Methods of Determining Litter Size in Beaver

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Abstract: Estimates of litter size in beaver (*Castor canadensis*), based on counts of corpora lutea, placental scars, and corpora albicantia, were compared to known litter size determined by fetus counts. Estimates based on corpora albicantia ($\bar{x} = 4.2$) were significantly higher ($P < 0.05$) than with any other method. Numbers of corpora lutea ($\bar{x} = 3.0$), placental scars ($\bar{x} = 2.8$), and fetuses ($\bar{x} = 2.6$) did not differ ($P > 0.05$). No reproductive parameter differed by beaver age-class.

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Litter size in beaver may be determined by counting fetuses or may be estimated from counts of corpora lutea, corpora albicantia, and placental scars (Hodgdon 1949, Provost 1958). Estimates based on counts of corpora lutea may differ from actual litter size due to either the failure of fertilized ova to implant or the loss of the ova prior to implantation (Provost 1958, 1962). Provost (1962) also found that both placental scars and corpora albicantia may regress with time and, therefore, differ from counts of fetuses.

In Mississippi, fetuses are usually found only during the peak breeding season of late December through early April (Wigley et al. 1983). If counts of corpora albicantia, corpora lutea, and placental scars provide accurate esti-

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mates of fetus counts, data from carcasses collected outside the breeding season could be used to predict litter size. The objective of this study was to determine the reliability of estimates based on numbers of corpora lutea, corpora albicantia, and placental scars by comparing them to known litter size determined by fetus counts.

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Methods

Beaver were collected in east-central Mississippi from July 1977 through January 1981 with No. 330 Conibear traps and by shooting at night. Additional winter samples were obtained from the Mississippi Beaver Cooperative in Sturgis, Mississippi, and commercial trappers. The reproductive tract and 1 mandible were removed from each carcass and frozen for later examination. Ovaries were fixed in 10% formalin and cut with a scalpel into 2-mm sections in order to count corpora lutea and corpora albicantia. Numbers of placental scars and fetuses were determined by examination of the uterine horns. Age of beaver was determined by basal closure of molar teeth (Woodward 1977, van Nostrand and Stephenson 1964).

Analysis of variance was used to test for differences in counts of corpora lutea, corpora albicantia, fetuses, and placental scars, and to test for differences in these parameters by year and age. All analyses were done with SPSS-X (SPSS Inc. 1983), and statistical significance was accepted at the 0.05 probability level.

Results and Discussion

A total of 239 female beaver was collected during the study period. At least 1 reproductive parameter was visible in 101 females. Litter size was determined by counting fetuses in 40 females. Estimates of litter size were derived from counts of corpora lutea in 48 females, placental scars in 26 females, and corpora albicantia in 20 females (Table 1). Because no parameter differed between years ($P > 0.05$), data were pooled.

Mean litter sizes differed ($P < 0.001$) by method of determination. Estimates based on corpora albicantia ($\bar{x} = 4.2$) were significantly higher ($P < 0.05$) than with any other method. Mean litter size estimated by corpora lutea ($\bar{x} = 3.0$), and placental scars ($\bar{x} = 2.8$) were not significantly different from counts of fetuses ($\bar{x} = 2.6$).

Litter size varies with age in many furbearers. For example, mean numbers of corpora lutea in river otter (*Lutra canadensis*) increase from age 3 to 6 and then decline for otters aged 7 to 15 (Lauhachinda 1978). Allen (1983)

Table 1. Mean litter size by age (years), derived from counts of fetuses, placental scars, corpora lutea, and corpora albicantia for beavers from Mississippi.

	Embryos			Placental scars			Corpora lutea			Corpora albicantia		
Age	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N
1–2	2.5	0.7	2	2.0		1	3.0	0.0	2			
2–3	2.6	0.8	7				2.7	1.1	7			
3–4	3.0	1.4	2				2.7	1.2	3	4.0	0.0	2
>4	2.6	1.1	29	2.8	0.9	25	3.1	1.1	36	4.2	1.3	18
Total	2.6[a]	1.0	40	2.8[a]	0.8	26	3.0[a]	1.1	48	4.2[b]	1.2	20

[a,b] Total means followed by different letters differ significantly ($P < 0.05$).

reported a significant correlation between age-class and mean number of placental scars in red fox (*Vulpes vulpes*) and recommended consideration of female age when deriving a single, annual litter size estimate. In this study, numbers of fetuses, corpora lutea, corpora albicantia, and placental scars did not differ by age-class ($P > 0.05$).

Counts of corpora lutea may differ from counts of fetuses because of pre- or postimplantation losses. Reported postimplantation losses range from 3 to 27% while preimplantation losses vary from 7 to 19% (Wigley et al. 1983). In the Southeast, however, these losses are relatively low. Postimplantation losses were reported to be 4.0% in South Carolina (Woodward 1977) and 7.9% in Mississippi (Wigley et al. 1983). Preimplantation loss was 7.0% in Mississippi (Wigley et al. 1983). In addition, Provost (1962) found that corpora lutea of pregnancy become appreciably larger than corpora lutea of ovulation and can be recognized on the basis of size within a few days following ovulation. Counts of corpora lutea in Mississippi should, therefore, provide a reliable estimate of litter size even without knowledge of pre- or postimplantation losses.

Numbers of corpora albicantia have been used to estimate ovulation rate. Woodward (1977) found that the number of corpora albicantia ≥ 2 mm in diameter did not differ from the number of corpora lutea in beaver collected during the following breeding season. Corpora albicantia <2 mm in diameter, however, were more than twice as numerous and probably represented regressing corpora lutea from previous years. Corpora albicantia in beaver are not pigmented and are difficult to identify macroscopically in ovaries preserved in formalin (Provost 1962). In this study, corpora albicantia in ovaries preserved in formalin were found to be difficult to both identify and measure. As a result, size could not be determined, and total number of corpora albicantia was higher than counts of other parameters. If ovaries are fixed in Mossman's AFA (30 parts 95% alcohol, 10 parts formalin, 10 parts glacial acetic acid, 50 parts distilled water), numbers of corpora albicantia ≥ 2 mm in diameter should provide a more accurate estimate of ovulation.

Counts of placental scars were not different ($P > 0.05$) from fetus counts

and may be a reliable predictor of litter size during the time period between parturition and the next breeding season. Hodgdon (1949) noted that counts of placental scars were similar to a combined count of fetuses and young kits and suggested that placental scars persist for only 1 year. Woodward (1977) also found counts of placental scars and fetuses to be similar. Difficulty in distinguishing between scars representing normal pregnancy and those representing a resorbed fetus has been cited as a limitation to the use of placental scar counts (Provost 1962). However, the similarity between counts of fetuses and placental scars in this study indicates that, at least in Mississippi, this difference is negligible.

The results of this study indicate that counts of fetuses, placental scars, and corpora lutea all provide statistically similar estimates of litter size in Mississippi despite pre- or postimplantation losses. Given the similarity of reported litter sizes for beaver in southeastern states and the similarity of ecological conditions, it is likely that these estimators could be used in much of the Southeast. Where pre- or postimplantation losses are high, however, correction factors may be necessary. At least 1 of these parameters was present in pregnant or postpartum females collected between 5 December and 14 November. Counts of corpora albicantia were not a reliable estimator of litter size, but others have found that counts of corpora albicantia $\geq$2 mm in diameter do not differ from counts of corpora lutea (Woodward 1977). Preserving ovaries in Mossman's AFA would probably make corpora albicantia more visible (Provost 1962) and, therefore, a more reliable estimator.

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