



Biology of Fleas of Dogs and Cats

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KEY FACTS

- ❑ The cat flea, *Ctenocephalides felis felis*, is the most common flea that infests both dogs and cats in North America.
- ❑ Flea larvae are very susceptible to heat and desiccation.
- ❑ The preadult stage, during which the flea resides in the cocoon, is potentially the longest stage of the life cycle of the cat flea.
- ❑ Cat fleas are far more permanently host associated than was previously believed.
- ❑ Female cat fleas are ravenous blood feeders; they consume many times their body weight in blood daily.

The veterinary literature contains numerous inconsistencies concerning the biology of fleas of dogs and cats. It is now apparent that these discrepancies have contributed to errors in designing regimens for control, administration of inappropriate treatment, and delays in practitioner acceptance of new flea products. During the past 10 years, clinical investigations and laboratory research concerning the biology of the cat flea, *Ctenocephalides felis*, have challenged many common beliefs. This article addresses many aspects of the biology of cat fleas, including host associations, host permanence, off-host and on-host survival, immature stage development, egg production, and feeding behavior.

FLEA SPECIES COMMONLY ASSOCIATED WITH DOGS AND CATS

Flea infestation is the most common ectoparasitic condition of dogs and cats in North America. Although more than 2000 species and subspecies of fleas are known throughout the world,¹ only a few species are found on dogs and cats in the United States in a large enough number and with sufficient regularity to be important; those species are *Ctenocephalides felis felis*, *Ctenocephalides canis*, *Pulex* species, and *Echidnophaga gallinacea*. The most common flea species associated with dogs and cats is *C. felis felis*, the cat flea. In a survey conducted in Indiana, *C. felis felis* and *C. canis* (the dog flea) were found on 93% and 18% of flea-infested dogs examined, respectively. *Ctenocephalides felis felis* was found on 97% of flea-infested cats.² A survey conducted in northern central Florida indicated that *C. felis felis* was the flea species found on 92.4% of the dogs and 99.8% of the cats.³ *Ctenocephalides felis felis* and *C. canis* occasionally occur in mixed infestations on dogs.² In such cases, *C. felis felis* usually predominates.

The term *cat flea* is the approved common name for *C. felis felis*. When the term appears in print, it refers to the specific genus and species of the flea and not to fleas recovered from cats. Currently, there are four recognized subspecies of *C. felis felis* throughout the world.⁶ *Ctenocephalides felis damarensis* and *C. felis strongylus* occur primarily in eastern Africa and are parasites of wild carnivores. *Ctenocephalides felis orientis* occurs in India and Australia and primarily infests cattle, sheep, and goats. *Ctenocephalides felis felis* occurs throughout the world and is the only subspecies that occurs in North America. Therefore, most of the North American literature refers to the cat flea simply as *Ctenocephalides felis*.

Other flea species found on dogs in the survey conducted in northern

central Florida included *Pulex irritans* (human flea), which accounted for 7.5% of the fleas on dogs.³ *Echidnophaga gallinacea* (poultry sticktight flea) was found on only one dog. No *C. canis* fleas were identified on the 100 dogs examined. Similarly, *C. felis felis* was the only flea recovered from cats and dogs in a survey conducted in Virginia.³

Another flea species occasionally recovered from dogs and cats is *Pulex simulans*.⁶ *Pulex irritans* and *P. simulans* are very similar morphologically, and specific identification is possible only by examining males. This similarity sheds doubt on the legitimacy of many reports of host records of these two species.

Echidnophaga gallinacea is a bird flea that occasionally feeds on dogs and cats. Infestations of this flea species occur more commonly in the southern United States.^{6,7}

In addition to the more common species, several other species of fleas for which dogs and cats serve as transport or accidental hosts have been recovered. It is not unusual to find rabbit, rodent, or squirrel fleas on dogs and cats that roam outdoors. When the pets prey on small wild mammals, the fleas leave the dying host for the closest warm body. These fleas often survive for only a short time on the pet and most likely do not remain reproductively active. Surveys conducted in Egypt,⁸ Denmark,⁹ and London¹⁰ found *C. felis felis* to be the most prevalent flea on dogs, whereas *C. canis* was the most common in Austria,¹¹ Ireland,¹² and New Zealand.¹³

The ratio of male to female cat fleas found on dogs and cats is remarkably similar. Researchers have reported that the ratio of cat fleas on the host varies from 1:1.8 to 1:2.2.^{2,14,15} The greater frequency of females on the host may result from increased longevity, disparity in survival of male and female immature stages, or the ability of females to evade host grooming activity more effectively.

Because the cat flea is the most common flea on domesticated dogs and cats in most parts of the world, it is the only flea of domesticated animals that has been extensively investigated. In fact, virtually no data exist concerning the biology of *C. canis*. Therefore, the following discussion primarily addresses the biology and behavior of the cat flea.

BIOLOGY OF THE CAT FLEA

Immature Stages

Flea eggs are pearly white, oval with rounded ends, and 0.5 millimeters in length (Figure 1). Eggs usually hatch within 1 to 10 days, depending on temperature and humidity.¹⁶ Fifty percent of eggs deposited under environmental conditions of 70% relative humidity and 35°C (95°F) hatched within 1.5 days, whereas

50% of eggs deposited at 13°C (55.4°F) hatched within six days.¹⁷

Newly hatched flea larvae are slender, white, segmented, sparsely covered with short hairs, two to five millimeters in length, and possess a pair of anal struts. Larvae are free-living; they feed on organic debris found in their environment and on adult flea feces, which are essential for successful development.^{18,19} As soon as they ingest adult flea feces or other material, larvae become darker in color (Figure 2). Larvae are negatively phototactic and positively geotactic.¹⁸ Therefore, they avoid direct sunlight in their microhabitat and actively move deep in carpet fibers or under organic debris (grass, branches, leaves, or soil).

Flea larvae undergo two molts before developing into the pupal stage. Although the first larval instar is only approximately two millimeters long, fully developed larvae can be four to five millimeters in length. The larval stage usually lasts 5 to 11 days, depending on the availability of food and the climate.^{16,17} At 24.4°C (75.2°F) and 78% relative humidity, pupation of a larval cohort begins on day 7 and is complete by day 11.² As the temperature decreases, the length of time for larval development increases.

Flea larvae are extremely susceptible to heat and desiccation. Moisture in the larval environment is essential for development; relative humidity below 50% causes desiccation, and larvae maintained in soil with low levels of moisture fail to develop.¹⁷ In one field study, temperatures exceeded 35°C (95°F) for more than 40 hours per month and there was no survival of larvae.¹⁷ Because of their susceptibility to heat and desiccation, flea larvae are not likely to survive outdoors in shade-free areas. Flea development outdoors probably occurs only in areas with shaded, moist ground where a flea-infested pet spends a significant amount of time to allow adult flea feces to be deposited into the larval environment. Likewise, in the indoor environment, flea larvae probably only survive in the protected microenvironment under a carpet canopy or in cracks between hardwood floors in humid climates.

When completely developed, larvae produce a silk-like cocoon in which they pupate. The cocoon is ovoid, approximately 0.5 centimeters in length, whitish, and loosely spun (Figure 3). Because the cocoon is sticky, it quickly becomes coated with debris from the environment; the coating of debris aids in camouflaging. Flea cocoons can be found in soil, on vegetation, in carpets, under furniture, and on animal bedding. Under conditions of approximately 27°C (80.6°F) and 80% relative humidity, adult cat fleas begin to emerge approximately five days after pupation and reach peak emergence in eight to nine days.^{20,21} As soon as the flea has fully developed, it

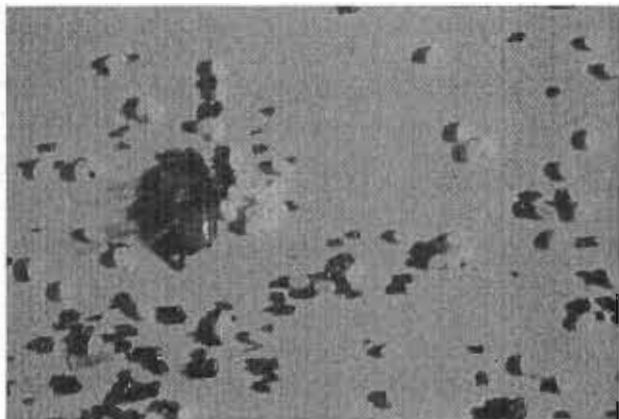


Figure 1—Flea eggs (white), flea feces (dark red), and an engorged female cat flea. (Courtesy of J.C. Blakemore, DVM, Department of Veterinary Clinical Sciences, College of Veterinary Medicine, Purdue University)

emerges from the cocoon under proper stimulation, that is, physical pressure, carbon dioxide, and heat. Temperature and physical pressure may be the primary stimuli for emergence.²¹ Although vibration is commonly reported to cause emergence of fleas, this has not been proven through research.²²

The fully formed adult flea that resides in the cocoon (i.e., a preemerged adult) is at the stage that can extend the longevity of the flea. If it does not receive the proper stimulus to emerge, the preemerged adult can remain quiescent in the cocoon for several weeks until a suitable host arrives. Preemerged adult fleas are capable of surviving for as long as 140 days inside the cocoon if protected from desiccation.²² Such adults in carpet are more resistant to desiccation than eggs or larvae and are extremely resistant to insecticides.^{17,23} Because of this insecticide resistance, fleas may continue to emerge from cocoons for as long as four weeks after insecticide application to the environment.

Depending on temperature and humidity, the entire life cycle of the cat flea can be complete in as few as 12 to 14 days or can be prolonged up to 174 days.²¹ Under most household conditions, however, cat fleas usually complete the life cycle within three to four weeks.

Adults

After emerging from the cocoon, the flea almost immediately begins seeking a host. Newly emerged fleas are attracted to house pets by various stimuli produced by these hosts: body heat, movement, and exhaled carbon dioxide.²⁴ The positive phototaxis and negative geotaxis that have been demonstrated in cat fleas enhance the success of the flea in host acquisition because newly emerged fleas move directly to the top of the carpet or hanging vegetation, where they are



Figure 2—The third larval instar of a cat flea. Note the dark color and sparse hairs.

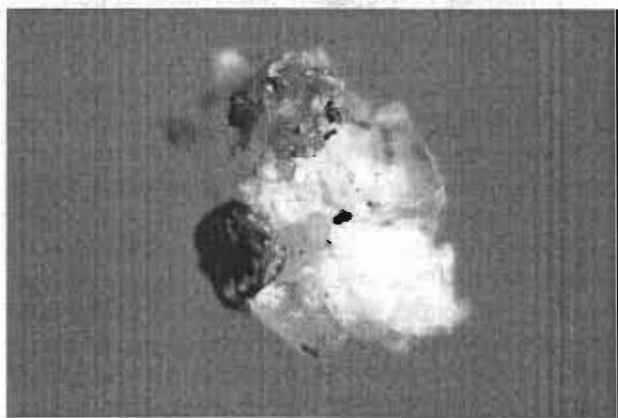


Figure 3—Pupal cocoon of a cat flea. Note the grains of sand attached to the sticky white silk.

more likely to encounter a passing host. Several stimuli affect the behavior of cat fleas in host acquisition; however, sound in the ultrasonic range apparently has no effect.²⁵⁻²⁷ Ultrasonic devices have failed to repel or kill fleas in several controlled studies.²⁸⁻³¹

Although newly emerged cat fleas can survive several days before requiring a blood meal, reports of extended longevity have been greatly exaggerated. Survival of newly emerged fleas in the off-host environment depends greatly on temperature and humidity. In moisture-saturated air, 62% of adult cat fleas survived for 62 days, whereas only 10% survived for 20 days in cool, dry air.²² In another study, only 5% of cat fleas maintained under conditions of 24°C (75.2°F) and 78% relative humidity were alive after 14 days; however, when fleas were maintained under ambient room conditions of 22.5°C (72.5°F) and 60% relative humidity, only 5% survived for 12 days.²

Newly emerged fleas residing in carpet or outdoors often bite humans before finding their preferred host. Although these fleas have usually emerged from local-

ized protected microenvironments, they often move from these areas in response to stimuli. If not stimulated, the newly emerged fleas do not move away from the site of emergence. Expenditure of energy would reduce longevity and would decrease the flea's chances of finding a host.

Cat fleas have been found on more than 50 hosts throughout the world.^{32,33} In North America, the hosts that are most commonly infested are domesticated and wild canids, domesticated cats, raccoons, opossums, and ferrets.

Fleas biting humans or their pets after extended absences of the hosts from the home usually results from one of two events. The first is from prolonged survival of the preemerged adult. Although fleas emerge from the pupal cocoon during the third or fourth week of development under most conditions, emergence may be delayed for several weeks if pre-emerged adults are not stimulated. When humans or pets reenter the home, these fully developed but previously unstimulated fleas residing in cocoons are aroused and are immediately ready to respond to host cues. This commonly occurs when pets have been boarded at a veterinary clinic or boarding kennel. On their return, owners notice fleas on the pet within a few minutes to a few hours. The owners thus erroneously believe that the fleas originated from where the pet was boarded; in fact, the fleas have been residing in cocoons until the return of a host.

The second common problem is infestation of the house (attic, basement, or crawl spaces) by raccoons, opossums, and scray cats.^{34,35} When these mammals vacate the premise, emerging fleas may enter the home in response to the presence of humans and animals.

Survival of newly emerged adult fleas or immature stages off the host during winter in northern temperate regions is an important consideration in the epidemiology of flea infestations. Although some northern-adapted flea species survive freezing temperatures as pupae or adults off the host,³⁶ the cat flea is apparently less tolerant to cold. It has been shown that no stage in the life cycle of the cat flea (i.e., egg, larva, pupa, or adult) can survive for 10 days at 3°C (37.4°F) or 5 days at 1°C (33.8°F).²¹ Therefore, cat fleas associated with dogs and cats in cold climates are most likely adults surviving on untreated dogs and cats or small wild mammals, such as raccoons and opossums, in the urban environment. As these animals pass through yards in the spring or set up nesting sites in crawl spaces or attics, the eggs laid by surviving female fleas drop off and subsequently develop into adults. Cat fleas may also survive the winter as preemerged adults in microenvironments protected from the cold.

Once on a host, cat fleas begin feeding within sec-

onds and mating occurs on the host in the first 8 to 24 hours, with most females having mated by 34 hours.^{37,38} It seems that female cat fleas have multiple matings because young as well as fully mature and gravid females have been observed in the act of mating.³⁷ It has also been observed that the spermatheca (sperm-holding organ) acquires progressively more sperm over the first 24 hours.³⁷ Female cat fleas begin producing eggs within 36 to 48 hours of their first blood meal, reach maximum production between four and nine days, and are capable of producing eggs for more than 100 days.³⁹ Contrary to common reports, cat fleas lay eggs on the host (Figure 4) and not in cracks and crevices in the home.^{19,37} Flea eggs are not sticky and readily fall from the pelage and are thus deposited in any location to which a flea-infested pet has access.

Cat fleas have an extremely high reproductive potential. In experiments in which host grooming was restricted, females peaked in egg production at 40 to 50 eggs per day, averaged 27 eggs per day through 50 days, and continued to produce eggs for more than 100 days.⁴¹ During these experiments, female fleas produced an average of 1348 eggs during the first 50 days on a host, which was equivalent to producing their body weight in eggs daily.

Production of such a large mass of eggs requires that the female cat flea consume sizable quantities of blood. In one experiment, female fleas weighed an average of 0.45 milligrams after emergence from the cocoon, whereas males weighed 0.36 milligrams.³⁶ During the first hour of feeding, females exhibited a 40% increase in body weight, primarily from the filling of the abdomen with blood. During that same time, males only increased 3% in body weight. Female fleas reached a maximum size of 1.08 milligrams within 48 hours, a 140% increase in size; male fleas only reached a maximum of 0.43 milligrams, a 19% increase in size.³⁶

Male fleas feed far less frequently than females. Females were observed attached and feeding in one site for more than three hours, whereas males were rarely seen attached for periods longer than 10 to 20 minutes.³⁶

During active reproduction, female cat fleas consumed an average of 13.6 microliters of blood per day, which is equivalent to 15.15 times their body weight.⁴⁰ At that volume of blood consumption, 72 female fleas could consume one milliliter of blood daily. Fleas in the genus *Ctenocephalides* have been reported to cause anemia and occasionally death in heavily infested dogs and cats as well as in calves, lambs, and goats.⁴¹⁻⁴³

During feeding, female cat fleas excrete large quantities of incompletely digested blood, which dries



Figure 4—Female cat flea feeding on a cat. Note the presence of several eggs laid in the pelage.

within minutes into reddish-black fecal pellets, known more commonly as flea dirt. Flea feces may appear as long tubular coils or as fine pellets (Figures 5 and 6), depending on the duration of interrupted feeding. Coils are produced only if female fleas are allowed to feed uninterrupted for a few hours. The dried fecal material falls off the host into the environment, where the feces serve as essential food for the larvae. Flea feces can often be found matted into the pelage and are diagnostic for the recent or current presence of fleas.

Contrary to what is commonly reported in veterinary texts, the adult cat flea is a rather permanent ectoparasite. Most of the literature concerning the biology of fleas of dogs and cats has been extrapolated from data on rodent fleas gathered in plague transmission studies. It is now known that flea-host associations vary widely—some flea species remain on the host only long enough to feed, whereas others remain on the host their entire life.

One investigation reported that female cat fleas removed from the host after initiating egg production died within 24 hours.⁴⁷ Similarly, when cat fleas were allowed to feed for five days on a host and then removed and held at approximately 24°C (75.2°F) and 78% relative humidity, males died within 48 hours and females died within 96 hours.² Interestingly, when cat fleas were allowed to feed for only 12 hours and then removed from the host, 5% were still alive at 14 days. Once they feed on a host for a few days and initiate reproduction, cat fleas apparently reach a point at which they become dependent on a constant source of blood.

Although cat fleas rarely leave their host voluntarily, the grooming activity of the host plays a significant role in survival of the fleas as well as in the ability of fleas to feed for prolonged periods and imbibe the amount of blood necessary to produce a large

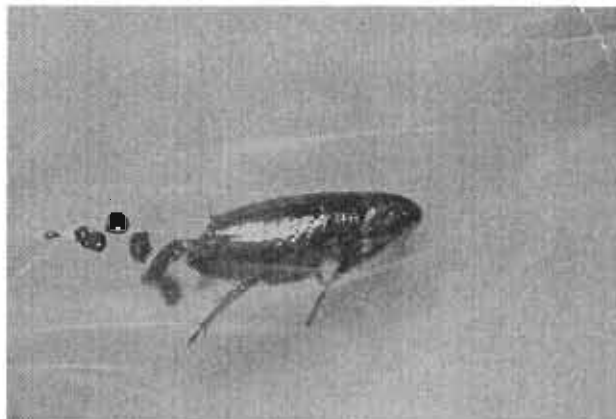


Figure 5—Female cat flea defecating partially digested blood during feeding.

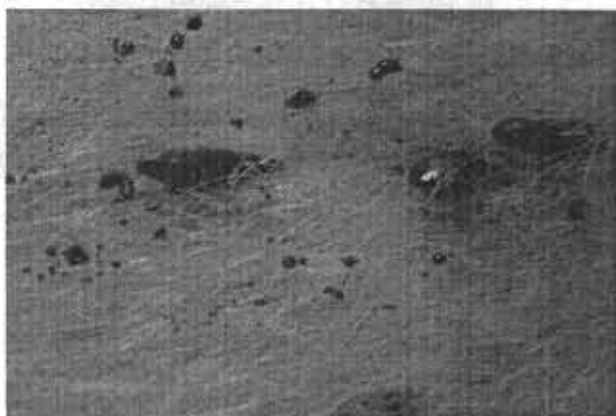


Figure 6—Fecal coils and pellets defecated by cat fleas feeding on a cat.

mass of eggs. Fleas placed on cats housed in metabolic cages with no restriction on host grooming exhibited significantly decreased egg production.^{45,46} Actual egg production on a dog or cat depends on the individual level of grooming activity.

In an investigation in which the normal grooming activity of cats was restricted, an average of 85% of the female and 58% of the male fleas were still present on the cats after 50 days.³⁹ Fleas found off the cats were dead or died within 24 hours. In the same investigation, it was noted that 72% of female fleas placed on cats were still alive after 113 days³⁹; however, if cats are housed in metabolic cages and allowed to groom freely, they ingest or groom off a substantial number of fleas in a few days.^{21,45,46} In another study, only 22% of the fleas were recovered after 22 days on a cat.³⁹ Although some pets may tolerate a small to moderate number of fleas, others groom themselves almost constantly, thereby ingesting and dislodging many of the fleas. Any cat flea dislodged from the host through grooming activity must return to the

host or acquire another within a couple of days or the flea will die.

CONCLUSION

Implementation of a successful flea control program requires a thorough understanding of the developmental biology and ecology of fleas. Virtually every on-animal or environmental flea product for animal or premise treatment that is sold by a veterinarian is also sold in pet, grocery, or department stores under a different label or in a different formulation. What the veterinarian can offer the client that the other establishments cannot is knowledge of the biology of fleas of dogs and cats as well as an understanding of the proper procedures necessary for safe and effective implementation of the flea control program.

About the Author

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Filaribits Plus®

(diethylcarbamazine citrate/oxibendazole)

Warning: Filaribits Plus (diethylcarbamazine citrate/oxibendazole) Chewable Tablets have been occasionally associated with hepatic toxicity including several fatalities. Close monitoring of animals receiving this drug may identify early hepatic injury. The hepatic injury has usually been reversible upon discontinuation of Filaribits Plus administration; thus dogs exhibiting signs of hepatic dysfunction should be removed from treatment immediately. Dogs with a history of liver disease or dogs receiving Filaribits Plus concurrently with other potentially hepatotoxic drugs should be carefully monitored for clinical or biochemical evidence of hepatic disease.

Filaribits Plus® (brand of diethylcarbamazine citrate/oxibendazole) Chewable Tablets For Veterinary Use Only

Composition: Each 60 mg/45 mg Filaribits Plus tablet contains 60 mg diethylcarbamazine citrate and 45.36 mg oxibendazole. Each 180 mg/136 mg Filaribits Plus tablet contains 180 mg diethylcarbamazine citrate and 136.1 mg oxibendazole.

Indications: Filaribits Plus are indicated for use in the prevention of infection with *Dirofilaria immitis* (heartworm disease) and *Angiostrongylus vasorum* (hookworm infection) in dogs. Filaribits Plus are also indicated for removal and control of Trichuris vulpis (whipworm infection) and mature and immature stages of intestinal *Toxocara canis* (ascariid infection) in dogs. Filaribits Plus may be given to dogs of all ages including litters throughout the reproductive period and following whelping.

Warning: See Warning box regarding hepatic toxicity. Dogs with established heartworm and/or hookworm infection should not receive Filaribits Plus until they have been converted to a negative status by the use of appropriate anthelmintic and microfilaricidal heartworm therapy and/or hookworm therapy. A dog on prophylactic therapy should be examined for the presence of heartworm microfilaria every six months.

Precautions and Side Effects: Occasionally in dogs, hepatic dysfunction, sometimes fatal, has been reported with the use of Filaribits Plus. Clients should be instructed to report any signs and symptoms which may suggest hepatic dysfunction so that appropriate biochemical testing can be done. Signs and symptoms reported as accompanying hepatic dysfunction include anorexia, vomiting, lethargy, jaundice, weight loss, polydipsia, polyuria, ataxia and dark urine. The use of diethylcarbamazine citrate is not recommended in dogs with active *Dirofilaria immitis* infections. Inadvertent administration to heartworm infected dogs may cause adverse reactions due to pulmonary occlusion. Overdosage may cause emesis.

CAUTION: U.S. Federal law restricts this drug to use by or on the order of a licensed veterinarian. Do not use in dogs that may be harboring adult heartworms. KEEP OUT OF REACH OF CHILDREN. For Veterinary Use Only.

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Animal Health

Clavamox® Tablets

amoxicillin trihydrate/clavulanate potassium

BRIEF SUMMARY

Before prescribing CLAVAMOX Tablets (amoxicillin trihydrate/clavulanate potassium), please consult Complete Product Information, a summary of which follows:

INDICATIONS—CLAVAMOX TABLETS are indicated in the treatment of CANINE:

Skin and Soft Tissue Infections such as wounds, abscesses, cellulitis, superficial/juvenile and deep pyoderma due to susceptible strains of the following organisms: β -lactamase producing *Staphylococcus aureus*, non- β -lactamase producing *Staphylococcus aureus*, *Staphylococcus spp.*, *Streptococcus spp.*, and *E. coli*.

FELINE:

Skin and Soft Tissue Infections such as wounds, abscesses and cellulitis/dermatitis due to susceptible strains of the following organisms: β -lactamase producing *Staphylococcus aureus*, non- β -lactamase producing *Staphylococcus aureus*, *Staphylococcus spp.*, *Streptococcus spp.*, *E. coli*, and *Pasteurella spp.*

CLAVAMOX TABLETS are also indicated in the treatment of feline Urinary Tract Infections (cystitis) due to susceptible strains of *E. coli*.

Therapy may be initiated with CLAVAMOX prior to obtaining results from bacteriological and susceptibility studies. A culture should be obtained prior to treatment to determine susceptibility of the organisms to CLAVAMOX. Following determination of susceptibility results, and clinical response to medication, therapy may be re-evaluated.

CONTRAINDICATIONS—The use of this drug is contraindicated in animals with a history of an allergic reaction to any of the penicillins or cephalosporins.

WARNINGS—Safety of use in pregnant or breeding animals has not been determined. For use in dogs and cats only. CLAVAMOX TABLETS should be stored at room temperature 15° to 30°C (59° to 86°F) and away from moisture.

CAUTION—Federal law restricts this drug to use by or on the order of a licensed veterinarian.

ADVERSE REACTIONS—CLAVAMOX contains a semisynthetic penicillin (amoxicillin) and has the potential for producing allergic reactions. If an allergic reaction occurs, administer epinephrine and/or steroids.

HOW SUPPLIED—CLAVAMOX Tablets in the following strengths are supplied in strip packs. Each carton holds 15 strips with 14 tablets per strip (210 tablets per carton).

62.5 mg tablet — dogs and cats 250 mg tablet — dogs only
125 mg tablet — dogs only 375 mg tablet — dogs only
CLAVAMOX is also supplied as an easy-to-administer oral suspension.

SB SmithKline Beecham
Animal Health

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ARTICLE #3 REVIEW QUESTIONS

The article you have read qualifies for 1 hour of Continuing Education Credit from the Louisiana State University School of Veterinary Medicine. Choose only the one best answer to each of the following questions; then mark your answers on the registration form inserted in *The Compendium*.

1. Which of the following statements regarding the longevity of newly emerged adult cat fleas is true?
 - a. Under conditions of approximately 24°C (75°F) and 78% relative humidity, 5% of newly emerged fleas survive without a host for two weeks.
 - b. Under conditions of approximately 24°C (75°F) and 78% relative humidity, 5% of newly emerged fleas survive without a host for four weeks.
 - c. Under conditions of approximately 22°C (72°F) and 60% relative humidity, 5% of newly emerged fleas survive without a host for one week.