Characterization of the bacterial population of the genital tract of adult cats

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Objective—To characterize the bacteria of the genital tract in adult cats; assess the effect of estrus, mating, and administration of progestins on those microorganisms in females; and evaluate whether results of bacteriologic culture of vaginal swabs are affected by cleansing of the vulva prior to sampling or by repeated sampling.

Animals—66 female and 29 male cats undergoing routine ovariohysterectomy or castration.

Procedure—Specimens were obtained from vaginal and uterine or preputial mucosae with swabs moistened with sterile saline (0.9% NaCl) solution. In 9 cats, vaginal specimens were obtained before and after cleansing of the vulva with ethanol; in 7 female cats, 2 vaginal specimens were obtained in immediate succession.

Results—Aerobic bacteria were most commonly isolated from cats’ vaginas and prepuces; anaerobic bacteria were isolated frequently from males (41%) but rarely from females (5%). Generally, culture results were not affected by cleansing of the vulva or repeated vaginal sampling. The bacterial population of the vaginas of cats was influenced by stage of the estrous cycle but not by mating or administration of progestins. Bacteria were not isolated from the uterus of any cat.

Conclusions and Clinical Relevance—In cats, bacteria of the genital tract in females are predominantly aerobic; in males, aerobic and anaerobic bacteria are found. The bacterial population of the vagina is affected by stage of the estrous cycle. Pure growth of bacteria in culture of genital tract specimens is a normal finding; antimicrobials should only be administered if clinical signs of genital infection are present.

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Bacteria are present in all natural environments in which mammals live. Bacteria can also be found at different locations in bodies of mammals; these commensal organisms inhabit the gastrointestinal and urogenital tracts, for instance. In animals with signs of a reproductive disorder, the presence of a resident bacterial population in the genital tract makes the diagnosis of contributing infections difficult. Bacteria, most commonly Escherichia coli but also streptococci and staphylococci, have been isolated from the uterus of cats with pyometra.1,2 Escherichia coli has also been associated with deaths of kittens during the preweaning period.3 The role of bacterial infections in many other reproductive disturbances has not been established in cats. As a consequence, owners of cats with reproductive disorders often want to have their cats treated with antimicrobials, especially when bacteria are detected in vaginal swab specimens. Prior to mating, owners of male cats sometimes require that the selected females be treated with antimicrobials to reduce the risk of transmission of bacteria to the male despite the fact that a microbial population is present on the preputial mucosa.4

In association with other defense mechanisms, the bacterial population that is normally present is thought to protect the host against potentially pathogenic bacteria. In monkeys, intravaginal administration of amoxicillin alters the normal vaginal microflora and promotes colonization with uropathogenic E coli.5 In healthy bitches treated with antibiotics, the bacterial population of the vagina was often altered; bacteria that have a pathogenic potential (ie, E coli and Mycoplasma spp) were identified in some bitches that did not have those bacteria in their vaginas prior to treatment.6 Therefore, treatment of animals with antimicrobials may affect the population of commensal bacteria and increase the risk for colonization of the urogenital tract with potentially pathogenic bacteria.

The normal bacterial population in mammals contains antimicrobial resistance genes, regardless of whether the host has ever received antimicrobial treatment. Exposure of the bacteria to antimicrobials increases the number of resistant bacteria in the population.7 Because the bacteria that cause infections, such as pyometra, are also normal inhabitants of the urogenital tract,8 antimicrobial treatment of the host may lead to the development of antimicrobial resistance that interferes with the treatment of pathologic conditions.

Characterization of the normal bacterial population of the genital tract in adult cats is therefore important; the information can be used to assess which antimicrobial treatments should be avoided. Other studies9,10 have characterized the bacteria of the vagina and uterus in colony cats and young household cats that were 6 to 12 months old and the aerobic bacteria of the preputial mucosa and semen of young adult male cats. To the authors’ knowledge, the bacterial population of the genital tract of adult household cats has not been thoroughly studied.

Cleansing of the vulva is usually regarded as a rou-
tine procedure performed prior to the collection of vaginal samples for bacterial analysis. The vulva of cats is small and thin. The introduction of cleansing agent into the vagina might therefore be greater in cats than in other species and compromise the detection of bacteria, but this has not been elucidated. The detection of bacteria may also be compromised by repeated sampling of the vagina (particularly if bacteria are sparse). For example, several swabs might be introduced into the vagina in succession to obtain specimens for cytologic evaluation, bacteriologic culture, and detection of *Chlamydia felis*. The latter samplings in the sequence may not be representative of the normal bacterial population.

The purposes of the study reported here were to characterize the aerobic and anaerobic bacteria of the genital tract in clinically normal, adult household cats; assess the effect of stage of the estrous cycle, mating, or administration of progestins on those microorganisms in females; and evaluate whether results of bacteriologic culture of vaginal swabs are affected by cleansing of the vulva prior to sampling or by repeated sampling.

**Materials and Methods**

**Cats**—Sixty-six female and 29 male cats undergoing ovariohysterectomy or castration were included in the study. The study was approved by the Swedish ethical committee for animal welfare, and all cat owners were informed and gave their written consent.

Breeds of the 66 female cats included domestic shorthair (*n* = 61), Birman (2), Norwegian Forest Cat (2), and Persian (1). Mean ± SD age of these cats was 3.1 ± 2.4 years (range, 1 to 10.5 years). Of the 66 female cats, 23 (37%) were housed strictly indoors, 30 (49%) had mated, and 29 (44%) had given birth to at least 1 litter. Progestins had been administered regularly (ie, medroxyprogesterone acetate; 5 mg/cat, PO, once weekly) to 36 (53%) and irregularly to 6 (9%) female cats; 24 (36%) of females had not received progestins.

Breeds of the 29 male cats included domestic shorthair (*n* = 25), Persian (1), Devon Rex (1), Norwegian Forest Cat (1), and British shorthair (1). Mean ± SD age of these cats was 0.8 ± 0.5 years (range, 0.5 to 2.5 years). Of the male cats, 17 (59%) were housed strictly indoors, and 2 of these had mated; 12 were allowed outdoors, but the number of those cats that had mated was not known.

**Sample collection**—All samples were obtained during the period of anesthesia required for surgery. In all 66 female cats, the vulva was cleansed with ethanol (on a piece of absorbent cotton). The lips of the vulva were separated; a sterile commercial swab moistened with sterile physiologic saline (0.9% NaCl) solution was introduced approximately 1 cm into the caudal portion of the vagina or the urogenital sinus (vestibulum vaginae), and the tip was rotated against the preputial mucosa and used in the preparation of smears for cytologic evaluation and the laboratory and prepared for bacteriologic culture the same day. After the sample for bacteriologic analysis, a cotton swab was rotated against the preputial mucosa and used in the preparation of smears for cytologic evaluation; these smears were also examined to detect signs of preputial inflammation.

To evaluate the effect that cleansing the vulva prior to obtaining swab specimens has on detection of bacteria, vaginal swab samples were obtained before and after cleansing of the vulva with ethanol in 9 cats. These paired swabs were transported to the laboratory and prepared for bacteriologic culture the same day. The 9 samples taken after cleansing were also included in the analysis of the normal bacterial population.

To evaluate the effect that repeated sampling of the vagina has on the results of bacteriologic culture, 2 consecutive samples were obtained in immediate succession after cleansing the lips of the vulva in 7 cats. These paired swabs were transported to the laboratory and prepared for bacteriologic culture the same day, and the 7 samples taken first from each cat were also included in the analysis of the normal bacterial population.

**Bacteriologic culture procedures**—Most samples were prepared for bacteriologic culture within 6 hours of collection. The swab specimens were streaked on agar plates, incubated in 37°C, and examined after 24 and 48 hours. One plate containing 3% horse blood agar and 1 containing lactose bromcresol purple agar were incubated aerobically. One plate contained blood agar to which a streak of *Staphylococcus aureus* (to provide growth-enhancing factors for fastidious bacteria) had been applied; this plate was incubated in an atmosphere containing 5% CO₂. One plate containing fastidious anaerobe agar with 3% defibrinated horse blood was incubated anaerobically. Because of practical difficulties, samples from the uterus of 1 cat were not cultured; also, no anaerobic bacteriologic cultures were performed for samples obtained from 1 female and 2 male cats. All agar plates were manufactured at the National Veterinary Institute, Uppsala, Sweden.

On the basis of the number of colonies, bacterial growth on the plates was classified as sparse (*n* < 20), moderate (20 to 100), or profuse (> 100). When only single colonies of different bacterial species were detected on a plate, growth was described as mixed culture. Otherwise, each of the isolated organisms was classified into family, genus, or species on the basis of morphologic characteristics of the colonies and results of staining with Gram's stain and biochemical characterization via standard methods. Lancefield group-G streptococci were considered to be *Streptococcus canis* without further evaluation. When bacteria (with similar morphologic and biochemical characteristics) that could not be identified via conventional methods were isolated from several cats, a selection of these organisms was sent to Culture Collection, University of Göteborg (CCUG), Sweden, for further identification.

**Statistical analyses**—χ² Analysis was used for comparisons between the prevalence of bacteria in different groups (cats in estrus vs cats not in estrus; cats that had received progestins vs cats that had not received progestins; and cats that had been mated vs cats that had not been mated). When cells with < 5 expected counts were present, the Fisher exact test and calculation by hand was used.

**Results**

**Bacteriologic culture of uterine specimens**—Bacteriologic cultures did not yield growth from any of the uterine samples.

**Cytologic evaluation of vaginal specimens**—The results of cytologic examination of smears prepared...
from vaginal swabs indicated that 10 cats were in estrus. Of the cats that were not in estrus, 1 had a moderate number of neutrophils detected in the smear.

**Bacteriologic culture of vaginal specimens**—Bacteriologic culture of vaginal specimens from 15 of 66 (23%) cats yielded negative results. Aerobic bacteria were isolated from the vaginas of 51 (77%) cats; anaerobic bacteria were also detected in 3 of those cats (2 had moderate growth of *Bacteroides* spp, and 1 had profuse growth of anaerobic streptococci). The most common aerobic bacteria detected were hemolytic and nonhemolytic *E coli*, *S canis*, and staphylococci (Table 1). Bacteriologic culture of the vaginal specimen from the cat with neutrophils detected on cytologic examination of the vaginal smear resulted in a sparse growth of nonhemolytic *E coli* only. Growth of unidentified gram-negative rods (similar in appearance to each other) was detected from cultured specimens of 6 of 66 (9%) cats; in 1 of these cats, bacteriologic culture of the vaginal swab revealed growth of 2 slightly different gram-negative rods. Four of these unidentified isolates were sent to CCUG; these were determined to belong to the Pasteurellaceae family of bacteria, but further identification was not possible.

Bacteriologic culture of vaginal specimens from 27 of 66 (41%) cats yielded growth of 1 species of aerobic bacteria, most commonly hemolytic *E coli* (in sparse to profuse growth), nonhemolytic *E coli*, and staphylococci. Thirteen of the 20 (65%) isolates of aerobic bacteria detected were hemolytic and nonhemolytic *E coli* (Table 1). Bacteriologic culture of the specimen from 1 cat in estrus yielded growth on bacteriologic culture, compared with 2 of 66 (3%) cats in estrus only. Growth of unidentified gram-negative rods (similar in appearance to each other) was detected from cultured specimens of 6 of 66 (9%) cats; in 1 of these cats, bacteriologic culture of the vaginal swab revealed growth of 2 slightly different gram-negative rods. Four of these unidentified isolates were sent to CCUG; these were determined to belong to the Pasteurellaceae family of bacteria, but further identification was not possible.

**Table 1**—Results of bacteriologic culture of swab specimens obtained from vaginas of 66 female cats and prepuces of 29 male cats

<table>
<thead>
<tr>
<th>Bacteria detected</th>
<th>No. of female cats (%)</th>
<th>No. of male cats (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic bacteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Escherichia coli</em>, nonhemolytic</td>
<td>11 (17)</td>
<td>4 (14)</td>
</tr>
<tr>
<td><em>E coli</em>, hemolytic</td>
<td>21 (32)</td>
<td>3 (10)</td>
</tr>
<tr>
<td><em>Staphylococcus</em> spp, coagulase-negative</td>
<td>7 (9)</td>
<td>1 (3)</td>
</tr>
<tr>
<td><em>Streptococcus canis</em></td>
<td>10 (15)</td>
<td>5 (17)</td>
</tr>
<tr>
<td><em>Streptococcus</em> spp, α-hemolytic</td>
<td>1 (2)</td>
<td>1 (3)</td>
</tr>
<tr>
<td><em>Lactobacillus</em> spp</td>
<td>2 (3)</td>
<td>0</td>
</tr>
<tr>
<td><em>Corynebacterium</em> spp</td>
<td>1 (2)</td>
<td>1 (3)</td>
</tr>
<tr>
<td><em>Haemophilus</em> spp</td>
<td>1 (2)</td>
<td>0</td>
</tr>
<tr>
<td>Gram-negative rods (unidentified)</td>
<td>3 (2)</td>
<td>6 (21)</td>
</tr>
<tr>
<td><em>Gram-negative cocci</em> (unidentified)</td>
<td>1 (2)</td>
<td>0</td>
</tr>
<tr>
<td>Gram-positive rods (unidentified)</td>
<td>1 (2)</td>
<td>0</td>
</tr>
<tr>
<td><em>Simonsiella</em> spp</td>
<td>0</td>
<td>1 (3)</td>
</tr>
<tr>
<td><em>Moraxella or Brahamella</em> spp</td>
<td>0</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Mixed culture*</td>
<td>7 (11)</td>
<td>1 (3)</td>
</tr>
<tr>
<td>Anaerobic bacteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Bacteroides</em> spp</td>
<td>2 (3)</td>
<td>7 (24)</td>
</tr>
<tr>
<td><em>Fusobacterium</em> spp</td>
<td>0</td>
<td>3 (10)</td>
</tr>
<tr>
<td><em>Streptococcus</em> spp</td>
<td>1 (2)</td>
<td>2 (7)</td>
</tr>
</tbody>
</table>

*Detection of only single colonies of different bacterial species was described as mixed culture. †Anaerobic culture was not performed in 1 female and 2 male cats.

Aerobic bacteriologic culture of vaginal swabs resulted in growth of 2 bacterial species in 14 (21%) cats and 3 bacterial species in 3 (5%) cats; unspecified mixed culture was detected in 4 (6%) cats. Mean number of aerobic bacterial isolates obtained from vaginal specimens was 1.1/cat; mean number of bacterial isolates detected in cats with positive results of bacteriologic culture of vaginal specimens was 1.4 (cats with mixed culture results not included). Growth of aerobic bacterial isolates in culture was classified as sparse for 32, moderate for 31, and profuse for 4 of 67 isolates.

**Bacteriologic culture of vaginal specimens with regard to estrus**—Vaginal samples from 9 of the 10 cats in estrus yielded growth on bacteriologic culture, compared with 41 of 56 cats that were not in estrus (*P = 0.19*). Bacterial growth was not more profuse in cultures of specimens obtained from cats in estrus than in cultures of specimens obtained from cats not in estrus. Of the cats that were not in estrus, bacteriologic culture of specimens from 2 (4%) yielded growth of similar unidentified rods. A sample of 1 of these growths was sent to CCUG for further evaluation and classified as a member of the Pasteurellaceae family of bacteria. Four of the cats in estrus had growth of gram-negative rods that could not be identified and were similar to the previously mentioned unidentified rods; 3 of these bacterial isolates were sent to CCUG for investigation and classified as belonging to the family Pasteurellaceae. Bacteriologic culture of the specimen from 1 cat in estrus yielded growth of *Haemophilus* spp (also belonging to the family Pasteurellaceae). With inclusion of the cats with unidentified gram-negative rods, 5 of 10 cats in estrus had growth from cultured vaginal samples of bacteria that belonged to the family Pasteurellaceae, compared with 2 of 56 (4%) of cats not in estrus. This difference was significant (*P < 0.001*). *Streptococcus canis* was detected in 3 of 10 cats in estrus and 7 of 56 cats that were not in estrus, though this difference was not significant (*P = 0.13*). Detection of *E coli* was equivalent in both groups of females (5/10 cats in estrus, compared with 26/56 cats not in estrus; *P = 0.8*). Bacteriologic culture of vaginal specimens from cats in estrus yielded no growth of *Staphylococcus* spp, whereas such bacteria were identified in samples from 11 of 56 (20%) cats that were not in estrus; however, this difference was not significant (*P = 0.14*). Bacteriologic culture of vaginal swabs from 1 cat in estrus and 2 cats that were not in estrus yielded growth of anaerobic bacteria (*Bacteroides* spp and streptococci).

**Effect of previous mating on the bacteria of the vagina**—For 61 of the female cats, it was known whether they had mated. Thirty cats had mated (mean age, 3.2 ± 2.2 years), and 31 cats had not mated (mean age, 3.4 ± 2.6 years). Negative results of bacteriologic culture of vaginal swabs were obtained with similar frequency in these 2 groups (23 and 26%, respectively; *P = 0.8*). Of the female cats that had mated, 1 had growth of anaerobic bacteria on bacteriologic culture of the vaginal specimen. There were no significant differences in prevalences of bacterial species obtained from vaginal swab cultures between the 2 groups, although 16

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cats that had mated had *E. coli* detected via culture, compared with 10 cats that had not mated.

Effect of progestin administration on the bacteria of the vagina—Among the 66 female cats, 24 had not been given progestins, and 36 had been given progestins regularly. Bacteria belonging to the family Pasteurellaceae (including unidentified rods) were identified in 4 (17%) cats that had not been given progestins, compared with 2 (6%) cats that had been given progestins, but this difference was not significant (*P* = 0.14). Frequency of detection of other bacteria via culture of vaginal swabs did not differ between the groups.

Cytologic evaluation of preputial specimens—No signs of inflammation were detected cytologically in the smears prepared from preputial samples obtained from 29 cats.

Bacteriologic culture of preputial specimens—Bacteriologic culture of preputial swabs from all 29 cats yielded growth. Only aerobic bacteria were detected in samples from 17 (59%) cats (samples from 2 cats were cultured aerobically only). From the preputial sample obtained from 1 cat, only anaerobic bacteria (moderate growth of *Fusobacterium* spp in mixed culture) grew in culture. Preputial swab specimens from 11 (38%) cats yielded aerobic and anaerobic bacteria in culture. Aerobic bacteriologic culture of preputial swabs resulted in growth of 1 bacterial species in 10 (34%) cats, 2 bacterial species in 13 (45%) cats, and 3 bacterial species in 4 (14%) cats; unspecified mixed culture was detected in 1 (3%) cat. Mean number of aerobic bacterial isolates obtained from preputial specimens was 1.8/cat.

Growth of aerobic bacterial isolates in cultures of preputial swabs was classified as sparse for 36 and moderate for 12 of 48 isolates. Growth of anaerobic bacteria in culture were classified as sparse for 2, moderate for 7, and profuse for 3 isolates. The aerobic bacteria most commonly isolated were *Pasteurella multocida*, gram-negative rods belonging to the family Pasteurellaceae, unidentified gram-negative rods, and *E. coli*. The most common anaerobic bacteria were *Bacteroides* spp, *Fusobacterium* spp, and *Streptococcus* spp (Table 1). Samples from only 3 of 29 male cats yielded bacterial growth in pure culture; all of these were aerobic bacteria and included sparse growths of *P. multocida*, *E. coli*, and unidentified gram-negative rod bacteria.

### Table 2—Effect of cleansing of the vulva on results of bacteriologic culture of vaginal swab specimens from 3 of 9* cats

<table>
<thead>
<tr>
<th>Cat No.</th>
<th>Sample obtained before cleansing of the vulva</th>
<th>Sample obtained after cleansing of the vulva</th>
</tr>
</thead>
</table>
| 1       | Nonhemolytic *Escherichia coli*, moderate growth
         | *Enterococcus* spp, moderate growth         | Nonhemolytic *E. coli*, sparse growth in sparse mixed culture |
| 7       | *Streptococcus canis*, profuse growth        | *S. canis*, moderate growth                  |
| 8       | *S. canis*, moderate growth                  | *S. canis*, sparse growth                    |

<table>
<thead>
<tr>
<th>Cat No.</th>
<th>Sample obtained before cleansing of the vulva</th>
<th>Sample obtained after cleansing of the vulva</th>
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*No difference in bacteriologic culture results between samples in 6 cats.

Effect of cleansing of the vulva on results of bacteriologic culture of vaginal swabs—Vaginal samples were obtained before and after cleansing of the vulva with ethanol in 9 cats, and bacteriologic culture of all of these samples yielded growth of aerobic bacteria. There was no growth of anaerobic bacteria on culture of any of the 18 vaginal swabs. In 6 cats, the number of bacterial colonies grown on culture of swabs obtained before and after cleansing of the vulva did not differ. The bacteria identified in these 6 cats included sparse growths of hemolytic (*n* = 1) and nonhemolytic *E. coli* (1) only, sparse growths of hemolytic *E. coli* and *Haemophilus* spp (1) or hemolytic *E. coli* with gram-negative rods and *S. canis* (1), moderate growth of nonhemolytic *E. coli* in sparse mixed culture (1), and mixed culture in moderate growth (1). However, in 3 cats, bacterial growth from culture of the sample obtained after cleansing was reduced, compared with that from culture of the sample obtained prior to cleansing; the growth reduction was from profuse to moderate or from moderate to sparse (Table 2).

Effect of repeated sampling on results of bacteriologic culture of vaginal swabs—Two consecutive vaginal specimens were obtained from 7 cats; of each pair of swabs, bacteriologic culture of the swab obtained first yielded growth of aerobic bacteria. For 5 of the cats, bacterial growth that was obtained on culture of the swab obtained first was not different from that obtained on culture of the swab obtained second. The bacteria identified in these cats included sparse (*n* = 2) and moderate (1) growth of hemolytic *E. coli* only, sparse growth of nonhemolytic *E. coli* only (1), and sparse growth of mixed culture (1). Bacteriologic culture of the pair of swabs from 1 of the remaining cats yielded sparse growth of hemolytic *E. coli* from the first specimen and no bacterial growth from the second; in the other cat, bacteriologic culture yielded sparse growth of *Lactobacillus* spp and α-hemolytic streptococci from the first specimen and very sparse mixed culture from the second.

### Discussion

The high proportion (23%) of female cats in which no bacteria could be isolated from the genital tract was not expected. In another study of the bacterial population of the vagina in cats, 1 of 53 vaginal samples (2%) did not yield growth on bacteriologic culture. In another study of the bacterial population of the vagina in cats, 1 of 53 vaginal samples (2%) did not yield growth on bacteriologic culture.
a study\textsuperscript{12} of the aerobic bacterial population of the genital tract in bitches, bacteriologic culture results were negative for 5.2\% of the specimens obtained. One reason for the high number of cats with negative culture results in our study might be a sparse bacterial population in the genital tract that is difficult to detect via routine methods. To facilitate transfer of bacteria to the sample swabs, the swabs were moistened before sampling; this procedure has been shown to reduce the number of vaginal specimens that yield negative bacteriologic culture results in dogs.\textsuperscript{13} Another reason might be introduction of ethanol into the vagina at the time of sample collection. In a study by Clemetson and Ward,\textsuperscript{9} no cleansing agent was used; in another study, Bjurström and Linde-Forsberg\textsuperscript{16} used ethanol to cleanse the vulvas of dogs prior to vaginal sampling, which is common in clinical practice. In the study reported here, cleansing of the vulva with ethanol was performed to simulate clinical practice. Vaginal specimens often have to be obtained from noncooperative cats that are not anesthetized; under those conditions, the risk of contamination of the vaginal specimen with bacteria from the vulva is increased. However, our data indicate that cleansing of the vulva is generally not needed prior to obtaining samples from the vagina of an anesthetized cat.

The results of the study reported here indicated that bacterial growth from cultures of vaginal swab specimens obtained after cleansing of the vulva was reduced, compared with growth from cultures of vaginal swab specimens obtained before cleansing of the vulva, in 2 of 9 cats. To determine whether this was an effect of repeated sample collection, 2 consecutive vaginal specimens were obtained in immediate succession from 7 cats. In 5 of those cats, results of bacteriologic culture of the vaginal swabs were not affected by the repeated sampling procedure. In 1 cat, bacterial growth resulting from culture of the second of the 2 samples was reduced, compared with that obtained from culture of the first; in another cat, bacteriologic culture of the second vaginal swab yielded negative results, unlike the culture of the first. This indicates that repeated sampling and also possibly cleansing of the vulva can influence detection of bacteria via culture, particularly when the bacterial population of the vagina is sparse. In a clinical setting, however, bacterial infection of the vagina is usually associated with large numbers of bacteria, and the risk of obtaining a false negative result from bacteriologic culture of vaginal specimens because of cleansing of the vulva or sampling technique would be expected to be small.

In the study reported here, vaginal specimens from only 3 female cats (5\%) yielded growth of anaerobic bacteria on culture; Clemetson and Ward\textsuperscript{8} reported growth of anaerobic bacteria on culture of vaginal specimens from 13\% of young household cats included in their study. Thus, it appears that the bacterial population of the vaginas of cats usually is comprised of only aerobic bacteria, which is similar to the bacterial population of the vaginas of bitches.\textsuperscript{15} The prepuberal bacteria identified in the male cats of the study reported here differed from bacteria identified in the vaginal swabs obtained from the female cats. In the cats of our study, anaerobic bacteria were more frequently isolated from males (41\%) than from females (5\%), and the growth of the anaerobic bacteria in both male and female cats appeared to be more profuse than that of aerobic bacteria. Anaerobic bacteria may have a role in the development of reproductive disorders of bitches,\textsuperscript{13} but cytologic examination of preputial smears from the male cats in the study reported here revealed no signs of infection. Of the female cats that had mated, only 1 had growth of anaerobic bacteria in culture of a vaginal specimen. This finding indicates that mating is not a prerequisite for establishment of a population of anaerobic bacteria in the vagina of cats, nor does it commonly lead to a permanent transfer of these bacteria between mating cats. Also, the aerobic bacteria of the genital tract (identified via culture) differed between female and male cats; \textit{E. coli}, \textit{S. canis}, and \textit{staphylococci} were most common in female cats, whereas \textit{P. multocida} (a gram-negative bacterium [rod] belonging to the family \textit{Pasteurellaceae}) and \textit{E. coli} were most common in male cats. Such diversity is not reported in dogs; usually similar bacteria are isolated from bitches and stud dogs.\textsuperscript{13} In the study reported here, the aerobic bacterial population of the vagina was similar regardless of whether the cats had mated or not. This further suggests that mating has a small influence (if any) on the normal bacterial population of the vagina of cats, which is a similar to the finding in dogs.\textsuperscript{8}

Compared with the findings of Clemetson and Ward,\textsuperscript{9} the type and number of bacteria detected via culture of samples from the genital tract of the cats of our study differed. In the former investigation in household cats, 1 to 6 bacterial species (mean, 3 species) were detected, compared with 1 to 3 (mean, 1.1 species) in the cats of the study reported here. There might be several reasons for this. The cats included in the study by Clemetson and Ward\textsuperscript{8} were younger (6 to 12 months of age, except for 1 cat that was 16 months old) than the cats in our study. The number of bacteria (but not the number of bacterial species) appears to be greater in young cats than in adults.\textsuperscript{9} However, age might also influence the composition of the bacterial population of the vagina in cats; Clemetson and Ward\textsuperscript{8} isolated coagulase-positive staphylococci only in 5- to 7-month-old kittens. A correlation between age and type of bacteria in the vagina of dogs has also been demonstrated\textsuperscript{17}; compared with older bitches, staphylococci were more commonly detected in female prepubertal dogs. It is possible that staphylococci are sensitive to changes in the vagina caused by gonadal hormones. Other factors influencing the bacterial population of the vagina may be environmental (including regional differences in use of antimicrobials) and breed-related.

The aerobic bacteria of the genital tracts of male cats in the study of this report differed from that previously described by Johnston et al,\textsuperscript{4} who found \textit{E. coli}, \textit{Pseudomonas aeruginosa}, \textit{Proteus mirabilis}, and \textit{Klebsiella oxytoca} to be most commonly isolated. \textit{Pseudomonas aeruginosa}, \textit{P mirabilis}, and \textit{K oxytoca} were not detected in the genital tracts of any male or female cat in our study. The male cats in the study by Johnston et al\textsuperscript{4} were described as young adult cats and...
were probably of similar age to the males of the study reported here; therefore, the difference in aerobic bacteria detected between these 2 groups of males is probably not a reflection of age, but other factors (eg, environmental) cannot be ruled out.

Growth of uterine bacteria was not detected in our study. In another study, uterine bacteria were detected in a few cats in estrus. Cervical patency in queens has been studied by deposition of a radiopaque medium into the vagina. In that investigation, the radiopaque medium did not enter the uterus, not even in cats that were in estrus. The lack of uterine bacterial growth detected in our study, including samples from queens in estrus, might therefore be an indication of the patency of cervix.

Estrus appeared to promote bacterial growth in the vaginas of cats included in the study reported here. Bacteriologic culture of vaginal specimens yielded aerobic bacteria in a larger proportion of cats in estrus than cats that were not in estrus; however, bacterial growth in cultures was not correspondingly greater in cats in estrus, unlike the finding of Clemetson and Ward. The type of aerobic bacteria obtained on culture of vaginal specimens in cats in estrus differed from that in cats that were not in estrus. A significantly higher proportion of bacteria belonging to the family Pasteurellaceae was isolated from vaginal specimens of cats in estrus than from cats not in estrus, whereas E coli was equally prevalent in both groups. Streptococcus canis was isolated more often from cats in estrus, and staphylococci were only isolated from cats not in estrus, but these differences were not significantly different. In the authors’ knowledge, variation in composition of the bacterial population in the vagina of cats during the estrous cycle has not been described. In dogs, P multocida and β-hemolytic streptococci were isolated from vaginal specimens more often in bitches in heat than in bitches that were not in heat, whereas the frequency of isolation of E coli in those samples did not vary with stage of the cycle. It has been speculated that the increased detection of P multocida and β-hemolytic streptococci from bitches in heat is associated with enhanced growth of these bacterial species in the presence of blood and serum in the vagina. In general, sanguineous discharge via the vagina does not occur in queens in estrus, so other mechanisms must be of importance to growth of P multocida in the vagina during estrus in this species. The effects of estrogens include increased blood supply to the vagina and thickening of the vaginal wall, which might enhance the growth of P multocida, whereas the less fastidious E coli grow well during the whole estrous cycle.

There were no significant effects of progestins on the bacterial population of the vaginas of cats. However, bacteria of the family Pasteurellaceae were detected on culture of vaginal specimens from 4 of 24 cats that had not been given progestins, compared with similar cultures from 2 of 36 cats that had been given progestins; although this difference was not significant, there may be an influence of multiple periods of estrus on the growth of this type of bacteria. Nevertheless, the effect of depomedroxyprogesterone on the bacterial population of the vagina in humans is small.

With regard to the clinical importance of bacterio-

logic cultures of vaginal specimens, the growth of bacteria in pure culture is sometimes assumed to indicate a causative relationship between the isolated organism and disease. In the study of this report, 43% of the female cats had growth of bacteria in pure culture, the most common bacterium of which was hemolytic E coli. In contrast, P multocida and β-hemolytic streptococci have been detected more frequently than E coli in pure culture from cultures of vaginal specimens from dogs.

Although E coli has been associated with urinary infections, abortion, pyometra, and vaginitis in cats, the results of the study reported here indicated that growth of hemolytic or nonhemolytic E coli in pure culture is common in the vagina of clinically healthy cats and not an indication of reproductive disorder, regardless of whether the bacterial growth is heavy.

References