ESCCAP

EUROPEAN SCIENTIFIC COUNSEL COMPANION ANIMAL PARASITES®

Control of Ectoparasites in Dogs and Cats

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INTRODUCTION

External or ectoparasites include a wide range of parasitic arthropods, which belong taxonomically to the sub-class Acari (ticks and mites) and to the class Insecta (fleas, chewing and sucking lice, mosquitoes, flies and phlebotomes (sand flies)) (Table 1).

External parasites are important because:

- They may cause cutaneous lesions
- They can induce immunopathological responses
- They can transmit pathogens
- They may be zoonotic or transmit zoonotic infections
- They may interfere with the human – animal bond
- Their control is part of maintaining healthy pets

Table 1: Overview of parasitic arthropods

Arthropod	Arthropod related infestation/disease	Major pathogenic agents transmitted (corresponding diseases)
Fleas	Flea infestation and sometimes flea allergy dermatitis (FAD)	*Dipylidium caninum* (dipylidiosis), *Bartonella henselae* (cat scratch disease = bartonellosis), *Bartonella vinsonii, Rickettsia felis, Acanthocheilonema reconditum*
Chewing and sucking lice	Louse infestation	*Dipylidium caninum, A. reconditum*
Dipteran fly larvae (maggots)	Myiasis	
Phlebotomes (sand flies)	Phlebotome (sand fly) infestation	*Leishmania infantum* (leishmaniosis) *L. infantum* is the major species in Europe
Mosquitoes (*Culex* spp., *Aedes* spp. and *Anopheles* spp.)	Mosquito infestation	*Dirofilaria immitis, Dirofilaria repens* (dirofilariosis), *Acanthocheilonema* [*Dipetalonema*] spp. (filariosis)
Flies (secretophagous and biting flies)	Fly infestation, myiasis	*Thelazia* spp. (ocular filariosis = thelaziosis)
Ticks (*Rhipicephalus sanguineus*, *Ixodes* spp., *Dermacentor* spp., *Hyalomma* spp., *Haemaphysalis* spp. and others)	Tick infestation	*Babesia canis, Babesia gibsoni, Babesia* [*Theileria*] *annae* (piroplasmosis, babesiosis), *Cercopithifilaria* spp., *Hepatozoon* spp. (hepatozoonosis), *Ehrlichia canis, Ehrlichia* spp., *Anaplasma phagocytophilum, Anaplasma platys* (ehrlichiosis, anaplasmosis), *Rickettsia* spp. (rickettsiosis), *Borrelia burgdorferi* s.l. (Lyme disease = borreliosis), Flaviviruses (e.g. tickborne encephalitis, louping ill), *Acanthocheilonema* [*Dipetalonema*] *dracunculoides*
Cheyletiella yasguri (in dogs) and *Cheyletiella blakei* (in cats)	Cheyletiellosis	- none described
Otodectes cynotis	Otoacarosis	- none described
Neotrombicula (Trombicula) autumnalis, Straelensia cynotis	Trombiculosis	- none described
Sarcoptes scabiei	Sarcoptic mange	- none described
Notoedres cati	Notoedric mange	- none described
Demodex canis, D. cati, D. inja, D. gatoi, D. spp.	Demodicosis	- none described

In addition, the following factors have clinical implications:

- Cutaneous lesions may lead to secondary bacterial or fungal (*Malassezia* spp.) infections and various kinds of dermatitis
- The immune response induced, especially by ectoparasite saliva, may lead to allergic reactions with flea allergic dermatitis being the most important
- Transmitted pathogens may cause diseases, the so called vector-borne diseases (VBDs), that are, in many cases, of more clinical relevance than the actual ectoparasite infestation itself
- Ectoparasite-infested pets may be a source for infestation of the pets' owners which can be a serious nuisance (e.g. fleas)
- The direct health implications of ectoparasite infestation can be more than skin deep: e.g. heavy blood-sucking arthropods can cause anaemia

SCOPE

Since many ectoparasites may act as vectors of various important companion animal diseases it is the aim of ESCCAP to produce a guideline which delivers comprehensive information and support to assist both veterinarians and pet owners to successfully control ectoparasite infection and prevent disease transmission to their pets. This guideline concentrates on the most important groups of ectoparasites namely fleas, ticks, lice (which taxonomically consist of two different groups, the sucking lice and the chewing lice) and mites. Other ectoparasites such as phlebotomes (sand flies) and mosquitoes are mainly of importance as vectors of disease and although briefly mentioned here are more appropriately dealt with in a separate guideline produced by ESCCAP on vector-borne diseases of companion animals (ESCCAP Guideline 5: Control of Vector-borne Diseases in Dogs and Cats).

For more information on endoparasite control see ESCCAP Guideline 1: Endoparasites: Worm Control in Dogs and Cats.

For more information about dermatophytic fungi see ESCCAP Guideline 2: Superficial Mycoses in Dogs and Cats.

PRESENT SITUATION AND EMERGING THREATS

In Europe, the increase in pet travel plus climatic changes will probably influence the present epidemiological situation of certain ectoparasites and the pathogens they carry or may introduce them into different regions. Rare diseases might increase in frequency due to increased importation or establishment of the causative agents and their vectors into presently non-endemic areas. For example, in the past few years canine babesiosis has been observed across central and northern Europe, emerging from the previous endemic regions around the Mediterranean basin and eastern European countries to more northern areas. Furthermore, within the European Union, removal of border controls under the Schengen Treaty and implementation of the PETS Travel Scheme in the UK have led to easy travel between the various countries within continental Europe and, except for the UK, there are no or limited customs controls of pet animals moving from one country to another. Whilst pets travelling with their owners account for a major part of the total pet movement, a large number of dogs and, to a lesser extent cats, are now being relocated by welfare organisations from, for example, Mediterranean countries to private households all over Europe. This is particularly significant as the Mediterranean is an area where infestations with numerous ectoparasites or pathogens transmitted by them are highly prevalent.

Veterinary medicinal products have to go through a rigorous testing process prior to their approval by European or national authorities and each indication for use has to be scientifically justified. Veterinarians are trained in the appropriate use of these compounds according to current national legislation.

Ectoparasiticidal compounds for companion animals can be used prophylactically or therapeutically to control ectoparasites. Visible infestations with fleas, lice or ticks require treatment to eliminate the infection. However, most modern ectoparasiticides have a residual effect and thus can be used prophylactically to prevent re-infestation.

BIOLOGY, DIAGNOSIS AND CONTROL OF ECTOPARASITES

1. Fleas

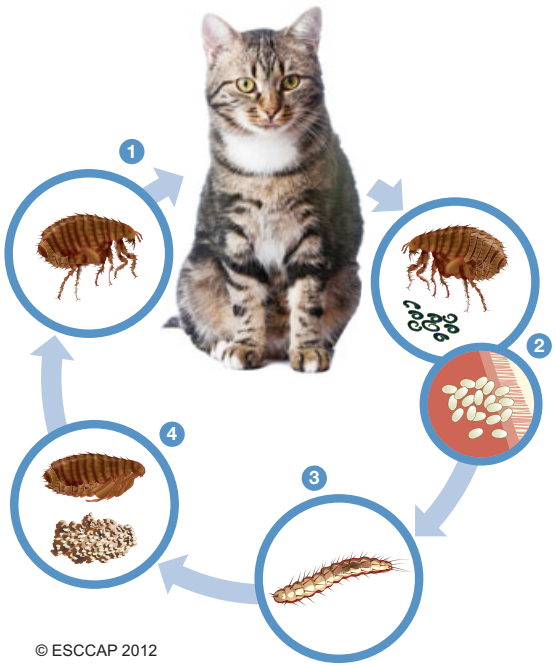
Fleas (Siphonaptera) are wingless, laterally flattened, blood sucking insects that occur on mammals and birds. Only the adult stages are found on the host with eggs and immature stages being found in the environment. Fleas are common parasites of cats, dogs and other small mammals housed in multi-pet households as companion animals. Fleas can act as vectors for a number of pathogens (for details see ESCCAP Guideline 5: Control of Vector-borne Diseases in Dogs and Cats).

1.1. Basic biology

Species

In Europe the most common flea species found on dogs, cats and on other small mammalian companion animals are *Ctenocephalides felis*, followed by *C. canis, Archaeopsylla erinacei* (hedgehog flea), and occasionally other flea species such as *Ceratophyllus gallinae*, *Echidnophaga gallinacea* (poultry fleas), *Spilopsyllus cuniculi* (rabbit flea) and *Pulex irritans* (human flea).

Figure 1: Life cycle of *Ctenocephalides felis*



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1 Fleas are 1-6mm long, latero-lateral flattened wingless insects, with robust hind legs enabling jumping and mouthparts adapted for piercing skin and sucking blood. Once emerged from the pupa, adult male and female fleas start to actively seek a host although in the absence of a host they can only survive for a few days. After the first blood meal, they need daily blood meals for survival and usually remain on the same host for the remainder of their life. Maximal recorded longevity is 160 days but most fleas survive for about one to three weeks as they are groomed out by the host.

2 Egg production and deposition for *C. felis* always occurs on the host with a female flea capable of laying an average of 20 (maximum 40 to 50) eggs per day. If males and females are present on the same animal, reproduction and egg deposition occur very rapidly (within 48 hours of infestation); once laid, the pearly white eggs (0.5mm in length) fall off into the environment. After a few days under ideal conditions the larvae hatch.

3 The larvae feed on debris such as dander and flea faeces in the environment and develop through three larval stages. The larvae (mostly L3) tend to move away from light and so can be found in hidden locations such as the base of carpets or under furniture where access for vacuuming is difficult.

4 Once fully grown, the larvae spin a cocoon and pupate. Following development the adult can emerge from the pupal case immediately or may be delayed for 6 months or more in the absence or appropriate stimuli such as CO_2, pressure and increased temperature.

Life Cycle
The life cycle of *C. felis* is depicted in Figure 1.

Survival and development of immature flea stages in the environment are highly dependent on environmental conditions. Development from egg to adult under ideal environmental conditions can be as fast as 14 days or may extend to 140 days. Fleas are well adapted to indoor environments, thus buildings or homes with central heating or carpeted floors may allow flea development to continue independent of seasonality. Nevertheless, from spring to autumn, they can multiply outdoors in suitable locations, which may explain some of the increased prevalence during warm seasons.

Epidemiology
Ctenocephalides felis has a remarkably low host specificity and has been found on a variety of pets such as rabbits and ferrets as well as wild mammals. Untreated canine, feline and other hosts can therefore act as sources of infestation. They may be a direct source of infestation of adult fleas, particularly where animals are in close contact, but more often they contaminate the environment with eggs and infestations occur with newly emerged adult fleas.

Once the flea larva has developed to the pupal stage, the pre-emerged flea within the cocoon is highly protected from changes in environmental conditions. Depending on environmental conditions, fleas can survive in this stage for months in the absence of any host. Emergence of the adult flea from the cocoon is not automatic and depends on the presence of appropriate stimuli. When a suitable host approaches, the flea can emerge from the cocoon rapidly.

1.2. Clinical signs

Flea infestation is highly variable. The grooming behaviour of the individual animal (especially cats) can have a major influence on the number of adult fleas and their longevity. Whether clinical signs due to flea infestation are present depends on the following factors:

- Frequency of flea exposure
- Duration of flea infestation
- Presence of secondary infections or other concurrent skin disease
- Degree of hypersensitivity

Non-allergic animals may have few or no clinical signs and only show occasional scratching due to irritation caused by fleas or their bites. Animals that are allergic or develop an immunological reaction to flea saliva, show pruritus, alopecia, broken hairs, papules and erythematous macules with crusts. Moist dermatitis may be seen typically in the dorsal lumbar and tail region. The lesions can extend to the thighs and abdomen. Secondary pyotraumatic dermatitis, pyoderma and seborrhoea are commonly seen. In chronic cases, the skin shows thickening of the dermis with acanthosis, hyperkeratosis and lichenification. In addition, especially in young, old or debilitated animals, heavy infestations with a large number of fleas can cause anaemia. Furthermore, infection with the tapeworm *D. caninum* can be a strong indication of a current or recent flea infestation.

1.3. Diagnosis

Due to hair length and thickness of the hair coat, especially in some dog breeds, low numbers of fleas may remain undetected. If adult fleas are present in large numbers, they may be detected macroscopically. Combing the animal is the most sensitive method to detect flea infestation.

In the apparent absence of fleas, flea faeces may be detected on the animal and in combed material. The material is combed on to damp white paper or tissue where the black spots of flea faeces become surrounded by a red ring of undigested blood.

It is sometimes difficult to confirm that adult fleas are present on animals with clinical signs of flea allergy dermatitis (FAD) because constant grooming effectively removes fleas. However, a combination of the presence of fleas (or flea faeces) and response to treatment, together with elimination of other possible causes can confirm the diagnosis of FAD. There are a number of allergy tests, with no single test being recognised as a gold standard. These tests may assist in reaching a diagnosis. Diagnosis can be further complicated as FAD-affected dogs are more likely than non-FAD dogs to be atopic or have other allergies (e.g. food allergy).

1.4. Treatment of an existing infestation

Therapy includes:

1. Elimination of the existing infestation of adult fleas using an approved ectoparasiticide. Individual product leaflets should be consulted for details. Depending on the severity of the infestation and the drug used, treatment may need to be repeated at intervals until the problem is controlled. It is important to treat not only an infested animal but all other pets living in the same household (dogs and especially cats); this is sometimes neglected by the owners.
2. An established adult flea infestation normally accounts for only a very small proportion of the total flea population which includes immature stages present in the pet's surroundings. Thus control of environmental stages must also be considered, especially in the case of heavy infestations. The regular use of products that eliminate adult fleas on the animal will progressively contribute to the reduction of immature stages in the environment.

   Flea eggs, larval and pupal stages may be targeted by using products specific for flea stages present in the environment. Some of these are specially designed for environmental application (sprays, foggers etc.), while others are licensed for animal administration. Environmentally- and animal-administered products may contain compounds with adulticidal and/or Insect Growth Regulator (IGR) activity. Environmental treatment should focus on areas where the animal spends most of its time, such as its basket or sleeping area. In cases of severe flea infestation, a combination or concomitant use of environmental and animal administered products is usually necessary and will control the infestation more rapidly.

   Other measures such as the vacuuming of carpets and washing of pet's bedding material can help in reducing flea stages in the environment. Combing the animal's hair coat for fleas may be used to monitor the level of infestation.

   Additional topical or systemic treatments may be necessary to bring the infestation under control and thus reduce the clinical signs of flea infestation or FAD.

1.5. Prevention and on-going control

Modern flea control should aim to prevent flea infestations on pet animals. Each pet and its premises should be considered as an individual flea habitat requiring a treatment protocol formulated and agreed by the owner and the veterinarian. The individual infestation or re-infestation risk depends on the lifestyle of the animal.

Factors to consider:

- How many dogs, cats and/or other pet animals are present in the house?
- Does the animal have free access to a place where immature stages may be present?
- Does the animal suffer from FAD?
- Is the owner prepared to follow a long-term prevention protocol?

In areas where re-infestation with fleas is highly likely, such as warm conditions and multiple animal households, regular prophylaxis using an approved product is recommended. While flea infestations

peak in summer and autumn, studies have shown that flea infestation can occur throughout the year, thus year-round flea control might be necessary.

For flea control, owner compliance is an important consideration. Some causes of failure of apparently well-developed protocols include:

- Failing to treat all animals simultaneously in the household
- Not appreciating that shampooing or swimming may decrease the efficacy of topical products
- Failing to identify and eliminate “hot spots” of flea infestation and not effectively treating the environment including for example, cars and sheds.
- Intermittent exposure to other flea-infested animals or contaminated environments outside the household

Table 2: Flea control - different scenarios

FLEA CONTROL	
1) Minimal infestation risk (e.g. animals with limited or no outdoor access)	Regular grooming and visual inspection should be carried out preferably using a flea comb. In the event of positive findings, only therapeutic treatment may be required to eliminate the infestation. This can be achieved by the application of any registered insecticide at appropriate treatment intervals to ensure that both adults and developing stages in the environment have been controlled and the problem is eliminated.
2) Moderate infestation risk (e.g. animals with regular outdoor access)	Regular prevention at appropriate treatment intervals is recommended. Daily mechanical cleaning (e.g. vacuuming) of the house and if necessary the car or any other place where the animal has rested, is required. The largest number of eggs and immature stages are found in the places where dogs and cats spend most of their time.
3) High, continual re-infestation risk (e.g. pet shelters, breeder’s premises, mixed-pet households, hunting dogs)	Sustained, integrated flea control is recommended. Generally monthly application of registered insecticides on the dogs/cats is recommended together with daily vacuuming and mechanical cleaning of cages or beds and bedding. Also advised is an animal administered or environmental treatment for immature stages.
4) Animals with recognised flea allergy dermatitis (FAD)	In these animals, exposure to flea salivary antigens needs to be minimised or eliminated to prevent clinical signs. As a consequence, long-term flea control is recommended to ensure that the flea populations are maintained at very low or virtually non-existent levels. This could include frequent, regular application of insecticides to the animals and appropriate environmental control measures. If the animal with FAD lives within a multi-pet household with other dogs, cats or other pet animals, these animals should to be considered in any flea control strategy.
5) Continued flea and tick presence or risk	Sustained tick control with integrated flea control is recommended. Generally monthly application of registered acaricides with insecticidal activity on the dogs/cats is recommended together with daily vacuuming and mechanical cleaning of cages or beds and bedding. Also advised is an animal administered or environmental treatment for immature flea stages.

2. Ticks

Ticks on dogs and cats belong to the family Ixodidae, which are hard ticks. Female hard ticks increase their weight up to 120 times as they engorge with blood prior to egg laying; when fully engorged a female tick can measure around one centimetre in length and appears like a small bean.

Occurrence/Distribution

Ticks are endemic throughout almost all of Europe, and there are more than 12 different species, with varying biology and geographical distribution. *Ixodes ricinus* is widely distributed except in northern Scandinavia. Figs 2a and 2b indicate the main distribution of *Rhipicephalus sanguineus* (2a) and *Dermacentor reticulatus* (2b). The latter tends to have patchy distribution.

Table 3: Tick species found on dogs and cats in Europe

		Common name
Ixodes spp.	*I. ricinus*	Sheep tick, castor bean tick or wood tick
	I. canisuga	Fox tick, deer tick, forest tick, dog tick
	I. hexagonus	Hedgehog tick
	I. persulcatus	Taiga tick
Rhipicephalus spp.	*R. sanguineus*	Brown dog or kennel tick
	R. bursa	
	R. turanicus	
	R. pusillus	Rabbit tick
Dermacentor spp.	*D. reticulatus*	Marsh tick
	D. marginatus	
Haemaphysalis spp.	*H. punctata*	
	H. concinna	
Hyalomma spp.	*H. marginatum*	Mediterranean *Hyalomma*

Tick importance as pathogen vectors varies according to species and in some cases, to geographical location.

Table 4: Overview of tick-transmitted pathogens causing tick-borne diseases (TBDs) in Europe

Disease	Causative agents	Hosts	Vectors	Geographic distribution in Europe	Severity of clinical signs
DISEASES CAUSED BY PROTOZOA					
Piroplasmosis (Babesiosis)	*Babesia canis*	Dogs, wolves	*Dermacentor reticulatus*	western, southern and central Europe up to the Baltic	moderate - severe
	B. vogeli	Dogs	*Rhipicephalus sanguineus*	southern Europe following distribution of vector	mild - moderate
	B. gibsoni and *B. gibsoni*- like	Dogs, wolves	*Haemaphysalis* spp., *Dermacentor* spp.	sporadic and rare in Europe	moderate - severe
	Babesia (Theileria) annae	Dogs, foxes	*Ixodes hexagonus**	north western Spain, Portugal, Croatia	moderate - severe
Hepatozoonosis	*Hepatozoon canis***	Dogs	*Rhipicephalus sanguineus*	southern Europe	mostly mild infection; subclinical
	Hepatozoon spp.	Cats	unknown	Spain	subclinical
DISEASES CAUSED BY NEMATODES					
Filariosis	*Acanthocheilonema (Dipetalonema) dracunculoides, Acanthocheilonema (D.) reconditum, Cercopithifilaria* spp.	Dogs, cats	*Rhipicephalus sanguineus*†	southern Europe	minor

* Not yet experimentally demonstrated.
** Transmission of *Hepatozoon* spp. is by ingestion of an infected tick and not a tick bite.
† Ticks are not the sole arthropod vectors for these diseases

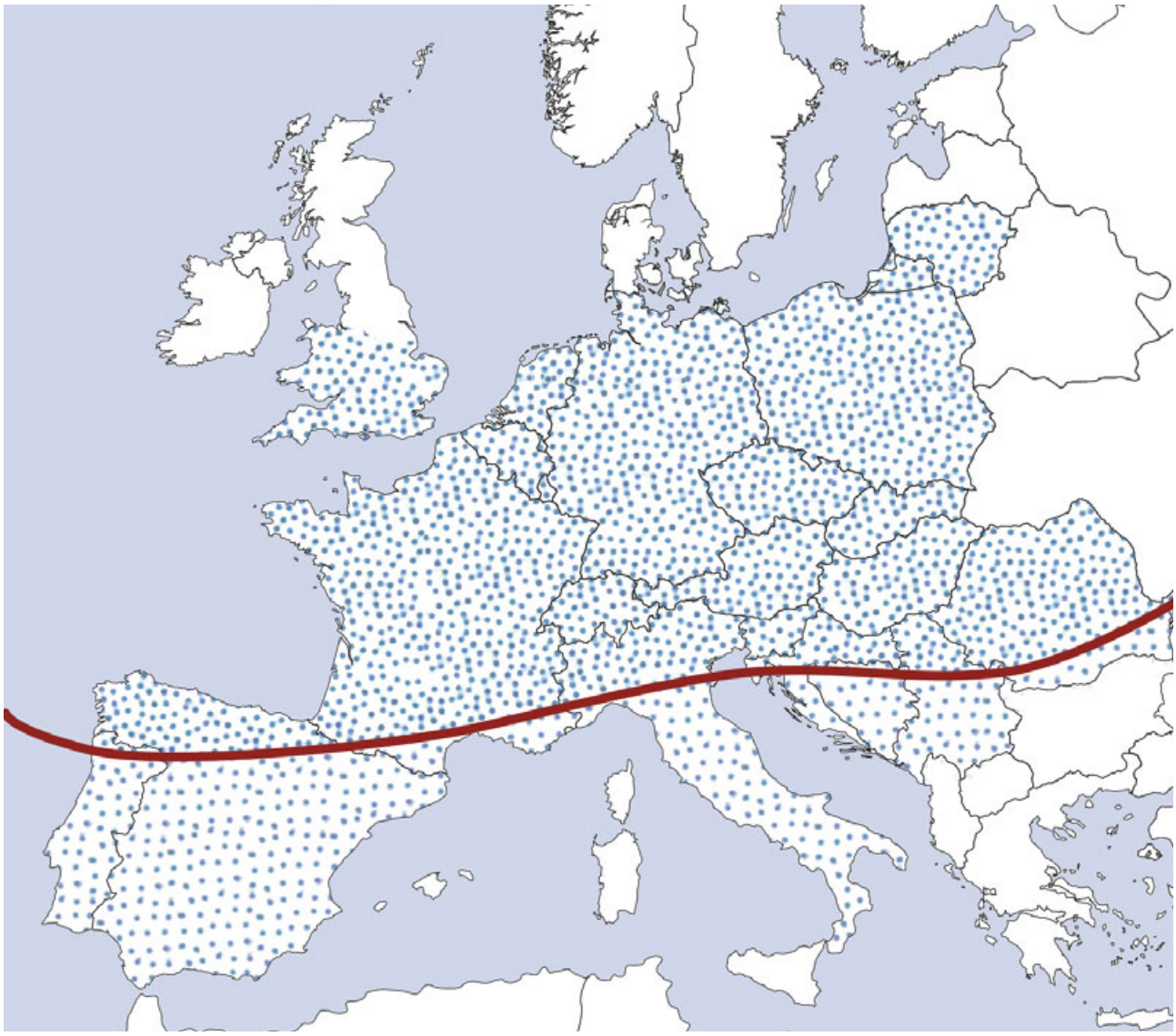
Table 4 contd.: Overview of tick-transmitted pathogens causing tick-borne diseases (TBDs) in Europe

Disease	Causative agents	Hosts	Vectors	Geographic distribution in Europe	Severity of clinical signs
DISEASES CAUSED BY BACTERIA					
Bartonellosis	*Bartonella henselae, Bartonella vinsoni, Bartonella* spp.	Many animals, dogs, cats, humans	Ticks suspected†	throughout Europe	commonly subclinical infection
Borreliosis (Lyme disease)	*Borrelia burgdorferi* complex (especially *B. garinii* and *B. afzelii* in Europe)	Many animals especially rodents, dogs, cats, humans	*Ixodes ricinus, I. hexagonus, I. persulcatus*	throughout Europe	mostly subclinical
Ehrlichiosis (monocytic)	*Ehrlichia canis*	Dogs (cats)	*Rhipicephalus sanguineus*	southern Europe following distribution of vector	moderate – severe
Neoehrlichiosis	*Candidatus Neoehrlichia mikurensis*	Rodents, humans, dogs	*Ixodes ricinus*	Europe	unknown
Anaplasmosis (granulocytic ehrlichiosis)	*Anaplasma phagocytophilum*	Many animals, dogs, cats, humans	*Ixodes ricinus, (I. trianguliceps)*	throughout Europe	mild and subclinical infections common
Anaplasmosis (infectious cyclic thrombocytopaenia)	*Anaplasma platys*	Dogs	*Rhipicephalus sanguineus*	southern Europe following distribution of vector	commonly asymptomatic
Rickettsial infections (Mediterranean spotted fever/MSF)	*Rickettsia conorii*	Dogs	*Rhipicephalus sanguineus*	southern Europe following distribution of vector	subclinical infection or moderate
Coxiellosis (Q Fever)	*Coxiella burnetti*	Ruminants, dogs, cats, humans	*Ixodes* spp.,† *Dermacentor* spp.	throughout Europe	subclinical infection
Tularaemia	*Francisella tularensis*	Lagomorphs , cats	*Ixodes* spp.,† *Dermacentor* spp., *Haemaphysalis* spp., *Rhipicephalus sanguineus*	southern Europe	subclinical infection occasionally moderate to severe in young cats
DISEASES CAUSED BY VIRUSES					
European tick-borne encephalitis	TBE virus (Flavivirus)	Many animals, rodents, dogs	*Ixodes ricinus, I. persulcatus*	central, eastern and northern Europe	can be moderate but not commonly reported
Louping ill	Louping-ill virus (Flavivirus)	Many animals, mainly sheep, dogs	*Ixodes ricinus*	UK, Ireland	can be moderate - severe but not commonly reported

* Not yet experimentally demonstrated.
** Transmission of *Hepatozoon* spp. is by ingestion of an infected tick and not a tick bite.
† Ticks are not the sole arthropod vectors for these diseases

Figure 2a: *Rhipicephalus sanguineus* is primarily a tick of southern Europe: below the red line indicates where it occurs most frequently

Figure 2b: *Dermacentor reticulatus* occurs in the blue dotted area with the highest frequency above the red line



2.1. Basic biology

Species
In Europe the ticks found on cats and dogs are mainly within the genera *Ixodes*, *Rhipicephalus* and *Dermacentor*, and less frequently *Haemaphysalis* and *Hyalomma* (Figures 2a, 2b, and Table 3). In northern Europe and the UK, most ticks found on cats and dogs are *Ixodes* spp., while *Hyalomma* ticks are currently only found in south-eastern Europe. Most species are able to feed on dogs or cats or on a range of other host species.

Life cycle
Figure 3 illustrates the life cycle of *Ixodes ricinus*. With the exception of *Hyalomma*, tick species found in Europe, like *I. ricinus*, are three-host ticks, i.e. each life cycle stage feeds once on a new host individual after actively seeking or 'questing' for their hosts by climbing, for example, on to the leaves of small plants such as blades of grass.

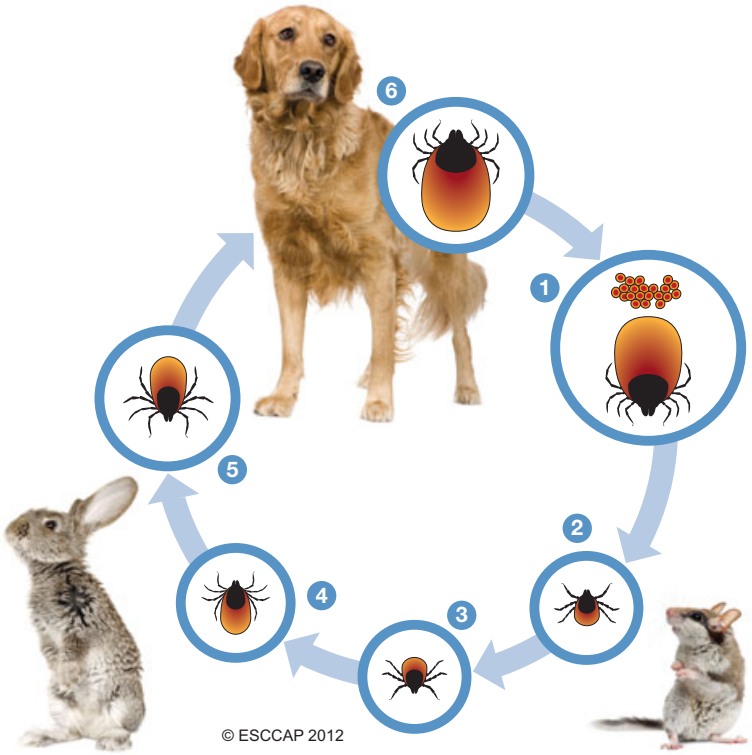
Epidemiology
Ticks are temporary blood feeding parasites which spend a variable time on their hosts; in the case of ixodid ticks, each stage feeds for only a short period of one to two weeks. Generally, ticks are of

most importance as vectors of bacteria, viruses, protozoa and nematodes affecting both companion animals and humans. Infections can be transmitted in saliva as the ticks feed or, more rarely, after the tick is ingested in the case of *Hepatozoon* spp..

The geographical distribution and density of ticks within an area is generally determined by climate/microclimate and host density. Change of climate or of the population density of hosts as well as redistribution of ticks or infested hosts by travel may influence the abundance and the geographical range of various ticks. Variations in wild animal populations may also influence the distribution of many tick species.

Generally, tick infestation is highly seasonal, for example in the UK and central Europe there are typically two peaks, one in March to June and a second in August to November. In more southern climates, tick species such as *R. sanguineus* and others are more prevalent during spring and summer but may feed all year round. In northern European countries *R. sanguineus* will not normally survive outdoors but may complete its life cycle inside kennels and houses. The current seasonality of ticks in central Europe may change due to variations in climate.

Figure 3: Life cycle of *Ixodes ricinus*



1 Female tick lays eggs in the environment and dies.

2 In the environment eggs hatch to six-legged larvae. The larvae feed quickly (2-3 days) on a suitable host.

3 Larvae return to the environment to moult to an eight-legged nymph.

4 Eight-legged nymphs feed for a short period (4-6 days) on a suitable host. Nymphs return to the environment and moult to become adults. Nymphs spend majority of time in the environment.

5 Eight-legged adult; majority of time is spent in the environment.

6 Females feed for a single blood meal of approximately 5-14 days on a large mammalian host, e.g. dog, domestic livestock or deer.

Ticks can be found all over the body but the main predilection sites are the non-hairy and thin-skinned areas such as the face, ears, axillae, interdigital, inguinal and perianal regions. Removal of blood, in heavy infestations and under certain circumstances, may lead to anaemia. The wound caused by a tick bite may become infected or a micro-abscess may develop as a reaction to the mouthparts if the tick is forcibly removed and the mouthparts remain embedded in the skin. Attached engorging female ticks, which can measure 1cm in length, are easy to see.

Clinical signs relating to the diseases transmitted by ticks may be seen, either whilst there is still evidence of tick infestation or subsequently. The main importance of ticks is their role as vectors of pathogenic agents which cause a range of tick-borne diseases (TBDs).

Some pathogens can be transmitted between different tick generations and/or life cycle stages, and some may thus be transmitted by every life cycle stage during feeding. Salivary fluid is the main route

for pathogen transmission. Tick-Borne Diseases are summarised in Table 4 and are considered in more detail in ESCCAP Guideline 5: Control of Vector-borne Diseases in Dogs and Cats.

2.3. Diagnosis

A diagnosis of infestation is usually made by identifying the ticks on the animal, although it is more difficult to detect small larval and nymphal stages than the males and the engorged adult females. There may be local skin reactions or small inflamed nodules (micro-abscesses) as a result of tick bites. If ticks are not noticed and pathogens have been transmitted, diagnosis may be more difficult as the clinical signs related to certain TBDs can be ill-defined. In this situation it is important to assess the possibility of a previous infestation by taking a thorough history. More diagnostic details for TBDs can be found in ESCCAP Guideline 5: Control of Vector-borne Diseases in Dogs and Cats.

2.4. Treatment of an existing infestation

Visible ticks should be removed as soon as possible after the ticks are seen to avoid the possible transmission of many of the TBDs (see ESCCAP Guideline 5: Control of Vector-borne Diseases in Dogs and Cats for individual minimum transmission times).

A large variety of purpose-designed tick removal tools are available; these may be used for removal of ticks attached to the skin (oil, alcohol or ether should not be used!).

Careful disposal of removed ticks is required, so that there is no opportunity for them to move to another host.

In addition, it may be advisable to apply an acaricide because not all of the ticks, especially the larval and nymphal stages and unengorged adults may be detected on the animal.

The possibility that other pathogens have already been transmitted must be considered. For more information see ESCCAP Guideline 5: Control of Vector-borne Diseases in Dogs and Cats.

Generally, after diagnosis of a tick infestation, tick prophylaxis should be instituted for the remaining tick season for the individual and all associated animals.

2.5. Prevention and ongoing control

Throughout Europe, substantial geographical and climatic differences are presently leading to differences in tick prevalence and seasonality.

Tick prophylaxis should cover the entire period during which ticks are active. Depending on the level of risk and local legislation, this may consist of regular checking of the pet for ticks and/or acaricidal treatment.

Dogs and cats that are travelling to regions with ticks and endemic TBDs should also receive a regular application of acaricidal products, particularly if these TBDs are not endemic in their home country.

To advise pet owners and achieve owner compliance, the duration of efficacy for an individual product should be established from the relevant product data sheet so that the owners can be advised of the correct retreatment intervals. It is advisable that animals are checked regularly, and in particular towards the end of the protection period to ensure that any visible ticks are removed and early repeat treatment considered if appropriate. It should also be remembered that the duration of efficacy may differ between tick species, again highlighting the importance of visual checking to verify that the treatment remains effective.

Steps to avoid tick infestation and reduce TBD risk:

Avoid or limit access to areas of known high tick density or at times of the year when ticks are known to be most active. Inspect animals for ticks daily and remove any ticks found. Use acaricides with a residual action and water resistance. Cats appear to be less affected by TBDs than dogs. Where ticks are a problem on cats then they should be controlled with a suitable acaricide. WARNING: highly concentrated synthetic pyrethroids or amidines (if registered for dogs only) are toxic for cats.

Table 5: Tick control - different scenarios

TICK CONTROL	
1) Minimal infestation risk (e.g. animals with restricted or no outdoor access)	Regular visual examination and, if ticks are found, manual removal. In the case where ticks have been found and removed, a follow up application of an acaricide may be advisable to ensure all ticks are killed.
2) Regular infestation risk (e.g. animals with regular outdoor access and undefined risk of reinfestation)	Regular treatments according to product label recommendations to achieve constant protection at least during the "tick season" in areas of Europe with clear cold winters. For warmer areas or where ticks may survive in houses or in shelters, e.g. *R. sanguineus*, treatments may be necessary throughout the year.
3) Ongoing reinfestation risk (e.g. shelters, breeders premises)	Regular treatments according to product label recommendations to achieve constant protection should be carried out throughout the year.
4) High risk of TBD transmission	In areas with a high prevalence of TBDs, pet animals are at risk of acquiring these diseases. Regular treatments according to product label recommendations to achieve constant protection should be carried out throughout the year. Acaricides with additional repellent activity have an immediate effect and prevent ticks from biting thus reducing the chance of acquiring TBDs. However it has also been demonstrated that other acaricides can be successful in the prevention of TBDs, especially those that are transmitted during the late stages in tick feeding.
5) Kennel or household infestation	Regular acaricidal treatment of pet animals coupled with environmental treatment using a compound from a different chemical group, can be used where an infestation with *R. sanguineus* or *I. canisuga* has established within a kennel or household environment.
6) Combined or risk of combined flea and tick infestation	Sustained tick control with integrated flea control is recommended. Generally, monthly application of registered acaricides with insecticidal activity on the dogs/cats is recommended together with daily vacuuming and mechanical cleaning of cages or beds and bedding. Also advised is an animal administered or environmental treatment for immature stages.

3. Sucking and Chewing Lice

Lice are dorso-ventrally flattened, wingless insects. They cause direct damage to the skin of affected animals and sucking lice can cause anaemia. The dog chewing louse, *Trichodectes canis*, can also act as an intermediate host for the tapeworm *Dipylidum caninum*.

3.1. Basic biology

The lice of importance on dogs and cats in Europe belong to the suborders Anoplura (sucking lice) and Ischnocera, which is a subgroup of the chewing lice which were formerly classified as Mallophaga.

Species
Lice are highly host-specific, with two main species on dogs, *Trichodectes canis* and *Linognathus setosus*, and only one species, *Felicola subrostratus*, on cats. Lice feed in one of two ways depending on the species: chewing lice feed on skin debris while sucking lice have piercing mouthparts and feed on blood. With the exception of *L. setosus*, which is a sucking louse with a typically elongated head, the other species found on dogs and cats are chewing lice with typical broad heads (Table 6).

Table 6: Sucking and chewing lice on dogs and cats in Europe

Suborder	Genus and species	Host	Occurrence
Anoplura	*Linognathus setosus*	dog	Rare all over Europe except in Scandinavia where it is more common
Ischnocera	*Trichodectes canis*	dog	Sporadic over most of Europe except Scandinavia where it is more common
	Felicola subrostratus	cat	All over Europe while rare, more common in stray cats

Life cycle
The entire life is spent on the host. Adult female chewing and sucking lice lay individual eggs, called nits, and cement these to hair shafts. The entire life cycle takes approximately 4-6 weeks.

Epidemiology
Chewing and sucking louse infestations occur sporadically in most of Europe. It is likely that the treatments used to control fleas which are commonly applied in Europe have served to also reduce the occurrence of louse infestations. The transmission of lice occurs by host to host contact which may be direct or from contact with shared materials such as bedding, hair brushes or combs.

3.2. Clinical signs

Heavy louse infestations are usually characterised by a poorly groomed coat and the presence of eggs or “nits” on the hair, or adult lice within the hair coat. Heavy infestation may cause eczema with crusts and alopecia. For *L. setosus,* which is a frequent blood feeder, skin lesions such as excoriation, miliary dermatitis or urticaria-like lesions and even necrotic skin lesions have been described. Louse infestations are generally highly irritating due to the wandering activities of the lice and infested animals can be restless, bad tempered and show excessive itching and rubbing.

3.3. Diagnosis

Louse infestation can be diagnosed by close inspection and detection of lice or their eggs (nits) within the hair coat.

3.4. Treatment of an existing infestation

Louse infestations can be treated with insecticides effective against lice. While there are a number of licensed products with efficacy claims against chewing lice, there are no European products with claims against the canine sucking louse *L. setosus.* However, it is likely that a product effective against chewing lice will also be effective against sucking lice.

3.5. Prevention and ongoing control

Bedding and grooming equipment should be washed and the environment and any other possible contact areas checked to prevent transmission to other animals.

4. Phlebotomes/Sand Flies

In Europe, only sand flies of the genus *Phlebotomus* are of veterinary importance and these are well described in the Mediterranean region. Little is known about the complex biology of the phlebotomes but they are extremely important as vectors of protozoan parasites of the genus *Leishmania. Leishmania infantum* is transmitted by sand flies and leishmaniosis is a serious disease of dogs, which are the main reservoir hosts for this parasite in Europe. *Leishmania infantum* can also affect humans and is thus a public health hazard especially for children and immunodeficient adults (see ESCCAP Guideline 5: Control of Vector-borne Diseases in Dogs and Cats).

Measures taken to prevent phlebotomine sand fly bites are recommended for endemic areas to reduce the risk of canine leishmaniosis. This includes measures to minimise the exposure of dogs to sand flies e.g. not taking pets to leishmaniosis-endemic areas or keeping animals indoors after dusk in endemic areas. Additionally, the use of insecticides with repellent activity against phlebotomes is recommended and regular application of these compounds throughout the sand fly season has been proven to significantly reduce the risk of dogs acquiring *L. infantum* infections. (For more information see ESCCAP Guideline 5: Control of Vector-borne Diseases in Dogs and Cats).

5. Mosquitoes (Culicidae)

There are more than 3,500 known species of mosquitoes worldwide and while they are mainly a nuisance for both animals and humans, they are of major significance as vectors of several important pathogenic organisms. (For more information see ESCCAP Guideline 5: Control of Vector-borne Diseases in Dogs and Cats).

6. Demodectic Mange Mites

6.1. Basic biology

Species
Canine demodicosis is mainly caused by one species, *Demodex canis*, commonly referred to as the follicle mite. Female mites are up to 0.3 mm long, males up to 0.25 mm.

Feline demodicosis is mainly caused by one species, *Demodex cati*. It is slightly longer and more slender than *D. canis*, whereas *D. gatoi*, is distinctly shorter and broader.

Table 7: Mites of dogs and cats of veterinary medical importance in Europe

Suborder	Dog	Cat
Prostigmata	*Demodex canis* *Demodex injai* *Demodex* spp. *(cornei)* *Cheyletiella yasguri* *Neotrombicula (Trombicula) autumnalis** *Straelensia cynotis**	*Demodex cati* *Demodex gatoi* *Demodex* spp. *Cheyletiella blakei* *Neotrombicula (Trombicula) autumnalis**
Mesostigmata	*Pneumonyssoides caninum*	
Astigmata	*Sarcoptes scabiei (var. canis)** *Otodectes cynotis**	*Notoedres cati* *Otodectes cynotis**

* These mite species are not host specific

Life Cycle
Demodex mites of dogs are considered to be physiological fauna of the skin and are found in small numbers on many dogs without any clinical signs. They spend their entire life in the lumen of hair follicles and, in heavy infestations, also invade the sebaceous glands. *Demodex* mites are unable to survive away from their hosts. Newborn puppies typically acquire mites from their mothers through direct contact within the first few days of life, but usually they show no clinical signs of infestation. Female mites lay eggs that develop into eight-legged, slender, cigar-shaped adults within approximately 3-4 weeks.

Feline demodicosis is a rare parasitic disease. The life cycle of *D. cati* is similar to *D. canis*. *D. gatoi* lives primarily in the stratum corneum.

Epidemiology
Canine demodicosis (demodectic mange) caused by *D. canis* is a common skin disease primarily of young dogs. Newborn puppies usually acquire mites from their mothers via direct skin contact during nursing, therefore the first sites of infestation and lesions are the upper lip, eyelids, nose, forehead and ears. Over time, mites may colonise the skin over most of the body. *Demodex* spp. are host-adapted mites and do not infest other animal (including human) species. Although transmission of mites may occur during direct contact between older animals, the disease is not considered to be contagious since most animals that develop demodicosis are thought to suffer from an underlying condition or a genetic defect that compromises their immune systems. The immunopathogenesis of the disease is not fully understood, and in most cases an underlying cause is not identified. However, long-term corticosteroid treatments, chemotherapy, and underlying cancer or endocrinopathic diseases have all been associated with the development of demodicosis in individual adult animals. Accordingly, dogs and cats should be carefully evaluated for potential underlying causes of the disease. Although no specific immune deficiencies have been identified in affected dogs, some studies suggest that cellular immunity may be compromised in some individuals that develop demodicosis.

6.2. Clinical signs

Dogs
Demodicosis generally occurs either as a localised or a generalised skin disease. Clinically, a less severe squamous demodicosis and more severe pustular demodicosis may be distinguished.

Pruritus is not usually a feature in uncomplicated cases, but is sometimes seen with secondary bacterial pyoderma.

Canine Localised Demodicosis (CLD) usually occurs with highest incidence in dogs less than 6 months old, but can also be seen in dogs aged up to 2 years as one or several small, circumscribed, partially hairless non-inflammatory patches, mainly on the face and the forelegs. However, it may also be seen in adult dogs. Very often eyelids and a narrow periorbital ring are affected causing a “spectacled” appearance of the lesions. Most cases of juvenile-onset localised demodicosis appear as squamous demodicosis and are characterized by patches of dry alopecia, scaling, erythema, folliculitis and thickening of the skin. In most cases this form is non-pruritic. CLD is not generally serious and often resolves spontaneously within 6 to 8 weeks without treatment. Relapses are rare because the host has usually regained full immunocompetence.

Canine Generalised Demodicosis (CGD) may occur as juvenile or adult-onset demodicosis.

Juvenile generalised demodicosis usually occurs in dogs from 2 months up to 18 months of age, although this age is not an absolute cut-off. Depending on the underlying condition, it may resolve spontaneously, but in most cases requires treatment, otherwise it may develop into a severe debilitating disease.

The adult-onset form of generalised demodicosis usually occurs in dogs older than 4 years of age and although it can be very severe, it is rare. It usually develops after a massive multiplication of mites and is often a consequence of concurrent debilitating conditions such as hyperadrenocorticism, hypothyroidism, neoplasia, other systemic infectious diseases, or prolonged immunosuppression, which reduce the immune defence mechanisms of the affected animal.

Although the hereditary nature of juvenile generalised demodicosis is not yet definitely proven, it is strongly recommended not to continue to breed from bitches which have had a litter of diseased puppies.

CGD may initially present as squamous demodicosis but frequently progresses to severe pustular demodicosis after secondary bacterial invasion of the lesions, which causes deep pyoderma, furunculosis and cellulitis. The skin becomes wrinkled and thickened with many small pustules which are filled with serum, pus or blood; this has resulted in the common name of “red mange” for this form of demodicosis. Affected dogs often have an offensive odour and this form very often develops into a severe, life-threatening disease that requires prolonged treatment. If present, any underlying condition needs to be addressed to maximise treatment success.

Cats
Demodicosis is a rare disease in cats. It usually occurs as a localised, squamous form with alopecia confined to the eyelids and the periocular region. Sometimes a generalised form will develop, especially if there is an underlying debilitating disease such as diabetes mellitus, FeLV or FIV.

Cats infested with *D. gatoi* are pruritic and may lick or groom affected areas excessively. *D. gatoi* dermatitis is not associated with underlying disease and mites may be transferred from cat to cat.

6.3. Diagnosis

Demodicosis is diagnosed by microscopic examination of deep skin scrapings from small affected areas of alopecia. The skin should be squeezed before or during scraping to promote extrusion of *Demodex* mites from the hair follicles. The skin or the scraping instrument can be wetted with mineral oil to facilitate collection of the sample. In long haired dogs, the area to be scraped is gently clipped to minimize the loss of scraped material into the surrounding hair coat. Skin scrapings to identify follicular *Demodex* species mites should be deep enough to result in capillary bleeding.

Alternatively, in uncooperative dogs, or in sensitive areas where scraping is difficult e.g., the feet, hairs may be plucked from an affected area and placed in mineral oil on a slide for microscopic examination. The area of skin selected should be similar in size to the area used for deep skin scrapings and as many hairs as possible should be plucked to maximise the diagnostic yield. Diagnosis depends on seeing the characteristic “cigar-shaped” mites or their eggs.

In cases with concurrent deep pyoderma, direct examination of the exudate from pustules, or fistulous draining tracts, may also reveal mites. Samples collected by squeezing the exudate onto a glass slide can be examined microscopically after adding mineral oil and a coverslip.

6.4. Control

Treatment

Dogs—Localised Demodicosis
Most cases of localised demodicosis resolve spontaneously within 6 to 8 weeks without treatment. Non-treatment of localised demodicosis allows identification of those patients with progressive disease. If treatment is desired, topical and/or systemic antibacterial therapy for the treatment of secondary bacterial infection may be initiated. There is currently no study-based evidence that the application of acaricides accelerates the healing process in localised demodicosis.

The use of any glucocorticoid-containing product, or any product acting via glucocorticoid receptors such as progestogens, is contraindicated and could encourage disease generalization. The animal's overall health should be evaluated with special consideration being given to conditions affecting the immune system such as poor husbandry, poor nutrition, and internal parasitism. Clinical examination with repeat skin scrapings every two to four weeks after initial diagnosis is indicated to monitor disease resolution or progression.

Dogs—Generalized Demodicosis
Generalized demodicosis may require extended, aggressive therapy to resolve the disease. Before initiating therapeutic measures, any factors affecting the animal's health status should be determined and any underlying diseases or conditions should be identified and treated accordingly. The prognosis and the possible need for costly and long term therapy need to be discussed with the owner.

Comprehensive treatment should include use of an effective acaricide, evaluation for any underlying disorders, with appropriate treatment when found, and antibiotic therapy when pyoderma is present. It is recommended that treatment must be continued for at least eight weeks after the first negative skin scraping. An animal can be regarded as completely cured of disease if no relapse occurs within 12 months after the end of the therapy. Relapses very often occur due to discontinued treatments.

Amitraz, a member of the formamidine family and the two macrocyclic lactones moxidectin and milbemycin oxime (in some countries) are currently registered for the treatment of demodicosis.

Amitraz as a 0.05% dip is applied topically every 5-7 days. To maximise skin contact for efficacy, clipping of the hair coat in long haired dogs is essential. The use of an antibacterial shampoo to remove crusts and bacteria before the first treatment is also recommended. Dipping should be done in a well-ventilated area and protective clothing should be worn according to the manufacturer's instructions. Side-effects may occur (for details see the product label). Dogs should be allowed to air-dry or should be dried with a blow dryer after each application. In between applications dogs should not get wet. Amitraz in combination with metaflumizone is registered in European countries as a monthly spot-on for the treatment of demodicosis.

Milbemycin oxime is registered in a number of European countries to treat demodicosis at one month intervals at a dosage of 0.5 to 1 mg/kg per os.

Moxidectin (2.5 mg/kg body weight) in combination with imidacloprid is registered as a monthly or weekly spot-on for the treatment of demodicosis.

An ectoparasiticide in the isoxazoline group, fluralaner has just been launched as a tablet for the treatment of ticks and fleas, but has also showed promise as a treatment for generalised demodicosis. It currently does not carry a license for this indication but both case reports and peer review studies indicate that a single dose has excellent efficacy against the parasite, both eliminating detectable infection and resolving clinical signs.

Cats
The localised form of demodicosis in cats resolves spontaneously in most cases, whereas generalised demodicosis requires treatment. There is no registered product for use in cases of demodicosis in cats. Lime sulphur dips have been reported to be effective. Dips should be performed weekly for 4 to 6 weeks with a 2% solution. As in canine demodicosis, feline demodicosis is often linked to other underlying diseases that should be treated as appropriate. Amitraz is registered for dogs only and should not be used in cats due to the risk of toxicity.

7. Sarcoptic Mange Mites

7.1. Basic biology

The genus *Sarcoptes* contains a single species, *Sarcoptes scabiei*, which causes sarcoptic mange in a wide range of mammalian hosts. However, strains have developed which are largely host-specific with the possibility to temporarily infest other mammals, which explains the zoonotic transmission from dogs to their owners. The condition is well recognised in both human and veterinary medicine and the human disease is generally referred to as scabies.

Species

Sarcoptes scabiei (var. canis) is the canine sarcoptic mange mite.

Life Cycle

The adult mites feed superficially on the skin forming small burrows and feeding pockets. After mating, the female mite burrows more deeply in the upper layers of the epidermis feeding on the fluid and debris resulting from tissue damage. In the tunnels and side-tunnels thus created it lays eggs for a period of several months. The development from egg to adult stage takes 2-3 weeks.

Epidemiology

Transmission to new hosts from infested individuals is by direct or indirect contact, most likely by transfer of larvae from the skin surface. *Sarcoptes scabiei* var. *canis* can be highly prevalent in the fox population. Especially in urban areas in the UK or central Europe, transmission of mites from the fox population to the dog population has been observed. It is known that *S. scabiei* can survive for a few weeks off their hosts, so contaminated bedding or grooming equipment could be a source of infestation. Infestation by host-adapted strains of *S. scabiei* between different host species usually results in a temporary infestation. Clinical disease in humans after contact with affected dogs is very common.

7.2. Clinical signs

The ears, muzzle, elbows and hocks are predilection sites for *S. scabiei* but in severe infestations, lesions may extend over the entire body. Initial lesions are visible as erythema with papules, which are then followed by crust formation and alopecia. Intense pruritus is characteristic of sarcoptic mange and this can lead to self-inflicted traumatic lesions. Dogs may begin to scratch before lesions become obvious and it has been suggested that the degree of pruritus may be exacerbated by the development of hypersensitivity to mite allergens. Without treatment the disease progresses and lesions spread across the whole skin surface; dogs may become increasingly weak and emaciated.

7.3. Diagnosis

Intense itching which accompanies the disease is the most useful clinical diagnostic feature of canine sarcoptic mange. The ear edge is the most commonly affected site and when rubbed this elicits a scratch reflex in 90% of dogs.

Clinical diagnosis should be confirmed by examination of several, rigorous, superficial skin scrapings for the characteristic mites, although the sensitivity of skin scrapings can be as low as 20%. The diagnostic yield is greatly increased if mineral oil is applied directly to large areas of affected skin before being scraped off and examined microscopically. Commercially available ELISAs (enzyme-linked immunosorbent assays) have helped to improve diagnosis considerably. Although sensitivity and specificity of serological tests may reach 90%, it must be emphasised that antibodies are not detectable until at least 5 weeks after infestation and that serological results have always to be interpreted in relation to clinical signs and other diagnostic results. The quality of different ELISA tests, especially in terms of specificity, is variable, and cross-reactions with dust mites could occur.

7.4. Control

Because of the protected predilection site of the parasites in the skin, its life cycle and the requirement to kill all of the mites to prevent the recurrence of disease, systemic treatments are necessary and most have proved to be effective. Registered treatments include selamectin and moxidectin in combination with imidacloprid, both as a single treatment repeated after four weeks, and milbemycin oxime which is registered for the treatment of sarcoptic mange in all European countries and available for this indication in France, Italy, Spain, Portugal, Greece, Denmark, Sweden, Finland and Norway. Some authors recommend increasing the frequency of application of certain products. Amitraz wash (0.05%), (not approved for this indication in all countries) should be repeated at weekly intervals until skin scrapes are negative for mites, or until three weeks after clinical signs have disappeared. Specific treatments should be preceded or accompanied by suitable washes to soften and remove crusts. Unfortunately the availability of effective acaricidal compounds for use in small animals is limited in many European countries. In severely affected animals pruritus and self-inflicted trauma may be reduced by the short term administration of corticosteroids (3-4 days) in association with acaricidal therapy.

Sarcoptic mange is highly contagious and affected dogs should be isolated from other animals while undergoing treatment. In multi-dog households and kennels it is advisable to treat all in-contact animals.

Note: Although sarcoptic mange is rare in cats, there have been a few confirmed cases. The clinical signs in such cases are reported to be similar to those of notoedric mange.

8. Notoedric Mange Mites

8.1. Basic biology

Notoedres cati closely resembles *Sarcoptes* both in behaviour and morphology. Infestation in cats is not readily transferable to other animals but cases have been recorded in dogs, rabbits, hamsters, wild cats and canids. Cat notoedric mange is not considered to be zoonotic (see also 8.3).

Life Cycle
The life cycle is similar to that of *S. scabiei*. Unlike *S. scabiei*, mites tend to aggregate in small groups forming small nests. The time taken for development from egg to adult stage is 1-3 weeks.

Epidemiology
Notoedric mange is highly contagious and tends to occur in local outbreaks. Transmission is by close direct or indirect contact, probably by the transfer of larvae or nymphs between hosts. The disease can spread rapidly in groups of cats or kittens.

8.2. Clinical signs

Early signs of infestation are local areas of hair loss and erythema on the edges of the ears and the face. This is followed by greyish-yellow, dry crusting and skin scaling, which progresses to hyperkeratosis with thickening and wrinkling of the skin in severe cases. These clinical signs are accompanied by intense pruritus and scratching, which often results in skin excoriations and secondary bacterial infection. Lesions may spread from the head and neck to other parts of the body when grooming or through simple contact. Untreated animals may become severely debilitated and die.

8.3. Diagnosis

Intensely pruritic lesions round the head and ears are characteristic. The small round mites with their characteristic concentric “thumb print” dorsal striations are relatively easy to demonstrate microscopically in skin scrapings. Occasionally humans in contact with affected animals may show a mild dermatitis due to a transient infestation.

8.4. Control

There are currently no licensed treatments, but systemic use of macrocyclic lactones has been used successfully and should be applied as described for sarcoptic mange. Before application of an appropriate acaricide, animals should be washed with an anti-seborrhoeic preparation to soften and remove skin crusts. Treatment should be repeated until there is a marked clinical improvement and for a minimum of at least 4 weeks. It is important to treat all in-contact animals and replace any contaminated bedding.

9. Otodectic Mange Mites

Ear mites, *Otodectes cynotis*, are a cause of aural irritation and discomfort in dogs, cats and ferrets. Infestation may affect one or both ears. Infrequently the mites may cause dermatitis across the body of the animal.

9.1. Basic biology

The entire life cycle is spent on the host, with transfer from animal to animal probably occurring through close contact. Eggs develop into adults within approximately three weeks.

9.2. Clinical signs

Ear mites can occur in any age group of cats or dogs, but are more common in puppies and kittens and more frequent in cats than dogs. *Otodectes cynotis* are surface dwellers and may be seen as small, motile, white spots in the external ear canal; infestation is typically accompanied by a brown, waxy discharge. Whilst ear mites may be tolerated without clinical signs in some animals, especially cats, there may be a history of pruritus with ear scratching or rubbing and self-inflicted trauma. The pinna and ear canal may be erythematous.

9.3. Diagnosis

Diagnosis may be reached by seeing the characteristic brown ear wax and mites in the external ear canal using an otoscope. Where necessary, samples of wax and debris can be collected from the affected ear canal using a cotton swab or similar. The ear canal may be inflamed and as examination and sample collection may be painful, care should be taken to have the animal suitably restrained. The cotton swab should be rolled onto a microscope slide and examined directly under low magnification. Alternatively, a drop of water, alcohol or liquid paraffin can be added to help to break up the debris. A coverslip can then be applied and the slide examined microscopically at x40 magnification.

9.4. Control

Ear mites may be treated with local administration of ear drops with acaricidal activity or with a systemic spot-on product containing selamectin or moxidectin in combination with imidacloprid. Depending on the treatment chosen, application may have to be repeated at intervals to eliminate the infestation. In multi-animal households and kennels it is advisable to treat all in-contact animals.

10. Fur Mites

Cheyletiella spp. mites can infest dogs, cats and rabbits. Whilst infestation may be well tolerated by some individuals, in others it can cause irritation and discomfort. The mites will also feed on humans, causing a localised dermatitis.

10.1. Basic biology

Species

Dog: *Cheyletiella yasguri*

Cat: *Cheyletiella blakei*

Life Cycle
The entire development takes approximately three weeks on the host, although female mites can survive for up to ten days in the environment. Transfer from host to host occurs readily and rapidly between animals in close contact. Cheyletiellosis is common in kennels and young and weak animals seem to be more susceptible.

10.2. Clinical signs

Dogs and cats are infested with distinct species: *Cheyletiella yasguri* infesting dogs and *Cheyletiella blakei* infesting cats. However, these species may not be strictly host-specific. The mites may be well tolerated in some animals with excessive scaling being the only clinical sign, while in other animals pruritus in variable degrees may be present. The large, 0.5 mm mites may be seen as white spots moving amongst the skin scales. Affected areas may show erythematous and crusting lesions which may appear as miliary dermatitis in cats. Humans may also be infested.

10.3. Diagnosis

For microscopic examination, brush or comb the animal's coat and collect the debris in a petri dish. Alternatively, apply a transparent adhesive tape strip to the affected area and then apply the strip to a microscope slide. It is also possible to lightly trim the coat, carry out a superficial skin scrape and collect the debris in a suitable container. The debris may be examined using a stereo microscope and mites may be seen walking amongst the debris. *Cheyletiella* spp. eggs may be seen attached to hairs. Since infected dogs or cats may groom excessively, eggs that have passed through the intestinal tract are sometimes detected on faecal examination.

10.4. Control

Infected animals can be treated with a suitable topical acaricide, but there is a general lack of licensed preparations. Studies have shown that topical applications of selamectin, moxidectin or fipronil and systemic administration of milbemycin oxime are highly effective against *Cheyletiella*. Depending on the duration of activity of any compound, treatment may need to be repeated to eliminate the infestation. Treatment of in-contact animals, particularly of the same species, is recommended, even if they are showing no signs of infestation. Cleaning of the environment, including washing bedding and vacuum cleaning, helps to eliminate any mites in the environment.

Public Health Considerations
Owners may be transiently infested and develop a skin rash after contact with infested animals.

11. Harvest Mites (Chigger Mites)

Harvest mites are responsible for the condition known as trombiculosis. The two species that cause trombiculosis in dogs and cats are: *Neotrombicula* (syn. *Trombicula*) *autumnalis* and *Straelensia cynotis.*

Neotrombicula (Trombicula) autumnalis

11.1. Basic biology

The adult mites lay their eggs in decomposing vegetable matter and in a few days the eggs hatch into larvae; these are of a characteristic orange colour and about 0.2-0.3 mm in length. Only the larvae are parasitic. In temperate climates, larvae become active in dry, sunny conditions at temperatures exceeding +16°C. This often occurs between July and October; thus the term “harvest mite”. The larvae climb onto the vegetation where they wait for passing hosts. There is no transfer from animal to animal and after attaching themselves to their hosts they feed for several (5-7) days on enzymatically liquefied tissue, epithelial secretions or blood. Thereafter, they detach and continue their development as free-living stages on the ground. To complete the life cycle may take 50-70 days or more.
Harvest mites are resistant to adverse climatic conditions and female mites can live for more than 1 year. In areas with a temperate climate there is usually one generation per year, but in warmer areas they may complete more than one cycle per year.

11.2. Clinical signs

Cutaneous lesions are usually found in ground-skin contact areas like the head, ears, legs, feet, and ventral areas. The lesions are highly pruritic. Macroscopically they are very peculiar due to the bright orange colour of the larval mites. Severe hypersensitivity reactions have been observed in case of repeated infestation.

11.3. Diagnosis

Gross observation of the lesions, together with the time of year and the history of affected dogs and cats having been in the countryside, are often sufficient for a diagnosis. The larval mites can also be seen fairly easily without magnification.

11.4. Control

Control of trombiculosis is difficult due to the fact that reinfestations are frequent in animals exposed to these mites.

Fipronil (in both dogs and cats) and synthetic pyrethroids (exclusively in dogs) can be successfully used to kill the mites.

Topical spray treatments may be repeated every 3-5 days in order to prevent reinfestation. Frequent spraying of the commonly affected areas such as paws and ventral abdomen may be more effective than less frequently applied spot-on preparations.

Straelensia cynotis

The biology of this mite is still unknown, although it is thought to be similar to other Trombiculidae, but there are some important differences. For example, the period of feeding on the host is much longer than in *Neotrombicula* with an average of 3 months in cases so far described.

This trombiculid mite causes straelensiosis, an emerging disease reported in the last decade from southern France, northern Spain and Portugal. This is also a mite infestation characterised by a marked seasonality, with cases appearing mostly between September and November. As this period coincides with the hunting season, straelensiosis often occurs in hunting dogs, or in dogs that have contact with woodlands and foxes’ dens, which may be a natural habitat for *S. cynotis*. Small wild mammals have also been considered potential hosts for this trombiculid mite.

Cutaneous lesions affecting dorsal areas of the body including the head are common in all reported

clinical cases; these include maculae that may progress to erythematous, alopecic nodules and papules. In contrast to neotrombiculosis, the degree of pruritus varies from case to case; straelensiosis appears to be primarily non-pruritic, with pruritus only appearing when there is a secondary infection. Typically the infestation is very painful.

Diagnosis is through observation of the typical six-legged larvae, usually present in dilated hair follicles of biopsies from affected skin.

Treatment based on a combination of systemic macrocyclic lactones and antibiotics may result in complete cure and prevent possible secondary infestations. The conventional topical acaricidal treatments for mites have not produced satisfactory results. Total remission occurs in almost all reported cases within 6-12 months. More studies are needed to provide further knowledge on this recently described parasitic infestation.

12. Canine Nasal Mites

Pneumonyssoides (Pneumonyssus) caninum

12.1. Basic biology

The life cycle of this infrequently occurring parasite is still not completely known. It is assumed that these mites are permanent parasites of the nasal cavities and paranasal sinuses, especially the ethmoid. The adults are visible macroscopically and the females reach a length of 1-1.5 mm and a width of 0.6-0.9 mm.

The most likely mode of transmission is by direct contact between dogs, considering the active movements of the larvae which can be detected in the nostrils of affected animals. Indirect transmission in cages and kennels and by fomites such as bedding cannot be ruled out since these parasites can survive for up to 20 days away from the host.

12.2. Clinical signs

The clinical signs described vary depending on the parasite burden, from an absence of any signs to severe cases of nasal discharge, sneezing, fatigue, and head-shaking. In very severe cases purulent rhinitis and sinusitis may occur.

12.3. Diagnosis

The inaccessible localisation makes *in vivo* diagnosis difficult and except in rare cases the presence of nasal mites is detected post-mortem.

Nasal discharge, collected using a catheter for retrograde nasal flushing, can be examined under a microscope, although this is considered of limited diagnostic value.

Observing the mites in their predilection sites using nasal endoscopy is feasible.

12.4. Control

Different ectoparasiticides have been tested in the treatment of this parasitosis with variable results. Although only milbemycin oxime is registered for the treatment of canine nasal mites in Italy and Norway, macrocyclic lactones such as selamectin, moxidectin and milbemycin appear to be the most effective. Three treatments at an interval of 7 to 14 days are recommended.

IMPACT OF PET HEALTH AND LIFESTYLE FACTORS

Some ectoparasite infestations, notably scabies and demodicosis, can be associated with poor nutrition, concomitant immunosuppression or ill-health.
The seasonal harvest mite infestations are typically acquired in late summer, often in well-defined geographical locations. Scabies infestation in foxes may be a source of scabies for dogs.

RESISTANCE

Although reduced efficacies have been described for insecticides and acaricides in livestock, in Europe to date there have been no proven cases of treatment failure caused by resistant tick, mite or insect populations., Where resistance is suspected, it is important to carry out a systematic investigation to rule out non-compliance and high environmental challenge. Initial checks to confirm that the appropriate amount of the correct product was applied as directed should be carried out.

Some mite infestations or diseases, for example demodicosis, can be refractory to treatment. Suspicion of acaricidal resistance of e.g. *Cheyletiella* spp. against ivermectin, has been reported from clinicians in the US, however definitive studies on resistance of canine and feline mites against acaricides are lacking.

Research and development of guidance to prevent or delay resistance in parasitic arthropods of veterinary importance is urgently needed. Particular attention should be paid in places where flea or tick products are used all year round and where parasite pressure is high, e.g. Mediterranean regions. The level of efficacy should be monitored at intervals and thought given to integrated control strategies using, for example, combined management and treatment strategies.

ENVIRONMENTAL CONTROL OF ECTOPARASITES

Environmental treatment including washing bedding and vacuum cleaning is important to eliminate possible sources of reinfestation.

It may be possible to avoid infestation with trombiculids by avoiding infested areas whilst larval mites are active.

OWNER CONSIDERATIONS IN PREVENTING ZOONOTIC DISEASES

Generally important preventive measures for pet owners in terms of ectoparasites include:

- reducing wherever possible the risk of a pet acquiring infestation
- controlling pet ectoparasite infestations through regular diagnostic testing and/or repeated application of appropriate ectoparasiticides, particularly for ticks and parasitic insects
- minimizing exposure, especially of children, to potentially contaminated environments
- practising good personal hygiene

People at risk of exposure to zoonotic parasites or any other zoonotic pathogen should be advised

of the health risks and made aware that such risks are generally increased during pregnancy, or when there is an existing illness or immunosuppression.

Specifically owners should be warned about the potential zoonotic risk of canine sarcoptic mange and cheyletiellosis. Harvest mites may also infest humans.

Other mites do not pose a zoonotic risk. Care should be taken in areas where tick borne diseases occur.

STAFF, PET OWNER AND COMMUNITY EDUCATION

Protocols for the control of parasitic infestation should be communicated by the veterinarian to veterinary clinic staff and to pet owners. Awareness of the potential risk of ectoparasite infestations and any zoonotic implications should be promoted to the medical profession, especially paediatricians, through information brochures. Cooperation between the medical and veterinary professions should be encouraged and its benefits underlined especially in the case of potential zoonoses.

Pet owners should be informed about the potential health risks of parasitic infestation, not only to their pets, but also to family members and all people living within the vicinity of their pets.

Additional information and resource materials can be obtained at www.esccap.org.

APPENDIX 1: Glossary

Acaricide (acaricidal compound)	Acaricides are compounds that act against ectoparasites belonging to the Class Arachnida, sub-class Acari by zoological nomenclature. In this guideline ticks and mites are acarids.
Application	Like treatment, but describing the various forms of veterinary medicinal products which can be given (applied) to animals, such as sprays, spot-ons, pour-ons, oral products, injectables etc.
Control	General term comprising 'therapy' (treatment) and 'prevention' (prophylaxis).
Ectoparasiticide	Compound developed for the animal administered use as a therapeutic agent to eliminate any existing ectoparasite infestation and prevent reinfestation.
IGR (Insect Growth Regulator)	Compound that may kill and/or inhibit the development of immature stages of insects.
Insecticide (insecticidal compound)	Insecticides are compounds that act against ectoparasites belonging to the Class Insecta by zoological nomenclature. In this guideline fleas, mosquitoes, sand flies and chewing and sucking lice are insects.
Integrated control	The use of several measures to control different parasites or parasite stages present on the animal and stages present in the environment.
Pesticide	Compound developed for the elimination of different stages of parasites in the environment.
Prevention	Measures taken prior to any infestation of the pet animal with ectoparasites, to prevent the establishment of an infestation. Prevention for an extended period may be achieved by the use of a product with persistent activity for certain periods of time following application.
Repellent	Compound, which makes a host unattractive to a parasite and thus can prevent attack or establishment.
Therapy	Any medical intervention to cure a disease; this includes the use of veterinary medicinal products (treatment), to eliminate an existing parasite infestation.
Treatment	Application of veterinary medicinal products (medication) as deemed necessary based on any given diagnosis.

Appendix 2: Background

ESCCAP (European Scientific Counsel Companion Animal Parasites) is an independent, not-for-profit organisation that develops guidelines and promotes good practice for the control and treatment of parasites in companion animals. With the proper advice the risk of diseases and parasitic transmission between animals and humans can be minimised. ESCCAP aspires to see a Europe where companion animal parasites no longer threaten the health and wellbeing of animals and humans.

There is a great diversity in the range of parasites and their relative importance across Europe and the ESCCAP guidelines summarise and highlight important differences which exist in different parts of Europe and, where necessary, specific control measures are recommended.

ESCCAP believes that:

- ***Veterinarians and pet owners must take measures to protect their pets from parasitic infestations***
- ***Veterinarians and pet owners must take measures to protect the pet population from risks associated with travel and its consequent potential to change local parasite epidemiological situations through the export or import of non-endemic parasite species***
- ***Veterinarians, pet owners and physicians should work together to reduce the risks associated with zoonotic transmission of parasitic diseases***
- ***Veterinarians should be able to give guidance to pet owners regarding risks of parasite infestation and diseases and measures which can be taken to minimise these risks***
- ***Veterinarians should attempt to educate pet owners about parasites to enable them to act responsibly not only for their own pet's health but for the health of other pet animals and people in their communities***
- ***Veterinarians should wherever appropriate undertake diagnostic tests to establish parasite infestation status in order to provide the best possible advice***

To achieve these objectives, ESCCAP produces:

- ***Detailed guidelines for veterinary surgeons and veterinary parasitologists***
- ***Translations, extracts, adaptations and summarised versions of guidelines which address the varied requirements of European countries and regions***

Versions of each guideline can be found at www.esccap.org.

Disclaimer:
Every effort has been taken to ensure that the information in the guideline, which is based on the authors' experience, is accurate. However the authors and publishers take no responsibility for any consequence arising from the misinterpretation of the information herein nor is any condition or warranty implied. ESCCAP emphasises that national, regional and local regulations must be borne in mind at all times before following ESCCAP advice. All dose-rates and indications are provided for guidance. However, vets should consult individual data sheets for details of locally approved treatment regimens.

ESCCAP

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