ESCCAP

EUROPEAN SCIENTIFIC COUNSEL COMPANION ANIMAL PARASITES

Ectoparasites Part 1: Control of Parasitic Insects and Ticks in Dogs and Cats

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Control of Parasitic Insects and Ticks 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 (sandflies) (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

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

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 for UK have led to easy travel between the various countries within continental Europe and, except for 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. 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 important groups of ectoparasites namely fleas, ticks, lice, phlebotomes (sandflies) and mosquitoes. Lice taxonomically consist of two different groups, the sucking lice and the chewing lice.

A separate ectoparasite guideline is in preparation which will deal with important mite infestations of dogs and cats

There is a separate guideline produced by ESCCAP on vector-borne diseases of companion animals (ESCCAP Guideline: Vector-borne diseases).

For more information on endoparasite control see ESCCAP Guideline 1: Endoparasites

For more information about dermatophytic fungi see ESCCAP Guideline 2: Ringworm

I. Biology, Epidemiology, Clinical Signs and Diagnosis

I.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 are common throughout Europe and can cause pruritus, particularly in sensitised individuals, and anaemia in heavily infested animals.

Fleas can act as vectors for a number of pathogens. For *Ctenocephalides felis*, the cat flea, these include *Rickettsia felis* and *Bartonella henselae*, the causative bacteria of cat scratch disease. Both *C. felis* and *C. canis* are intermediate hosts for the tapeworm *Dipylidium caninum*.

Fleas can bite humans and provoke pruritic and cutaneous lesions.

I.1.a. Basic biology

Species

In Europe the most common flea species found on dogs, cats and on other small mammalian companion animals are *C. 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), *Pulex irritans* (human flea) and others.

Life Cycle

The life cycle of fleas is depicted in Figure 1 with *C. felis* as an example.

Survival and development of immature flea stages in the environment are highly dependent on environmental conditions; greater than 50% relative humidity is required for the larval development stage, as this is the stage most susceptible to desiccation. 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 fall, they can multiply outdoors in suitable locations, which may explain some of the increased prevalence during warm seasons.

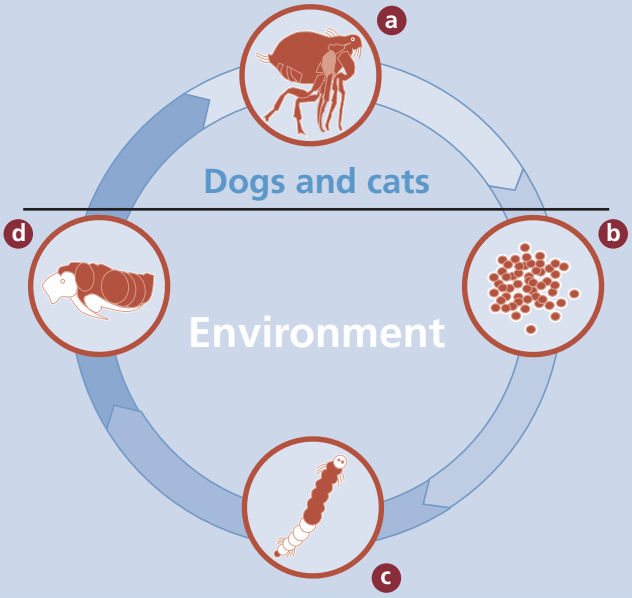
Table 2 shows the effect of environmental conditions on flea development and survival.

Figure 1: Life cycle of *Ctenocephalides felis*

a) Fleas are 1-6 mm 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.

b) 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 (in 48 hours following infestation) once laid, the pearly white eggs (0.5 mm in length) fall off into the environment. After a few days under ideal conditions the larvae hatch.

c) 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.



d) 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 of appropriate stimuli such as CO_2, pressure and increased temperature.

Epidemiology

C. 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.

Development and survival of stages off the host is dependent on environmental conditions (Table 2). Speed of development accelerates in warm weather, thus outdoor development tends to be highly seasonal. Outdoor environments that will support flea development are moist but not wet and are not exposed to strong direct sunlight. Development is often non-seasonal indoors, because central heating and relative humidity greater than 50% can ensure a suitable environment all year round.

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, including insecticidal treatments of premises or animal bedding; thus it can survive for prolonged periods of time (> 6 months). This phase, known as the pre-emerged adult stage or pupal window, is a crucial part of flea epidemiology. 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; these include vibration or pressure (for example, the host walking over an infested area) and heat (as produced by the host's body). When a suitable host approaches, the flea can emerge from the cocoon rapidly.

Infestation with fleas other than *C. felis* or *C. canis* normally indicates close contact with another host environment. For example, hedgehog fleas (*A. erinacei*) may occasionally be observed on a dog or cat after contact with hedgehogs or their resting places.

I.1.b. Clinical signs

Flea infestation in dogs and cats as well as other small mammals is highly variable; host animals may carry low numbers of fleas or may have massive infestations. 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.

Clinical signs in individual companion animals are extremely variable and a detailed listing is beyond the scope of this guideline. Instead, specific dermatological and immunological textbooks and references should be consulted.

I.1.c. Diagnosis

A detailed history may assist in the diagnosis of flea infestation. 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, particularly if the coat is white and the skin pale. Fleas are brown, laterally flattened wingless insects that are readily visible to the naked eye. Combing the animal is the most sensitive method to detect flea infestation whereas searching with fingers may be unsuccessful.

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 adult fleas on animals with clinical signs of flea allergy dermatitis (FAD) because the constant grooming effectively removes the evidence of 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).

I.2. Ticks

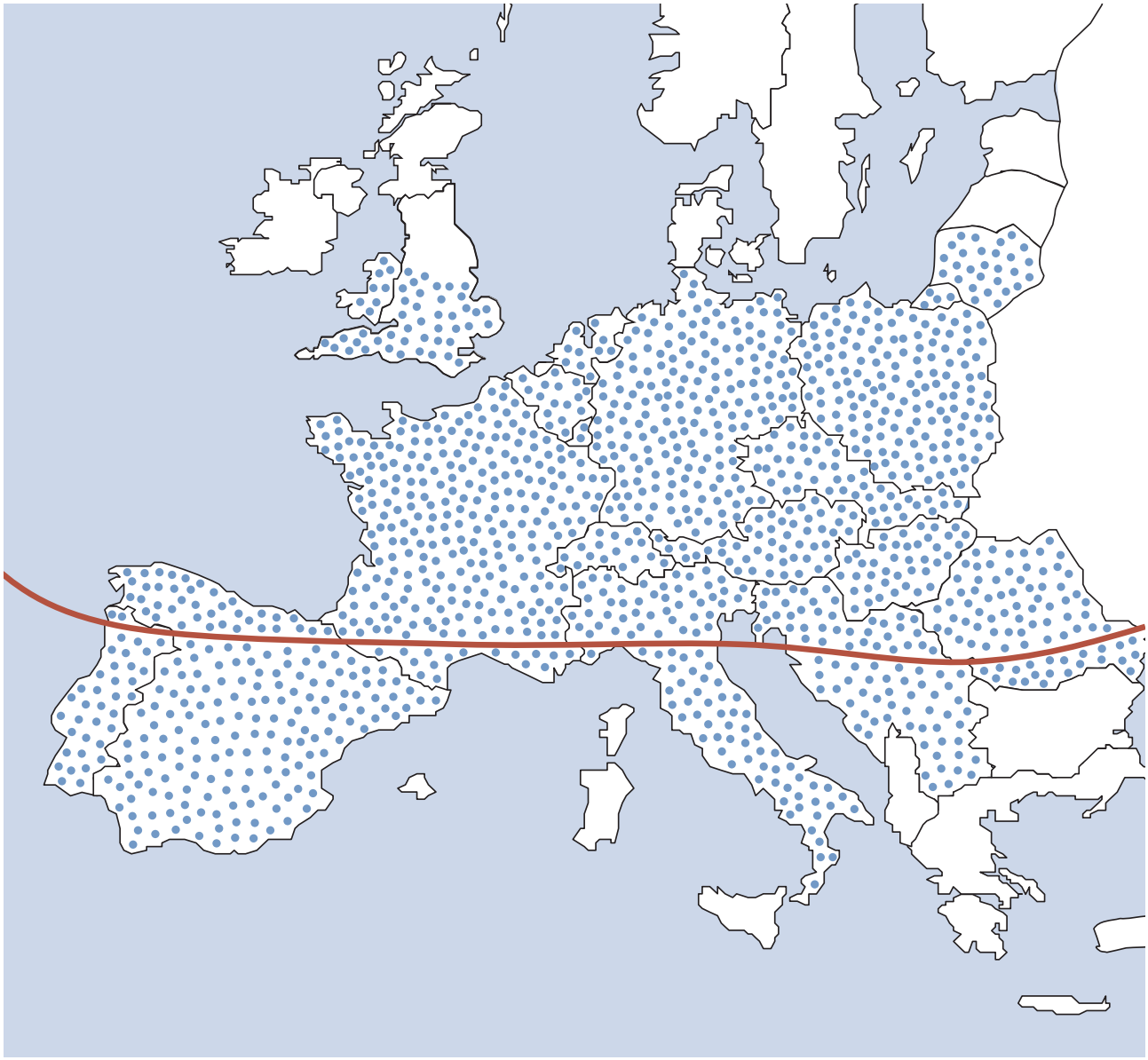
Ticks belong to one of two families: the Ixodidae, or hard ticks, and the Argasidae, or soft ticks. Ticks, like other Acari, have small "heads" or capituli. Ticks on dogs and cats are hard ticks. Female hard ticks increase their weight up to 120 times as they engorge with blood prior to egg laying; when fully engorged a female tick can measure around one centimetre in length and appears like a small bean, Dermacentor may be larger.

Ticks are endemic throughout almost all of Europe, and there are more than 12 different species (Table 3), 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. Tick importance as pathogen vectors varies according to species and in some cases, to geographical location (Table 4).

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..

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



I.2.a. Basic biology

Species

In Europe the ticks found on cats and dogs are members of the Ixodidae and include species within the main genera *Ixodes, Rhipicephalus* and *Dermacentor*, and secondarily *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., *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. Two species, *Ixodes canisuga* and *Rhipicephalus sanguineus* which are found on dogs, are much more host-specific.

Life cycle

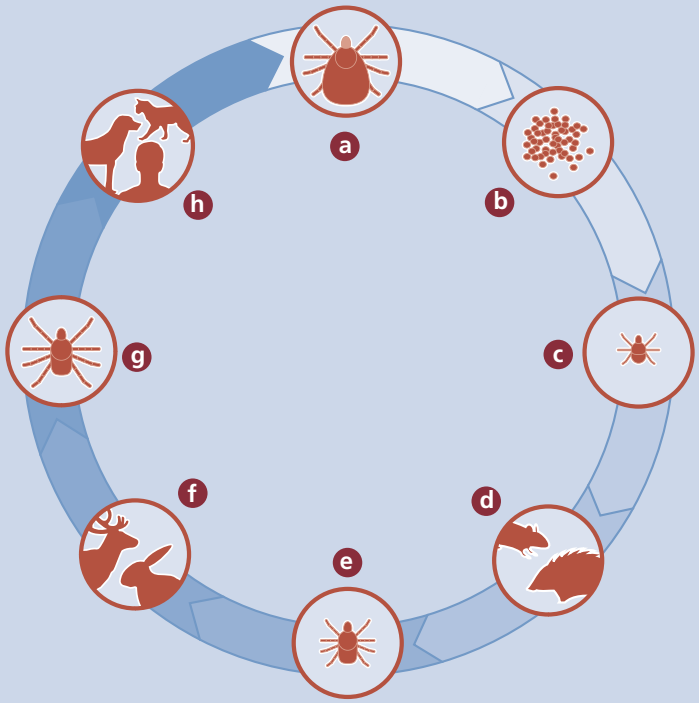
Figure 3 illustrates the life cycle of *Ixodes ricinus*. Tick species found in Europe, like *I. ricinus*, are three-host ticks, i.e. each life cycle stage feeds once on a new host individual after actively seeking or 'questing' for their hosts by climbing, for example, on to the leaves of small plants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

Epidemiology

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.

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*



a) Female tick lays eggs in the environment and dies.
b) + c) In the environment eggs hatch to six-legged larvae.
d) The larvae feed quickly (2-3 days) on a suitable host.
e) Larvae returning to the environment to moult to an eight-legged nymph.
f) 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.
g) Eight-legged adult; majority of time is spent in the environment.
h) Females feed for a single blood meal of approximately 5 - 14 days on a large mammalian host, e.g. dog, domestic livestock or deer.

I.2.b. Clinical signs

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 the 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 females 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. *Babesia* spp., *Borrelia burgdorferi* s.l., *Hepatozoon canis*, *Acanthocheilonema (Dipetalonema)*

spp., *Bartonella* spp., *Ehrlichia* spp., *Anaplasma phagocytophilum, A. platys, Rickettsia* spp., flaviviruses and others can all be transmitted by ticks. Individual ticks may harbour more than one pathogen often leading to clinical syndromes atypical of a single disease. Tick-Borne Diseases are summarised in Table 4 and are considered in more detail in ESCCAP Guideline: Vector-borne Diseases.

I.2.c. 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. Identification of species can be carried out by specialist laboratories where appropriate. 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: Vector-borne Diseases.

I.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 act as an intermediate host for the tapeworm *Dipylidum caninum*.

I.3.a. 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, *T. 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, all lice found on dogs and cats are chewing lice with typical broad heads (Table 5).

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. During her life time a single female may lay around 30 – 60 eggs. Nymphal stages, which are grossly identical but smaller than adults, emerge from the eggs after approximately 1-2 weeks; they then go through up to five moults before reaching the adult stage, with the entire life cycle taking approximately 4-6 weeks.

Epidemiology

Chewing and sucking louse infestations occur sporadically in most of Europe and are particularly prevalent in old and young or immunocompromised animals (e.g. Feline Immunodeficiency virus positive cats), especially in poorly cared for cats and dogs, such as stray animals. Some groups of dogs such as hunting dogs may be more prone to infestation and in certain areas such as Scandinavia, lice are the main external parasites found on dogs and cats as flea infestations are not common. 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 or hair brushes or combs.

I.3.b. 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, 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.

Direct skin damage due to louse infestation is rarely serious, while it can be severe if complicated by secondary bacterial infections. For example, some cases of pyotraumatic dermatitis have been linked to louse infestation. Severe infestation with sucking lice may result in anaemia, particularly in young puppies or kittens.

I.3.c. Diagnosis

Louse infestation can be diagnosed by close inspection and detection of lice or their eggs (nits) within the hair coat. Microscopic examination of adult lice from dogs allows identification of the louse species present.

I.4. Phlebotomes/Sandflies

In Europe only sandflies 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. L. infantum* is transmitted by sandflies and leishmaniosis is a serious disease of dogs, which are the main reservoir hosts for this parasite. *L. infantum* can also affect humans and is thus a public health hazard especially for children and immunodeficient adults (see ESCCAP Guideline: Vector-borne Diseases).

Phlebotomes also transmit viruses which are responsible for sandfly fever of humans in the Mediterranean area.

I.4.a Basic biology

Species

The species in the Mediterranean region which transmit *L. infantum* are *P. perniciosus, P. ariasi, P. perfiliewi, P. neglectus, P. tobbi* and *P. langeroni*. In Central Europe other autochthonous sandfly species are described, e.g. *P. mascitii*, but their role as vectors is unknown. Most sandflies have a broad host range and feed on a large variety of warm-blooded animals including humans.

Life cycle

The development of sandflies from egg to adult fly takes place in soil rich in organic matter and laboratory studies indicate that organic matter from lagomorph or rodent faeces is necessary. The development from egg to adult under favourable conditions is around 4 – 6 weeks. The seasonal dynamics of sandflies have not been fully explored but some species go into diapause over winter as fourth stage larvae. Most species of sandflies seek their hosts immediately after sunset and during the day, adult flies rest in cool humid places such as cracks and holes in stone walls, dark cellars or livestock accommodation.

Epidemiology

Phlebotomine sandflies are widespread in the Mediterranean area, Africa and the Middle East. They are well adapted, depending on the species, to tropical, subtropical and even arid habitats. The areas where the known *Leishmania* vector species *P. perniciosus* has been detected have extended northwards from the Mediterranean area to parts of northern Italy, Switzerland and southern Germany. Sandflies prefer windless conditions and their flying range is rather limited. However, they may be distributed by wind over long distances and this could result in their presence in previously non-endemic areas. Since little is known about the natural breeding sites of sandflies, vector control measures aimed at reducing the developmental stages are impossible. Control programmes for leishmaniosis are therefore concentrated on the dog as the major reservoir host and the sandfly-host interaction.

I.4.b Clinical signs

Initial sandfly bites typically induce sensitisation resulting in immediate or delayed-type skin reactions to subsequent bites. These are seen as pink to red, 2-3 mm papules, which remain prominent for several days before gradually disappearing. The moderate to severe pruritus induced results in scratching and self traumatisation with subsequent secondary bacterial infection. The biting sites are predominantly hairless

regions of the dog such as the muzzle, around the eyes and the ears. For humans, desensitisation of those living in sandfly endemic areas is well described. In dogs, the sandfly bites themselves will rarely be reported to the veterinary clinic and demonstration of *Leishmania* infection may be the only indicator of any previous sandfly-host interaction.

I.4.c Diagnosis

Phlebotomine sandflies seek their hosts mainly at dusk or during the night. They are intermittent external parasites and as they feed quickly, they are rarely found on dogs. The sandfly bite is painful but will only be recognised after the fly has left. More diagnostic details are provided in ESCCAP Guideline: Vector-borne Diseases.

I.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.

I.5.a Basic biology

Species

In Europe more than 70 species are known as potential intermediate hosts for filarial worms of the genus *Dirofilaria*. These include mosquitoes of the genera *Culex, Anopheles*, and *Aedes* including *Ae. albopictus*, the Asian Tiger Mosquito. The latter, originating from the south east Asia, has now been reported from 12 European countries including, Spain, France, Italy, Switzerland and as far north as the Netherlands. *Dirofilaria immitis* and *D. repens* are important nematodes in dogs and cats and are described in detail in ESCCAP Guideline 1: Endoparasites and ESCCAP Guideline: Vector-borne Diseases.

Life cycle

All mosquitoes develop from egg to pupal stage in water. Adult flies lay their eggs in a variety of water sources ranging from small containers to vast expanses of marshland. The larval stage is always aquatic and shuttles from the subsurface, where it feeds on micro-organisms, to the surface to obtain oxygen through its breathing apparatus. The pupal stage does not feed, but unlike most insect pupae it is extremely active. The adult emerges from the pupal case using air pressure and then assumes a terrestrial existence.

Epidemiology

When adult mosquitoes emerge they mate and in most species, the female seeks a blood meal to obtain the protein necessary for the development of her ovaries and the production of eggs. The females of a few species may produce eggs without first having a blood meal. The male mosquito does not feed on blood but on plant material and only lives for a short time after mating. Most mosquito species overwinter as eggs awaiting the spring rise in temperature when waters warm and the eggs then hatch. A few species spend the winter as adult mated females resting in protected cool locations. With the advent of warm spring days these females seek a blood meal and begin the cycle again. Only a few species can overwinter as larvae. In most species, the adult life expectancy is 3 – 4 weeks.

I.5.b Clinical signs

Most mosquito bites are harmless but unpleasant and usually itch due to an allergic reaction to mosquito saliva. Their main veterinary importance is in the transmission of the heart worm *D. immitis* and *D. repens*, which causes cutaneous dirofilariosis; mosquitoes also transmit other pathogens, especially viruses.

I.5.c Diagnosis

Mosquitoes are occasionally observed on dogs and cats when they are taking a blood meal, however, clinical and diagnostic procedures are usually directed to the demonstration of the presence of mosquito-transmitted pathogens in endemic areas or after animals have returned from endemic areas.

II. Impact of pet health and lifestyle factors

Animals require care tailored to their individual needs. Certain factors may dictate more intensive monitoring and/or treatment, while others may suggest a less intensive approach. When recommending a parasite control programme, veterinarians should consider the following:

Animal

Age and health status of the animal including its history and origin need to be considered. Any debilitating disease may play a role by rendering dogs and cats more susceptible to parasite infestations (lice infestation is more common in kittens and/or very old, debilitated or immunocompromised animals).

Environment

Dogs in kennels, those living outdoors, those living with other dogs or cats, or stray dogs and hunting dogs may be at greater risk of acquiring external parasites and may require special consideration. The same holds true for cats living in catteries, stray or feral cats, and cats living with other cats or dogs.

Nutrition

Poor nutrition may contribute to susceptibility for heavy infestation with external parasites and/or clinical symptoms.

Location and travel

Animals living in or travelling to specific geographical areas e.g. for holidays or relocation, boarding facilities, dog and cat shows and field trials, may be at increased risk of acquiring infestations that occur in these areas.

Pet and pet owner lifestyle

Pet and pet owner lifestyle may play a part in the likelihood of the acquisition of external parasites. For example, where dogs and cats visit or live close to rural woodland areas they may be likely to be exposed to some species of ticks. Reinfestation with fleas from outside the home environment may occur more readily in urban areas where cat and dog population density is likely to be highest. Infestations of fleas, especially in multi-animal households, may be more difficult to eradicate and expense can be an important consideration in these cases.

III. Control of infestations and of the parasites transmitted

The strategies to control external parasites depend on various factors that include:

- The external parasites present
- The owners' needs and wishes
- Local or national legislation
- Availability of parasite control agents
- Spectrum of parasites, including internal parasites to be controlled

Ectoparasite control includes elements of management and use of parasiticides. The treatment regimen, route of administration and, if necessary, retreatment frequency, should be clearly stated for any external parasite control measures. The plan may be simple or complex depending on perceived requirements. Animals may be at risk of infection with various unrelated parasites, such as insects and nematodes. Since there are now drugs that are effective against a range of parasite species or which contain combinations of different compounds that cover a broad range of different parasites, options for integrated control should be considered.

Options for external parasite prevention and treatment

This section examines the management and therapeutic options available to treat and prevent external parasite

infestations. The main groups of drugs, including combinations, that are widely available in Europe, together with their spectra of activity, can be found in frequently updated tables on the ESCCAP website (www.esccap.org) and individual product data sheets. Other factors to consider in choosing a treatment include:

- Route of administration
- Duration of activity
- Animal details including species (dogs or cats), age and weight
- Animal activity including swimming or bathing
- Other parasiticides and/or other medications the animal may be receiving
- Any clinical signs associated with infestation

III.1. Fleas

III.1.a. Treatment of an existing infestation

Therapy includes:

1. Elimination of the existing infestation of adult fleas using an approved ectoparasiticide. Currently registered ectoparasiticides in European countries are summarised at www.esccap.org where further information on treatments by country is also provided. 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 must not be forgotten to treat not only the diagnosed infested animal but all other pets living in the same household (dogs and especially cats, which are sometimes neglected by the owners).
2. An established adult flea infestation normally accounts for only a very small proportion of the total flea population including 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 also 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 administered application. Environmentally and animal-administered products may contain compounds with adulticidal and/or Insect Growth Regulator (IGR) activity. Environmental treatment should be focussed on areas where the animal spends the most time, such as their basket. It can be difficult to eliminate pupal stages, partly because they tend to be located in hidden locations such as the base of carpets. 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 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. More rarely, flea traps have been used to assess the environmental contamination but this is mainly done for research purposes.

   Additional topical or systemic treatments may be necessary to reduce the clinical signs of flea infestation or FAD, until the infestation is brought under control.

III.1.b. Prevention and ongoing 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 reinfestation risk depends on the lifestyle of the animal. The following questions may help to define an appropriate strategy:

- 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?
- Does legislation allow preventative treatments?

In areas where reinfestation 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.

Flea control often requires considerable and continued commitment and effort from the owner, and 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
- Visiting other premises with little or no flea control for example the homes of friends or family.

III.1.c. Scenarios

1) Minimal infestation risk (e.g. animals with very limited or no outdoor access):

   Regular visual inspection should be done preferably using a flea comb and grooming. In the event of positive findings only therapeutic treatment may be required to eliminate the infestation. This can be 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 until 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. Within the home and garden careful observation of the pets habits will reveal the environmental "hot spots" where flea development is concentrated. Ensure that treatment is continued until all developing stages in the environment have been controlled.

3) High, continual reinfestation 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 population is 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) Flea infestation of the owners:

Humans may be infested/bitten where there are large numbers of emerging adult fleas due to heavy environmental infestation. Flea control for the owner's pets and environment is then recommended as described in 3) above and section V until the problem is eliminated.

Although there is no clear guidance about the risk of selecting for resistance through repeated or continuous treatments, in order to minimise the potential risk, it may be advisable to change to a different class of compounds every year or two. See section IV.

III.2. Ticks

III.2.a. 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: Vector-borne Diseases for individual minimum transmission times).

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

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 had been transmitted must be considered. For more information see ESCCAP Guideline: Vector-borne Diseases.

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

The registered veterinary medicinal ectoparasiticides to be used on dogs and cats are listed on www.esccap.org.

III.2. b. Prevention and ongoing control

Throughout Europe substantial geographical and climatic differences are present 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.

III.2.c. Scenarios

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 late in feeding.

5) Pet Travel Scheme (PETS) in the UK:

   Dogs, cats or ferrets returning to or entering the UK from abroad must have received veterinary treatment with a licensed acaricide between 24 and 48 hours before their arrival in UK. Impregnated collars are not an acceptable form of treatment. Treatments must be recorded on the EU pet passport, official third country veterinary certificate.

6) 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.

There are special formulations of acaricides for use in kennel or household environments. The active compounds mostly belong to the same chemical classes as acaricides used for pets.

The World Health Organisation (2006) has published a review of pesticides and their application, which contains sections on safe use and environmental application (see www.esccap.org).

The owner may contact a professional pest control technician.

III.3. Sucking and chewing lice

III.3. a. 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, this is mainly due to the difficulty to find enough cases to meet the registration guidelines from the European agency for veterinary medicine. It is likely that a product effective against chewing lice will also be effective against sucking lice. One treatment may be all that is necessary if the product has a persistency beyond the egg to egg development time of lice. In case of a short persistency of the insecticide, reapplication after 10 to 14 days is required to treat larvae (nymphs) hatching from the eggs (nits).

III. 3.b. 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.

III. 4. Phlebotomes/Sandflies

III. 4.a. Treatment of an existing infection

Phlebotomine sandflies, as intermittent external parasites, cannot be included in any therapeutic approach similar to that applied for flea and tick infestations. All veterinary efforts are directed to minimise the sandfly-host interaction.

III. 4.b. Prevention and on-going control

The sandfly season in endemic areas may vary from year to year and is also dependent on the region and availability of suitable habitats. As a general rule however, the season starts in April and continues until November.

Measures taken to prevent phlebotomine sandfly bites are recommended to reduce the risk of canine leishmaniosis. This includes measures to minimise the exposure of dogs to sandflies eg. 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 sandfly season has been proven to significantly reduce the risk of dogs acquiring *L. infantum* infections. (For more information see ESCCAP Guideline: Vector-borne Diseases).

III. 4.c. Scenarios

1) Dogs in phlebotome sandfly endemic areas:

   Dogs living in such areas should be treated prophylactically with insecticides with repellent properties and with proven efficacy before the start of the sandfly season.

2) Dogs travelling to phlebotome sandfly endemic areas:

   Dogs from non-endemic areas travelling to endemic regions in the sandfly season must be protected against sandfly bites by application of insecticides, with proven efficacy against sandflies, for at least 24 hours before arriving; appropriate treatments should then be maintained throughout the duration of their stay in the area. Dogs returning from phlebotome endemic areas should be examined regularly for evidence of *L. infantum* infections.

III. 5. Mosquitoes

Some insecticides with repellent activity are also effective against mosquitoes but reliance on such compounds to prevent canine heart worm disease cannot be recommended. Control of *Dirofilaria* infections, are described in ESCCAP Guideline 1: Endoparasites and ESCCAP Guideline: Vector-borne Diseases.

The mosquito season may vary from year to year and is also dependent on the region and availability of habitats.

The application of insecticides to prevent mosquito bites may be recommended in some animals with sensitive skins. Although mosquitoes are a nuisance and transmit *Dirofilaria* spp., prevention of heart worm disease and cutaneous dirofilariosis is independent of any mosquito control measures.

Combined infestations.

In some households there is a combined infestation of two or more of the external parasites included in this guideline, or a risk from more than one infestation. Where this is the case then control using parasiticides with a broad spectrum of activity covering all infestations should be considered.

IV. 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 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. If there still appears to be a query the manufacturer should be contacted to report a suspected lack of efficacy so that detailed investigations can be carried out as appropriate. This may include efficacy follow-up and other specific assays which are not currently available for use in practice.

In the absence of evidence to the contrary, it is logical to assume that among other reasons the risk of developing resistance is proportional to the exposure of the parasite population to specific drugs. Therefore it is important that the effectiveness of insecticides and acaricides in shelters, catteries, hunting dogs and other high-usage environments is closely monitored, because these are situations with a potentially increased selection pressure for resistance on existing parasite populations.

Whilst there is an absence of scientific recommendations for the avoidance and subsequent handling of resistance in canine and feline ticks and insects, integrated flea control (IFC) where a combination of treatments with different modes of action are used simultaneously has been advocated. Unnecessary treatment should be avoided and rotation between drug classes at intervals of one or two years might be appropriate. Research is required to define appropriate protocols.

V. Environmental control of ectoparasites

Control of flea eggs, larvae and pupae in the environment is important in order to minimise the potential level of challenge to animals or humans. Indoor environmental control includes regular vacuum cleaning of the rooms where the animals spend most of their time and safe disposal of vacuum cleaner contents, restriction of access to recognized "hot spots" and the use of products effective against immature stages. Treatment of outdoor locations is difficult, and treatment of the animal with a product effective against immature stages is one way of reducing environmental contamination. Wildlife as a source of flea infestation has to be considered, thus interaction of pet animals and wildlife should be observed. In general environmental control of developmental stages of fleas should always be accompanied by concomitant application of ectoparasiticides targeting adult fleas on the animals.

For ticks, environmental treatment with acaricides is normally impossible as the off-host stages are usually widely distributed outdoors and in inaccessible locations. Treatment of premises may be of use in dog kennels or homes where infestation by *R. sanguineus* or *I. canisuga* has established within a discrete environment. In such environments, elimination of locations suitable for off-host stages, such as filling of crevices, may assist with control.

Lice and louse eggs can survive in the environment and on materials such as brushes or hair combs for a limited period. Care should therefore be taken to ensure that infestation is not transferred in this way from one infested animal to other animals in the same or other households.

The World Health Organisation (2006) has published a review of pesticides and their application, which contains sections on safe use and environmental application (see www.esccap.org).

VI. Owner considerations in preventing zoonotic diseases

Fleas, phlebotomine sandflies, mosquitoes, ticks and lice may carry various pathogens capable of causing diseases, some of which are of zoonotic importance.

For ticks, there is no direct risk associated with ticks attached to a dog or cat. Ticks manually removed from a dog or cat should be disposed of carefully. This is important to ensure that humans are not exposed to any fluid from the tick potentially containing pathogens and that ticks cannot subsequently find another human host.

Fleas are capable of transferring easily between animals and humans. Any kind of flea infestation in households, especially those with young children, carries the zoonotic risk of flea-borne infections, such as *Bartonella* spp.. Eradication of flea infestation is also of importance simply for public health reasons.

Lice are host specific, thus the species parasitising dogs and cats are not considered to be of any health risk to humans.

Important preventive measures for pet owners in terms of ectoparasites include:

- **Educating wherever possible the risk of a pet acquiring infestation**
- **Controlling pet ectoparasite infestations through regular diagnostic testing and/or repeated application of appropriate ectoparasiticides**
- **Minimising 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 may be increased during pregnancy or when there is an existing illness or immunosuppression.

VII. Staff, pet owner and community education

Protocols for the control of parasitic infection 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 infection, not only to their pets but also to family members and all people living within the vicinity of their pets.

APPENDIX 1: Glossary

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’ and ‘prevention (prophylaxis)’.

Integrated control = The use of several measures to control different parasites or parasite stages present on the animal and stages present in the environment.

IGR = Insect Growth Regulator = Compound that may kill and/or inhibit the development of immature stages of insects.

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.

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.

Insecticide (Insecticidal compound) = Insecticides are compounds that act against ectoparasites belonging to the Class Insecta by zoological nomenclature. In this guideline fleas, and chewing and sucking lice are insects.

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 are acarids.

Ectoparasiticide = Compound developed for the animal administered use as a therapeutic agent to eliminate any existing ectoparasite infestation and prevent reinfestation.

Pesticide = Compound developed for the elimination of different stages of parasites in the environment.

Repellent = Compound, which makes a host unattractive to a parasite and thus can prevent attack or establishment

APPENDIX 2: ESCCAP Background

ESCCAP 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:

1. Veterinarians and pet owners must take measures to protect their pets from parasitic infestations.
2. 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.
3. Veterinarians, pet owners and physicians should work together to reduce the risks associated with zoonotic transmission of parasitic diseases.
4. Veterinarians should be able to give guidance to pet owners regarding infection risk of parasite infestation and diseases and measures which can be taken to minimise these risks.
5. 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.
6. 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 guidelines in two formats:

1) A detailed guideline for veterinary surgeons and veterinary parasitologists;

2) A summarised guideline which can be used by both veterinarians and pet owners.

Both versions of each guideline can be found at www.esccap.org.

Various guidelines for treatment and control of parasitic infestations in companion animals have been provided in other countries for example by organisations such as the CAPC (Companion Animal Parasite Council) in the USA. However, to date no single comprehensive guidelines have been developed for Europe.

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.

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*
Chewing and Sucking lice	Louse infestation	*Dipylidium caninum*
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*),* *Hepatozoon* spp. (hepatozoonosis), *Ehrlichia canis, E.* spp.*, Anaplasma phagocytophilum, Anaplasma platys* (ehrlichiosis, anaplasmosis), *Rickettsia* spp.*,* (rickettsiosis), *Borrelia burgdorferi* s.l. (Lyme disease = borreliosis), Flaviviruses (e.g. tick-borne 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

Table 2: Abiotic factors affecting flea survival

Temperature (°C)	Effect on flea	Relative humidity (RH) (%)	Effect on flea
-1	All life stages dead within 5 days	**12**	100% mortality of larvae at 27°C following 24 hours exposure
3	All eggs larvae and pupae killed by 5 days exposure, up to 65% adults can survive at this temperature with 75% RH	**33**	100% mortality in larvae at 32°C following 24 hours exposure
13	Development of 50% of eggs to adult takes between 130 and 140 days (75% RH)	**50**	Lowest relative humidity for survival of eggs and larvae maintained at 35 °C
21	Development of 50% of eggs to adult takes approximately 40 days (75% RH)	**75**	RH with highest survival and development for every stage
27	Development of 50% of eggs to adult takes approximately 24 days (75% RH)		
32	Development of 50% of eggs to adult takes approximately 16 days (75% RH)		

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	

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 canis*	Dog	*Dermacentor reticulatus*	Southern and Central Europe up to Baltic	moderate - severe
	B. canis vogeli	Dog	*Rhipicephalus sanguineus*	Southern Europe following distribution of vector	mild - moderate
	B. gibsoni and gibsoni like	Dog	*Haemaphysalis* spp., *Dermacentor* spp.	Sporadic and rare in Europe	moderate - severe
	Babesia (Theileria) annae	Dog	*Ixodes hexagonus***	North - Western Spain	moderate - severe
Hepatozoonosis	*Hepatozoon canis**	Dog	*Rhipicephalus sanguineus*	Southern Europe	mostly mild infection; subclinical
	Hepatozoon spp.	Cat	Unknown	Spain	subclinical
DISEASES CAUSED BY NEMATODES					
Filariosis	*Acanthocheilonema (Dipetalonema) dracunculoides Acanthocheilonema (Dip.) grassi Acanthocheilonema (Dip.) reconditum*	Dog	*Rhipicephalus sanguineus†*	Southern Europe	minor

* Transmission of *Hepatozoon* spp. is by ingestion of an infected tick and not a tick bite.
** Not yet experimentally demonstrated.
† 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 in dog and cat
DISEASES CAUSED BY BACTERIA					
Bartonellosis	*Bartonella* spp.	Many animals, dog, cat, human	Ticks suspected†	Throughout Europe	commonly subclinical infection, chronic endocarditis
Borreliosis (Lyme disease)	*Borrelia burgdorferi* complex (especially *B. garinii* and *B. afzelii* in Europe)	Many animals especially rodents, dog, cat, human	*Ixodes ricinus* *I. hexagonus* *I. persulcatus* *D. reticulatus*	Throughout Europe	mostly subclinical, sometimes clinical signs typically malaise and lameness in dogs
Ehrlichiosis (monocytic)	*Ehrlichia canis*	Dog (cat)	*Rhipicephalus sanguineus*	Southern Europe following distribution of vector	moderate – severe
Anaplasmosis (granulocytic ehrlichiosis)	*Anaplasma phagocytophilum*	Many animals, dog,cat, human	*Ixodes ricinus, (I. trianguliceps?)*	Throughout Europe	mild and subclinical infections common moderate with lethargy
Anaplasmosis (infectious cyclic thrombocytopenia)	*Anaplasma platys*	Dog	*Rhipicephalus sanguineus*	Southern Europe following distribution of vector	commonly asymptomatic
Rickettsial infections (Mediterranean spotted fever/MSF)	*Rickettsia conorii*	Dog	*Rhipicephalus sanguineus*	Southern Europe following distribution of vector	subclinical infection or moderate with lethargy
Coxiellosis (Q Fever)	*Coxiella burnetti*	Ruminants, dog, cat, human	*Ixodes* spp.† *Dermacentor* spp.	Throughout Europe	subclinical infection
Tularaemia	*Francisella tularensis*	Lagomorphs, cat	*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, dog	*Ixodes ricinus* *I. persulcatus*	Central, Eastern and Northern Europe	clinical signs neurological and can be moderate but not commonly reported
Louping ill	Louping-ill virus, (Flavivirus)	Many animals, mainly sheep, dog	*Ixodes ricinus*	UK, Ireland	clinical signs neurological and can be moderate-severe but not commonly reported

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

Table 5: Sucking and chewing lice on dogs and cats in Europe

Suborder	Genus & Species	Host	Occurence
Anoplura	*Linognathus setosus*	dog	All over Europe rare except in Scandinavia
Ischnocera	*Trichodectes canis*	dog	Sporadic over most of Europe except Scandinavia
	Felicola subrostratus	cat	All over Europe while rare, more common in stray cats

ESCCAP

EUROPEAN SCIENTIFIC COUNSEL COMPANION ANIMAL PARASITES

Ectoparasites Part 1: Control of Parasitic Insects and Ticks in Dogs and Cats

Guideline 3, March 2009

Bayer HealthCare Animal Health

MERIAL

NOVARTIS ANIMAL HEALTH

Intervet Schering-Plough Animal Health

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