

THE CORPUS LUTEUM OF THE INDIAN FRUIT BAT, *ROUSETTUS LESCHENAULTI* DESMAREST

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ABSTRACT

The corpus luteum of *Rousettus leschenaulti* occupies nearly the entire ovary and persists as such until the commencement of the next pregnancy, although on cytological basis it appears to become nearly defunct after the establishment of the placenta. The protracted persistence of the corpus luteum brings about physiological alternation of the two ovaries in successive cycles.

INTRODUCTION

THE Indian fruit bat, *Rousettus leschenaulti* breeds twice in the year in quick succession, the first cycle commencing in November with deliveries in the colony occurring during the following March, and the second cycle commencing soon after parturition and ending with deliveries late in July^{1,2}. Although the female genitalia are perfectly morphologically symmetrical, only one ovary releases an ovum and a single young is born in each cycle. There is a functional alternation of the two sides of the genitalia in successive cycles and this is brought about by the persistence of a large corpus luteum occupying almost the entire ovary until the commencement of the succeeding pregnancy³. The growth pattern and some observations on the cytology of the corpus luteum at different stages of its growth and regression are described in this paper.

MATERIALS AND METHODS

Specimens of *R. leschenaulti* were collected at frequent intervals from an underground tunnel near Bibi-Ka-Mukbara at Aurangabad during four successive years (1962-65), such that every calendar month is represented by several collections. The specimens were killed by chloroform and their genitalia dissected out, photographed and all measurements taken immediately. The genitalia were fixed in various fixatives, and after 24 hr of fixation the ovaries were processed by the usual histological technique and paraffin embedded tissues were serially sectioned at 5 to 8 μ thickness and the sections were stained with Ehrlich's or Harris' haematoxylin and counterstained with eosin, dehydrated by passing through graded ethanol and mounted in Canada balsam or DPX. A few sections

from each series were stained by the periodic acid-Schiff procedure⁴, some with and others without prior salivary digestion. Photomicrographs, detailed notes and all measurements were made soon after the slides were prepared.

OBSERVATIONS

Following ovulation the space vacated by the ovum becomes filled with extravasated blood. The granulosa cells increase rapidly in number and size and fill up the space occupied by the extravasated blood. Consequently the corpus luteum rapidly increases in size and occupies almost the entire ovary leaving only a small region near the hilus, where a few primary follicles remain. The enormous increase in the size of the corpus luteum is accompanied by the enlargement of the ovary, so that, when the corpus luteum reaches its maximum size the ovary increases by nearly four times its original size. This is attained by the time the embryo in the uterus reaches the late neural groove stage of development. After this the corpus luteum commences to undergo slow regression accompanied by a reduction in the size of both the corpus luteum and the ovary. However, the corpus luteum and the ovary remain large. With the commencement of the succeeding sexual cycle the corpus luteum and the ovary undergo rapid decrease in size until the embryo of the following pregnancy in the contralateral uterine cornu reaches the neural groove stage of development. After this stage the corpus luteum of the previous pregnancy disappears altogether, and the ovary reaches its original size at anestrus. In March-April, when pregnancy commences within a short period after parturition of the first cycle, the corpus luteum regresses very rapidly, but after

delivery in July after the second pregnancy cycle, the corpus luteum remains almost constant in size during the following anestrus period and commences to regress rapidly only after ovulation takes place in the contralateral ovary in November, and disappears only after the embryo in the contralateral uterine cornu reaches the neural groove stage of development. It is thus evident that, whereas the corpus luteum of the first pregnancy persists for about 5½ months, the corpus luteum of the second pregnancy remains for over 9 months. Figure 1 illustrates the pattern of growth and regression of the corpus luteum in the two cycles in this animal. The histological changes in the corpus luteum are the same during both the cycles. Immediately after ovulation the follicle undergoes a slight collapse and one or two cavities filled with extravasated blood remain in the ovulated follicle (figure 2).

The cells of the granulosa rapidly increase in number by mitotic division and also undergo hypertrophy with the result that not only the blood-filled spaces become occupied by the cells, but also there is a rapid increase in the size of the corpus luteum which occupies almost the whole of the ovary. Only a small part in the region of the hilus is not invaded by the corpus luteum (figure 3). At this stage the corpus luteum appears to be composed of three or four main lobes, the adjacent lobes being separated by bands of connective tissue (figure 4) composed of fusiform cells amidst which lie blood capillaries. The connective tissue partitions are derived from the theca folliculi which invade the growing corpus luteum from all the sides. At a slightly later stage of

development the corpus luteum occupies nearly the entire ovary and the ovary with the contained corpus luteum is nearly four times its original size. At this stage the luteal cells are polygonal or ovoid and each contains a spherical vesicular nucleus. The luteal cells appear to be arranged in rows (figures 5 and 6), the adjacent rows being separated by fine strands of connective tissue composed of fusiform cells amidst which occur blood capillaries. The partitions are formed as branches of connective tissue partitions formed earlier by the invasion by the theca folliculi. At its maximum stage of development the cells of the corpus luteum are enormously hypertrophied, each possessing a vesicular nucleus and a darkly staining nucleolus (figure 7). The cells contain large amounts of PAS-positive material (figure 8) in the form of fine granules, and thus the cells appear to be in an active secretory phase. The connective tissue partitions are less conspicuous than in the earlier stage. This stage is reached when the embryo in the uterus develops into the late neural groove stage.

After this stage the luteal cells progressively lose their vacuolation and become smaller, each having a darkly staining small spherical nucleus (figure 9). However, the size of the corpus luteum does not get appreciably reduced because of the accumulation of large amounts of intercellular fluid in the spaces formed by the shrinkage of the individual cells of the corpus luteum (figure 10). This condition remains until parturition after which there is a rapid decrease in the size of the cells of the corpus luteum and the cells become compactly arranged (figure 11). The connective tissue partitions disappear and the cells

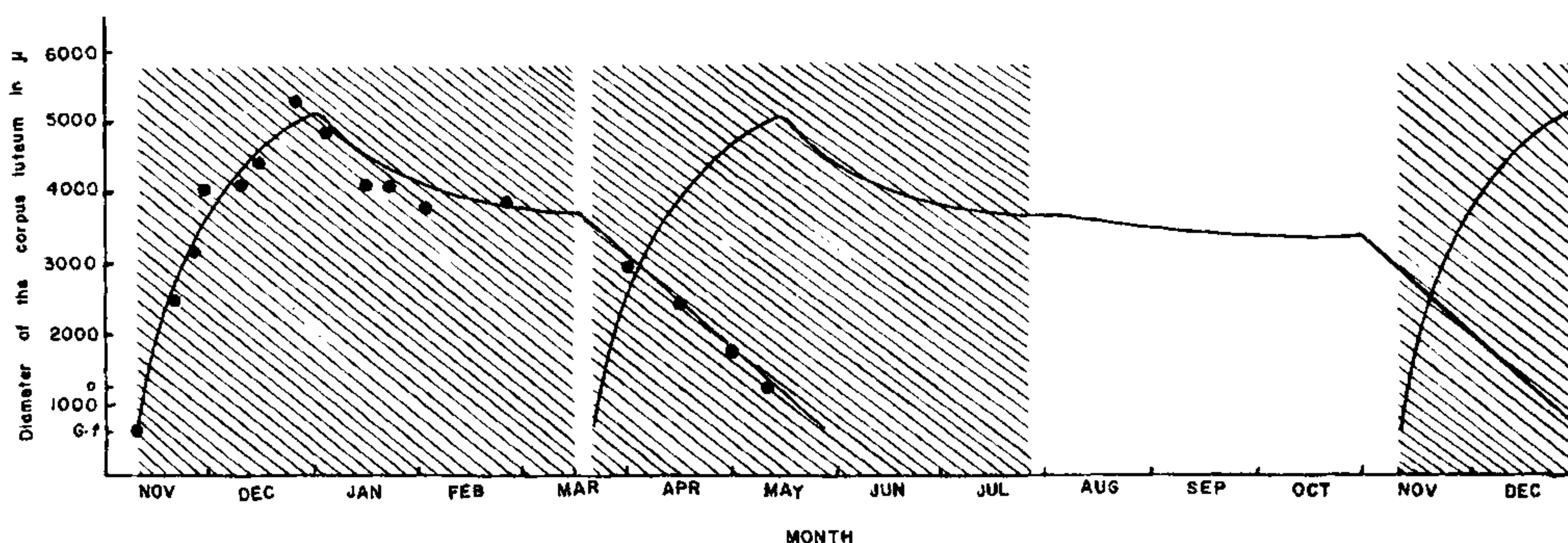
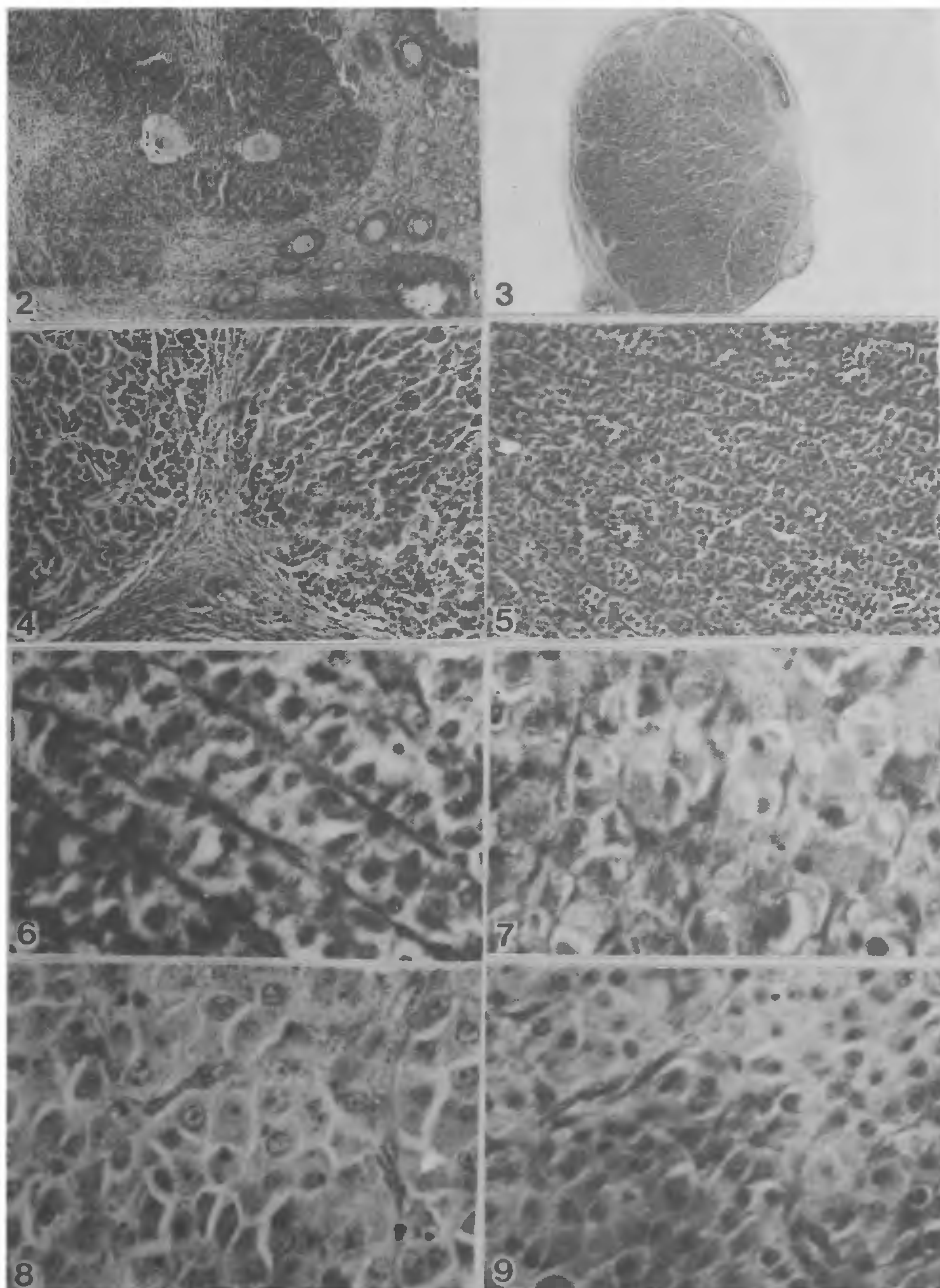
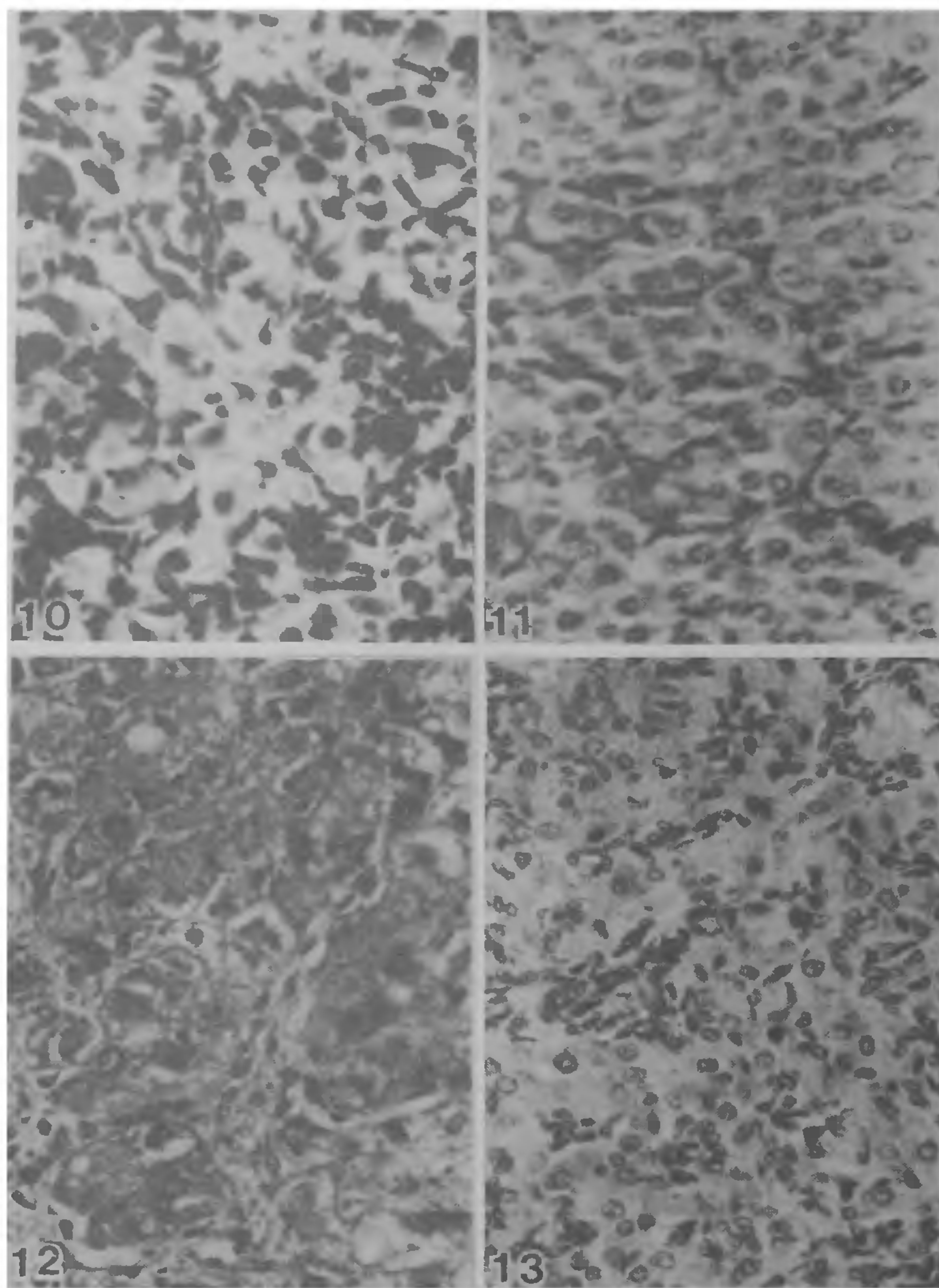


Figure 1. The increase and decrease in the size of the corpus luteum during the two pregnancy cycles in the year. G. f. Pre-ovulatory Graafian follicle; o, ovary.



Figures 2–9. Part of the section of an ovary with an early corpus luteum. Note the presence of two spaces containing blood ($\times 45$); 3. Ovary of a specimen containing an embryo in the free blastocyst stage of development. The corpus luteum occupies nearly the entire ovary ($\times 15$); 4. Part of the corpus luteum shown in 3. Note the fibrous partitions between adjacent lobes ($\times 85$); 5. Part of the corpus luteum of a specimen carrying an embryo in the neural groove stage of development. Note the occurrence of luteal cells in rows. ($\times 80$); 6. Part of figure 5 magnified ($\times 110$); 7. Part of corpus luteum of a specimen having an embryo in late neural groove stage of development for description ($\times 110$); 8. Part of corpus luteum of the same specimens as in figure 7. (PAS-Weigert staining) ($\times 110$); 9. Corpus luteum at mid-pregnancy ($\times 95$).



Figures 10–13. 10. Corpus luteum at advanced pregnancy. Note small shrunken cells and numerous inter-cellular spaces ($\times 95$); 11. Corpus luteum immediately after parturition ($\times 95$); 12. Part of the corpus luteum a few days after parturition ($\times 95$); 13. Part of the corpus luteum during late lactation. The cells of the corpus luteum become merged with the ovarian stroma ($\times 90$).

lie randomly scattered in the ovarian stroma (figure 12). Remnants of the thecal cells also lie amidst these cells. During the final stages of regression the cells of the corpus luteum become indistinguishably merged with the cells of the ovarian stroma (figure 13). No trace of the corpus luteum is visible after the embryo in the contralateral uterine cornu reaches the late neural groove stage of development.

CONCLUSIONS

It is well known that the corpus luteum is the main source of progesterone which is necessary for the initiation and maintenance of pregnancy. The initial rapid growth of the corpus luteum is evidently to meet this need. The maximum development of the corpus luteum, both in gross size and in cytological

differentiation of the cells, is attained by the time the embryo reaches the late neural groove stage of development. This is precisely the period when the chorio-vitelline placenta becomes well established. However, after the placenta is established, the maintenance of pregnancy is largely taken over by the chorionic gonadotrophins produced by the placenta. The regression of the corpus luteum after this stage, specially with respect to cytological changes leading to the cells becoming nearly defunct as secretory cells, is evidently due to a switch over of the function of maintenance of pregnancy from the corpus luteum to the placenta. Hence, the luteal cells become rapidly reduced in size and lose all their vacuolations and cytological characteristics of secretory cells.

The occupation of the entire ovary by the corpus luteum beyond pregnancy and during the early stages of the succeeding pregnancy in *Rousettus leschenaulti* is an unique adaptation in this bat to

bring about a physiological alternation of the two ovaries in successive cycles since this bat breeds twice in quick succession in a year. Such a mechanism has not been known to exist in any other mammal.

ACKNOWLEDGEMENT

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ANNOUNCEMENT

WORKSHOP ON BIOELECTROCHEMISTRY

Bioelectrochemistry is an interdisciplinary subject; it covers the application of electrochemistry to fundamental problems of biological and bio-medical areas. It is having close relationship to bio-electromagnetism. It examines the events occurring in living bodies (redox reactions, membrane phenomena, transmission and information and repair of damaged tissues). The biological events occurring from the point of view of morphologies are of vital importance. The biological events are examined from a physico-chemical view point—kinetic and molecular basis. Examples of this class are the respiratory chain, (combustion in living organisms at the expense of appropriately transported atmospheric oxygen of biological materials) hereditary mechanisms etc.

With a view to bringing together researchers working in the above fields and to motivate younger researchers through experimentation and discussion,

'The Society for Advancement of Electrochemical Science and Technology' (Bombay Chapter) is organizing a workshop on Bioelectrochemistry during *February 19-20, 1987* at Nehru Science Centre, Bombay. It will be useful for researchers in Universities, Colleges, Medical Colleges and Hospitals. The following topics will be covered by scientists from India as well as from abroad: (a) Energetics of biological redox reactions, (b) Electronmotive and protonmotive biological system and their equivalent circuits, (c) Electrical activity in biological functions and (d) Applied aspects of bioelectrochemistry.

The practical sessions on some of the above topics will also be arranged.

Further details may be had from: Prof. K. S. V. Santhanam, Convener, Chemical Physics Group, Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 400 005.