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Domestic queens under natural temperate photoperiod do not manifest seasonal anestrus

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ABSTRACT

Domestic cat seasonality between the tropics and the arctic zones is scarcely described and results are inconsistent. The aim of this study was to describe domestic feline seasonal patterns under a natural temperate photoperiod. A total of 372 estrous cycles were studied in 34 post pubertal cats during 900 days. The queens were housed in a cat colony (31°25′ South Latitude, 64°11′ West Longitude), acclimated under natural photoperiod and daily observed for reproductive behavior. Vaginal cytology was conducted three times a week. For each cat the number of estrous cycles and days in estrus per month for each year were recorded. The months of the year were grouped in four periods of 3 months each according to day length and photoperiod. Comparisons of estrous days among periods were performed by ANOVA for repeated measures. All the cats had estrous cycles throughout the year without intervals of anestrus. Mean number of estrous days differed among the periods ($P < 0.01$), those of long day length and ascending photoperiod being greater (12.5 ± 0.6) to those of descending photoperiod either with long (8.9 ± 0.7) or short (9.3 ± 0.7) days. When the two periods with ascending day lengths were merged and compared to the two periods with descending day lengths merged, the number of estrous days were greater when day length ascended ($P < 0.01$). Nearly 60% of the estrous cycles occurred during the periods of ascending day length. It is concluded, that domestic cats under natural temperate photoperiod have estrous cycles throughout the year showing peak activity the months with increasing photoperiod.

1. Introduction

Domestic cat (*Felis catus*) reproductive physiology differs widely to that of other domestic animals. The queen has traditionally been classified as a seasonal, polyestrous female with induced ovulation (Johnston et al., 2001). Cats exhibit successive waves of ovarian follicular growth without the fully expressed estrous cycle in the manner of spontaneous ovulators. Spontaneous ovulation is not uncommon in this species (Johnston et al., 2001). Another particular reproductive feature of this species is the seasonality. In this regard, most of the descriptive studies have been conducted in research colonies (Hurni, 1981; Robinson and Cox, 1970) or from surveys of client-owned breeding cats probably held under artificial illumination (Gerrits et al., 1999; Jemmett and Evans, 1977; Johnstone, 1987; Prescott, 1973). Additionally, most of the queens received by practitioners are spayed or treated with contraceptives. Thus, very little is known about the reproductive seasonality of this species in natural conditions (Abeya et al., 2011; da Silva et al., 2006; Nutter et al., 2004; Scott et al., 2002; Tsutsui et al., 2004).

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A detailed knowledge of the reproductive physiology is required whenever exogenous manipulation of the estrous cycle is required (e.g., estrous induction or prevention for clinical, research or biotechnological purposes). The simple assumption of reproductive seasonal patterns described in a specific location may lead to failure of the exogenous control of the estrous cycle in another geographical location.

The main environmental factor affecting seasonal breeding in mammals is the annual change in day length. Photoperiodic control of reproductive patterns is mediated through circadian rhythmic secretions of melatonin by the pineal gland during darkness. In this positively photoperiodic species, melatonin negatively influences the gonadotropin-releasing hormone pulse generation and the hypothalamic–pituitary–gonadal feedback loop (Leyva et al., 1989).

In equatorial, tropical and subtropical regions, changes in day length are less pronounced than in temperate and polar regions. Domestic cats bred in natural equatorial regions have estrous cycles throughout the year (da Silva et al., 2006). The situation between the tropics and the arctic zones (i.e., temperate areas) is less clear and inconsistent among studies (Abeya et al., 2011; Nutter et al., 2004; Scott et al., 2002; Tsutsui et al., 2004). Thus the aim of the present study was to describe domestic feline seasonal patterns under natural temperate photoperiods.

2. Materials and methods

2.1. Geographical location and animals

A total of 372 estrous cycles were studied in the 34 post-pubertal female cats during 900 days from 2007 to 2009. The queens (age: 1–4 years; body weight: 2.4–3.2 kg) were housed together in the cat colony facilities (6 m × 4 m) of the Veterinary Faculty of the Catholic University of Cordoba, Argentina (31°25′ South Latitude, 64°11′ West Longitude) and acclimated under natural photoperiod through glass windows and access to an open yard (6 m × 4 m).

In the city of Cordoba day length varies from 10.12 h in June to 14.15 h in December and mean temperature ranges from 9.6 °C in July to 23.1 °C in January. The cats were fed a commercial premium cat food and given water *ad libitum*. This study was approved by the Institutional Care and Animal Use Committee Faculty of Veterinary Medicine of the National University of La Plata.

2.2. Cat monitoring

The queens were daily observed for reproductive behavior and vaginal cytology was conducted three times a week, or whenever estrous signs appeared (Johnston et al., 2001). Estrus was diagnosed based on the appearance of both typical estrous behavior and vaginal cytology (>80% superficial cells; Mills et al., 1979). The total number of days in estrus per month for each year of observation and the number of estrous cycles (interval from the onset of one estrus to the onset of the next) were recorded for each cat.

2.3. Statistical analysis

The months of the year were grouped into four periods of 3 months each. Months with long days and decreasing photoperiod (LD): January, February and March, months with short days and decreasing photoperiod (SD): April, May and June, months with short days and ascending photoperiod (SA): July, August and September, and months with long days and increasing photoperiod (LA): October, November and December. Comparisons of estrous days per month among periods were performed by ANOVA for repeated measures followed by Tukey comparison test. To further characterize data, percentage number of estrous cycles was also calculated for each period. In all the cases results were expressed as mean ± SEM and P values <0.05 were considered significant (SPSS 17.0, SPSS Inc. Chicago, IL, USA).

3. Results

All the cats had estrous cycles throughout the year without intervals of anestrus. Mean number of estrous days per month differed among the periods ($P < 0.01$), being significantly greater in SA than in either LD or SD (Fig. 1). When the two periods with ascending day length were compared to the two groups of descending day length, the number of estrous days was greatest in the group with ascending day length (11.9 ± 0.5 compared to 9.1 ± 0.5; $P < 0.01$). Furthermore, nearly 60% of the estrous cycles commenced during the periods of ascending day length (SA + LA) and only 15% in the first 3 months of the decreasing photoperiod (LD) in spite of the rather long days (Fig. 2).

4. Discussion

The present study describes the breeding seasonality of domestic cats under natural temperate photoperiod providing a background for comparative studies not only with other felids, but also with other seasonal mammals. It is worth noting, that in the present study the number of estrous days per period could have been influenced by the vaginal sampling and the consequent eventual induced ovulation in some queens. Although, as this procedure was performed uniformly throughout the trial, its influence was constant among the periods which should have maintained relative differences.

In agreement with all the previous descriptions in natural equatorial (da Silva et al., 2006) and temperate regions (Scott et al., 2002; Nutter et al., 2004; Abeya et al., 2011), the cats here studied had estrous cycles continuously (i.e., throughout the year). Evidently, in these regions the small change in photoperiod (4 h in the present study) is not enough to cause a seasonal anestrus.

Conversely, in the study in 35°40′60 North Latitude, 139°46′0 East Longitude the breeding season differed noticeably among individual animals and the mean reproductive activity was 6 months long (Tsutsui et al., 2004). These discrepancies with the present and previous reports at similar latitudes (Abeya et al., 2011; Nutter et al., 2004; Scott et al., 2002) could be explained by differences in

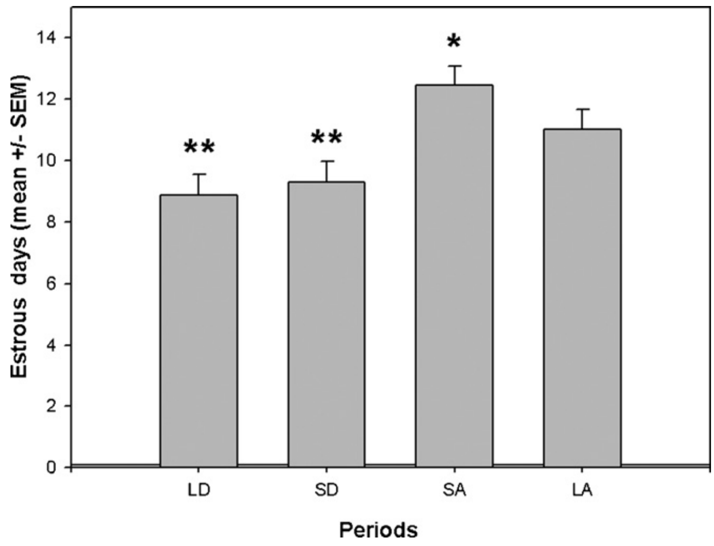

Fig. 1. Estrous days per month (mean ± SEM) of 372 estrous cycles of 34 post-pubertal female cats that appeared during January, February and March (LD), April, May and June (SD), July, August and September (SA), and October, November and December (LA) in the city of Cordoba, Argentina. Different number of asterisks above the bars indicates $P < 0.01$.

climate, food availability, breed or physiological stage of the animals.

Interestingly, according to present and previous findings (Abeya et al., 2011; Nutter et al., 2004; Scott et al., 2002) the proportion of cats showing seasonal anestrus is less than expected being nil up to, at least, 35° latitude. The same latitude (>35°) has been described as the commencement for seasonality in goats (Fatet et al., 2011). It is assumed that the proportion of cats affected by seasonal anestrus is greater in the high Northern and Southern latitudes. Further investigations are necessary to describe photoperiod effect in higher latitudes and polar regions in this species.

A lack of seasonality was also found in several surveys from breeding cats (Gerrits et al., 1999; Jemmett and Evans, 1977; Johnstone, 1987), although this should be taken with caution as these animals were probably exposed to an artificial photoperiod.

The months with the greatest number of estrus days (i.e., July, August and September) were preceded

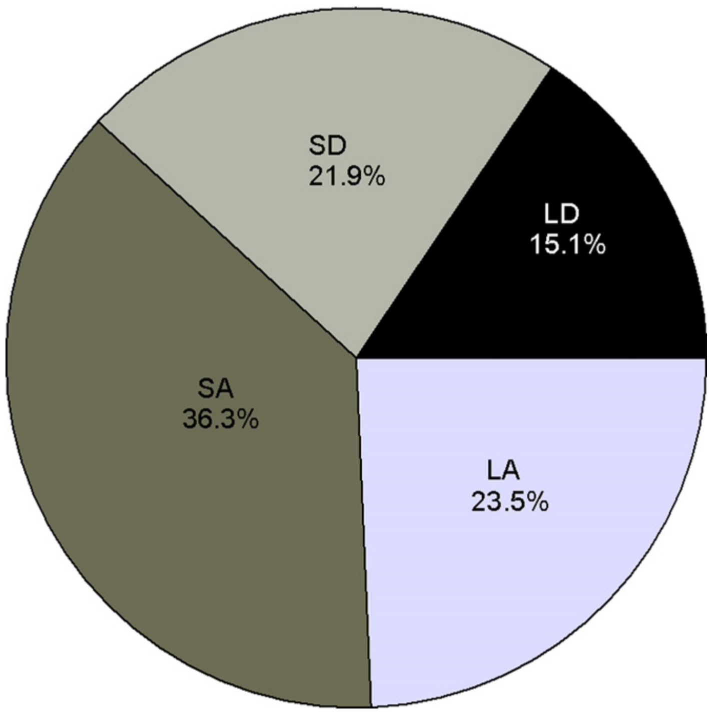

Fig. 2. Percentage onset of estrous cycles of 372 estrous cycles of 34 post-pubertal female cats that appeared during January, February and March (LD), April, May and June (SD), July, August and September (SA), and October, November and December (LA) in the city of Cordoba, Argentina. Different number of asterisks above the bars indicates $P < 0.01$.

by a 3-month period of the shortest day length and descending photoperiod. The same has been previously described in experimental laboratory conditions in this domestic species (Hurni, 1981). Thus, both in natural and laboratory settings the change from diminishing to increasing photoperiod seems to induce estrus in cats.

Findings in the present study are consistent with those in a study at a similar latitude but in the northern hemisphere (35° North Latitude, 80° West Longitude) where the percentage of pregnant cats was greatest in March, April, and May which means that estrous cycles occurred in January, February and March (Nutter et al., 2004). These latter 3 months represent the Northern corresponding counterpart (i.e., adding 6 months) of the months most estrous days occurred in the present study.

At a lower latitude (29°39′5″N/82°19′30″W) of the Northern hemisphere it was described that pregnancy rate peaked in March and April and decreased from October through January (Scott et al., 2002). Using the same rationale for months conversion, the periods of maximum and minimum reproductive activity are consistent with results in the present study. In another investigation in a temperate region of the northern hemisphere (35°40′60 North Latitude, 139°46′0 East Longitude), maximum reproduction was described between the end of January and the end of July which also coincides with findings in the present study (Tsutsui et al., 2004). Furthermore, in the Southern hemisphere, in a slightly higher latitude (34°8′ South Latitude, 57°54′ West Longitude) it has been recently described a significantly augmentation of the estrous days during the 6 months of ascending photoperiod (Abeya et al., 2011).

It is concluded, from this and previous investigations, domestic cats under natural temperate photoperiod have estrous cycles throughout the year with the greatest reproductive activity during the months with increasing photoperiod.

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