

## Breeding Season in Female Cats Acclimated Under a Natural Photoperiod and Interval Until Puberty

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**ABSTRACT.** The breeding season was investigated in 174 female cats that were acclimated under a natural photoperiod, and determined the interval between birth and initial estrus (puberty) was determined in 125 cats. Although the breeding season differed noticeably among individual animals, the mean was  $180.4 \pm 3.0$  (SE) days between the end of January and the end of July. The interval between birth and first estrus ranged from 181 to 560 days, with a mean of  $345.0 \pm 0.9$  days. With respect to month of birth, the mean interval was  $343.0 \pm 9.5$  days in cats born between March and June. Among cats that were born between July and October, the mean intervals were  $242.0 \pm 6.3$  days in cats that exhibited estrus the year after birth and  $519.2 \pm 5.8$  days in those that exhibited estrus 2 years after birth.

**KEY WORDS:** breeding season, feline, natural photoperiod.

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The domestic cat is a seasonally polyestrous animal. The onset of puberty in female cats occurs at an average age of 8 to 10 months [5,11]. Ovulation and the initial release of LH are usually observed 24 to 30 hr after copulation [15]. It has been reported that the breeding season starts in December to February, and continues until September [2, 6, 13]. These factors may depend on the day length, that is, latitude [4].

The mechanism by which the photoperiod influences the hypothalamus pituitary gland gonadal axis system via melatonin has been clarified in cats [8, 9]. In cats, when the photoperiod is shortened, melatonin and PRL secretion are enhanced, reducing ovarian function [1, 8, 9]. Leyva *et al.* [9] reported that no recurrent estrus occurred after melatonin was administered to cats under 24-hr lighting. No recurrent estrus occurs under 8-hr lighting in the cat room, whereas estrus recurs under 12-hr lighting [4, 8, 10, 13, 14]. Therefore, it is recommended that the lighting cycle should be 14 hr or more for cat breeding [10, 12, 14]. Nevertheless, no previous study has provided detailed data on the estrus status when cats are acclimated under a natural photoperiod. In this study, we investigated the breeding season in female cats that were acclimated as a group at a constant room temperature under a natural photoperiod. We also investigated the interval required until first estrus (puberty) in female cats that were born under those conditions.

**Animals:** We used 103 female cats ranging in age from 2 to 8 years that were acclimated via passage breeding in our laboratory between 1989 and 2002 (latitude: 35 degrees, 42 min N). In some cats, estrus was investigated for 2 to 6 years. A total of 174 cats were investigated. The cat room was located on the second floor, and measured  $4.5 \times 3.0 \times 2.5$  (height) m. The east, west, and south sides were transparent and glass-plated. The east and west glass windows measured  $3.6 \times 0.9 \times 0.9$  (height) m. The south glass win-

dow measured  $1.8 \times 0.9 \times 0.9$  (height) m. Room temperature was  $23 \pm 2^\circ\text{C}$ . The cats were acclimated as a group. Dry food (Hill's feline maintenance, U.S.A.) and water were given *ad libitum*. First estrus was investigated in 125 cats that were born between 1984 and 2001.

To investigate estrus in female cats, we used 12 male cats with the capacity to copulate, ranging in age from 1 to 13 years. These cats were acclimated in individual cages measuring  $1.2 \times 0.75 \times 0.7$  (height) m.

All the animals were maintained according to the guidelines of the Animal Care and Use Committee of the Nippon Veterinary and Animal Science University.

**Observation of estrus:** Female cats were put with male cats twice a day (morning and evening). Estrus in female cats was evaluated from the status of accepting copulation. Briefly, cats with calling, lordosis, and rolling were regarded as being in estrus.

**Breeding season:** The interval from the start of estrus until the last estrus was regarded as the breeding season in female cats. We also recorded the number of estrous cycles during the period.

**Interval until first estrus:** We investigated the interval (days) required until first estrus in 125 female kittens that were acclimated under a natural photoperiod.

**Statistical analysis:** Data obtained in this study were analyzed with Student's *t*-test, and a P value of  $<0.05$  was regarded as significant.

**Breeding season and the number of estrous cycles:** The breeding season and number of estrous cycles per year in cats are shown in Table 1. Furthermore, the interval from the start of estrus until the end (breeding season) in each year is shown in Fig. 1. Briefly, estrus started on December 22 at earliest and on March 25 at latest, but in many years, estrus started in January.

Table 1. The breeding season and number of estrus cycles in cats

Years	Cases	Start of estrus (month/day)		End of estrus (month/day)		Breeding season (days)		Number of estrus	
		range	mean $\pm$ SE	range	mean $\pm$ SE	range	mean $\pm$ SE	range	mean $\pm$ SE
1989	16	Jan.27~Feb.23	Feb.2 $\pm$ 1.9	Jun.12~Sep.19	Aug.12 $\pm$ 6.5	134-235	189.9 $\pm$ 6.9	3-9	5.3 $\pm$ 0.4
1991	14	Jan.7~Jan.27	Jan.16 $\pm$ 1.5	May 28~Aug.4	Jul.7 $\pm$ 5.8	129-202	172.1 $\pm$ 5.7	3-10	5.9 $\pm$ 0.6
1992	8	Jan.1~Feb.18	Jan.21 $\pm$ 5.1	Jul.1~Sep.13	Jul.29 $\pm$ 10.4	163-242	189.1 $\pm$ 12.3	3-11	7.0 $\pm$ 1.0
1993	20	Feb.2~Mar.20	Feb.22 $\pm$ 3.6	May 20~Sep.11	Jul.15 $\pm$ 6.4	94-221	143.1 $\pm$ 8.1	2-7	4.2 $\pm$ 0.2
1994	13	Jan.9~Feb.19	Jan.25 $\pm$ 4.5	May 31~Aug.20	Jul.28 $\pm$ 4.8	153-221	184.9 $\pm$ 6.0	5-12	7.4 $\pm$ 0.7
1995	10	Jan.12~Mar.1	Feb.4 $\pm$ 5.1	Jun.18~Aug.24	Jul.31 $\pm$ 7.0	127-211	177.1 $\pm$ 9.2	3-11	4.9 $\pm$ 0.8
1996	10	Jan.3~Feb.21	Jan.22 $\pm$ 5.3	Jun.22~Sep.7	Aug.8 $\pm$ 8.6	122-240	198.9 $\pm$ 11.5	3-6	4.6 $\pm$ 0.4
1997	7	Jan.3~Mar.5	Feb.4 $\pm$ 10.4	Jun.14~Aug.7	Jul.22 $\pm$ 8.2	156-212	168.0 $\pm$ 11.2	3-8	5.7 $\pm$ 0.7
1998	23	Jan.1~Mar.14	Jan.24 $\pm$ 3.4	Jun.9~Sep.27	Aug.4 $\pm$ 5.6	109-258	192.0 $\pm$ 7.2	3-9	6.3 $\pm$ 0.4
1999	20	Jan.13~Mar.21	Feb.19 $\pm$ 4.4	May 22~Sep.11	Jul.20 $\pm$ 8.5	72-238	151.1 $\pm$ 11.1	3-9	5.6 $\pm$ 0.4
2000	14	Jan.2~Mar.6	Jan.28 $\pm$ 5.3	Jul.24~Oct.5	Aug.26 $\pm$ 5.5	170-269	211.5 $\pm$ 8.3	3-10	6.7 $\pm$ 0.6
2001	8	Nov.22~Mar.25	Jan.20 $\pm$ 13.0	Jun.30~Sep.14	Aug.3 $\pm$ 15.7	97-266	194.5 $\pm$ 21.3	2-9	5.7 $\pm$ 1.3
2002	11	Nov.22~Feb.21	Jan.15 $\pm$ 7.0	Jul.11~Sep.5	Aug.11 $\pm$ 4.7	102-245	207.8 $\pm$ 9.4	3-11	7.0 $\pm$ 1.8
	174	Mean $\pm$ SE	Jan.31 $\pm$ 1.6		Jul.30 $\pm$ 2.2		180.4 $\pm$ 3.0		5.8 $\pm$ 0.2

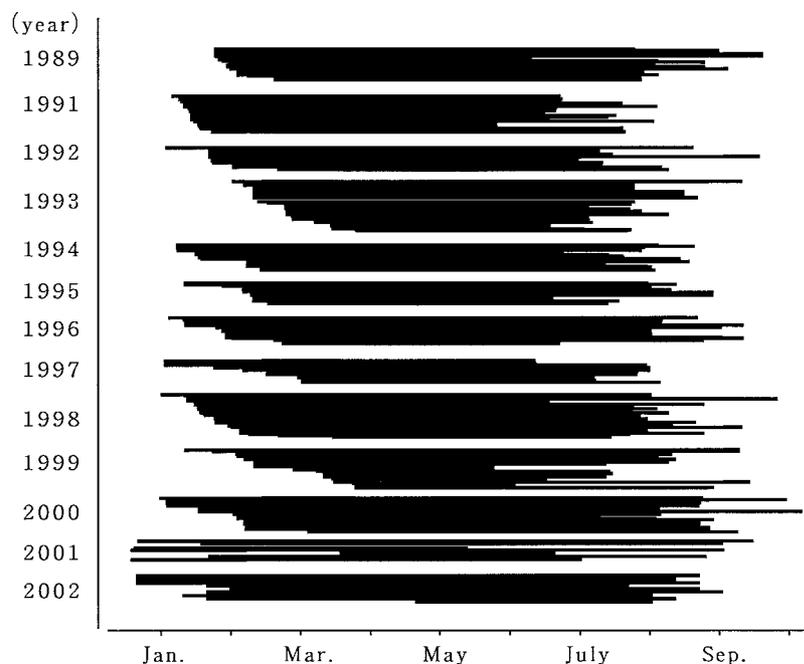


Fig. 1. The interval from the start of estrus until the end of estrus (breeding season) in each year (174 cases). Bar shows the interval from the start of estrus until the end of estrus in each cat.

Estrus ended between May 20 and October 5. The breeding season ranged from 72 to 269 days, with a mean of  $180.4 \pm 3.0$  days, so that the breeding season in cats in Tokyo was 6 months from the end of January until the end of July.

The number of estrous cycles ranged from 2 to 12, with a mean of  $5.8 \pm 0.2$ .

Interval until first estrus in female cats: The birth month and interval until first estrus in 125 female kittens that were acclimated under a natural photoperiod are shown in Fig. 2.

The interval until first estrus ranged from 181 to 560 days after birth, with a mean of  $345.0 \pm 9.0$  days. With respect to the month of birth, 67 kittens that were born between March and June entered estrus between January and August the following year. The interval ranged from 272 to 471 days, with a mean of  $343.0 \pm 9.5$  days, but 58 kittens that were born between July and October exhibited estrus the year after birth or 2 years after birth. In 33 kittens that entered estrus between January and August the year after birth, the interval

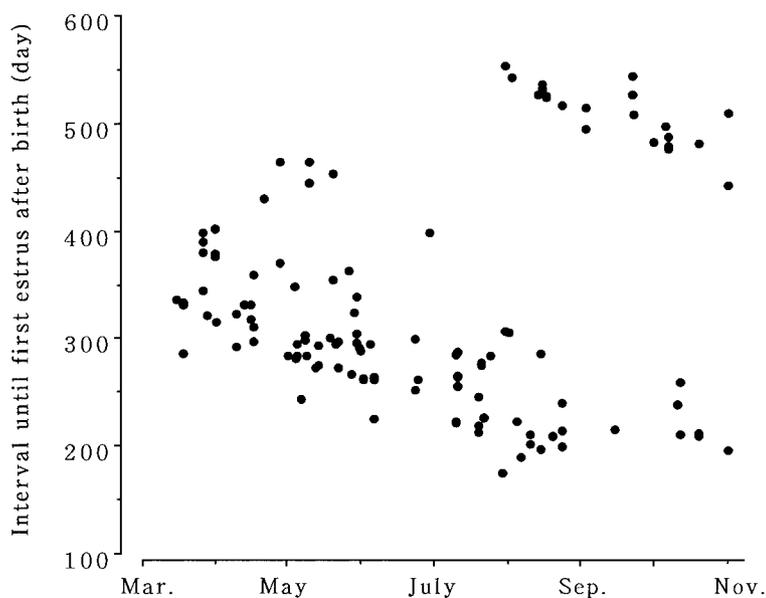


Fig. 2. The birth month and interval until the first estrus (puberty) in 125 female kittens.

ranged from 181 to 313 days, with a mean of  $242.0 \pm 6.3$  days. The interval until first estrus was noticeably shorter than that in cats that were born between March and June ( $p < 0.01$ ). Furthermore, 25 kittens exhibited estrus between January and March 2 years after birth. The interval ranged from 483 to 560 days, with a mean of  $519.2 \pm 5.8$  days. Two (11.1%) of 18 kittens that were born in July, 10 (50.0%) of 20 kittens that were born in August, 6 (85.7%) of 7 kittens that were born in September, and 7 (53.8%) of 13 kittens that were born in October exhibited estrus 2 years after birth.

The mean breeding season in female cats that were acclimated under a natural photoperiod in Tokyo was 180.4 days (from the end of January until the end of July), but the breeding season differed noticeably among individual animals. These results were similar to generally reported findings [2, 6, 12], but our study may be the first one presenting results obtained under a natural photoperiod. The number of estrous cycles during the breeding season ranged from 2 to 12, with a mean of  $5.8 \pm 0.2$ . The mean duration of the breeding season was 180.4 days. The mean number of estrous cycles was 5.8. On average, 31 days per estrous cycle was required. In this study, the duration (days) of estrus was not investigated, but considering that the mean duration is 7 days [6, 11, 12, 14, 16], the interestrus interval is 24 days (31 days - 7 days). The interval is different from values reported by Michel [10], Shille *et al.* [14], and Wildt *et al.* [16]. There was no relationship between the number of estrous cycles and the duration of the breeding season, suggesting that the interestrus interval differs noticeably among individual animals, but Lawler *et al.* [7] found that individual acclimation led to spontaneous ovulation in a

high proportion of cats. Gudermuth *et al.* [3] reported that a high proportion of cats showed spontaneous ovulation under group acclimation. In particular, when female cats were acclimated as a group, 13 (86.7%) of 15 cats showed spontaneous ovulation. They speculated that ovulation without cervical stimulation occurs in response to various factors such as tactile perception, visual perception, auditory perception, and olfactory perception in female cats. In our colony, if spontaneous ovulation occurred in cats with a small number of estrous cycles, estrus would not recur during the pseudopregnancy period, since the period persists for about 40 days. But it is unclear whether ovulation without cervical stimulation occurred in our colony.

When female kittens were acclimated under a natural photoperiod, the interval until first estrus depended on the month of birth. The interval was shortest in cats that were born between July and October and entered estrus the year after birth (181–313 days, mean: 242.0 days). Therefore, puberty in female kittens was obtained 8.0 months after birth at minimum.

#### REFERENCES

1. Banks, D.R., Paape, S.R. and Stabenfeldt, G.H. 1983. *Biol. Reprod.* **28**: 933–939.
2. Foster, M.A. and Hisaw, F.L. 1935. *Anat. Rec.* **62**: 75–93.
3. Gudermuth, D.F., Newton, L., Daels, P. and Concannon, P. 1997. *J. Reprod. Fertil. (Suppl.)* **51**: 177–184.
4. Hurni, H. 1981. *J. Lab. Anim.* **15**: 229–233.
5. Jemmett, J.E. and Evans, J.S. 1977. *J. Small Anim. Pract.* **18**: 31–37.
6. Kirk, R.W. 1966. *Mod. Vet. Pract.* **47**: 40.
7. Lawler, D.F., Johnston, S.D., Hegstad, R.L., Keltner, D.G. and

- Owens, S.F. 1993. *J. Reprod. Fertil. (Suppl.)* **47**: 57–61.
8. Leyva, H., Addiego, L. and Stabenfeldt, G.H. 1984. *Endocrinology* **115**: 1729–1736.
  9. Leyva, H., Madley, T. and Stabenfeldt, G.H. 1989. *J. Reprod. Fertil. (Suppl.)* **39**: 125–133.
  10. Michel, C. 1993. *Lab. Anim.* **27**: 278–280.
  11. Povey, R.C. 1978. *Can. Vet. J.* **19**: 207–213.
  12. Root, M.V., Johnston, S.D. and Olson, P.N. 1995. *J. Am. Anim. Hosp. Assoc.* **31**: 429–433.
  13. Scott, P.P. and Lloyd-Jacob, M.A. 1959. *Nature (Lond.)* **26** (suppl.184).
  14. Shille, V.M., Lundstorm, K.E. and Stabenfeldt, G.H. 1979. *Biol. Reprod.* **21**: 953–963.
  15. Shille, V.M., Munro, C., Farmer, S.W., Papkoff, H. and Stabenfeldt, G.H. 1983. *J. Reprod. Fertil.* **68**: 29–39.
  16. Wildt, D.E., Chan, S.Y.W., Seager, S.W.J. and Chakraborty, P.K. 1981. *Biol. Reprod.* **25**: 15–28.