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**Superfoetation in European Beaver**

[With 1 Table &amp; Plates I—II]

Six cases of oestrus in European beaver (*Castor fiber* Linnaeus, 1785) females occurring during pregnancy are described. Histological analyses of ovaries and of the reproductive tract of the dead females, as well as vaginal smears, have revealed a high activity of ovaries during pregnancy. Kits differing in size and the degree of hairiness has been observed in two abnormal litters of two females. The ovaries of one of these females which died at parturition, contained *corpora lutea* at different stages of development. These facts indicate the possibility of superfoetation in beaver.

## I. INTRODUCTION

Beavers belong to polyestrous animals with a well-defined breeding season. Within a typical mating season which lasts from the end of December until the beginning of March there take place a few oestrous cycles, usually occurring at irregular time intervals governed by climatic conditions. The normal reproductive rhythm runs, therefore, as follows: oestrous, successful covering, gestation lasting of the average 107 days, parturition, period of lactation extending under farm conditions nearly three months (Żurowski *et al.*, 1974). Afterwards ensues a period of sexual inactivity lasting about 165 days. Under farm breeding of beavers, though, certain anomalies have been observed in the process of reproduction. It may be interesting to report these anomalies as a contribution to the knowledge of the reproduction of the European beaver, and important for breeding practice.

## II. MATERIAL AND METHODS

Observations of the symptoms of the mating season and the recurrence of heat were carried out at the Experimental Farm Popielno in 1971—1973. During the

period of heat there take place discharges from the reproductive tracts of females, also a perceivable excitement of the animals. Records have been taken of the dates of occurrence of these symptoms, as well as of cases of noticed coverings. Furthermore, from the reproductive organs of three females (nos. 24, 36 and 49) which had died at the farms of Popielno and Wiartel material was taken for histological investigations. The ovaries were fixed in AFA fluid, dehydrated in alcohol and xylene, then embedded in paraffin. Transverse microscopic sections were stained by Mallory's method (Bagiński, 1969). Sections from oviducts, the uterus and vagina were fixed in Bouin's fluid and stained in haemotoxylin-eosin. Vaginal smears of female no. 35 were taken by original method, involving the use of a special glass spoon protected with a glass tube 6 mm in diameter. The smears were then fixed and stained by Krupiński's method modified by Doboszyńska (Krupiński, 1955).

### III. RESULTS

In the breeding season of 1971—1973, there were noticed symptoms of heat and even copulations among pregnant females (Table 1). These observations suggest persistence of a high activity of ovaries during the mating season, despite the onset of pregnancy. These assumptions have been confirmed by morpho-histological analyses carried out on organs of dead females. The females no. 36 and 49 were bitten to death on Feb. 24 and March 3, 1970, hence towards the closing of the regular breeding season. The uterus of female no. 36 was found to contain two resorbed embryos, 2×3 cm in dimensions; whereas in female no. 49 there were three embryos undergoing the process of resorption, the largest of them 3×4 cm in size (Fig. 1). Ovaries of these females displayed a similar histological picture indicating recent ovulations. The left ovary of female no. 36 contained seven disrupted Graafian follicles of which *corpora lutea* became formed. Three of the latter were in the stage of *corpus hemorrhagicum* with blood clot, while the remaining ones owed their origin to somewhat earlier ovulations, with blood clots beginning to undergo organization (Fig. 2). The right ovary held nine disrupted Graafian follicles, two of which occurred in the form of *corpus hemorrhagicum*. In the left ovary of female no. 49, there were six ruptured Graafian follicles, one of which was in the *corpus hemorrhagicum* stage, while the remaining ones in the *corpus luteum* organizing stage. On the other hand, in the right ovary were five *corpora lutea* and a single *corpus hemorrhagicum*. In both females, the ovaries contained *corpora lutea* of pregnancy as well as Graafian follicles approaching maturation.

Oviducts of female beavers are made up of the following layers: mucous membrane protected with a unistratal, cylindrical epithelium; circular and longitudinal muscular coat; a serous membrane coat (Doboszyńska, 1970). They respond to the activity of the ovary by



changes in thickness of the different layers. Ovulation in females no. 36 and 49 caused a softening of the mucous layer of the oviducts, the appearance of numerous folds and formation of high, ciliated cells of the epithelium. In both females the cavities of the uteri were closed, the mucous membrane being very thick, softened and congested. The epithelium were characteristic for the secretory phase of the uterus (Fig. 3).

Table 1

Symptoms of heat observed in females of European beaver.

No of female	Date of successful covering	Dates of observed symptoms of heat <sup>1</sup>	Dates of copulations <sup>2</sup>	Dates of parturitions
75	Jan. 18, 1971	Dec. 30, 1970		May 5, 1971
		Jan. 9, 1971		
		Jan. 18, 1971		
		Feb. 5, 1971		
		March 9, 1971		
41	Jan. 10, 1971	Dec. 30, 1970	Dec. 30, 1970	April 25, 1971
		Jan. 10, 1971	Jan. 10, 1971	
		Jan. 18, 1971		
73	Jan. 19, 1972	Jan. 10, 1972		March 3, 1972
		Feb. 9, 1972		
		Feb. 16, 1972		
		March 3, 1972		
75	Jan. 10, 1972	Jan. 10, 1972	Feb. 16, 1972	May 6, 1972
		Jan. 12, 1972		April 26, 1972
		Jan. 20, 1972		
		Jan. 27, 1972		
73	Feb. 9, 1973	Dec. 23, 1972	Jan. 4, 1973	May 26, 1973
		Jan. 4, 1973		
		Jan. 29, 1973		
		March 5, 1973		
111	Jan. 30, 1973	Jan. 5, 1973		May 18, 1973
		Jan. 12, 1973		
		Jan. 30, 1973		
		Feb. 14, 1973		

<sup>1</sup>The act of covering can be observed in the farm if it takes place in the open reservoir; <sup>2</sup> In a vast majority of cases symptoms of oestrus persist over a period of a few days. Reported are dates of the first day on which symptoms were noticed.

Uterine glands occurred in large numbers and their size increased. In both females the vagina was lined with a very thick layer of proliferated mucous membrane, the multistratified squamous, keratic epithelium had about 12 layers. Desquamation of large groups of enucleate cornified cells of the epithelium indicate a phase of heat (Fig. 4).

To find out if there exist high ovarian activity after successful mating vaginal smears were collected from female no. 34 on May 23 and 24, during the first half of the gestation, this female was covered on May 2, 1973. The vaginal smears taken on May 23 indicated of oestrus, further

smears had not been collected to avoid possible interfering with the pregnancy. The female gave birth on Aug. 16, 1973, a litter of four normally developed kits. The delayed reproduction in this female was connected by other experiments.

The events described above may prove helpful in explaining cases of abnormal parturitions in females no. 24 and 46. At the Popielno farm, female no. 24 gave birth on May 19, 1970, to a single normal young, which died after the delivery. Six days later, on May 25, the same female gave birth to two more young beavers. This time the animals were underdeveloped, scantily covered with hair, dead. Next morning this female gave birth to still another young, dead in spite of its normal development. Parturition having ceased, but examination through abdominal wall indicated the presence of another foetus, Caesarean section was started. However, the greatly exhausted female died after injection of Combelen. *Post-mortem* examination revealed in the uterus two more foetuses, one of them hairy and of normal size, the other naked and much smaller.

At the Wiartel farm, on June 11, 1972, female no. 46, multipara, gave birth to five kits, three of which were fully developed and alive, while two were much smaller, bare and dead.

During histological examination of female no. 24, *corpora lutea* of pregnancy at different stages of development have been found in the ovaries. The left ovary contained two well-developed *corpora lutea* of pregnancy; whereas in the right ovary there was one fully developed *corpus luteum* and three *corpora lutea* in the process of regression (Fig. 5). Fully-developed *corpora lutea* situated immediately below the *tunica albuginea* were oval-shaped, surrounded by well vascularized *theca folliculi*. Luteal and paraluteal cells were arranged radially around the vesicular cavity of the *corpus luteum*. These *corpora lutea* were much larger than the Graafian follicles before maturity. Regression *corpora lutea* were within the inner part of the cortical partion. They were much smaller than the formed ones and than Graafian follicles (Fig. 5), and displayed a complete atrophy of the follicular cavity and proliferation of connective tissue deep into the parenchyma of the *corpus luteum*. In structure they were similar to *corpora albuginea* observed in the other females a few months after gestation. In this female the ovaries contained also maturing Graafian follicles and arthritic follicles (Fig. 5). In the oviduct of female no. 24 the muscular coat was rather thick, while the mucous membrane was thin and with only few folds, covered by a single layered not high, columnal epithelium. The epithelium contained secretory cells. There were very few ciliated cells. Free segments of the uterus were provided with a well-developed muscular coat. The



mucous membrane of the uterus was comparatively thin, the rather small uterine glands produced no secretion, and the unistratal epithelium was rather low (Fig. 6). Presumably the process of involution of the mucous membrane of the uterus was already under way. The low mucous membrane of the vagina covered with a stratifical squamous epithelium had no inclination to proliferate, there were no keratic cells, nucleated ones on the other hand being present (Fig. 7). The histological picture of the vagina was not yet influenced by the Graafian follicles maturing in the ovaries.

#### IV. DISCUSSION

All the above described facts prove that both cases of abnormal parturitions were caused by the phenomenon of superfoetation. Changes found in the reproductive systems of the examined females correspond with the scheme leading to superfoetation in mammals as reported by Nalbandow (1966). Rolhäuser (1949) described superfoetation in mice, ended in two successive and successful parturitions. Cases of superfoetation in small rodents have been reported by Burrows (1941), Slonaker (1934) as well as by Bilewicz & Minkiewiczowa (1954); whereas in swine and sheep by Smith (1927a and 1927b). Occurrence of superfoetation in hares kept in captivity has been proved in many cases (Hediger, 1948; Jacobs, 1966). In hares, moreover, there has been discovered the possibility for the semen translocation to the opposite oviduct through the pregnant corner of the uterus, at the beginning of gestation (Bloch *et al.*, 1967). Occurrence of superfoetation in hares had been analysed critically by Knaus (1966 and 1967) who regards the period of prenatal regression of the *corpus luteum*, taking place during the final 24 hours of pregnancy, as the sole opportunity for heat and ovulation in doe-hares at time of gestation. However, the facts reported by the earlier mentioned authors remain unquestionable. The reproductive tract of female beaver no. 24 which died at parturition precludes the possibility of fertilization during the prenatal period, in spite of the development of Graafian follicles in the ovary.

The two cases of superfoetation in European beaver described above suggest this anomaly in reproduction of beavers to be a hindrance in parturitions leading to death of at least of a portion of kits. Obviously it does not increase fertility of this species. Superfoetation in an abnormal and undesirable phenomenon in beaver breeding, yet hard to eliminate under the present system of keeping breeding animals in reproductive pairs. Possibly, the occurrence of superfoetation in animals bred a farm

is caused by Whitten's effect (1956) and an incomplete pregnancy block (Bruce, 1959).

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## SUPERFETACJA U BOBRA EUROPEJSKIEGO

## Streszczenie

Opisano 6 przypadków występowania objawów rui u samic (Tabela 1) bobra europejskiego (*Castor fiber* Linnaeus, 1758) skutecznie wcześniej pokrytych. Badania histologiczne jajników i dróg rodnych padłych samic oraz rozmazy pochwowe wskazywały na wysoką aktywność jajników samic ciężarnych. W dwóch nienormalnych miotach dwóch różnych samic obserwowano rodzące się młode różniące się między sobą wielkością i stopniem owłosienia. W jajnikach jednej z tych samic, padłej przy porodzie, stwierdzono obecność ciałek żółtych w różnym stopniu rozwoju. Fakty te wskazują na możliwość występowania superfetacji u bobra (Tablica I—II).

## EXPLANATION TO PLATES

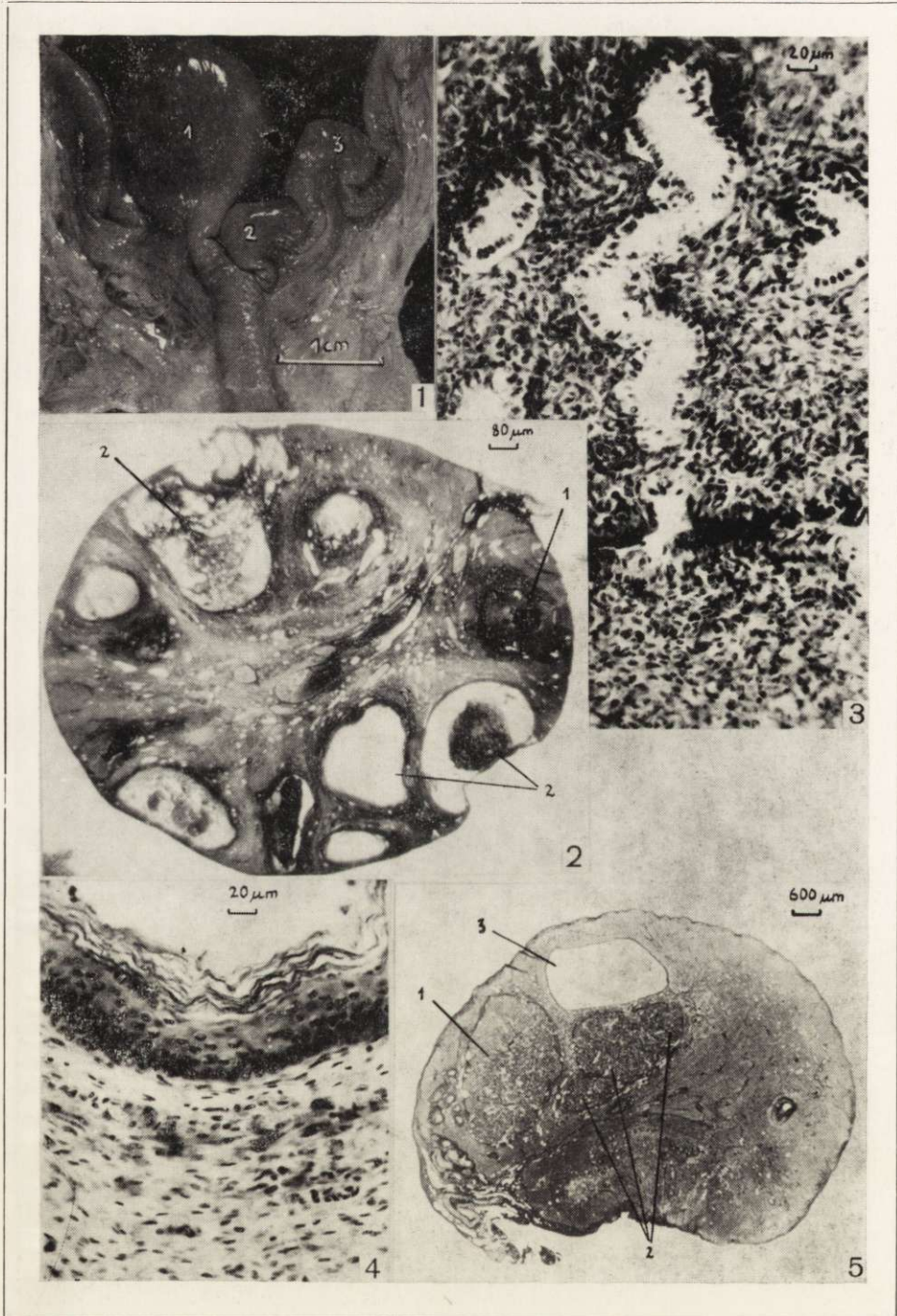
## Plate I

- Fig. 1. Uterus with three resorbed embryos of different sizes, 1,2 and 3.  
No. 49 female.
- Fig. 2 Cross-section of ovary showing different stages of *corpus luteum* formation, just after ovulation, and a *corpus luteum* of pregnancy.  
1 — *corpus luteum* of pregnancy, 2 — *corpora lutea* in the process of formation.  
No. 36 female. Mallory's staining method.
- Fig. 3. Developmental stage of the uterus — closed lumen, high cylindrical epithelium, high tubules of the uterine glands. No. 49 female.  
Haematoxylin-eosin staining.
- Fig. 4. Proliferation of vaginal epithelium. Formation of a layer of keratotic cells.  
No. 49 females. Haematoxylin-eosin staining.
- Fig. 5. Cross-section of ovary showing *corpora lutea* of pregnancy in full development beside atressing *corpora lutea*.  
1 — *corpus luteum* of pregnancy in full development, 2 — *corpus luteum* of pregnancy in the process of atrophy, 3 — mature Graafian follicle. No. 24 female.  
Mallory's staining method.

## Plate II

- Fig. 6. Low epithelium protection the mucous membrane of the uterus; uterine glands — inactive. No. 24 female. Haematoxylin-eosin staining.
- Fig. 7. Mucous membrane of the vagina. Low, non-keratotic epithelium with nucleate cells. No. 24 female. Haematoxylin-eosin staining.

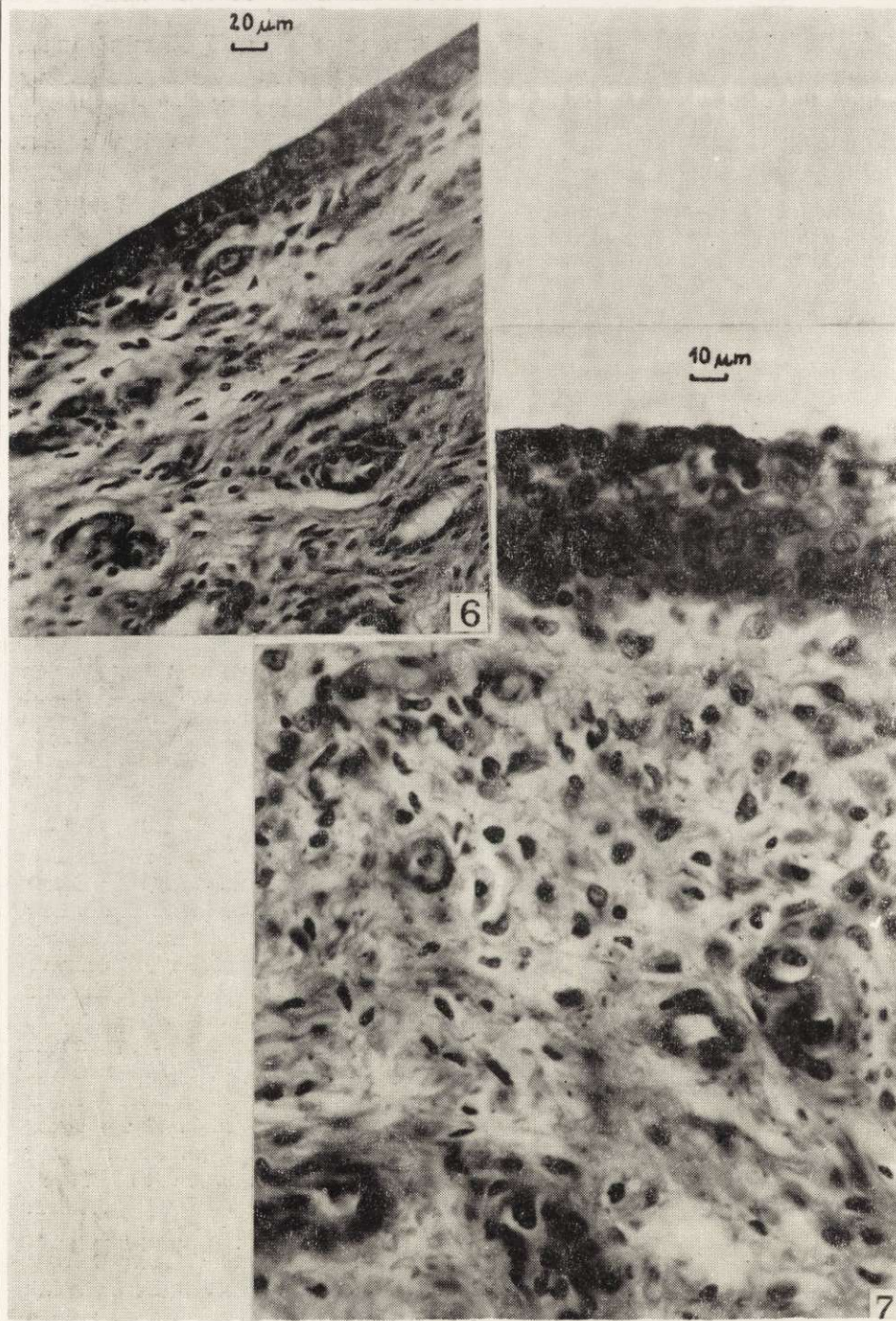




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