

*Contributions to the Physiology of Mammalian Reproduction.*  
 Part I.—*The Œstrous Cycle in the Dog.* Part II.—*The Ovary as an Organ of Internal Secretion.*

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(Abstract.)

PART I.

*The Œstrous Cycle in Carnivores.*—The bitch is monœstrous and has typically two sexual seasons in the year. The wild species of the genus in their natural state have only one sexual season annually, but in captivity they may experience two sexual seasons like the bitch. The Cape hunting-dog (*Lycæon*) in captivity has been shown to come on heat usually only once a year.

The domestic cat has three or four sexual seasons in the course of the year. We find also that it is polyœstrous and may have four heat-periods in a single sexual season. The duration of the diœstrous cycle is about a fortnight. The wild cat probably experiences only one sexual season in the year. The male possesses a rutting season.

The lioness, failing pregnancy, may have several annual sexual seasons, at the same time being polyœstrous. The duration of the diœstrous cycle is said to be three weeks. Bears, polecats, and seals, and probably most other carnivores, appear to be monœstrous and breed once a year; but the otter, in captivity at any rate, is polyœstrous, having a continuous series of diœstrous cycles, each of a month's duration.

The periodicity of œstrus is dependent to some extent upon environmental conditions as illustrated in the case of the fox. Domestication and captivity appear to favour increased frequency in the recurrence of the cycle.

*The Histology of the Uterus during the Cycle.*—The histological changes which the uterus undergoes may be divided into the following periods:—

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|-----|-----------------------------|--------------|
| (1) | Period of rest.....         | Anœstrum.    |
| (2) | „ growth and congestion ... | } Proœstrum. |
| (3) | „ destruction .....         |              |
| (4) | „ recuperation .....        | { Œstrus.    |
|     |                             | { Metœstrum. |

The second period is characterised by congestion and increase in the number of capillaries. This is followed in the next period by extravasation of blood and emigration of polymorphs. External bleeding is shortly afterwards observed, having been preceded by a flow of mucus, containing polymorphs. There is considerable denudation of uterine epithelium, but the denudation does not extend to more than a single layer of stroma cells. In the recuperation period the epithelium is re-formed and new capillaries arise. This stage is also characterised by the large number of leucocytes that occur free in the stroma. These are of several kinds: (1) Large mononuclear leucocytes containing iron pigment derived from the extravasated red corpuscles, (2) coarsely granular eosinophil leucocytes, and (3) basophil cells. The latter, which occur in unusual abundance both in the stroma and in the muscle layers, are often very large. It is obvious that the changes occurring in the uterus throughout the cycle are homologous with those which are undergone in the sheep, the ferret, the monkey, and the human female.

*Ovulation and the Vitality of the Spermatozoa.*—Ovulation in the bitch takes place after external bleeding has been going on for several days. It occurs during the period of œstrus but it is quite independent of coition or of the presence of spermatozoa in the uterus.

No systematic investigation as to the vitality of mammalian sperms has hitherto been attempted. It has been ascertained by us, however, that the period of survival in the male passages of rabbits is probably not more than 10 days.

*Some Theoretical Considerations.*—The fact that ovulation does not take place until after the proœstrum (or at any rate until after the commencement of the external bleeding stage of the proœstrum) is in opposition to the view that heat and menstruation are produced by ovulation, or by the corpus luteum. It is also contrary to the theory that the degeneration stage occurs as a result of the absence of a fertilised ovum for which the preceding growth was preparing. The theory that the destruction stage of the proœstrum is of the nature of an abortion related to an ovum released at the preceding period is untenable, owing to the comparative infrequency of the heat periods (and, therefore, of the ovulation periods) in the bitch. On the other hand, the hypothesis that the entire proœstrous process is of the nature of a preparation for the lodgment of the ovum is in accordance with the facts.

## PART II.

*The Cause of Heat.*—As pointed out by Brown-Séquard and others, the ovaries, like the testes, exercise an influence on the general metabolism of the organism throughout the reproductive period. Ovarian medication has been

employed to a considerable extent for disorders associated with the female generative organs, and in the majority of cases is said to have produced beneficial results. This method of treatment, however, is in many cases purely empirical and is adopted without regard to the condition of the ovaries from which the extract is obtained.

Several investigators have experimented with ovarian grafts both in normal and abnormal positions. From some of these experiments it would appear that portions of ovarian tissue may obtain vascular connections, and produce an effect on the general metabolism comparable to that produced by ovaries in normal animals.

It has been shown by Goltz and others that the occurrence of œstrus is not due entirely to cerebral or spinal reflexes. Our experiments have demonstrated that "heat," or a transient condition resembling it, can be produced by the injection of extracts made from ovaries in a proœstrous or œstrous condition, and that when such ovaries are successfully grafted into an animal previously deprived of its ovaries, the condition produced is identical with a normal heat, and that irrespective of the situation of the graft.

*The Function of the Corpus Luteum.*—Of the various theories as to the function of the corpus luteum, that of Fraenkel is the only one that is supported by experimental evidence. According to this theory the corpus luteum is the only ovarian organ of internal secretion, and exerts an influence on the generative functions generally throughout the whole reproductive period of the animal's life. Among its other functions, according to this theory, it produces heat and menstruation and controls the attachment of the ovum and the formation of the placenta. This theory is only partially correct. Corpora lutea are not present during the proœstrum and are therefore only functional subsequent to ovulation.

From our own experiments upon bitches and rats we draw the conclusion that the presence of luteal tissue is necessary during the first part of pregnancy, but that the corpus luteum ceases to be functional during the later stages. In these experiments we removed the ovaries from animals at various intervals after impregnation, and found that pregnancy did not continue, except in those cases in which the operation was performed in the later stages of pregnancy. Control experiments in which the ovaries were damaged or partially removed were also performed, when it was found that the animals brought forth young.

*General Conclusions.*—The ovary is an organ providing an internal secretion which is elaborated by the follicular epithelial cells or by the interstitial cells of the stroma. This secretion circulating in the blood induces menstruation and heat. After ovulation, which takes place during œstrus, the corpus

luteum is formed and this organ provides a further secretion whose function is essential for the changes taking place during the attachment and development of the embryo in the first stages of pregnancy.

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*Chitin in the Carapace of Pterygotus osiliensis, from the Silurian Rocks of Oesel.*

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(Communicated by Professor W. D. Halliburton, F.R.S. From the Physiological Laboratory, King's College, London. Received May 27,—Read June 8, 1905.)

Professor E. Ray Lankester, who has been interested in the constitution of the carapace of certain fossil Eurypterids found in Oesel in rocks of Silurian age, placed the matter in the hands of Mr. Bather, of the Geological Department, Natural History Museum.

In March last Mr. Bather asked Professor Halliburton's co-operation in the chemical investigation, stating that a preliminary examination, made by himself and Mr. G. T. Prior, led them to believe that the material retained its chitinous nature. When the small fragments of the carapace, which were all that could be spared from the duplicate specimens in the British Museum, arrived in this laboratory, Professor Halliburton placed them in my hands, and I proceeded to examine them for chitin.

Gamgee, in his 'Text-book of Physiological Chemistry,'\* gives a long list of various invertebrate structures, mainly epiblastic, where chitin has been described, but the list is only approximately accurate, as Gamgee points out that, in many cases, a chitinous composition has been ascribed to a structure solely on the ground of its insolubility in caustic alkalis and dilute acids, or even in only one of these two classes of reagents. In 1884 the list was extended by Halliburton,† who showed that the cartilages occurring in *Sepia* and *Limulus* contain a small percentage of chitin; this was confirmed in the case of *Sepia* by Krukenberg,‡ who found the same material in the skeletal structures in that animal. It has further been found in certain fungi.§

\* Vol. 1, p. 299.

† 'Roy. Soc. Proc.' No. 235, 1885; 'Quart. Journ. of Micros. Science,' vol. 25, p. 173 1885.

‡ 'Ber. d. deutsch. Chem. Ges.,' vol. 18, p. 993, 1885.

§ Gilson, 'Comptes Rendus,' vol. 120; Winterstein, 'Ber. d. deutsch. Chem. Ges.,' vols. 27 and 28.