

BEARS AS INDUCED OVULATORS—A PRELIMINARY STUDY

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Abstract: We visually verified corpora lutea and measured serum progesterone concentrations during the estrous cycle in 8 semi-captive black bears (*Ursus americanus*) in South Dakota. Our data suggested that black bears ovulate after they mate, indicating that black bears are induced ovulators. These preliminary findings may aid scientists in their efforts to save endangered bear species through controlled breeding programs.

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Key words: black bear, corpora lutea, induced ovulation, ovulation, progesterone, reproduction, *Ursus americanus*.

Induced ovulation is the process whereby nervous stimuli from copulation pass to the brain, which, in turn, initiates events leading to the release of 1 or more oocytes. Numerous mammalian species are induced ovulators including the short-tailed shrew (*Blarina brevicauda*), 13-lined ground squirrel (*Citellus tridecemlineatus*), short-tailed field vole (*Microtus agrestis*), domestic cat (*Felis catus*), rabbit (*Oryctolagus cuniculus*), ferret (*Mustela putorius*), mink (*Mustela vison*), raccoon (*Procyon lotor*), and llama (*Lama glama*) (Milligan 1982).

Since becoming interested in reproductive habits of bears, biologists have asked “Are bears induced ovulators?” Do bears ovulate only after mating as do domestic cats and other species (Milligan 1982)? Are bears spontaneous ovulators—do bears release oocytes at a specific time of the reproductive cycle regardless of exposure to a male as do livestock and humans (Sadleir 1972)? Wimsatt (1963:72) proposed that this question of indicated ovulation “...could easily be resolved in captive bears; one need only isolate females during the period when ovulation normally occurs and examine the ovaries thereafter for the presence of large follicles or corpora lutea. It would be essential to the experiment not only that sexually mature females be used, but that they had not borne cubs the preceding winter or that they had been deprived of their cubs in early spring.”

This basic question concerning oocyte release is paramount to bear biologists who are interested in reproduction (Wimsatt 1963, Erickson and Nellor 1964) and scientists who are interested in trying to save endangered and threatened bear populations through such means as

assisted reproductive technology (ART). Scientists must know the answer to this question to use one female as a surrogate for an embryo from another female. If bears are induced ovulators, as some scientists speculate (Wimsatt 1963), without the mating process the surrogate would not ovulate or undergo the hormonal events associated with ovulation. These events physiologically prepare the uterus to accept the transferred embryo. Without these events initiated through coitus in induced ovulators, the host reproductive tract would reject the foreign embryo and pregnancy would not occur.

Our present study was conducted to ascertain whether the bear is an induced ovulator. In these preliminary findings, observations of the ovaries and measurements of serum progesterone (P_4) in captive bears will be discussed in relation to mating.

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STUDY AREA

The bears used in this study were located at Bear Country USA, a 120-ha drive-through park in Rapid City, South Dakota, that houses animals native to North America.

Each species has a specific amount of land in which to roam; one-fourth of the land is dedicated to black bears. Approximately 80 female and 110 male black bears can be found within these confines.

MATERIALS AND METHODS

Study Design

We randomly chose 8 female bears from approximately 80 females. The 8 females were approximately the same age (exact ages unknown), reproductive status, and weight (females with compromised body weight and reproductive status may fail to complete the reproductive cycle and lose cubs before birth [Hellgren et al. 1990, Derocher et al. 1992]). All bears were believed to have had cubs 2 years before our study. Furthermore, cubs are removed from their mothers annually in March at Bear Country, USA.

We isolated 4 bears (separated from any males) in a pen of approximately 220 m². We allowed 4 other females to roam with males in the 30-ha pen.

Estrous Detection

Beginning in mid-May, all 8 bears were aroused daily at 1000 hours and observed for signs of estrus (sexual receptivity), including mating. Observations were continued until 2000 hours. Only females that stood for mounting were considered to be in estrus.

Preparation for Examination

Following intramuscular sedation with either approximately 4 mg/kg ketamine hydrochloride (Fort Dodge Laboratories, Fort Dodge, Ia) or 8 mg/kg of Telazol (A.H. Robins Company, Richmond, Va), and 1 mg/kg rompun (Miles Inc., Shawnee Mission, Kans.), the bears were transported to the on-site laboratory on a stretcher. In the laboratory, bears were intubated and placed on inhalant anesthetic. Heart rate and respiration were monitored every 5 minutes.

Blood Collection and Processing

In July, blood samples were drawn from an intravenous catheter every 15 minutes. Serum was removed and stored at -20C. We shipped the serum on dry ice to the endocrinology laboratory where the specimens were analyzed, as previously described, for P₄ (Palmer et al. 1988).

Laparoscopic Procedure

After surgically preparing the abdomen, we placed a pneumoperitoneum needle through the umbilicus and

filled the abdominal cavity with CO₂. A trocar and sleeve were passed through the umbilicus. The trocar was removed and a laparoscope was passed through the sleeve. Using direct visualization, we placed a trocar and a sleeve in each of the lower abdominal quadrants; the trocars were removed and a retractor and a grasper were inserted to retract the bowel and allow a better view of the uterus and ovaries.

RESULTS AND DISCUSSION

By means of laparoscopy, we observed ovaries in 4 mated females and 4 nonmated females (Table 1). The females exposed to males had 1–4 corpora lutea (CL)/female, while the females that were kept in isolation had large follicles but no CL. Bear ovaries are somewhat encased in adipose tissue, but could be manipulated to determine CL development.

The P₄ concentrations were determined in serum for the same females (Table 1). When P₄ concentrations of mated bears were compared to those of nonmated bears, the *t*-test indicated a trend toward significance (*t* = 1.82, *P* = 0.059, 1-tailed), but a highly significant difference was noted only if values ≥20 days post-breeding were included (*t* = 4.15, *P* = 0.004, 1-tailed). The P₄ concentrations remained near baseline in the nonmated females (0.75–1.50 ng/ml). Similar findings were reported for serum P₄ concentrations from pre-bred, estrus, and lactating adult black bears (<1.0 ng/ml [Hellgren et al. 1990]); for brown bears that were 210–300 days pre-parturition (0.4–1.1 ng/ml [Tsubota et al. 1987]), and for non-pregnant polar bears (<1.0 ng/ml [Palmer et al. 1988]). Higher concentrations of P₄ were observed in mated females, increasing with time post-mating (0.70–2.70 ng/ml). Progesterone concentrations of ≥2.5 ng/ml have been reported for pregnant bears, regardless of

Table 1. Breeding dates, observed corpora lutea (CL), and serum progesterone concentrations in American black bears in South Dakota in 1993.

Bear no.	Days post-breeding	Number of CL observed	Progesterone (ng/ml)
209		0	1.50
211		0	0.95
237		0	0.75
240		0	0.95
214	9	1	0.70
207	20	2	1.75
217	30	4	2.50
212	35	1	2.70

the species (Tsubota et al. 1987, Palmer et al. 1988, Hellgren et al. 1990, Derocher et al. 1992).

We visually confirmed that mated black bears had ovulated, as indicated by presence of CL, whereas nonmated black bears failed to ovulate. From these limited data, it appears that the black bear is, indeed, an induced ovulator. Endocrine data also confirmed ovarian activity. Progesterone concentrations increased as the mated bears extended their luteal phase. This finding agrees with others who indicated that progesterone increases with the onset of pregnancy in bears (Derocher et al. 1992, Foresman and Daniel 1983, Palmer et al. 1988, Hellgren et al. 1990). The somewhat elevated progesterone concentration that appeared in bear 209, who had not mated, is puzzling. This bear could have been entering a pseudopregnancy state as described by Tsubota et al. (1987) and Hellgren et al. (1990). In these instances the bears had elevated P_4 concentrations even though the bears failed to produce cubs. Both sets of authors suggested that this increase in progesterone may have been due to spontaneous ovulation and resulting CL formation that was responsible for the elevated progesterone. However, in the case of bear 209, we did not observe CL formation, although we may have missed a deep-seeded CL that was not exposed to the surface. Others should repeat this preliminary study to validate these findings.

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