ESCCAP

EUROPEAN SCIENTIFIC COUNSEL COMPANION ANIMAL PARASITES

Worm Control in Dogs and Cats

Guideline 1, December 2006

ESCCAP Guideline No.1

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Background

ESCCAP (European Scientific Counsel Companion Animal Parasites) is an independent, non-profit making organization whose aim is to develop guidelines for the control and treatment of parasites in pet animals. The guidelines are developed to protect the health of pets, enhance the safety of the public and preserve the bond between pets and people. The long term goal for ESCCAP is that parasites are no longer an issue for pets or humans across Europe.

There is great diversity in the parasites and their importance across Europe. ESCCAP guidelines summarise the different situations within Europe, highlighting important differences between parasites and between different parts of Europe where necessary, and recommend specific control measures.

ESCCAP believes that:

- Veterinarians and pet owners must take measures to protect pets from parasitic infections.
- Pet travel has the potential to change epidemiological situations with export or import of non-endemic parasite species, therefore veterinarians and pet owners must protect the pet population from risks associated with travel and its consequences.
- Veterinarians, pet owners and physicians should work together to reduce the risks associated with zoonotic transmission of parasitic diseases.
- Veterinarians can and should give guidance to the pet owner regarding infection risk and risk of disease caused by different parasites and measurements against them.
- Veterinarians should inform the pet owner about parasites and enable them to act responsibly for their pet's life and the pets and other animals and people in their communities.
- Wherever appropriate, veterinarians should undertake appropriate diagnostic tests to establish parasite infection status.

To assist in this process, ESCCAP produces each guideline in two formats: 1) Full: detailed for veterinary surgeons and veterinary parasitologists 2) Summarised: for veterinarians and pet owners. Both versions of the guideline can be found at www.esccap.org.

Various guidelines for treatment and control of parasitic infections in companion animals have been implemented in other countries such as USA by organizations such as the CAPC. However, to date no single comprehensive guideline for Europe with its diverse parasite spectrum has been developed.

Worm Control in Dogs and Cats

Introduction

There are a wide range of helminth infections that include nematode, cestode and trematode infections that can infect dogs and cats in Europe. Major species are summarised in Tables 1 and 3. Some of these worms are more important than others due to a) their prevalence and either b) their pathogenicity for the host or c) their zoonotic potential, or due to a combination of these reasons. This guideline aims to give an overview of these worms, their significance and, importantly, suggest rational control measures for the most important species in order to prevent animal and/or human infection. This guideline concentrates on worm control, but gastrointestinal protozoal parasites are included in tables to provide a complete overview of intestinal parasites.

The measures include methods of preventing or controlling infection in the animal (sections I and II), prevention of transmission via environmental contamination to other animals or humans (Section III) and prevention of human infection (Section IV). The final section (Section V) addresses education issues.

For simplicity the nematodes, cestodes and trematodes referred to in this guideline will be referred to as "worms" and treatments are referred to as anthelmintics.

The guideline is divided into five sections:

1. **Consideration of pet health and lifestyle factors**
2. **Lifelong control of worms**
3. **Environmental control of parasite transmission**
4. **Owner considerations in preventing zoonotic disease**
5. **Staff, pet owner and community education**

I. Consideration 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 aggressive approach. When recommending a parasite management program, veterinarians should consider the following (See Tables 2 and 4 for more details):

Animal:

Age (puppies, kittens and geriatric animals are at greater risk than healthy adults). Pregnant and lactating bitches (pregnant bitches may pass *Toxocara* canis to their pups and lactating bitches may pass *T.canis* and *Ancylostoma caninum* infection to their pups and in addition they may also have patent *T. canis* infections), and queens (may pass *T. cati* to kittens during lactation). Health status of the animal including ectoparasite infestation, history of the animal and origin will have to be considered.

Environment:

Dogs in kennels, living outdoors, living with other dogs or cats or stray dogs and hunting dogs may be at greater risk of acquiring parasites and may require special consideration.

Cats living in catteries, stray or feral cats and cats living with other cats or dogs may be at greater risk of acquiring parasites and may require special consideration.

Nutrition

Dogs with access to rodents, molluscs, raw fish and raw meat including viscera, placenta or aborted foetuses may be at risk of acquiring specific parasites.

Location and travel

Dogs living in or travelling to (e.g. for holidays or relocation, boarding facilities, dog and cat shows and field trials) specific geographic areas may be at increased risk of acquiring infections that occur in those areas.

II. Lifelong control of common worms

II.1. Important preventive measures include:

- Hygiene measures especially cleaning up pet faeces regularly to reduce environmental contamination with infective parasite stages (section III);
- Pets should be fed commercial diets or cooked food to prevent raw meat-transmitted parasite infection (See Tables 2 and 4), should not be allowed access to rodents, carcasses or placenta and aborted foetuses of cattle or sheep, and provided fresh, potable water;
- Controlling parasite infections through worm and ectoparasite control and treatment.

Although the risk of some parasites is greatest for the young puppy or kitten, parasite infections are not strictly age-related, and so the risk continues throughout life. Therefore consideration should be given to provide all dogs and cats with appropriate worm control throughout their lives.

Where a specific worm infection is diagnosed, then the infection should be appropriately treated and then preventative measures put in place. Symptomatic dogs should have an accurate physical examination, including faecal examination or blood sample (where heartworm is suspected), and complete history as these are crucial for diagnosis, treatment and control of parasitic infections. In addition faecal examinations can be useful especially for stray animals, kennels or cattery situations and after travelling.

For the healthy dog or cat, prevention of worm infection is imperative. To simplify preventative measures, ESCCAP has identified three "key" parasite groups that themselves can cause severe disease and/or pose a zoonotic risk and have high prevalence in some or all areas of Europe:

A. *Toxocara* spp. (ascarids) and Hookworm

B. *Echinococcus* spp.

C. Heartworm *(Dirofilaria immitis)*

Ascarid and hookworm infection occur across Europe, whilst the distribution of the other infections is geographically related. By adding *Echinococcus* spp. and/or heartworm control to an ascarid and hookworm control plan, basic control plans can be produced for dogs and cats anywhere in Europe. Appropriate anthelmintic treatment for that parasite can then be identified and the animals treated at suitable intervals. More detailed considerations for each of the key parasites can be found below. Control of other parasites, such as lungworms and the French heartworm (*Angiostrongylus vasorum*) (Tables 1 - 4) which may be important in particular areas, should be added as necessary according to need.

A. *Toxocara* spp. and hookworm

Puppies can be severely infected by these intestinal worms in utero or via nursing and these may cause serious illness, before diagnosis is possible by faecal examination. For this reason, puppies should be treated with appropriate anthelmintics normally starting when puppies are 2 weeks of age, with treatment repeated according to data sheet indications. Because prenatal infection does not occur in kittens, fortnightly treatment can begin at 3 weeks of age, repeated at 5 and 7 weeks or according to data sheet recommendations. Nursing bitches and queens should be treated concurrently with their offspring since they may develop patent infections along with their young.

Toxocara spp. infection can occur in older dogs and cats, and as it is extremely unlikely to be associated with clinical signs in older animals, it is difficult to tell whether a dog is infected unless regular faecal examinations are conducted. In addition, these parasites are fecund egg-layers and just one or two worms can produce large numbers of eggs. Therefore continued regular treatment of dogs and cats is appropriate using a suitable anthelmintic if regular diagnostic testing is not instituted (see next paragraph). An anthelmintic with a broad or narrow spectrum of activity can be chosen according to the risk of other worm

infections. As the pre-patent period for *Toxocara* spp. is a little over four weeks, monthly treatment will minimise the risk of patent infections and can be recommended in risk scenarios such as the pet living in the family with small children and common use of a garden (or similar). Annual or twice annual treatments have been shown not to have a significant impact on preventing patent infection within a population, so a treatment frequency of at least 4 times per year is proposed as a general recommendation.

Where an owner chooses not to use anthelmintic treatment regularly then monthly or 3 monthly faecal examination may be a feasible alternative. Faecal examinations should be performed using at least 3 to 5 grams of faeces and centrifugal flotation technique associated with other methods (such as direct exam, stained smear, sedimentation) (Tables 5 - 6) as needed.

B. *Echinococcus* spp.

Both *Echinococcus granulosus* and *Echinococcus multilocularis* are zoonoses of major public health concern. In areas where *Echinococcus granulosus* (including the equine and bovine genotypes recently proposed as species *E. equinus* and *E. ortleppi*) is endemic (Fig. 1) dogs that may have potential access to carcasses or raw viscera especially from sheep, pigs, cattle or horses (depending on the *Echinococcus* genotypes) should be treated at least every 6 weeks with an effective compound containing praziquantel or epsiprantel.

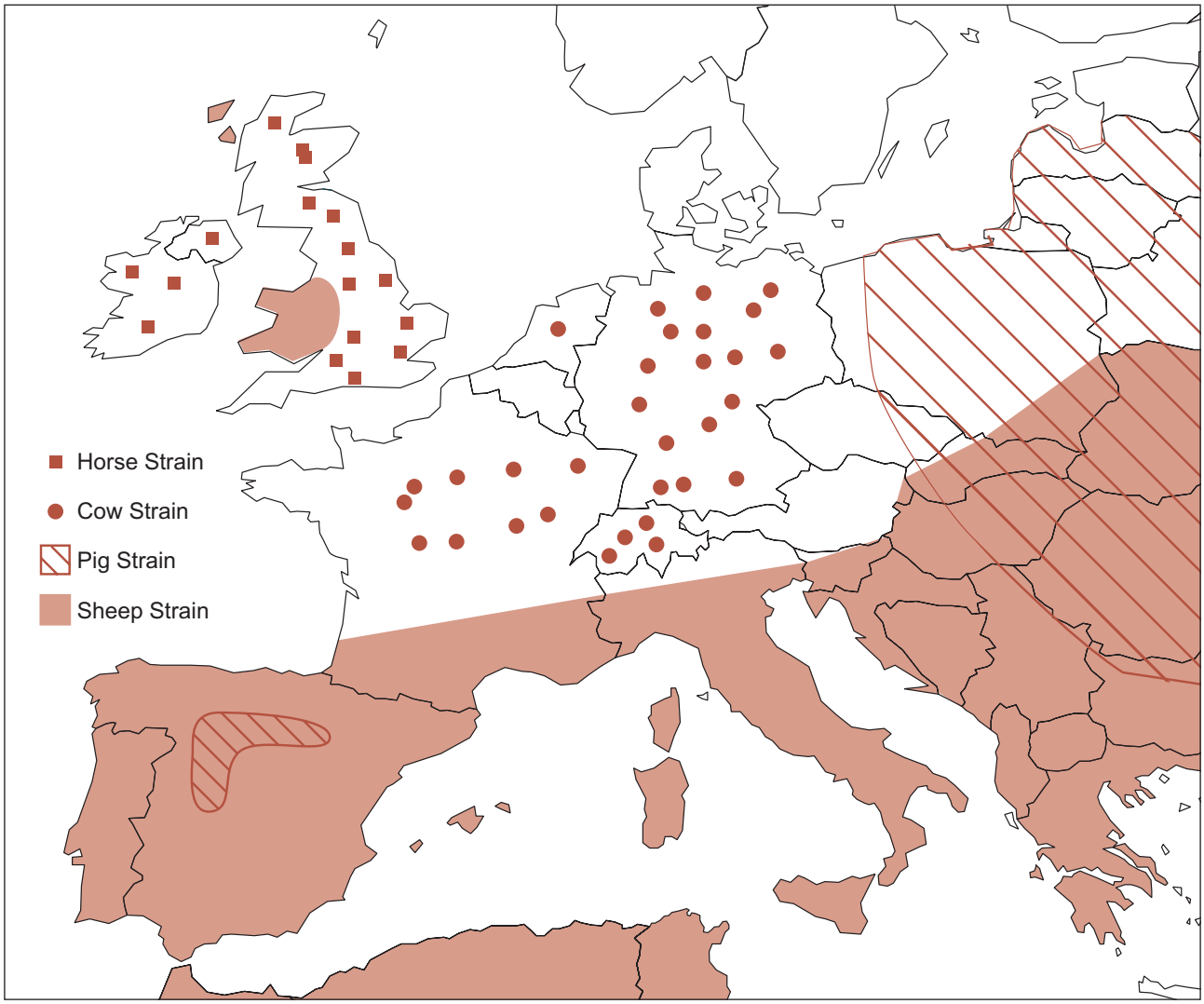

Fig. 1 Distribution of *Echinococcus granulosus* in Europe

In the Central and Eastern European endemic area of *Echinococcus multilocularis* (Fig. 2) with red foxes as main definitive hosts and voles as intermediate hosts, dogs that have access to rodents should be treated at four weekly intervals with an effective anthelmintic containing praziquantel or epsiprantel. Cats, in contrast to dogs, are thought to be of minimal zoonotic risk as they are poor hosts for this worm.

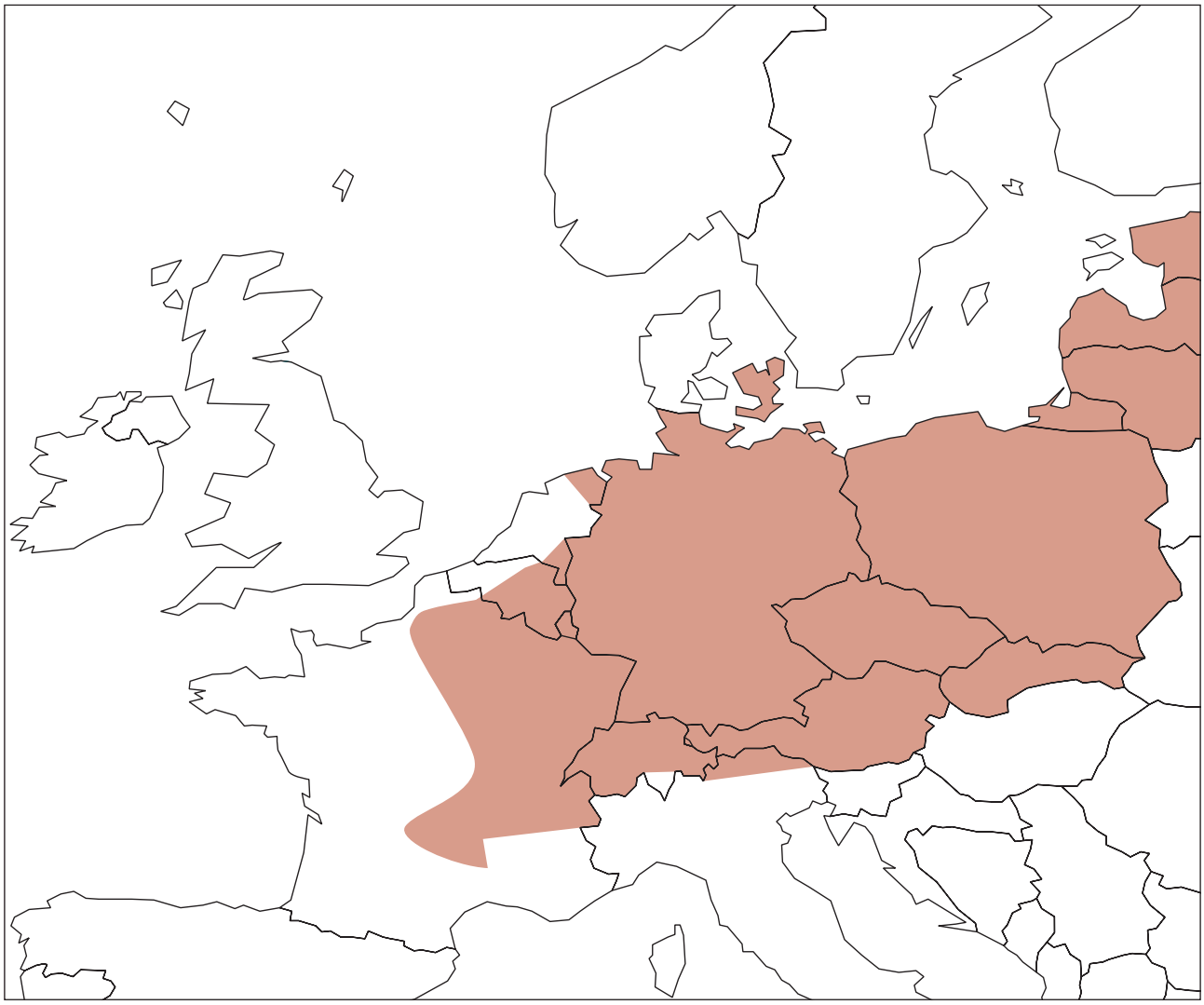

Fig. 2 Distribution of *Echinococcus multilocularis* in Europe

Specific diagnosis of *Echinococcus* infections in definitive hosts is difficult as the taeniid-eggs cannot be differentiated morphologically. Coproantigen tests are not available commercially and PCRs enabling species and /or genotype identification are performed in specialised laboratories only. Therefore, in *Echinococcus* endemic areas taeniid-infections based on egg detection should be handled as potential *Echinococcus* infection. Where animals are infected with *Echinococcus* species it is advisable that they are treated on two consecutive days with a highly efficient compound under supervision of a veterinarian and the animal should be shampooed to remove parasite eggs adherent to the coat using suitable protective clothing such as protective gloves and mask for the personnel involved.

C. Heartworm

Heartworm infection (*Dirofilaria immitis*) and subcutaneous dirofilariosis (D. *repens*) are endemic in many south and eastern European countries (Fig. 3). Climatic changes favourable to parasite development and the increasing number of pets who travel have increased the risk of infection for dogs and cats.

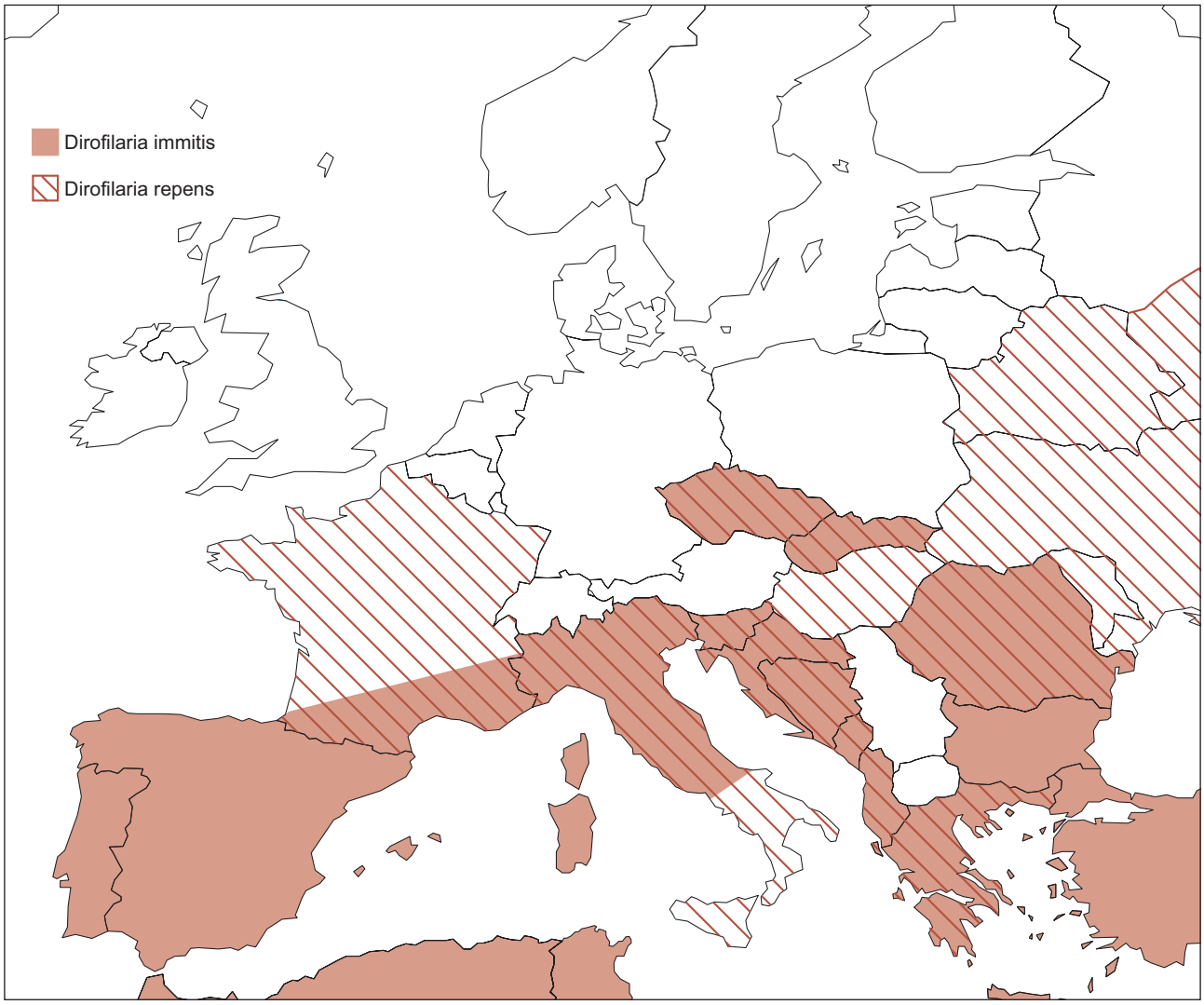

Fig. 3 Distribution of *Dirofilaria immitis* and *Dirofilaria repens* in Europe

C.1. *Dirofilaria immitis* - Dog

Presently there are no repellents/insecticides that have been demonstrated to disrupt transmission of heartworm, therefore control depends on the use of heartworm preventatives that kill the young heartworm prior to their migration towards the heart. Using appropriate products adult heartworm can be effectively prevented. In most parts of Europe where infection is endemic, the transmission season of heartworm infection generally lasts from April to October. In the Canary Islands infection can be transmitted throughout the year. For products that are administered once a month, the treatment must begin within 30 days following the estimated season onset of transmission and be continued until 30 days after the period has ended. An injectable product exists that is able to protect dogs for a year following a single injection.

Puppies and kittens have to be placed on preventive heartworm treatment as soon as possible after birth (consistent with label recommendations).

In areas at risk for heartworm infection, adult dogs should be tested for circulating microfilariae and heartworm antigen before starting preventive treatment for the first time. Annual retesting will ensure that preventive treatment, including owner compliance, are adequate.

C.2. *Dirofilaria immitis* - Cats

Although cats are susceptible hosts for heartworms, they are more poorer hosts for this infection than are dogs. Furthermore, feline heartworm infection is more elusive to diagnose than in dogs and can be easily missed due to the different behaviour of heartworms in this host.

Cats living in canine heartworm endemic areas frequently become infected but parasites do not develop to the adult stage. Furthermore, most heartworm infections in cats are light and consist of 1-2 adult worms, often of the same sex. Consequently, microfilaremia is absent. If present, microfilaremia lasts only a few months and the life span of adult parasites is quite short. As a consequence, tests for circulating microfilariae have poor/very poor diagnostic value in cats. Antigens and antibody tests can be used but often have to be repeated because of either low sensitivity (antigens) or low index of suspicion of adult heartworm infection (antibody). A definite diagnosis of heartworm infection can often be obtained only by the application of haematological and serological tests in conjunction with thoracic radiography and echocardiography.

Testing cats before administration of anthelmintics or re-testing during preventive anthelmintic treatment is recommended. However, if an antibody test is used, it might show a positive result in sensitised animals exposed to 3rd-4th stage larvae: it will demonstrate that the cat is exposed to a heavy risk of infection and reinforces justification for recommending prevention. Since microfilaremia in cats is uncommon, transient if present and below concentration levels that might trigger an adverse reaction to microfilaricidal preventive drugs, pretesting for microfilariae is unnecessary in healthy cats.

C.3. *Dirofilaria repens*

D. repens can infect both dogs and cats. Most infections are asymptomatic, though cold, not painful nodules containing the adult parasites can be found on the skin surface of infected animals. Seldom, in case of heavy infection or in sensitised animals, light to severe dermatitis can be observed. Most cases of zoonotic *Dirofilaria* infections in Europe are caused by this species. Like *D.immitis, D.repens* infection results in microfilariae in the circulation. It is important to determine whether microfilariae are those of *D.immitis* or *D.repens*.(see Tables 5 and 6)

C.4. Comments

Most heartworm preventative anthelmintics have the potential to control a range of other worms and so an appropriate product may be chosen to control other nematodes and cestodes as necessary. In addition, treatment can be extended throughout the year to ensure the continued control of non-seasonal parasites such as *Echinococcus* spp. and *Toxocara* spp., where necessary.

II.2. Diagnosis

Patent infections of all of the worms mentioned can be identified by faecal examination, except for *D. immitis* (heartworm) where a blood sample is examined for microfilariae, antigens or antibodies (Tables 5 and 6). Faecal examination for worm eggs can be carried out using a modified McMaster or other flotation technique (Tables 5 and 6). The scale of the worm burden can be crudely estimated from the number of eggs present in the sample. However, it should be noted that for ascarids such as *Toxocara*, a negative correlation between fecundity and number of adult worms has been reported.

Where larvae are produced, samples can be examined using the Baermann technique (Tables 5 and 6). Repeat samples can be examined approximately 7 – 10 days after treatment to check that treatment has resulted in the removal of the worm infection.

Where it is important to minimise any infection risk and preventative treatment is not chosen then monthly faecal examinations may be a suitable alternative.

II.3. Resistance

There are few documented case reports of anthelmintic resistance in dogs and cats, and fewer where the case has been well investigated. Apparent low incidence may be associated with low frequency or absence of resistance. At present there is no way of detecting anthelmintic resistance in dogs or cats other than the faecal egg-count reduction test. It is desirable that more sensitive tests including molecular techniques are developed to allow monitoring of continued efficacy.

Traditional anthelmintic treatment of dogs and cats has always left many parasite stages outside the host that are unselected by treatment of the dog or cat. If the frequency of anthelmintic treatments increases then this could increase the selection pressure on parasites, most likely to result in resistance in the case of the kennel situation where simultaneous treatment of a group of dogs with the same product might result in a high selection pressure. It is therefore recommended that careful consideration should be given to worm control programs for dogs in a kennel situation and it is recommended that faecal monitoring is regularly conducted to identify worm species present and the effectiveness of any control program.

In the absence of evidence to the contrary, it is logical to assume that the risk of resistance developing is proportional to the exposure of the parasite population to specific drugs. Therefore strategies that avoid excessive or unnecessary worming are likely to select less strongly for resistance, and risk-based rather than blanket strategies are justified.

III. Environmental control of parasite transmission

Control of parasite stages (eggs, larvae) in the environment is essential to minimize the infection pressure to humans (zoonosis) or animals. Parasitic contamination of the environment can occur in a number of ways, including excretion of parasitic stages in the faeces and the release of cestode proglottids. Furthermore, environmental infection pressure of dog-transmitted parasites can be maintained by wild foxes and stray dogs in both rural and urban areas, and feral and wild cats can similarly form a reservoir of feline infection.

Most of environmental parasite stages are highly resistant (for month to years). Freshly excreted stages for many parasites can be directly infective (*Taenia* and *Echinococcus* eggs). Other parasites require anything from a few days to a few weeks (eggs of nematodes) at appropriate temperatures above 16°C. Therefore, appropriate disposal of faeces is recommended. This should be on a daily basis and should not be flushed down the toilet or disposed of in compost. Infections in intermediate hosts may result in prolonged survival in the environment eg birds, rodents, slugs and snails.

Leash laws and faecal cleanup laws especially for urban areas should be enforced. Legislation to control stray dogs and wild cat populations should also be enforced. Other measures to facilitate faecal removal, such as provision of disposal bins and bags should be encouraged. As it is difficult to control where outdoor cats defaecate, particular attention should be given to worm control in cats.

It is most important to prevent initial parasite environmental contamination with comprehensive parasite control programs which have to be designed based on the local epidemiological knowledge. Parasitized animals should be rigorously treated to prevent environmental contamination and monitored, where necessary, by faecal examination to confirm treatment efficacy.

All eggs of cestode and nematode worms are highly resistant in the environmental and may persist in the soil for months or years. For highly contaminated areas, extreme measures are needed for decontamination, including removal of sand or soil or covering the soil with concrete or asphalt (for example in highly populated kennels). Therefore, for kennel or animal homes strict treatment and quarantine of new entrants is required to avoid introduction of infected animals. Children's playgrounds should be well fenced to prevent entry of animals including cats. Sandboxes should be covered when not in use. Sand should be replaced regularly, e.g. once or twice a year. Dessication and ultraviolet light exposure are detrimental to worm eggs so allowing access of sunlight and drying to contaminated areas can assist in reducing the level of contamination.

IV Owner considerations in preventing zoonotic diseases.

Important preventive measures for pet owners include:

- practicing good personal hygiene;
- controlling pet parasite infections through repeated treatments and/or regular diagnostic testing;
- preventing infection by reducing where ever possible the pet from acquiring infection;
- cleaning up pet feces regularly to reduce environmental contamination with infective parasite stages;
- minimizing exposure of children in particular to potentially contaminated environments;

People in contact with animals that may transmit zoonotic parasites should be advised of the risks and made aware that health risks generally increase by pregnancy, underlying other illnesses and immunosuppression. This information should be made available through physicians and veterinarians at anybodies request without obtaining a medical history of the client and his/her family.

In this respect special care should be taken in case of:

immunocompromised individuals such as:

- pregnant women
- elderly people
- people with HIV-infection
- patients undergoing chemotherapy, organ transplantation, or treatment for autoimmune diseases
- diabetics

other susceptible groups:

- babies and toddlers
- mentally disabled persons
- people with specific occupational risks

V Staff, pet owner and community education.

Protocols for the control of parasitic infection should be communicated to veterinary and para-veterinary staff and consistently applied. Awareness of parasitic zoonoses, including clinical manifestations in people and particularly children should be created in the medical profession through information brochures. Co-operation between the medical and veterinary profession should be initiated and its benefits underlined in case of 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 action radius of their pets. Brochures in veterinary practices, pet shops, posters or specific websites are useful tools to achieve this. Regular deworming or joining "pet health-check programmes" should be made clear to the general public (e.g. by wearing clear coloured fobs associated with a calendar year). Responsible dog and cat ownership can remove public health concerns.

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

Further Reading

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Table 1A: Characteristics of major internal worms and protozoa of dogs in Europe: intestinal roundworms (nematodes)

Worm species	Pre-patent period	Patent period	Infective stages and route of infection	Distribution in Europe	Final hosts
INTESTINAL WORMS					
Roundworms or ascarids					
Toxocara canis	Variable, typically 21 days after prenatal infection; 27 – 35 days after lactogenic infection; 32 – 39 days after ingestion of eggs	4 – 6 months except where immunity intervenes, for example in pups	Embryonated eggs from soil, larvae in milk or paratenic host, in utero from dam	Everywhere	Dogs and foxes
Toxascaris leonina	About 8 weeks	4 – 6 months	Embryonated eggs from soil, larvae from paratenic host	Everywhere	Dogs and cats
Hookworms					
Ancylostoma caninum	2 – 3 wks	Can be prolonged depending on immune status (7 months to 2 years)	3rd stage larvae from environment, larvae in bitches' milk, paratenic hosts	Predominantly southern Europe, sporadic in Northern Europe	Dogs and foxes
Uncinaria stenocephala	3 – 4 weeks	Can be prolonged depending on immune status	3rd stage larvae orally from environment	Predominantly central and northern Europe	Dogs and foxes (cats)
Strongyloides					
Strongyloides stercoralis	Variable, from 9 days	Several months (3 – 15 months)	Larvae from environment percutaneously	Everywhere but more predominant in the South	Dogs (humans and cats)
Whipworm					
Trichuris vulpis	8 wks	Up to 18 months	Embryonated eggs from the environment	Everywhere but most predominant in the South	Dogs

Table 1B: Characteristics of major internal worms and protozoa of dogs in Europe: tapeworms (cestodes)

Worm species	Pre-patent period	Patent period	Infective stages and route of infection	Distribution in Europe	Final hosts
Tapeworms					
Taenia spp.	4 – 10 wks	Months up to several years	Larval stages in intermediate host (cysticerci or coenurus)	Everywhere	Dogs and foxes (and cats)
Mesocestoides spp.	4 – 10 wks	Several years	Larval stages in meat or tissues of prey	Everywhere	Dogs, cats and foxes
Dipylidium caninum	3 wks	Several months	Larval stages in fleas or lice	Everywhere	Dogs and cats
*Echinococcus granulosus***	45 days	Several months	Larval stages in intermediate hosts (herbi and omnivores)	See map (Fig.1)	Dogs (and foxes)
Echinococcus multilocularis	28 days	Several months	Larval stages in intermediate hosts (rodents)	See map (Fig.2)	Foxes, dogs (and cats)

**: There are different strains: sheep strain, cattle strain = *E.ortleppi*, horse strain = *E.equinus*, pig-, *cervid*- and other strains

Table 1C: Characteristics of major internal worms and protozoa of dogs in Europe: non-intestinal roundworms (nematodes)

Worm species	Pre-patent period	Patent period	Infective stages and route of infection	Distribution in Europe	Final hosts
NON-INTESTINAL WORMS					
Heartworm					
Dirofilaria immitis	6 months	Several years	3rd stage larvae transmitted by mosquito vector (intermediate host)	Portugal, Spain, South of France, Italy, Greece, Croatia, Bosnia, Czech Republic and Turkey (Fig.3)	Dogs (and cats)
French heartworm					
Angiostrongylus vasorum	40 – 49 days	Up to 5 years	3rd stage larvae in mollusc infection orally	Everywhere	Foxes and dogs
Lungworms					
Oslerus osleri	10 wks		Direct transmission bitch to pups	Everywhere sporadically	Foxes and dogs
Filaroides hirthi	10 - 18 wks			Everywhere sporadically	Dogs
Capillaria spp.	4 wks	10 – 11 months	Larvae from environment or via earthworms	Everywhere	Foxes. Dogs and cats
Crenosoma vulpis	3 wks	290 days	Larvae within mollusc or paratenic host, infection orally	Everywhere	Dogs and foxes
Subcutaneous worms					
Dirofilaria repens	27 – 34 weeks	Several years	3rd stage larvae transmitted by mosquito vector (intermediate host)	Portugal, Spain, South of France, Italy, Greece, Croatia, Bosnia, Czech Republic and Turkey, Hungary (Fig.3)	Dogs (and cats)

Table 1D: Characteristics of major internal worms and protozoa of dogs in Europe: protozoa

Protozoal species	Pre-patent period	Patent period	Infective stages and route of infection	Distribution in Europe	Final hosts
Protozoa – intestinal (see separate guideline)					
Cystisospora spp.	4 – 11 days	4 – 28 days	Sporulated oocysts from soil; paratenic hosts	Everywhere	Dogs, cats
Neospora caninum	5 – 9 days	11 – 20 days (rarely months)	Oocysts from soil, cysts in intermediate hosts and transplacentally	Everywhere	Dogs, foxes
Hammondia spp.	5 – 9 days	1 – 20 days	Oocysts from soil, cysts in tissues	Everywhere	Dogs, cats
Cryptosporidium spp.	2 – 14 days	25 – 80 days	Oocysts in soil	Everywhere	Dogs, cats
Sarcocystis spp.	8 – 33 days	Several months	Oocysts in soil, cysts in tissues	Everywhere	Dogs, cats
Giardia spp.	4 – 16 days	Several weeks to months	Cysts in the environment, oral infection	Everywhere	Vertebrates

Table 2: Risk factors for major internal worms and protozoa for dogs in Europe

Some dogs are more likely to have parasite infections than others, although the difference is rarely absolute. This table highlights those factors that are likely to increase the likelihood of dogs carrying specific parasites. It has been drawn up on the basis of available understanding but is not the result of a formal risk assessment. Shaded boxes indicate increased risk.

Worm species	Dog type			Health	Environment		Nutrition			Location and travel
	Pup	Lactating	Stray	Fleas or lice	In kennels	Outdoors	Rodents	Molluscs	Raw meat /viscera	
INTESTINAL WORMS										
Roundworms or ascarids										
Toxocara canis	■	■	■		■	■	■		■	
Toxascaris leonina			■		■					
Hookworms										
Ancylostoma caninum	■	■	■		■	■				More in southern Europe
Uncinaria stenocephala	■	■	■		■	■				More in northern Europe
Strongyloides										
Strongyloides stercoralis	■	■			■					
Whipworm										
Trichuris vulpis										
Tapeworms										
Taenia spp.						■	■		■	
Mesocestoides spp.						■	■		Prey	
Dipylidium caninum			■	■						
Echinococcus granulosus									■	
Echinococcus multilocularis						■	■			Central Europe

Table 2: Risk factors for major internal worms and protozoa for dogs in Europe *(continued)*

Some dogs are more likely to have parasite infections than others, although the difference is rarely absolute. This table highlights those factors that are likely to increase the likelihood of dogs carrying specific parasites. It has been drawn up on the basis of available understanding but is not the result of a formal risk assessment. Shaded boxes indicate increased risk.

Worm species	Dog type			Health	Environment		Nutrition			Location and travel
	Pup	Lactating	Stray	Fleas or lice	In kennels	Outdoors	Rodents	Molluscs	Raw meat /viscera	
NON-INTESTINAL WORMS										
Heartworm										
Dirofilaria immitis						■				Portugal, Spain, South of France, Italy, Greece, Croatia, Bosnia, Czech Republic and Turkey (Fig. 3)
French heartworm										
Angiostrongylus vasorum						■		■		
Lungworms										
Oslerus osleri					■					
Filaroides spp.										
Capillaria spp.						■				
Crenosoma vulpis						■		■		
Sub-cutaneous worms										
Dirofilaria repens						■				Portugal, Spain, France, Italy, Greece, Croatia, Bosnia, Czech Republic, Turkey and Hungary (Fig. 3)
Protozoa – intestinal										
Cystisospora spp.	■									
Neospora caninum	■								■	
Hammondia spp.	■								■	
Cryptosporidium spp.	■									
Sarcocystis spp.	■								■	
Giardia spp.	■				■					

Table 3A: Characteristics of major internal worms and protozoa of cats in Europe: roundworms (nematodes) and tapeworms (cestodes)

Worm species	Pre-patent period	Patent period	Infective stages and route of infection	Distribution in Europe	Final hosts
INTESTINAL WORMS					
Roundworms or ascarids					
Toxocara cati	Variable, usually around six weeks after ingestion of eggs	4 – 6 months	Embryonated eggs from soil, larvae in milk or paratenic host	Everywhere	Cats
Toxascaris leonina	About 13 weeks	4 – 6 months	Embryonated eggs from soil, larvae from paratenic host	Everywhere	Dogs and cats
Hookworms					
Ancylostoma tubaeforme	2 – 3 wks	Can be prolonged depending on immune status	Larvae from soil	Predominantly southern Europe, sporadic in Northern Europe	Cats
Uncinaria stenocephala	3 – 4 weeks	Can be prolonged depending on immune status	Larvae from soil	Predominantly northern Europe	Dogs and foxes
Tapeworms					
Taenia taeniaeformis	4 – 11 wks	Several years	Larvae in rodents	Everywhere	Cats
Mesocestoides spp.	4 – 10 wks	Several years	Larval stages in meat or tissues	Everywhere	Cats, Dogs and foxes
Dipylidium caninum	3 wks	Several months	Larval stages in fleas or lice	Everywhere	Dogs and cats
Echinococcus multilocularis	28 days	Several months	Larval stages in intermediate hosts (rodents)	See map (Fig.2)	Dogs and foxes (cats)
NON-INTESTINAL WORMS					
Heartworm					
Dirofilaria immitis	6 – 8 months months	Rarely occurs with cats, and usually short	3rd stage larvae transmitted by mosquito vector (intermediate host)	Portugal, Spain, South of France, Italy, Greece, Croatia, Bosnia, Czech Republic and Turkey (Fig. 3)	Dogs (and cats)
Lungworms					
Aelurostrongylus abstrusus	7 – 9 weeks	Several years	Larvae in mollusc or paratenic host	Everywhere	Cats
Subcutaneous worms					
Dirofilaria repens	27 – 34 weeks	Several years	3rd stage larvae transmitted by mosquito vector (intermediate host	Portugal, Spain, South of France, Italy, Greece, Croatia, Bosnia, Czech Republic and Turkey, Hungary (Fig. 3)	Dogs (and cats)

Table 3B: Characteristics of major internal worms and protozoa of cats in Europe: protozoa

Protozoal species	Pre-patent period	Patent period	Infective stages and route of infection	Distribution in Europe	Final hosts
PROTOZOA – INTESTINAL (SEE SEPARATE GUIDELINE)					
Cystisospora spp.	9 –11 days	4 – 28 days	Sporulated oocysts from soil; paratenic hosts	Everywhere	Cats
Toxoplasma gondii	3 – 10 days	11 – 20 days (rarely months)	Oocysts from soil, cysts in intermediate hosts	Everywhere	Cats
Hammondia spp.	7 – 17 days	1 – 20 days	Oocysts from soil, cysts in tissues	Everywhere	Cats
Cryptosporidium spp.	3 - 7 days	25 – 80 days	Oocysts in soil	Everywhere	Dogs, cats
Sarcocystis spp.	10 - 14 days	Several months	Oocysts in soil, cysts in tissues	Everywhere	Cats
Giardia spp.	4 – 16 days	Several weeks to months	Cysts in the environment, oral infection	Everywhere	Vertebrates

Table 4: Risk factors for major internal worms and protozoa for cats in Europe

Some cats are more likely to have parasite infections than others, although the difference is rarely absolute. This table highlights those factors that are likely to increase the likelihood of cats carrying specific parasites. It has been drawn up on the basis of available understanding but is not the result of a formal risk assessment.

Worm species	Cat type			Health	Environment		Nutrition			Location and travel
	Kitten	Lactating	Stray	Fleas or lice	In cattery	Outdoors	Rodents/ amphibians or reptiles	Molluscs	Raw meat /viscera	
INTESTINAL WORMS										
Roundworms or ascarids										
Toxocara cati	■	■	■		■	■	■		■	
Toxascaris leonina			■		■					
Hookworms										
Ancylostoma tubaeforme	■	■	■		■					■
Uncinaria stenocephala	■		■		■					■
Tapeworms										
Taenia taeniaeformis							■			
Mesocestoides spp.							■			
Dipylidium caninum				■	■					
Joyeuxiella pasqualei							■			
Echinococcus multilocularis							■			Central Europe

Table 4: Risk factors for major internal worms and protozoa for cats in Europe *(continued)*

Some cats are more likely to have parasite infections than others, although the difference is rarely absolute. This table highlights those factors that are likely to increase the likelihood of cats carrying specific parasites. It has been drawn up on the basis of available understanding but is not the result of a formal risk assessment.

Worm species	Cat type			Health	Environment		Nutrition			Location and travel
	Kitten	Lactating	Stray	Fleas or lice	In cattery	Outdoors	Rodents/ amphibians	Molluscs	Raw meat /viscera	
NON-INTESTINAL WORMS										
Heartworm										
Dirofilaria immitis						■				Portugal, Spain, South of France, Italy, Greece, Croatia, Bosnia, Czech Republic and Turkey (Fig. 3)
Lungworm										
Aelurostrongylus abstrusus							■	■		
Protozoa – intestinal										
Cystisospora spp.	■									
Toxoplasma gondii	■									
Hammondia spp.	■									
Cryptosporidium spp.	■									
Sarcocystis spp.	■									
Giardia spp.	■									

Table 5: Worm infection of dogs: main clinical signs and diagnosis

Worm infection	Clinical symptoms	Material	Diagnoses
Hookworms: Ancylostoma caninum, Uncinaria stenocephala	Diarrhoea, bloody diarrhoea in the case of Ancylostoma caninum, weight loss and anaemia. May be acute or chronic signs	3 - 5 g faeces (fresh or fixed)	Egg detection by flotation
Toxocara canis	Low burden asymptomatic, higher burden may appear as cachexia and pot-bellied appearance in pups. Large number of worms may cause intestinal blockage or intussusception	See above	See above
Toxascaris leonina	Mostly asymptomatic	See above	See above
Trichuris vulpis	Asymptomatic but heavy infections associated with anaemia, diarrhoea and weight loss	See above	See above
Dirofilaria immitis (Heartworm disease)	Low worm burdens asymptomatically First clinical manifestation 5-7 month p.i. reduced condition, dyspnoea, cough Chronic disease cough, tachycardia. "Caval syndrome": tachypnoea	2-4 ml EDTA blood 1 ml serum or plasma	Detection of microfilariae from 6.2 month p.i. detection improved by concentration of microfilariae with Difil-Test or Knott's Test. Microfilariae can be speciated using morphological, biochemical or molecular species identification* Circulating antigens*(from 5. month p.i. (sensitivity around 90% if 1 female worm or approximately 100% if more are present)
Dirofilaria repens (Cutaneous filariosis)	Mostly asymptomatic, cutaneous lesions	2-4 ml EDTA blood	Detection of microfilariae from 6.2 month p.i. detection improved by concentration of microfilariae with Difil-Test or Knott's Test. Microfilariae can be speciated using morphological, biochemical or molecular species identification*
Thelazia callipaeda	Blepharospasm and epiphora	Material from the surface of the eye	Detection of adult or larval stages from samples of the tear film from the surface of the conjunctiva

* in specialised laboratories only

Table 5: Worm infection of dogs: main clinical signs and diagnosis *(continued)*

Worm infection	Clinical symptoms	Material	Diagnoses
Angiostrongylus vasorum	Often asymptomatic, cardiovascular and respiratory symptoms: cough dyspnoea, coagulopathy (eg subcutaneous haematomas anaemia), neurological symptoms	Fresh faeces (at least 4 g) or bronchial lavage fluid	Detection of live larvae from fresh faeces (4 g) using the Baermann method, or microscopical detection of larvae in bronchial lavage material
Lungworms: *Crenosoma vulpis, Filaroides spp.*	Respiratory symptoms coughing and possibly exercise intolerance	Fresh faeces (at least 4 g) or bronchial lavage fluid	See above
Echinococcus granulosus, E. multilocularis	Asymptomatic	At least 4 g faeces, freezing of faeces by -80° C destroys eggs	Morphology and size of proglottids. Egg detection with flotation, sedimentation or combined techniques (sensitivity reduced, taeniid eggs can not be further differentiated morphologically). *PCR/sequencing allows species and genotype identification (from isolated eggs or proglottids) Coproantigen detection enables detection of prepatent infections 10 days p.i., Sensitivity more than 90% if more than 50 worms are present, reduced if under 50 worms PCR/sequencing allows species identification (from isolated eggs or proglottids)
Taenia hydatigena, T. multiceps, T. ovis, T. pisiformis and other	Asymptomatic	Proglottids on faeces or faeces (See above)	Proglottids grossly visible: morphology of proglottids. Taeniid eggs in faeces (see above).
Dipylidium caninum	Mostly asymptomatic, anal pruritus	Proglottids on faeces or faeces	Proglottids similar size to Taenia spp proglottids; eggs within proglottids grouped in egg packets can be seen microscopically within faecal samples

* in specialised laboratories only

Table 6: Worm infection of cats: main clinical signs and diagnosis

Worm infection	Clinical symptoms	Material	Diagnoses
Hookworms: *Ancylostoma tubaeforme, Uncinaria stenocephala*	Diarrhoea, bloody diarrhoea in the case of *Ancylostoma tubaeforme*, weight loss and anaemia. May be acute or chronic signs	3 - 5 g faeces (fresh or fixed)	Egg detection by flotation
Toxocara cati	Low burden asymptomatic, higher burden may appear as cachexia and pot-bellied appearance in kittens. Large number of worms may cause intestinal blockage or intussusception. Occasional pneumonia in kittens	See above	See above
Toxascaris leonina	Mostly asymptomatic	See above	See above
Dirofilaria immitis Heartworm disease	Often worm burdens asymptomatic Initial signs as the worms reach the heart. Later disease acute symptoms associated with worm death, cough, tachycardia, tachypnoea	2-4 ml EDTA blood 1 ml serum or plasma	Microfilariae and/or antibody detection. Detection of microfilariae from 8 months p.i. may be negative as levels can be very low in cats. Detection may be improved by concentration of microfilariae with Difil-Test or Knott's Test. Microfilariae can be speciated using morphological, biochemical or molecular species identification*. Antibodies are sensitive, but can be positive in case of pre-patent infections which will not develop into patent infection. A definite diagnosis of heartworm infection can often be obtained only by the application of haematological and serological tests in conjunction with thoracic radiography and echocardiography.
Dirofilaria repens Cutaneous filariosis	Mostly asymptomatic, cutaneous lesions	2-4 ml EDTA blood	Detection of microfilariae from 6.2 month p.i. detection improved by concentration of microfilariae with Difil-Test or Knott's Test. Microfilariae can be speciated using morphological, biochemical or molecular species identification*

* in specialised laboratories only

Table 6: Worm infection of cats: main clinical signs and diagnosis *(continued)*

Worm infection	Clinical symptoms	Material	Diagnoses
Thelazia callipaeda	Blepharospasm and epiphora	Material from the surface of the eye	Detection of adult or larval stages from samples of the tear film from the surface of the conjunctiva
Lungworms: *Aelurostrongylus abstrusus*	Respiratory symptoms coughing and possibly exercise intolerance	Faeces or bronchial lavage material	Detection of live larvae from fresh faeces (4 g) using the Baermann method or microscopical detection of larvae in bronchial lavage material
Echinococcus multilocularis	Asymptomatic and rare to have patent infections in cats	At least 4 g faeces, freezing of faeces by -80° C destroys eggs	Morphology and size of proglottids. Egg detection with flotation, sedimentation or combined techniques (sensitivity reduced, taeniid eggs can not be further differentiated morphologically). *PCR/sequencing allows species and genotype identification (from isolated eggs or proglottids) Coproantigen detection enables detection of prepatent infections 10 days p.i., Sensitivity more than 90% if more than 50 worms are present, reduced if under 50 worms PCR/sequencing allows species identification (from isolated eggs or proglottids)
Taenia taeniaeformis	Asymptomatic	Proglottids or faeces (See above)	Proglottids grossly visible: morphology of proglottids. Taeniid eggs (see above).
Dipylidium caninum	Mostly asymptomatic	Identification of proglottids on faeces or eggs in faeces	Proglottids similar size to Taenia spp proglottids; eggs within proglottids grouped in egg packets can be seen microscopically within faecal samples

* in specialised laboratories only

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EUROPEAN SCIENTIFIC COUNSEL COMPANION ANIMAL PARASITES

Worm Control in Dogs and Cats

Guideline 1, December 2006

Bayer HealthCare Animal Health

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