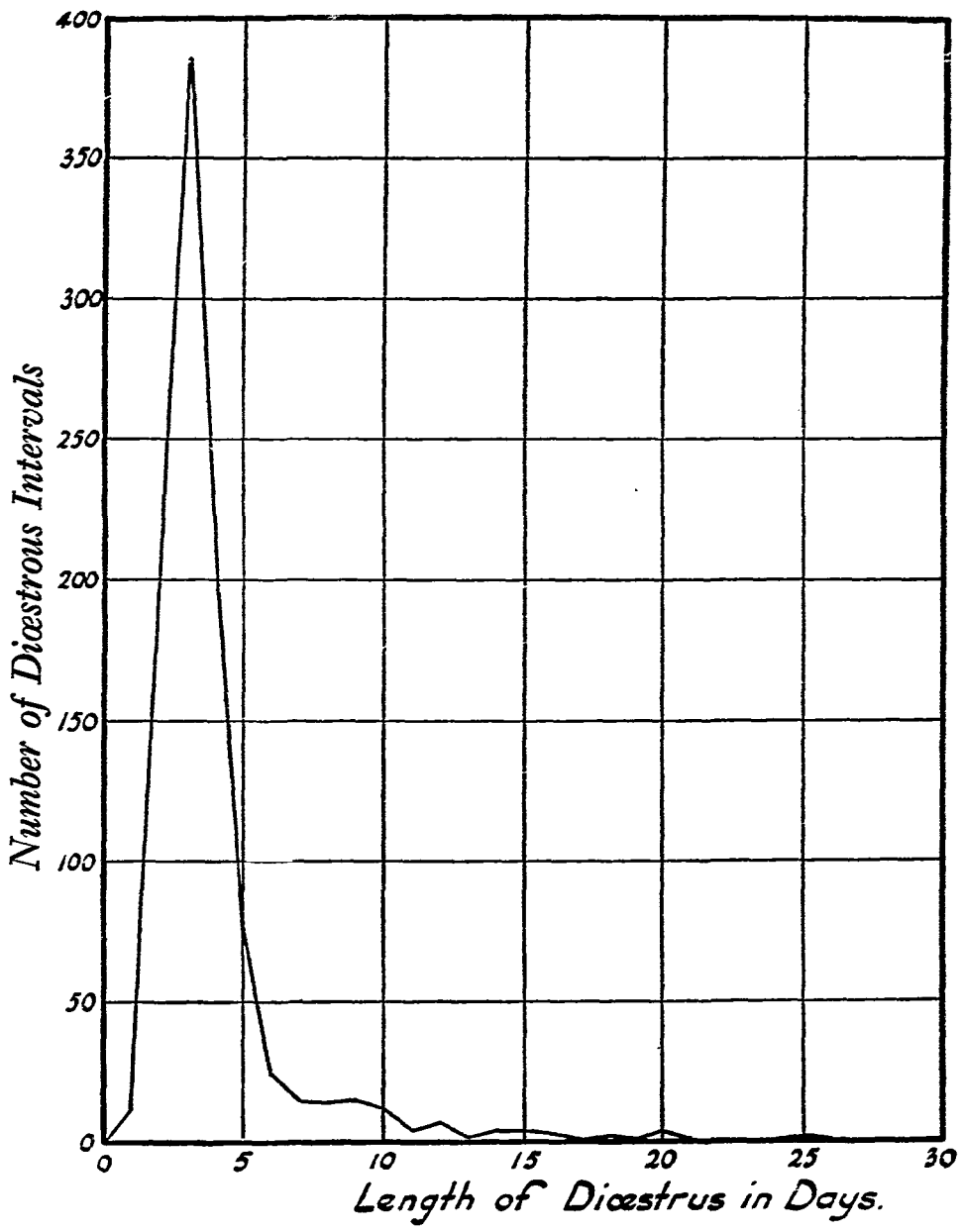


Fig. 2. Frequency polygon for length of dioestrus.

## 5. LENGTH OF PRO-OESTRUS AND OESTRUS COMBINED.

The frequency distribution for length of oestrus is given in Table III.

The following values are given by this distribution:

Mean = 2·494 — s.d. of mean = 0·0330

$\sigma$ = 1·043 — p.e. of mean = ± 0·0223.

This table shows well the remarkable restriction of the duration of oestrous symptoms to 2–3 days. 80 per cent. of the periods are of this duration, while 96 per cent. have a duration of 1–4 days. Cornification of greater duration than

this must therefore be considered as most unusual. The frequency polygon is given in Fig. 3.

Table III. *Frequency distribution for length of pro-oestrus and oestrus combined.*

| Length in days | No. of periods | Total days occupied |
|---|---|---|
| 1 | 85 | 85 |
| 2 | 522 | 1044 |
| 3 | 279 | 837 |
| 4 | 80 | 320 |
| 5 | 17 | 85 |
| 6 | 6 | 36 |
| 7 | 5 | 35 |
| 8 | 4 | 32 |
| 9 | 1 | 9 |
| 10 | 0 | — |
| 11 | 1 | 11 |
| Total | 1000 | 2494 |

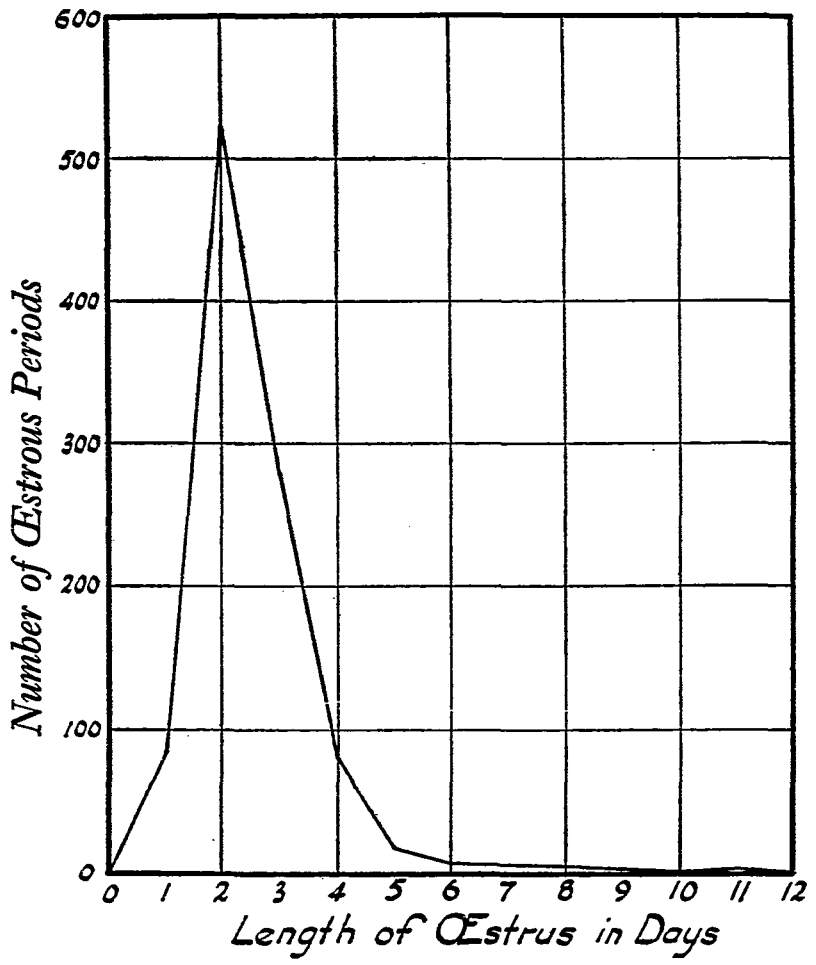


Fig. 3. Frequency polygon for length of pro-oestrus and oestrus combined.

## 6. SUMMARY.

Analysis of the records of 1000 oestrous cycles in the normal unmated mouse give the following results:

Mean length of whole cycle = 6·213 ± 0·0554 days.
Mean length of dioestrus (including meta-oestrus) = 3·719 ± 0·0502 days.
Mean length of oestrus (including pro-oestrus) = 2·494 ± 0·0223 days.

## REFERENCES.

(1) ALLEN (1922). *Amer. Journ. Anat.* **30.**
(2) LATASTE (1888). *Mem. Soc. Biol.* **40.**
(3) LONG and EVANS (1922). *Memoirs of the University of California*, **6.**
(4) PARKES (1926). *Roy. Soc. Proc.* B, **100.**
(5) —— (1927). *Roy. Soc. Proc.* B, **101.**
(6) STOCKARD and PAPANICOLAOU (1917). *Amer. Journ. Anat.* **22.**