

Flea infestations: epidemiology, treatment and control

Fleas (Order: Siphonaptera) are highly specialised insects with more than 2500 species, worldwide. Adult fleas are small (~2–10 mm in length), dark brown, and blood-sucking insects. Although wingless fleas have strong hind legs adapted for leaping, allowing significant mobility.

As holometabolous insects fleas complete a life cycle from egg to adult through larval and pupal stages (Figure 1). A female flea lays up to 50 eggs per day and around 1500 in a lifetime. Fleas lay their eggs in the hair coat of the host, and because eggs are not sticky they fall off the host into the environment. Eggs usually hatch in about 2 to 5 days into larvae. Flea larvae are grub-like and feed on organic debris in the environment, such as flea faeces and dander (Rust and Dryden, 1997). Larvae tend to move away from light and burrow deep into carpets, under furniture or into cracks and crevices. Mature larvae develop into new adults inside a whitish, loosely spun silk-like cocoon, the pupa. Because it is sticky, the cocoon quickly becomes coated with environmental debris, which provides protection from insecticidal treatments and thus, pupae will continue to hatch after pets and the household have been treated. The pupal stage is often the key to an unresolved flea problem and it is thus paramount that veterinary practitioners, nurses and clients understand its complexities.

When the adult flea emerges from the cocoon, it immediately begins seeking a host for a blood meal. Fleas move towards light and prefer to move upward. As a result, newly hatched fleas move directly to the top of the carpet pile, bedding material, or other surface, where they are more likely to encounter a passing host. If a host is not immediately available, a newly emerged flea can survive for several days before acquiring a host and a blood meal. Once it is on the host the flea begins feeding within minutes (Dryden and Gaafar, 1991). The flea feeds through a long, slender mouthpart called a proboscis. Before feeding, the flea pumps anticoagulant-containing saliva into the wound to prevent the blood from clotting. Flea faeces (dirts) are produced within about 10 minutes of feeding. Fleas mate at about 8 hours of the flea taking their first blood meal and egg production begins at 24 hours. The adult flea is a permanent resident that will not leave the host voluntarily. Once a flea has fed on

Abstract

Fleas (Insecta, Siphonaptera) are a complex insect species and cause pets and their owners a lot of concern worldwide. Besides being clinically important, the cat flea, *Ctenocephalides felis*, is responsible for the production of flea allergic dermatitis (FAD), acts as the vector of many bacterial pathogens, and serves as the intermediate host for cestode and filarid parasites. Despite an arsenal of effective products, failures in flea control programmes are commonplace due to poor compliance, inappropriate drug use and unrealistic client expectations. It is vital for veterinary professionals to give good advice, consider compliance and manage expectations if flea control programmes are to be successful. This article discusses the epidemiology, diagnosis, treatment and control of flea infestations.

Key words: *Ctenocephalides felis*; fleas; flea allergy dermatitis; flea-borne diseases; control

a host and has begun egg production, it becomes dependent on a constant blood source; thus adult fleas rarely jump from one animal to another. On the host, fleas can continue to survive and reproduce for 3 to 4 months.

Epidemiology of fleas

By far the most commonly seen on both dogs and cats is the 'cat flea' *Ctenocephalides felis*. On the other hand, the 'dog flea' *Ctenocephalides canis* is observed infrequently on dogs and rarely on cats, although may be found more commonly in more temperate climates, such as Ireland. *Pulex simulans* and *Echinophaga gallinacea* (poultry sticktight flea) can also occur on dogs and cats.

The adult fleas which are seen on the pet are only the tip of the iceberg; 95% of the flea problem exists

Ian Wright BVMS BSc MSc MRCVS
Veterinary Surgeon and Parasitologist
Withy Grove Veterinary Surgery, 39 Station
rd, Bamber Bridge, Preston PR56QR

Hany Elsheikha BVSc MSc PhD FRSPH FHEA
DipEVPC, Associate Professor in Veterinary
Parasitology at University of Nottingham,
School of Veterinary Medicine and Science,
Sutton Bonington Campus, Leicestershire,
LE12 5RD, UK

Sponsored by



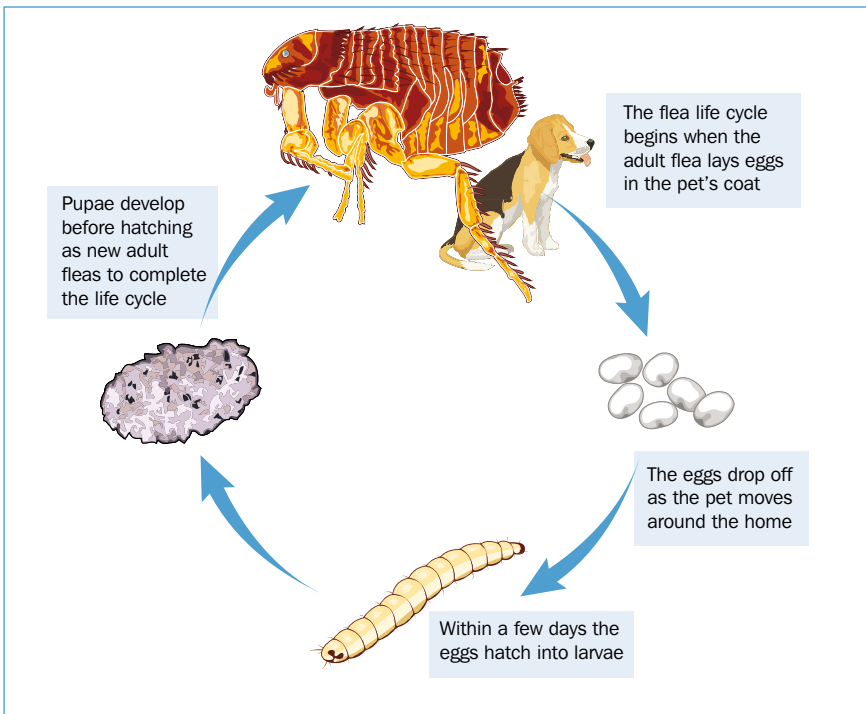


Figure 1. Life cycle of the cat flea (*Ctenocephalides felis*).

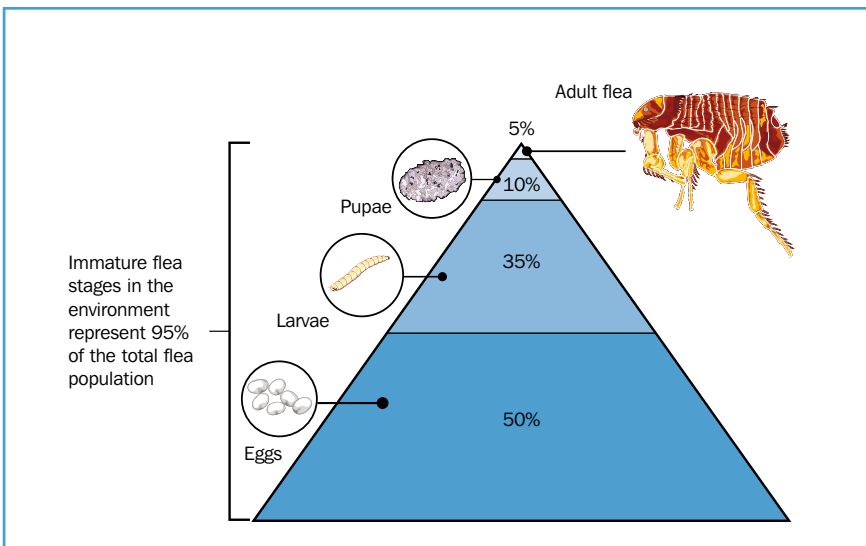


Figure 2. Flea population pyramid showing the proportions of the different forms of the flea life cycle with adult fleas only representing the 'tip of the iceberg'.

in the home as eggs, larvae and pupae (Figure 2). Under most household conditions, cat fleas complete their life cycle in 3–8 weeks (Blagburn and Dryden, 2009). However, the range could be from 2 weeks to 12 months depending on temperature and humidity, which impact the hatch times. Fleas are most numerous during warm summer months, however with fluctuations in climate and as homes are now centrally heated, fleas should now be considered a year round problem.

Veterinary and medical importance

Irritation

Fleas cause pruritus (itching) and irritation in affected cats and dogs. It is possible, however, for some pets to carry significant flea burdens without showing obvious signs. Cat and dog fleas can also feed on humans temporarily if they cannot find a dog or a cat host. This is manifested as small red bites around the ankle/calf region.

Anaemia

Because fleas feed on the pet's blood it is possible for them to cause iron deficiency anaemia, particularly in small kittens and puppies (Rust and Dryden, 1997). This blood loss can be life threatening in very small pets, or in pets that are ill for other reasons.

Flea allergy dermatitis (FAD)

Some cats and dogs suffer from an allergy to the flea dirt and/or saliva, leading to FAD (Elsheikha, 2012). This is one of the most common and serious skin diseases in dogs and a major cause of feline miliary dermatitis (Rust and Dryden, 1997).

Flea-borne diseases

Due to their haematophagous nature fleas can be vectors of various diseases in many parts of the world.

- **Worms:** fleas serve as the intermediate host (IH) for the tapeworm of dogs and cats, *Dipylidium caninum*. Flea larvae ingest *D. caninum* eggs from the environment. Dogs and cats then ingest the infected fleas when they groom themselves. It is essential to control fleas in order to prevent *D. caninum* infection in dogs and cats. *D. caninum* can also affect humans, particularly children. Fleas also can act as the IH of *Hymenolepis nana* and the nonpathogenic subcutaneous filarid nematode of dogs, *Acanthocheilonema (Dipetalonema) reconditum* (Rust and Dryden, 1997; Blagburn and Dryden, 2009).
- **Blood-borne bacterial infections:** fleas may also carry blood-borne infections, some of which may affect humans. For example, *Bartonella henselae*, the causative agent of cat scratch disease (CSD), can cause flu-like symptoms in humans. Other blood-borne pathogens which have been isolated from fleas include *Rickettsia felis* (the spotted fever agent) and *Haemoplasma* spp, which causes anaemia in cats. Fleas also play a role in the transmission of bubonic plague (*Yersinia pestis*) and murine (endemic) typhus (*Rickettsia typhi*).

Diagnosis

A flea comb remains the mainstay of diagnosis and can be used to rapidly find adult fleas (*Figure 3*) or flea dirt (*Figure 4*). Flea dirt comprises mostly partially digested blood and will smear red on cotton wool or can be identified microscopically. Clients will sometimes find flea larvae and present them for identification (*Figure 5*).

Treatment and prevention

Flea infestations on pets and in homes are becoming an increasingly common problem in the UK and attempts to eliminate infestations are expensive and take time to achieve. Up until the mid-1900s flea control relied on on-animal products without significant residual activity. Most of these products were effective at eliminating adult fleas but infestation would



Figure 3. An adult flea recovered from an infested animal.

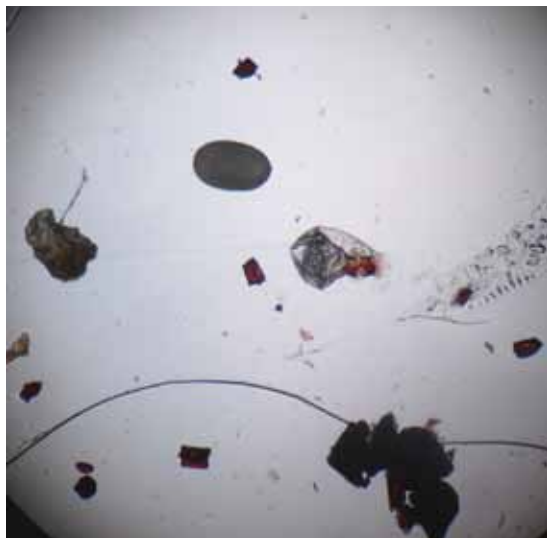


Figure 4. Flea dirt (droppings) and egg.

then often reoccur. The ‘holy grail’ of companion flea treatment was a pesticide with residual activity, wide safety margins for the patient and in a formulation that was convenient to apply. Fipronil in 1987 was the first of a series of compounds that met these criteria. These compounds used in combination with insect growth regulators have proved effective at eliminating flea populations from households. For flea elimination programmes to be successful adult fleas must be killed on the pet before they can initiate reproduction and egg production. While use of growth regulators and environmental insecticides are useful at controlling environmental populations no product will kill pupae in the environment and so effective rapid killing of adults is required to completely break the reproductive cycle. To achieve this good advice must be given, both in terms of recommending efficacious products and also correct method and frequency of application. Compliance is a pivotal factor and owner preference in terms of use of a spot-on preparation or tablet should also be considered. Often flea control will also form part of wider parasite control requirements, such as ticks and endoparasites. Giving this advice will often fall to veterinary nurses as advice is often sought at reception and nurse consultations rather than with the veterinary surgeon.

The objectives of flea control are three folds:

- The use of an effective adulticide — to prevent egg laying and break the reproductive cycle
- Effective environmental control — use of environmental sprays to reduce environmental factors and prevent growth. These sprays typically contain a larvicide/ovicide and a growth inhibitor. Lufenuron can also be used in pets to prevent flea eggs from hatching
- Management of client expectation — flea infestations may take months to eliminate, even when using effective control measures and if this is not made clear to clients they may become disheartened very quickly.

The flea product market is fluid with products constantly being introduced and withdrawn and so an exhaustive list of up-to-date available products is not possible, but examples of products containing these compounds are summarised in *Table 1*. Examples of efficacious compounds in flea control are:

- Fipronil and imidacloprid — these are still highly efficacious compounds if administered every 4 weeks with greater than 95% adult kill still achieved after 5 weeks (Young et al, 2004). Some have the advantage of carrying NFA-VPS (non-food animal medicine — veterinarian, pharmacist, suitably qualified person (SQP)) status allowing nurses and SQPs the flexibility to



Figure 5. Flea larva, approximately 1-2 mm long.

prescribe products containing them without seeing pets but correct advice about the frequency of application is vital. This is especially true for fipronil where the license under some circumstances recommends a frequency of application longer than 4 weeks. Care should also be taken where sebum stripping shampoos are being used as this will also reduce efficacy and increase the need for more frequent application. Imidacloprid also has some larvicidal activity as it is shed into the environment. Fipronil has some activity against ticks and biting lice. Treatment can be initiated from 8 weeks of age or from 2 days old in the case of fipronil sprays. Fipronil is toxic in rabbits. A sustained release POM-V imidacloprid collar (Seresto®) lasting up to 8 months is now available for cats and dogs.

- Selamectin — POM-V status, absorbed into the bloodstream. It has larvicidal activity as active drug is passed in flea dirt. It also has activity against *Toxocara* spp, *Dirofilaria immitis* as well as sarcoptic mites and biting lice. It needs to be applied every 4 weeks and treatment can be initiated from 6 weeks of age.
- Pyriprole — POM-V status. Efficacious and safe in dogs aged 8 weeks or over. It needs to be applied every 4 weeks. Care should be taken where sebum stripping shampoos are being used as this will reduce efficacy and increase the need for more frequent application. Toxic in rabbits.
- Nitenpyram — AVM-GSL status. Rapid kill of adult fleas but no residual activity.
- Pyrethroids — while useful for tick control on dogs, they are not effective flea adulticides. They are useful in reducing environmental load and as a result permethrin, deltamethrin and tetramethrin are used in combination with an insect growth regulator in environmental sprays. Care must be taken however as these compounds are potentially toxic to cats, aquatic life and bees.
- Lufenuron — administered to pets by injection (cats) or in food (cats and dogs). It acts by preventing flea eggs from hatching and so is a useful adjunct to flea control, but has no adulticide activity.
- Methoprene/S-methoprene/Pyriproxyfen — inhibit larval development (methoprene and pyriproxyfen) and egg development (pyriproxyfen) and so are useful in environmental treatments either via the pet or in environmental sprays.
- Indoxocarb — POM-V status. It is absorbed into the body and is efficacious and safe in cats and dogs over 8 weeks of age. Needs to be applied every 4 weeks.
- Dinotefuran — POM-V status. Efficacious and safe in dogs aged 7 weeks or over. Kills fleas on contact, within 2 hours of application, without the need for the flea to bite. This antifeeding effect prevents the clinical signs of allergy in dogs with FAD and contributes to environmental control of fleas. Needs to be applied every 4 weeks. Care should also be taken where sebum stripping shampoos are being used as this will also reduce efficacy and increase the need for more frequent application. Only available licensed in combination with permethrin and so is not safe for use on cats.
- Spinosad — POM-V status. Has rapid kill, is absorbed into the body and is highly efficacious if administered every 4 weeks. Safe in cats and dogs if given from 14 weeks of age.
- Products containing isoxazolines — POM-V status. Isoxazolines are highly efficacious against fleas and ticks, killing ticks within 12 hours. This rapid speed of kill is useful in reducing tick borne disease transmission. Two products containing isoxazolines are available, Bravecto® (MSD) (fluralaner) and NexGard® (Merial) (afoxolaner). Both products are administered orally and have a 3 and 1 month duration of activity respectively. Bravecto®'s licensed duration of activity against *Rhipicephalus sanguineus* ticks is 8 weeks so this should be considered for pets travelling abroad for long periods to countries where *Rhipicephalus sanguineus* ticks are endemic. Both products can be used from 8 weeks of age and fluralaner is safe for use in pregnancy in lactation.

Table 1. Selection of flea treatments currently on the UK market

Active flea treating compound	Status	Preparations	Mode of administration	Species license
Fipronil	NFA-VPS, POM-V (Frontline combo®, Certifect®, Frontline spray®)	Frontline®, Frontline combo®, Certifect® (dogs only), Pestigon®, Effipro®, Vexitor®, Eliminal®, Fevox®, Fiproline®, Vexitor®	Spot on, spray	Cats, dogs, ferrets
Imidacloprid	NFA-VPS, POM-V (Seresto®, Advocate® and Advantix®)	Advantage®, Advantix® (dogs only), Advocate®, Seresto®	Spot on, collar	Cats, dogs, rabbits (Advantage), ferrets (Advocate)
Selamectin	POM-V	Stronghold®	Spot on	Cats, dogs
Pyriprole	POM-V	Practic® (dogs only)	Spot on	dogs
Nitenpyram	AVM-GSL	Capstar®	Tablet	Cats and dogs
Lufenuron	POM-V	Program®	Tablet, suspension, injectable	Cats and dogs
Indoxocarb	POM-V	Activyl®, Activyl plus® (dogs only)	Spot on	Cats and dogs
Dinotefuran	POM-V	Vectra 3D® (dogs only)	Spot on	Dogs
Spinosad	POM-V	Comfortis®, Trifexis® (dogs only)	Tablet	Cats and dogs
Afoxolaner	POM-V	NexGard®	Tablet	Dogs
Fluralaner	POM-V	Bravecto®	Tablet	Dogs

The oral nature of these products will help to circumvent concerns about the use of pyrethroids in tick control where there are young children or cats in households.

Perceived product inefficacy

Ctenocephalides felis is thriving in the UK with successive mild winters and reservoir populations in centrally heated homes, and the persistence of fleas in the environment and visible fleas on the pet after application of flea products has led to questions of resistance. Despite numerous large scale studies into the efficacy of POM-V flea treatments fipronil and imidacloprid, there is currently no evidence of flea resistance in the field. Even where resistance genes are known to exist in laboratory strains of flea, fipronil,

selamectin and spinosad have all been shown to be highly efficacious at 3 weeks post application (Bass et al, 2004; Dryden et al, 2013). The question then arises as to why resistance is perceived to be present when this is not the case in practice. There are numerous reasons why resistance may appear to be occurring. The lack of consideration of the following factors might lead to failure of control programmes and in some cases fleas will still be present despite the use of efficacious products.

- Not treating all animals in the home — if all susceptible animals are not treated in the home at the same time then the opportunity arises for fleas to breed and control programmes will fail. Although the license for some products advise treatment of all in contacts for FAD they do not for routine control. Responsibility for this advice therefore falls to the dispensing person. All dogs, cats and ferrets must be treated. Also, rabbits in the home must be treated with imidacloprid (licensed for use in rabbits).
- Not treating pets frequently enough — advice may be inaccurate, misinterpreted or confused. Some licenses are misleading. For example, fipronil spot on is licensed for 5 weeks in cats and for 2 months in dogs depending on level of challenge. The spray is licensed for 2 months cats and 3 months in dogs. The license advises monthly application in FAD cases but in reality heavy infestations will require monthly treatment of all in contacts to achieve control. Sebum stripping shampoos will

Key Points

- Fleas cause pets and their owners a lot of concern, worldwide.
- Control of fleas is essential, not only to avoid economic losses and to maintain the health and welfare of the animals, but also to protect public from fleas bites and fleas-borne zoonosis.
- Effective management of fleas necessitates treatment of the animal, the home environment and the outdoors.
- It is very difficult to eradicate outdoor infestations and there are no effective flea repellents. Thus, it is expected to see fleas on treated pets whenever the pet enters an area infested with flea pupae.
- All veterinary professionals need to educate their clients on all aspects of flea control so that they can have realistic expectations to the currently used control measures.

also increase the required frequency of application if compounds, such as fipronil and imidacloprid are absorbed into this layer. When frequent application of these shampoos is required, such as in *Malassezia* spp infection, then flea products absorbed into the body, such as selamectin, indoxo-carb or spinosad may be more desirable.

- Not treating the environment — without treatment of the environment some flea infestations will take many months to eliminate (Dryden et al, 2000).
- Lack of management of expectation — heavy infestations of fleas may take at least 3 months to eliminate, even when environmental treatment is used (Dryden et al, 2000).

Conclusions

Flea control is important in terms of human nuisance and revulsion, reducing vector-borne disease and the clinical signs resulting from flea infestation. Flea control continues to remain a challenge and it is vital for veterinary nurses and SQPs to remain up to date both in terms of new products coming onto the market, but also giving accurate advice. This includes frequency of application, compliance and management of client expectation when choosing what flea control products to employ. VN

Conflict of interest: none.

References

- Bass C, Schroeder I, Turberg A et al (2004) Identification of the Rdl mutation in laboratory and field strains of the cat flea, *Ctenocephalides felis* (Siphonaptera: Pulicidae). *Pest Management Science* **60**: 1157–62
- Blagburn BL, Dryden MW (2009) Biology, treatment, and control of flea and tick infestations. *Vet Clin North Am Small Anim Pract* **39**: 1173–200
- Dryden MW, Denenberg TM, Bunch S (2000). Control of fleas on naturally infested cats and dogs and in private residences with topical spot on applications of fipronil and imidacloprid. *Vet Parasitol* **93**(1): 69–75
- Dryden M, Gaafar S (1991) Blood consumption by the cat flea, *Ctenocephalides felis* (Siphonaptera: Pulicidae). *J Med Entomol* **28**(3): 394–400
- Dryden MW, Payne PA, Smith V et al (2013) Efficacy of selamectin, spinosad, and spinosad/milbemycin oxime against the KS1 *Ctenocephalides felis* flea strain infesting dogs. *Parasites and Vectors* **6**: 80
- Elsheikha HM (2012) Flea allergy dermatitis: the continued challenge. *The Veterinary Nurse* **3**(6): 350–6
- Rust MK, Dryden MW (1997) The biology, ecology, and management of the cat flea. *Annu Rev Entomol* **42**: 451–73

The Veterinary Nurse CPD

To answer the CPD questions on this article visit www.theveterinarynurse.com and enter your own personal login.

Now provides all your CPD hours.

Supported by an educational grant from Merial, the manufacturer of

NexGard