Semen Collection and Assessment, and Artificial Insemination in the Cat

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Introduction

Both semen collection and artificial insemination (AI) in cats was first described more than 30 years ago [1] but the procedures are still not routine because very few veterinary clinics are offering these services. While the more advanced biotechnology techniques such as in vitro fertilization (IVF), intracytoplasmic sperm injection (ICSI) and cloning have been successfully performed experimentally in the cat, they are not performed in practice and even the clinical application of AI is not as well developed in the cat as it has been since decades in many other domestic species [2-4]. Much of the research that has generated knowledge about assisted reproduction in the cat has been developed using the domestic cat as a model for the wild cat species that are threatened by extinction. There is, however, an increasing demand for these services among the breeders of domestic cats. The behavior of intact male cats makes them unsuitable to keep in a household. Consequently, the number of available stud cats is very small and many more females than males are used for breeding. This eventually has lead to a small genetic variation in many breeds of cats. If semen was to be frozen from genetically valuable male cats before they were castrated, the situation would be greatly improved. The use of chilled and frozen semen in an AI program would also make it easier to exchange genetic material over long distances and would, in addition, reduce the risk of transmission of infectious diseases.

How to Collect Cat Semen

Semen collection in domestic animals is usually done with the aid of an artificial vagina or by digital manipulation. An artificial vagina can be used for semen collection also in the domestic cat but the method is not very practical in the clinical situation because of the behavior and temperament of this species. Semen collection by digital manipulation has not been described in the cat. The most commonly used method for semen collection in cats is electroejaculation. Spermatozoa can also be collected from the epididymides after surgical castration, post-mortem, or by vaginal lavage after a natural mating.

Artificial Vagina

Collection with an artificial vagina usually requires that the tom be trained for this method. Not all male cats can be successfully trained [1]. If the male is placed in unfamiliar surroundings for the semen collection, which is usually the case in the clinical situation, it is unlikely that this method will work even in a trained male. In research colony cats, collection with an artificial vagina can, however, be a very useful method. The artificial vagina is easily made from a rubber bulb for a Pasteur pipette and a small test tube (Fig. 1). The tom is allowed to mount an estrous female and the artificial vagina is slipped over the glans penis of the male as he thrusts in search for the opening of the vulva (Fig. 2).

Figure 1. Artificial vagina for cats. - To view this image in full size go to the IVIS website at www.ivis.org.

Figure 2. Semen collection with an artificial vagina in the cat. - To view this image in full size go to the IVIS website at www.ivis.org.
Electroejaculation - To collect semen by electroejaculation an electric stimulator and a rectal probe are required (Fig. 3) and the male cat has to be anesthetized during the procedure. The method is reliable and safe and therefore suited for semen collection in privately owned cats. The authors use medetomidine (Domitor® vet.) 80 µg/Kg body weight sc, in combination with ketamine-HCl (Ketalar®) 5 mg/Kg body weight im to anesthetize the cats. The anesthesia will last long enough to allow completion of the protocol described below, and usually long enough to also allow repeated semen collection after 5 to 10 minutes if this is desirable. Atipamezol can be used to reverse the anesthesia. The electroejaculator can be custom made but can also be bought from various manufacturers. The rectal probe has three longitudinal electrodes. It is lubricated and inserted 7 - 9 cm into the rectum with the electrodes directed ventrally [5]. Care should be taken to evacuate any feces from the rectum. A weak electric current stimulates the nerves supplying the reproductive organs. The electrical stimulations are applied intermittently and are of a low frequency. Different stimulation protocols have been described but many are using the one by Howard et al., [6], which consists of a total of 80 electrical stimuli from 2 - 5 volts applied in three series (30, 30 and 20 stimuli). Each stimulation is applied so that it takes approximately 1 second to go from 0 V to the desired voltage, then stays for 2 - 3 seconds at the desired voltage followed by an abrupt return to 0 V where it stays for 2 - 3 seconds. The first serie consists of 10 such stimuli at 2 V, then 10 at 3 V and finally 10 at 4 V. The cat is then rested for 2 - 3 min. The next serie consists of 10 stimuli at 3 V, 10 stimuli at 4 V and finally 10 at 5 V, and the cat is again rested for 2 - 3 min. The last serie consists of 10 stimuli at 4 V followed by 10 at 5 V. For each stimulation the cat responds with rigid extension of the hindlegs. If this reaction is not seen at 2 V or stronger stimulation this indicates either that the electrodes are not in the right position in the rectum, or there is interference by feces. To collect the semen, the cat’s penis is extruded by applying a gentle pressure at its base, and the ejaculate is collected into a prewarmed test tube which has been placed over the glans penis (Fig. 4).

Figure 3. A custom made electroejaculator. The machine is equipped with an amperemeter and a voltmeter, and is connected to a rectal probe that has 3 longitudinal electrodes. - To view this image in full size go to the IVIS website at www.ivis.org. -

Other Methods to Collect Spermatozoa from Male Cats - Spermatozoa can also be obtained from the epididymides after castration, or post-mortem. The cauda epididymidis are dissected free from the testicles and placed in a suitable buffer (for example, Ham’s F-10 or PBS) at 37ºC and spermatozoa are released by slicing the cauda epididymidis [7]. Vaginal lavage, for instance with saline and using a syringe with a smooth tip, can be performed after mating to find out if the male cat produces spermatozoa, but this method is less well suited for semen evaluation or for semen preservation, as many spermatozoa will be lost and the recovered spermatozoa will be affected by vaginal secretions and the media used for flushing.

The Effect of Collection Method on Semen Quality
Ejaculates collected by electroejaculation generally have a larger volume, lower sperm concentration, lower total number of spermatozoa, and a higher pH than samples collected by an artificial vagina [8,9]. The larger volumes obtained by electroejaculation are believed to be due to overstimulation of the accessory sexual glands [5]. Dooley and Pineda [9] could not find any significant differences in osmolality between ejaculates collected by an artificial vagina and those collected by electroejaculation. They did, however, find that osmolality in semen collected by applying 6 V was higher than in semen collected by applying 1 V, which shows an effect of the voltage on the osmolality of the ejaculate. Platz et al., [8] found a significant effect of collection method on sperm motility with lower motility when using electroejaculation, while Dooley and Pineda [9] did not find such an effect.

Methods for Cat Semen Assessment
Volume - The volume of the ejaculates of domestic cats is quite small (see Table 1). This limits the number of evaluations that can be performed in one sample. The volume is best measured with a variable micropipette. If the volume is very small it may be necessary to dilute the sample before further processing. Dilution can, however, induce bending or coiling of the sperm tails due to osmotic differences between the seminal fluids and the dilution media [6,7].

Sperm Motility - Sperm motility can, for routine purposes, be subjectively assessed under a phase-contrast microscope. It
should be measured at 38°C on a warming plate on the microscope or on a pre-warmed slide. Motility is assessed as the percentage of the spermatozoa that are moving progressively. The quality of movement can also be graded using a scale from 0 to 5, where 0 represents no motility at all and 5 represents a very rapid forward progression [5]. The motility can vary much between collections also from the same cat [10].

Color - A semen sample with a high concentration of spermatozoa is more whitish in color than a sample with a lower concentration of spermatozoa. A yellow discoloration reveals contamination of the sample by urine, and may be an occasional finding in samples collected by electroejaculation, especially if high voltages are used [11]. In contrast to the dog, discoloration of the ejaculate due to prostatic disease is extremely rare or never seen in the cat.

Concentration and Total Number of Spermatozoa - An aliquot of the semen sample is diluted in for example formol-saline at a 1:40 to 1:100 dilution rate depending on the sperm concentration and is evaluated in a counting chamber (e.g., a Bürker chamber or Makler chamber) under a microscope. The total number of spermatozoa is calculated from the volume and the sperm concentration.

Sperm Morphology - Different methods for fixation of spermatozoa and classification of sperm defects have been described. It is of advantage to assess sperm morphology both from stained slides and from wet fixation preparations. Abnormal sperm heads are better visualized on stained slides, while cytoplasmic droplets are more easily seen on the wet smears [12]. Carbol-fuchsin stained slides for evaluation of head morphology combined with formol-saline fixed wet smears for evaluation of other sperm abnormalities have been used for assessment of semen from several species including the cat [10,13,14]. In most cat studies, however, only one fixation method has been used for evaluation of all sperm abnormalities. Examples of methods that have been used to evaluate sperm morphology in cats are fixation in glutaraldehyde or Hancocks solution, or to stain the smears with Papanicolaou stain or eosin-nigrosin [6,15-17].

When a combination of carbol-fuchsin stained slides and formol-saline fixed wet smears are used, sperm abnormalities are classified as follows:
- Stained smears: Sperm head abnormalities that can be seen on the stained smears are pear shaped heads, heads that are narrow at the base, heads with abnormal contours, undeveloped heads, narrow heads and heads of abnormal size (larger or smaller than normal) [13] (Fig. 5).
- Wet smears: Sperm abnormalities that can be seen on the wet smears are acrosomal defects such as knobbed acrosomes, swollen acrosomes or acrosomes with abnormal borders, and proximal and distal cytoplasmic droplets. The sperm mid-piece can exhibit different abnormalities such as irregularities of the mitochondrial sheath and double mid-pieces. Abnormalities of the sperm tail can be classified as single bent tail, double bent tail or a coiled tail. Other abnormalities that can be assessed on the wet smear are multiple heads, defects of the terminal piece of the tail and detached heads. If a spermatozoon has more than one abnormality, all the abnormalities should be counted since different abnormalities may have different etiologies and it is not known which abnormalities that are most serious in the cat. Spermatozoa with no visible abnormalities are also counted and are classified as "normal". At least 100 to 200 spermatozoa should be counted and classified in each preparation.

Alkaline Phosphatase - Alkaline phosphatase originates from the epididymides. If an azoospermic ejaculate is collected measurement of ALP in the seminal plasma can be done using the same equipment as for blood plasma, and can give valuable information: High concentrations of ALP are found in complete ejaculates that include epididymal fluids (Table 1). Low concentration of ALP in the ejaculate indicates incomplete ejaculation or bilateral obstruction of the epididymis or the vas deferens.

Semen Parameters in the Cat.
Semen parameters in the domestic cat are shown in Table 1.

Relationship Between Semen Quality and Fertility
Very little is known about the correlation between different semen parameters and fertility under natural conditions in the cat. It has been shown that spermatozoa from male cats with high proportions of abnormal spermatozoa have impaired ability to penetrate oocytes in vitro when compared with spermatozoa from males with low proportions of abnormal spermatozoa [22].
Males with high proportions of abnormal spermatozoa in their ejaculates have, however, been used for breeding with good results [10] (Axner et al., unpublished observations). Males that have been investigated because they did not produce litters after several matings, have usually been found to have such serious changes in their spermiograms that there has been little doubt about their lack of ability to produce kittens. Azoospermia (total absence of spermatozoa), severe oligozoospermia (very low sperm concentrations), teratozoospermia (high proportion of abnormal spermatozoa) and asthenozoospermia (immotile spermatozoa) are examples of semen parameters that have been found to occur in infertile male cats [23].

Subfertility is more difficult to diagnose than total or near total infertility. The proportions of different sperm abnormalities and the proportion of normal spermatozoa can vary between semen collections in the same male cat. A decrease in the proportion of spermatozoa with distal droplets and with tail abnormalities was observed when two consecutive ejaculates were collected [10]. Abnormalities of the sperm heads, acrosomes and mid-pieces originate in the testes and the proportion of spermatozoa with these defects decrease during the passage through the epididymis, while sperm tail abnormalities originate in the epididymis and the proportion increases slightly during epididymal passage. Many sperm tail abnormalities are, however, induced at or after ejaculation when the spermatozoa are mixed with seminal fluids [7]. It is likely that the sperm abnormalities that have their origin in the testes are caused by testicular dysfunctions and probably have a stronger negative influence on fertility than other sperm abnormalities. During spermatogenesis, when the spermatozoa leave the testes and enter into the caput epididymidis, most sperm have cytoplasmic droplets in a proximal position on the sperm tail. The cytoplasmic droplet moves from a proximal to a distal position on the sperm mid-piece during the passage of the spermatozoon through the caput and corpus epididymidis. Most of the spermatozoa which are located in the cauda epididymidis have distal droplets, which are shed at ejaculation [7,24]. Sometimes the cytoplasmic droplet remains in a proximal or distal position on the sperm mid-piece even after ejaculation. Spermatozoa with a remaining proximal droplet probably lack fertilizing capacity, while the presence of a distal droplet is considered of minor importance [25].

There are, to the authors’ knowledge, no studies that show the minimum value for different semen parameters that are required for normal fertility under natural conditions in the cat. Therefore, it is important not to draw too far-reaching conclusions about a male cat’s fertility from a single semen sample. It is, however, reasonable to assume that the higher the number of morphologically normal spermatozoa which exhibit good motility, the better the fertility.

<table>
<thead>
<tr>
<th>Table 1. Semen Parameters in Male Domestic Cats</th>
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<tbody>
<tr>
<td><strong>Parameter</strong></td>
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<tr>
<td>Volume of the ejaculate</td>
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<tr>
<td>Sperm concentration</td>
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<tr>
<td>Total number of spermatozoa in an ejaculate</td>
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<td>Sperm morphology</td>
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<td>Motility</td>
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<td>pH</td>
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<tr>
<td>Osmolality</td>
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<td>ALP</td>
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**Cat Semen Preservation**

Cat semen can either be inseminated as fresh and undiluted if it is used immediately after collection, as chilled extended in case of short term storage, or as frozen and thawed if it is to be stored for a longer period of time. Different cryopreservation protocols have been described in the literature both for ejaculated spermatozoa and for spermatozoa obtained from the epididymides [8,16,26]. The authors use a protocol that was originally developed for cryopreservation of dog semen [27]. The composition of the extenders is given in Table 2. The semen sample is centrifuged at 700 G for 6 min and the sperm pellet is resuspended in Uppsala Equex Extender 1 to twice the desired final sperm concentration. The best concentration for cryopreservation of cat spermatozoa remains to be determined. After 1 hour of chilling from room temperature to 4°C an equal volume of Uppsala Equex Extender 2 is added. The cat semen is then filled in 0.25 ml-straws and frozen with the straws placed in goblets, which are placed at the top of a cane and then in a canister which is lowered in 3 steps into an Apollo SX-18 LN, tank (MVE Cryogenetics®, New Prague, MN, USA). The tank should contain 16 - 18 cm of LN and the canister is held for 2, 2 and 1 min at 7, 13 and 20 cm below the opening of the tank [27].

The straws are thawed in a waterbath at 37°C for 15 s and emptied in a tube with the same volume of Uppsala Equex Thaw Medium at 37°C and allowed to equilibrate at this temperature and in the dark for 5 min before assessment and performing of AI. Examples of other extenders that have been used for cat semen cold storage and cryopreservation are the egg yolk lactose extender (Table 3) and the TesT-egg yolk extender (Table 4).

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**Table 2. Extenders for Cryopreservation of Cat Spermatozoa [27].**

<table>
<thead>
<tr>
<th></th>
<th>Uppsala Equex Extender 1</th>
<th>Uppsala Equex Extender 2</th>
<th>Uppsala Equex Thaw Medium</th>
</tr>
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<tbody>
<tr>
<td>Tris</td>
<td>2.4 g</td>
<td>2.4 g</td>
<td>2.4 g</td>
</tr>
<tr>
<td>Citric Acid</td>
<td>1.4 g</td>
<td>1.4 g</td>
<td>1.4 g</td>
</tr>
<tr>
<td>Glucose</td>
<td>0.8 g</td>
<td>0.8 g</td>
<td>0.8 g</td>
</tr>
<tr>
<td>Na-Benzylpenicillin</td>
<td>0.06 g</td>
<td>0.06 g</td>
<td>0.06 g</td>
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<tr>
<td>Streptomycin Sulfate</td>
<td>0.1 g</td>
<td>0.1 g</td>
<td>0.1 g</td>
</tr>
<tr>
<td>Egg Yolk</td>
<td>20 ml</td>
<td>20 ml</td>
<td>20 ml</td>
</tr>
<tr>
<td>Glycerol</td>
<td>3 ml</td>
<td>7 ml</td>
<td>-</td>
</tr>
<tr>
<td>Equex STM Paste*</td>
<td>-</td>
<td>1 ml</td>
<td>-</td>
</tr>
<tr>
<td>Distilled Water</td>
<td>to 100 ml</td>
<td>to 100 ml</td>
<td>to 100 ml</td>
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</table>

*The Equex STM Paste described in the above recipe is produced by Nova Chemical Sales Inc., Scituate, MA, USA. Note that the formula of the Equex paste produced by Minitüb is different.

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**Table 3. Egg Yolk Lactose Extender for Cryopreservation of Cat Spermatozoa [8].**

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<table>
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<tbody>
<tr>
<td>Lactose</td>
<td>11 g</td>
</tr>
<tr>
<td>Glycerol</td>
<td>4 ml</td>
</tr>
<tr>
<td>Streptomycin Sulfate</td>
<td>1000 µg/ml</td>
</tr>
<tr>
<td>Penicillin G</td>
<td>1000 IU/ml</td>
</tr>
<tr>
<td>Egg Yolk</td>
<td>20 ml</td>
</tr>
<tr>
<td>Distilled Water</td>
<td>to 100 ml</td>
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**Table 4. TesT-buffer for chilling or freezing cat spermatozoa. 325 Mosm Tes is titrated against 325 Mosm Tris to pH 7.4. Egg yolk, glycerol and antibiotics are added [21,28-30].**

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<tr>
<td>N-Trishydroxymethyl-methyl-2-aminomethane-sulphonic acid (Tes)</td>
<td>11.2 g in 150 ml distilled water</td>
</tr>
<tr>
<td>Trishydroxymethyl-aminomethane (Tris)</td>
<td>2.9 g in 75 ml distilled water</td>
</tr>
<tr>
<td>Egg yolk</td>
<td>15 - 20%</td>
</tr>
<tr>
<td>Glycerol (can be omitted for chilling)</td>
<td>7 - 7.5%</td>
</tr>
<tr>
<td>Penicillin G</td>
<td>1000 IU/ml</td>
</tr>
<tr>
<td>Streptomycin</td>
<td>1 mg/ml</td>
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Artificial Insemination

Anatomy of The Genital Tract of The Female Cat - For vaginal and especially for transcervical intrauterine artificial insemination, a thorough knowledge of the genital anatomy of the female cat is necessary. The distance between the vulva and the cervix is between 45 and 60 mm [31]. The cranial vagina is narrow. The fornix is located ventrolateral to the external cervical opening. The cervical canal is oriented obliquely between the uterine body and the vagina. (Fig. 6a and Fig. 6b)

Figure 6a. Schematic drawing of the anatomy of the genital tract in the female cat [44]. - To view this image in full size go to the IVIS website at www.ivis.org . -

Figure 6b. Close up of the paracervical region in the cat. Modified from Crouch, 1969 [45] - To view this image in full size go to the IVIS website at www.ivis.org . -

Timing of the Artificial Insemination - Vaginal cytology can be used to confirm estrus. A small cotton swab (i.e., a urethral swab for men) is moistened with saline, inserted well into the vagina and rolled against the mucosa to obtain epithelial cells from the vaginal wall. The cotton tip is rolled onto a slide and the slide is stained with, for instance, Giemsa stain. When the queen is in estrus more than 80% of the vaginal cells are cornified and the background is clear [32] (Fig. 7 and Fig. 8). It is important to remember that this procedure may induce ovulation. Cat spermatozoa have a fertile life that is at least as long as the time between induction of ovulation and ovulation (26 to 29 hours) since ovulation is induced by mating and pregnancy can result after a single mating [1]. Pregnancy can result after mating or AI for up to 49 hours after the induction of the ovulation [1]. The cervix is only open for passage of contrast medium during a certain period during estrus [31]. In most queens the cervix is patent during mid- and late estrus, with some individual variation. The time when the cervix is patent usually coincides with the time when the vaginal smear is cornified [31]. Therefore, AI should be performed during mid- or late estrus and within 49 hours after the induction of ovulation. The vaginal smear should have a typical estrus appearance. It is probably beneficial if a vaginal insemination is repeated on two occasions, either on two consecutive days or with the second insemination two days after the first. This will increase the likelihood that the cervix is open on at least one occasion [31].

Figure 7. Vaginal smear from a female cat that is not in estrus. - To view this image in full size go to the IVIS website at www.ivis.org . -

Figure 8. Vaginal smear from a female cat in estrus. - To view this image in full size go to the IVIS website at www.ivis.org . -

Induction of ovulation - The cat is an induced ovulator. When performing AI in the queen there is no mating stimuli to induce the ovulation and, therefore, ovulation has to be induced artificially. A dose of 100 IU hCG is usually effective to induce ovulation when given on the third day of estrus. Administration of hCG on day 1 or 2 of estrus is less effective [33]. Ovulation usually takes place within 26 to 29 hours after treatment [1,34]. Ovulation can also be induced by administering 25 µg GnRH, or by mechanical stimulation of the vagina with a cotton swab [35,36].

Insemination Technique - Artificial insemination can be performed by depositing the semen in the vagina or in the uterus. Higher pregnancy rates are obtained both in the dog and cat when semen is deposited in the uterus compared to with vaginal semen deposition, and fewer spermatozoa are needed [37-39]. Intrauterine semen deposition can be accomplished either by
transcervical catheterisation or by surgery. Surgical AI is not allowed in all countries. A transcervical catheter for use in the cat has been developed. It consists of an outer catheter that is introduced into the ventral fornix and an inner catheter that is directed dorsally into the cervical canal [40,41] (Fig. 9 and Fig. 10). An outer catheter with a maximal diameter of 2.7 mm has been reported to fit the vaginal lumen of most females [40]. Zambelli et al., [42], however, found that a thinner catheter was required in some queens and used a 1 mm diameter catheter that was inserted through the cervix with the help of rectal palpation. The method of transcervical catheterisation probably needs to be further developed before it can be used routinely in clinical practice [31]. If the semen is going to be deposited in the vagina, efforts should be made to place the AI catheter as close to the cervix as possible. A 3.5 mm French tomcat catheter is narrow enough to pass through the anterior vagina and reach the cervical os [31]. Chatdarong et al., [31] found that placing the sedated queen in dorsal recumbency with the hind quarters elevated at 30° angle facilitated infusion of vaginally deposited contrast medium through the cervix into the uterus during estrus.

Figure 9. An AI catheter for cats [42]. - To view this image in full size go to the IVIS website at www.ivis.org . -

Figure 10. The outer vaginal catheter (a) fits into the ventral vaginal fornix (f) and aligns the transcervical catheter (b) with the cervical canal (g), permitting the intrauterine deposition of semen, via the inner catheter (c), into the uterus (h). Dorsal median postcervical fold (d), vagina (e) [41]. - To view this image in full size go to the IVIS website at www.ivis.org . -

Sedation vs. no Sedation - Sedation is not always needed for vaginal insemination but facilitates manipulation of the catheter to an appropriate position. Insertion of a catheter through the anterior vagina usually induces the post-coital reaction in an unsedated queen. Howard et al., [43] found that anesthesia compromised ovulation. That is why they recommended that when anesthesia is required for AI the insemination should be performed after ovulation has taken place. Tsutsui et al., [39] did not find an effect of anesthesia on ovulation rate when using the same anesthesia protocol as Howard et al., [43]. In contrast, they obtained higher pregnancy results after surgical insemination before ovulation than after ovulation. The difference between these two studies might be that Tsutsui et al., [39] used a higher dose of hCG to induce ovulation. Another difference is that Tsutsui et al., [39] inseminated queens that were in natural estrus while Howard et al., [43] used PMSG (eCG) to induce estrus.

Number of Spermatozoa per AI - Sojka et al., [1] reported that at least 5 - 50 x 10^6 spermatozoa were required for consistent pregnancy results of between 40 and 67%, after vaginal insemination of fresh cat semen. When queens were inseminated twice on two consecutive days with 5 x 10^6 spermatozoa the conception rate was 75% (6/8 queens) [1]. Tanaka et al., [38] showed that 80 x 10^6 spermatozoa were required to obtain a pregnancy result of 77.8% (7/9 queens) with vaginal deposition of fresh semen. With surgical intrauterine insemination only 8 x 10^6 spermatozoa were required to obtain a pregnancy result of 80% (8/10 queens) [26]. Pregnancy results after insemination of frozen cat semen have been considerably lower than those reported using fresh semen. Platz et al., [8] reported a pregnancy rate of 10.7% (6/56 queens) when using 50 - 100 x 10^6 frozen-thawed spermatozoa for vaginal insemination in gonadotrophin-induced estrous queens. Tsutsui et al., [26] froze spermatozoa in an egg yolk Tris-fructose citric acid extender or in an egg yolk sodium citrate solution and reported a pregnancy rate of 57.1% (8/14) when using 50 x 10^6 frozen-thawed spermatozoa for intrauterine insemination in queens in natural estrus.

Conclusion
With increasing knowledge about feline male and female reproductive physiology and improvement of semen preservation and AI techniques, semen conservation and artificial insemination have the potential to become as valuable tools in cat breeding as they already are for breeding of several other domestic species.

References


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