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Feline Reproduction and Breeding Management

The first estrus or heat may occur in queens anytime between 4 and 12 months of age. The time of the first estrus is influenced by breed (many shorthair breeds reach puberty earlier than longhair breeds), the time of year (which determines the length of daylight), and the body condition of the queen. The average body weight at puberty is 2.3 to 3.2 kg (5 to 7 lbs, or 80% of adult body weight). After maturity, most queens can produce litters for five to seven years before age-related changes cause decreased litter size and a decreased number of pregnancies.

The cat is described as being seasonally polyestrous and a long-day breeder. Queens cycle repeatedly during a breeding season unless interrupted by pregnancy, pseudopregnancy (false pregnancy), or illness. Estrous cycles will occur at intervals ranging from four to 30 days but are typically 14 to 21 days apart. This is in marked contrast to the canine, where bitches may cycle only twice per year. Over 50% of all shorthair cats will have estrous cycles year-round.

Litter size in pedigree breeds varies greatly, but most studies, including a very recent one from the United Kingdom, find a range of 1 to 13 kittens. This large U.K. study found an average litter size of 4.6 kittens in data from 14 different breeds. My own data from 11 different pedigreed breeds, indicates an average litter size of 4.2 kittens.

Table 1: Feline Reproduction Data

Length of estrus	average 5.8 +/- 3.3 days, range 2-19 days
Length of pseudopregnancy	40-50 days
Pregnancy rate	73.9%
Queening rate	65.2 %
Length of gestation	66.9 +/- 2.9 days, range 62 to 74 days
Litter Size (from various sources)	4-5 kittens, range 1-13
Number of litters/year	average 2 - 2.5, range 1-3
Age at puberty - male	7-18 months
Age at puberty - female	6-10 months, as early as 4 months

Sources:

Root MV et al. Estrous length, pregnancy rate, gestation and parturition lengths, litter size, and juvenile mortality in the domestic cat. J Amer Anim Hosp Assoc 31(5): 429-433, 1995

Feldman EC, Nelson RW. Feline reproduction. *Canine and Feline Endocrinology and Reproduction*, 2nd ed. W.B. Saunders, Philadelphia, PA, 741-768, 1996

Sparkes AH et al. A questionnaire-based study of gestation, parturition and neonatal mortality in pedigree breeding cats in the UK. J Fel Med Surg, 2005, in press

Verstegen, JP. Physiology and endocrinology of reproduction in female cats. *Manual of Small Animal Reproduction and Neonatology* (G. Simpson et al, eds.). British Small Animal Veterinary Assoc., Cheltenham, U.K., 11-16, 1998

The queen has four stages in her estrous cycle: proestrus, estrus, diestrus and anestrus. The stage just before estrus is called proestrus. In this stage, many queens begin to rub their head and neck against convenient objects and display affectionate behavior. Occasionally, queens in proestrus have a slight mucoid vaginal discharge and increased frequency of urination. This stage may last only one day or so, and the signs may be subtle, so it is often not detected. During proestrus, toms may be attracted to the queen but she will not be receptive. Estrus is the stage of behavioral receptivity to mating. This stage may last from as little as one day to as long as 21 days, with the average duration being seven days. The queen will crouch with her front legs pressed to the ground, with her back in a position of lordosis, and her tail turned to one side to present the vulva. Queens in estrus often call or vocalize to attract the attention of males. They may be restless, have a poor appetite, urine mark, and show increased affection to their owners.

Occasionally, queens with prolonged estrus are seen. In some cases, it is thought that this is due to the maturation of overlapping waves of ovarian follicles (and therefore, prolonged high levels of the hormone estradiol). Other such cats, however, are having normal distinct patterns of follicular growth. Why these queens show prolonged estrus rather than distinct estrus periods is not understood. Persistent estrus can also be associated with cystic follicles. Another normal variation is the queen that appears to be in estrus while pregnant.

Follicle stimulating hormone (FSH), produced by the pituitary gland in the brain, initiates the development of ovarian follicles. An average of three to seven follicles develop and start producing the hormone estradiol-17β (a type of estrogen). It is estradiol that causes the behavioral signs of estrus, which occurs as the follicular activity peaks, with blood estradiol levels reaching a high of 20 to 50 pg/ml (or higher). The estradiol levels stay high for three or four days and then abruptly fall.

Traditionally, queens are described as induced ovulators. Ovulation should not occur unless mating or a similar stimulus induces it. However, spontaneous ovulation in response to visual, auditory or tactile stimulation is well documented. The length of estrus is not affected whether ovulation does or does not occur. The period between one estrus and the next in queens that have not ovulated is called the interestrus. During this time the blood estradiol level is low (under 15 pg/ml) and no sexual behaviors are seen. The time of interestrus can range from two to 19 days but on average is seven days.

If a queen has ovulated during a cycle, the period following estrus is called diestrus. During this phase, the ovulated follicles become structures called corpora lutea or CLs. The CLs produce progesterone, which is the dominant hormone at this stage, starting 24 to 48 hours after ovulation. If the queen ovulated but did not become pregnant, a pseudopregnancy will occur, which lasts about 40 to 50 days. Estrus may resume about 10 days after the end of diestrus, but nursing queens often experience a lactational anestrus that can last for up to two to three weeks past the point of weaning the kittens. However, it is entirely possible for a queen to return to estrus and conceive while still nursing. Very often the first estrus after a pregnancy is shorter and less fertile. Anestrus is the absence of cycling activity, which may occur naturally in periods of short daylight. In the northern hemisphere, this is between October and December. Individual variation is

common. During this time, blood progesterone and estradiol are at baseline levels (estradiol-17β under 8 pg/ml and progesterone under 0.5 ng/ml).

Breeding Management

Under optimum conditions, most queens will have two litters per year. Litters may be born anytime in the year, although most studies show there are slightly more litters born to pedigreed cats in the spring. Queens can breed successfully until the age of 8 or 10 years. Queens over seven years of age tend to have more irregular estrous cycles, have smaller litters, and have more spontaneous abortions and congenital defects.

Control of Estrus and Reproduction

The traditional medications used to prevent estrus are synthetic drugs based on progesterone called progestins. The most commonly used drugs in North America are megestrol acetate (Ovaban® and others) and medroxyprogesterone acetate (Provera®, Depo-Provera®).

These medications must be used with great care. They cannot be used in cats with liver disease. If they are to be used, ideally treatment should start when the queen is in anestrus to decrease the risk of uterine disease. There are various published doses for use of these drugs, but the best advice is to use the least amount necessary. They should also be used for the shortest time period possible. They should not be used in a very valuable breeding queen due to the risk of uterine disease. Once the drug is stopped, the first estrus should be allowed to pass and the queen should be bred on the second estrus.

The side effects of progestins are numerous and potentially serious. They include behavior changes such as increased friendliness toward humans, lethargy, depression, and other changes such as increased appetite, weight gain, increased thirst, and increased urination. Long-term therapy carries the risk of several diseases such as epidermal atrophy, cutaneous xanthomatosis, mammary hyperplasia and mammary cancer, cystic endometrial hyperplasia, pyometra, adrenal suppression, and diabetes mellitus (transient or permanent). These drugs are not licensed for use in cats in North America.

Cystic Endometrial Hyperplasia and Endometritis

Cystic endometrial hyperplasia (CEH) is a disorder of proliferative and degenerative changes in the endometrium associated with aging and hormonal stimulation. Endometritis and pyometra are forms of CEH associated with bacterial infection. Progesterone causes changes in the cells and glands of the endometrium. Fluid in the cystic structures is usually uncontaminated, but if free in the uterus, it easily supports bacterial growth. Progesterone also inhibits immune responses in the uterus and decreases myometrial contractility. In queens, endometrial changes may also be influenced by chronic estrogenic stimulation from recurrent estrous cycles that do not result in pregnancy.

Queens with uncomplicated CEH usually have no clinical signs of illness. The results of blood and urine tests are within normal ranges. However, CEH is associated with failure of implantation and subsequent small litters or infertility, as well as early embryonic death. Most studies have found an increased incidence in older queens and in unbred queens more than three years old. However, the CEH/pyometra complex can be diagnosed at any age, and in multiparous queens.

CEH may also be associated with spontaneous ovulation in queens. Breeding catteries may have high rates of CEH, especially in queens three years of age and older. This may be due to several factors, including frequent spontaneous ovulation and the limitations imposed on the timing of pregnancies to accommodate show schedules and planned breeding schedules. Pregnancy protects the uterus against pathologic changes.

Breeders have few choices when they wish to discontinue breeding a particular queen for any period of time. No drugs are approved for this purpose in cats in the United States. Methods that induce pseudopregnancy, such as induced ovulation (acupressure technique or vaginal stimulation) or the use of progestins, may increase the risk of CEH. Repeated estrous cycles without pregnancy are also known to result in loss of body condition due to reduced appetite, behavioural changes, and stress-related conditions such as self-trauma.

CEH is difficult to diagnose without uterine biopsy. However, it should be suspected in queens that repeatedly ovulate when bred but do not conceive, provided the tom is known to be fertile. There is no effective treatment for CEH and affected queens should be removed from the breeding program.

Endometritis is characterized by inflammation of the endometrium. Most queens with endometritis have bacterial infections. Ascending infections from the vagina may occur during estrus, when estrogens dilate the cervix. The feline vagina hosts a wide range of normal bacterial flora. The only sign associated with endometritis may be infertility. The results of routine blood testing are within normal ranges and the amount of vaginal discharge may be very small and go unnoticed. Thickening of the uterine wall or fluid retention may be seen on ultrasound.

Endometritis often progresses to pyometra and so most affected queens should be removed from the breeding program. If the diagnosis is suspected or confirmed with uterine biopsy and culture, an attempt may be made to breed valuable queens while administering a broad-spectrum antibiotic, such as amoxicillin/clavulanic acid (Clavamox®, Pfizer Animal Health).

Pyometra

Pyometra represents a severe endometrial infection with an accumulation of pus in the uterus. *E. coli* is reported to be the most common bacterial species involved in feline pyometra. Other bacterial species involved in pyometra include *Staphylococcus* and *Streptococcus*. Diagnosis of pyometra is based primarily on history, clinical signs, and physical examination findings.

Common signs associated with pyometra in the queen include vaginal discharge, lethargy, anorexia, abdominal enlargement, dehydration, and fever. Queens with a closed cervix pyometra have abdominal enlargement with no vaginal discharge and may be severely ill. These queens are at increased risk for uterine rupture and septic peritonitis. Increased white blood cell counts are common findings in queens with pyometra. Blood chemistries may show various changes, such as increased protein levels. Uterine enlargement may be seen on x-rays or abdominal ultrasound.

Initial management of queens with pyometra revolves around patient stabilization. Intravenous fluid therapy and correction of electrolyte imbalances may be required if the queen is ill. Antibiotic therapy should be started with a broad-spectrum product such as enrofloxacin (Baytril®, Bayer) or amoxicillin/clavulanic acid (Clavamox®, Pfizer Animal Health). Choice of antibiotic may also be based on results of culture and sensitivity testing of the vaginal discharge. However, antibiotic treatment as sole therapy, or combined with vaginal douching, is not usually successful for resolution.

Ovariohysterectomy is the treatment of choice for most queens with pyometra, and is the only choice for those queens with closed cervix pyometra or critically ill queens, but it is not without risk. In one study, 8% of cats died or were euthanized after surgery. Post-operative complications of some kind, such as anorexia, lethargy, fever, and vomiting, were seen in 21% of cats.

Valuable breeding queens with open cervix pyometra may be treated with prostaglandin (Lutalyse®, Pharmacia & Upjohn) and antibiotics. Prostaglandin treatment causes evacuation of the uterus via smooth muscle contraction. While risks associated with this treatment regime are few, it entails expense to the breeder and most importantly, must be carried out by a veterinarian experienced in feline reproduction medicine.

Clearly, avoidance of the CEH/pyometra complex in queens should be a focus of breeding programs. Breeders can accomplish this by choosing cats for breeding from reproductively healthy bloodlines and by interfering as little as possible with the normal reproductive patterns of cats, including avoiding the use of progestins to prevent estrus. Understanding the nature of feline reproductive physiology is critically important to healthy breeding management. Breeders and veterinarians must be especially aware that in reproduction, as in other aspects of feline medicine, cats are not "small dogs."

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