

DOG PARASITES

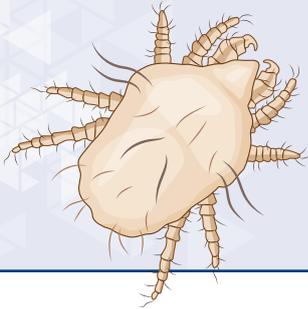


M. Servonnet, E. Tielemans, N. Perier, L. Antoine, F. Beugnet
Global Veterinary Technical Services, Boehringer Ingelheim Animal Health, Lyon, France

TABLE OF CONTENTS

	Acarids	<i>Cheyletiella</i> Chiggers (harvest mites) <i>Demodex</i> mites Ear mites Mange mites Ticks		
	Insects	Fleas Lice		
	Digestive Nematodes	Ascarids Hookworms Oesophageal worm Threadworm Whipworm		
	Non Digestive Nematodes	Lungworm		
	Plathelminths	<i>Dipylidium caninum</i> tapeworm <i>Echinococcus</i> tapeworms <i>Taenia</i> tapeworms Uncommon tapeworms in dog		
		Digestive protozoans	<i>Giardia</i> <i>Isospora</i> coccidia <i>Neospora</i>	
			Vector-borne diseases	<i>Borrelia</i> <i>Ehrlichia</i> spp. and <i>Anaplasma</i> spp. Heartworm <i>Leishmania</i> Piroplasmids (<i>Babesia</i> spp.)
				Anthelmintic treatment in dog

ACARIDS

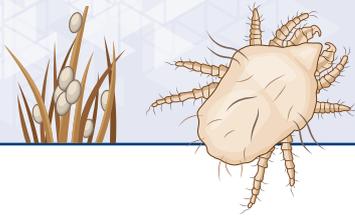
CHEYLETIELLA
Cheyletiella yasguriAdults
0.5 mmEggs
0.1-0.2 mm

Visible under the microscope



- *Cheyletiella yasguri*, also nicknamed ‘walking drandruff’ is distributed worldwide.
- *Cheyletiellosis* is more common in puppies and dogs living in kennels.
- *Cheyletiella yasguri* is **host-specific** and is **highly contagious** among dogs.
- Adult mites **live on the skin surface** and feed on skin debris and epidermis.
- *Cheyletiella* mites are quite active, moving scales, explaining why they are also called ‘walking dandruff’ mites.

*Cheyletiella* sp. mite.

**MODE OF INFESTATION**

By direct contact between dogs or through contaminated environment, where the *Cheyletiella* mites can live several weeks by preying on other acarids like dust mites.

CLINICAL SIGNS

Dogs can be asymptomatic carriers, especially adults.

Preferred site of infestation: dorsum.

Most common clinical signs: pruritus (variable), skin scaling, erythema, crusted lesions.

DIAGNOSIS

Based on visual **mite identification by microscopy.**

The easiest way to detect *Cheyletiella* mites is to apply an adhesive tape on hairs and scales, then to stick it on a slide for microscopical examination.

ZOOONOTIC RISK

C. yasguri is zoonotic: people can acquire transient pruritic and papular rash. The mites do not stay on humans and lesions will disappear once the animal has been successfully treated.

CONTROL MEASURES**TREATMENT**

1. No parasiticides are labeled against *C. yasguri* but a number of topical acaricides acting by contact (e.g., fipronil) licensed for use in dogs have been shown to be effective.
2. All the animals of the household must be treated to prevent reinfestation from asymptomatic carriers.

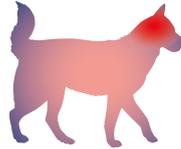


Dorsal scaling caused by cheyletiellosis in a puppy.

ACARIDS

CHIGGERS (HARVEST MITES)

Neotrombicula autumnalis, *Eutrombicula alfreddugesi*,
Eutrombicula splendens, *Eutrombicula sarcina*



Adults
0.2-0.4 mm



Eggs
0.2 mm



Visible under the microscope



- Different species of harvest mites exist, including: *Neotrombicula autumnalis* (Europe), *Eutrombicula alfreddugesi* (North and South America), *Eutrombicula splendens* (North and South America) and *Eutrombicula sarcina* (Australasia).
- The larval stage is the **only parasitic stage**, infesting a wide range of mammals (dogs, cats, rodents, rabbits, humans...), birds, reptiles, and even amphibians.
- Larvae are **often attached to the skin in clusters** and appear as 'orange powder'. They feed by digesting dermal tissues, similarly to ticks.
- Infestations mostly occur in summer and autumn, but Trombiculids can be seen all year round.



Neotrombicula spp. larva.



ACARIDS

DOG ECTOPARASITES

CHIGGERS (HARVEST MITES)

Neotrombicula autumnalis, Eutrombicula alfreddugesi, Eutrombicula splendens, Eutrombicula sarcina

BIOLOGY AND MODE OF INFESTATION

- **Infestation only occurs from the environment**, there is no contamination by direct contact from an infested animal to another.
- Larvae stay attached for a few days (3-4) before leaving their host. Larvae molt to the nymphal stage, nymph to adults, which are free in the environment.

CLINICAL SIGNS

- **Pruritus and dermal irritation signs.**
- **Lesions and clinical signs may persist for several days after mites have fed and left the host.**
- Preferred sites of infestation: eyelids, ears, face, lips, periocular region, feet and interdigital spaces, pinnae, axillae...

DIAGNOSIS

Based on medical history, time of the year and clinical signs.
Clumps of orange-coloured mites can be seen with the naked eye.
Skin scrapings help to identify mites.

ZOONOTIC RISK

Humans can be infested by larvae in the environment like other animals.

CONTROL MEASURES

TREATMENT

No parasiticides are registered for this indication, but many **topical acaricides**, such as fipronil and permethrin, are effective and can be used in dogs. **Isoxazolines are also effective** in killing chiggers, but cannot prevent clinical signs' appearance.

PREVENTION

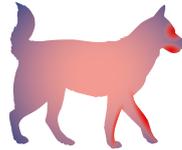
Prevention is very difficult due to the frequent reinfestations of animals.



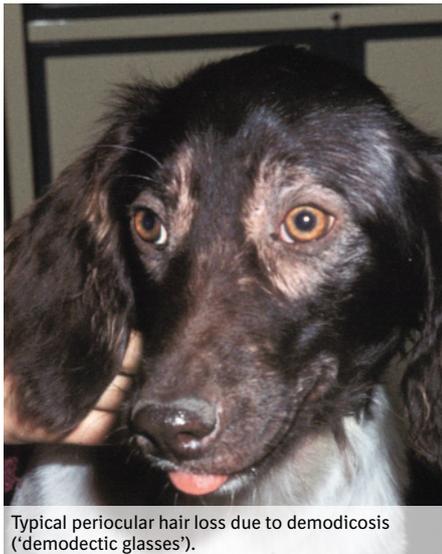
Trombiculosis in a dog.

ACARIDS

DEMODOX MITES

Demodex canisAdults
0.25-0.3 mmEggs
0.05-0.1 mm

Visible under the microscope



Typical periocular hair loss due to demodicosis ('demodectic glasses').

- *Demodex canis* are cigar-shaped/wormy mites with atrophied legs.
- *Demodex canis* are commensal mites: they live in the hair follicles and sebaceous glands, and feed on scales and sebum.
- At least 50% of adult dogs are asymptomatic carriers of *Demodex*.
- Demodicosis is caused by the uncontrolled proliferation of the mites.
- *Demodex* mites cannot live off their host.



Nummular hair loss due to demodicosis.



Adult *Demodex canis*.

**MODE OF INFESTATION**

Acquired soon after birth, through direct contact with the mother, usually during milking.

CLINICAL SIGNS

Demodex canis is responsible for localised or generalised forms.

Localised demodicosis:

- More frequent in puppies and young dogs (< 2 years old).
- Often benign and self-resolving.
- Dermatological signs: one to four, **circumscribed, erythematous, partially hairless patches**, mainly on the face and the forelegs. Pruritus is generally absent.

Generalised demodicosis:

- Demodicosis is considered to be generalised if **at least five distinct body regions** or at least two feet are affected.
- Observed in young dogs with idiopathic immunodeficiency.
- In adult dogs, severe clinical signs are usually associated with underlying conditions, such as diabetes mellitus, acquired immunodeficiency, Cushing's syndrome, hyperadrenocorticism, etc.
- Dermatological signs: **erythema, comedones, hair loss**, papules, pustules and scales.
- Secondary bacterial infections often occur and severe systemic signs may arise.

DIAGNOSIS

- Based on the detection of mites in deep **skin scrapings**.
- A trichogram may be useful in areas that are difficult to scrape, as the mite inhabits hair follicles.

CONTROL MEASURES**TREATMENT**

- Prognosis for generalised demodicosis may be poor when underlying diseases co-exist.
- **Treatment is long** and takes usually not less than 3 months. It can be even longer for pododemodicosis.
- Some **isoxazolines** (e.g., afoxolaner) are approved for the treatment of *Demodex canis* infestation in dogs.
- Treatment should be continued until skin scrapings are negative on at least 2 consecutive occasions one month apart. The underlying condition should also be treated to limit the risk of relapses.



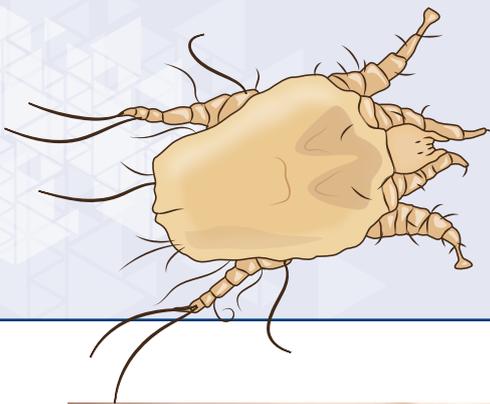
Generalised alopecia due to demodicosis.



Erythema due to demodicosis. Courtesy of Parasitology Unit, Alfort Veterinary School.

ACARIDS

EAR MITES

Otodectes cynotisAdults
0.5 mmEggs
0.2 mm

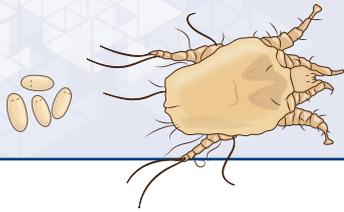
Visible under the microscope



Dark-brown cerumen in ear mite infestation.

- *Otodectes cynotis* is a one-host parasite of dogs, cats and ferrets, but is less frequent in dogs than in cats.
- All life stages (eggs, larvae, nymphs, and adults) **live permanently in the ear canal**. Ear mites can leave one ear to move to the other ear, or other hosts.
- They feed on cerumen and inflammatory secretions.
- Ear mites are **highly contagious between animals, but not zoonotic**.

*Otodectes cynotis* female and eggs.



MODE OF INFESTATION

Direct by close contact between infested dogs, cats and ferrets, or from a recently contaminated environment (e.g., bedding).

CLINICAL SIGNS

- *Otodectes cynotis* is an **important agent of external otitis** in dogs.
- The otitis induced is often bilateral and characterised by **pruritus, redness and dark brownish dry cerumen**.
- Self-induced pruritic lesions on and around the ears and secondary bacterial or yeast infections can occur.

DIAGNOSIS

Based on clinical signs and/or visual detection of mites in the ear canal using an otoscope, or by the **examination of ear canal swabs under the microscope**. The severity of the otitis does not always correlate to the number of mites.

CONTROL MEASURES

TREATMENT

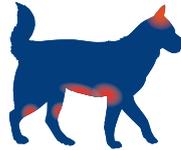
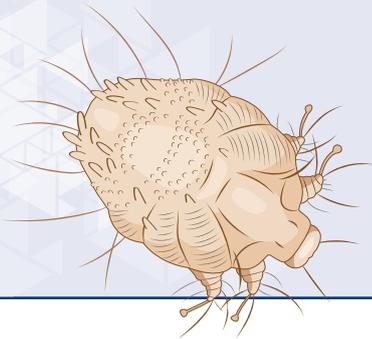
1. **Ear cleaning** to remove the ceruminous exudate.
2. Treatment of the dog with an acaricidal formulation effective against ear mites such as **systemic spot-on or oral product** containing moxidectin, selamectin, afoxolaner, fluralaner, sarolaner. A second administration may be required one month later to break the parasite life cycle.
3. **All susceptible animals** (cats, dogs, ferrets) **of the household must be simultaneously treated** to prevent reinfestation from asymptomatic carriers.

PREVENTION

Preventive treatment may be considered in young dogs and in breeding females which often infest their offspring by direct contact.

ACARIDS

MANGE MITES

Sarcoptes scabiei var. *canis*Adults
0.2-0.4 mmEggs
0.2 mm

Visible under the microscope



Sarcoptic mange lesions: diffuse hair loss on the legs, lower abdomen and face.

- *Sarcoptes scabiei* var. *canis* infestations are observed worldwide, more commonly in dogs living in groups, in those belonging to homeless people, and in stray dogs.
- All stages (eggs, larvae, nymphs and adults) **live in the epidermal layers of the skin.**
- Infestations with *S. scabiei* are **often under-diagnosed** in dogs.
- Sarcoptic mange is **highly contagious** between dogs of all ages. Occasionally, infested dogs may contaminate cats living closely with them.

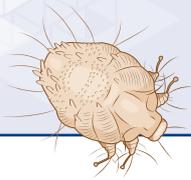


Sarcoptes scabiei.

MANGE MITES

Sarcoptes scabiei var. *canis*

ACARIDS



BIOLOGY AND MODE OF INFESTATION

- Mating occurs at the surface of the skin. **Females then dig tunnels and lay eggs in the epidermis.** Larvae evolve into nymphs which reach out to the surface to reproduce.
- Infestation is due to **direct contact** with infested dogs (or other canids), rarely from a contaminated environment (e.g., bedding) where both nymphs and adults may survive up to 3 days.

CLINICAL SIGNS

- **Dermatological signs:** intense pruritus, hair loss, erythema, papules, scaling, crusting, with common secondary bacterial and fungal infections.
- Lesions are **initially distributed on the face** (external part of the ear flaps), **legs and lower abdomen.**
- **General signs** (anorexia, fever, weight loss...) may be seen in **chronic cases.**



Diffuse erythema and crusted papules on the external part of the ear. *Courtesy of Parasitology Unit, Alfort Veterinary School.*

DIAGNOSIS

Based on clinical signs and microscopical observation of the mites through **deep skin scraping.** Mites may be difficult to find despite a high clinical suspicion.

ZOOBOTIC RISK

The mites can temporarily infest humans, causing a pruritic dermatitis with papules. Unlike *S. scabiei* var. *hominis*, *S. scabiei* var. *canis* cannot survive in human skin. The lesions will disappear along with the treatment of the dog.

CONTROL MEASURES

TREATMENT

1. Treatment of skin disorders (antiseborrheic shampoos, antibiotics...)
2. Registered systemic acaricidal products are available, containing **avermectins/milbemycins and/or isoxazolines.**
3. **All in-contact animals must be treated** with suitable acaricides.
4. As relapses may occur, **treatments should be repeated** until skin scrapings are negative and lesions resolved.

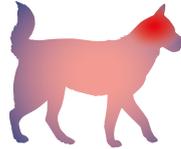
ENVIRONMENT

Regular cleaning/disinfection of the environment by vacuuming and washing bedding must be carried out throughout the treatment period.

ACARIDS

TICKS ^{1/2}

Amblyomma spp., *Dermacentor* spp., *Haemaphysalis* spp.,
Hyalomma spp., *Ixodes* spp., *Rhipicephalus* spp.



Adults ♂
3-5 mm



Adults ♀
3-5 mm
(unfed)



Adults ♀
8-10 mm
(engorged)



 Visible with naked eye



Tick feeding on a dog.

- Ticks (Ixodida) are the giant of acarians, they are divided in two groups, hard ticks (Ixodidae) and soft ticks (Argasidae). **Mammals are mainly infested by Ixodidae or hard ticks**, divided in 6 genus and **more than 650 species**.
- Hard ticks have a **dorsal chitinous part** called scutum, which is **fully developed in males and smaller in females, allowing the latest to engorge during feeding**. Hard ticks have three stages (larva, nymph and adult), which are all **hematophagous**. Adult ticks measure 3 mm to 10 mm depending on the sex and the status of engorgement, the biggest ones being females at the end of their blood meal.
- Tick **infestations can be seasonal** in temperate zones, **or year-round** in warmer regions.
- **Major tick species** infesting dogs are:
 - ***Amblyomma* spp.** (e.g., *A. americanum*, *A. maculatum*): forest ticks found in warm climates in north, central and south America. Larval and nymphal

ACARIDS

*Dermacentor variabilis* male.*Rhipicephalus sanguineus* male.

stages feed on small mammals and birds, while adults have a tropism for large mammals, especially ruminants. They can also infest humans and companion animals.

- ***Dermacentor* spp.** (e.g., *Dermacentor reticulatus*, *D. variabilis*) are meadow ticks found in cold and temperate climates. Larvae and nymphs are found on small mammals, while adults feed on larger ones including ruminants and horses. They may also infest humans and companion animals.
- ***Haemaphysalis* spp.**, bush and forest ticks, are found in warm and tropical climates, especially in Asia. They have a tropism for small mammals, birds and reptiles at larval and nymphal stages. Adults rather feed on large mammals (ruminants, wildlife). *Haemaphysalis* ticks are able to infest companion animals.
- ***Ixodes* spp.** include forest ticks (e.g., *Ixodes ricinus*, *I. scapularis*) found in temperate and cold climates, worldwide, but also species adapted to tropical or semi-arid zones (e.g., *Ixodes holocyclus*, *I. gibbosus*). Larvae and nymphs rather feed on small mammals, birds and lizards; adults are more specific to large mammals, especially ruminants. They can also infest humans and companion animals.
- ***Rhipicephalus sanguineus***, the brown dog tick, is found in warm areas worldwide, and has a high tropism for dogs at all stages of the life cycle.

Amblyomma spp., *Dermacentor* spp., *Haemaphysalis* spp.,
Hyalomma spp., *Ixodes* spp., *Rhipicephalus* spp.

ACARIDS



BIOLOGY AND MODE OF INFESTATION

- The classical tick life cycle is **triphasic**, meaning **3 hosts per generation**: **larvae** search for a host to take their blood meal, fall off and moult into **nymphs**, which will then search for a host to take their blood meal, fall off and moult into **adults**. The adults will do the same, searching for a host to take their blood meal which lasts from 3 to 7 days. Females and males mate on the host. After feeding, the females fall off their host onto the ground and lay around **3000 eggs within 48 to 72 hours**, before dying.
- Each stage can survive for a year, waiting for a host or the next favorable season.
- Almost all ticks infesting pets are 3-host ticks, but some have a diphasic (2-hosts) cycle, larvae moulting in nymphs on the host (i.e., *Hyalomma marginatum*). A specific sub-genus of ticks infesting ruminants, *Boophilus*, are monophasic (only 1 host), all stages moulting on the same host.
- Ticks identify the proximity of a host through carbon dioxide, smell (using specific organs located on their first pair of leg, called Haller organs), body temperature. Some tick species have eyes.
- **To infest their host, ticks have two strategies:**
 - **Questing** (*Dermacentor*, *Haemaphysalis*, *Ixodes*): the ticks climb onto the vegetation during the day, remain immobile and wait for their host to approach before sticking to it.
 - **Hunting** (*Amblyomma*, *Hyalomma*, and *Rhipicephalus* to a certain extent): the ticks are highly mobile, following their hosts to infest them (they can 'run' quite fast).



Amblyomma americanum female tick questing.



Ixodes ricinus female tick questing.

CLINICAL SIGNS

- Anaemia in cases of heavy infestation.
- Inflammatory granulomas in cases of improper tick removal.
- Paralysis (caused by paralysis ticks such as *Ixodes holocyclus* in Australia).
- The attachment and feeding are not pruritic and not painful.

TICKS CAN TRANSMIT PATHOGENS TO DOGS

- **Protozoans**, such as *Babesia* spp., the agents of piroplasmosis (see specific memo card).
- Rickettsial agents, such as *Ehrlichia canis*, *Anaplasma phagocytophilum* and *Anaplasma platys* (see specific memo card).
- **Bacteria**, such as *Borrelia burgdorferi*, the agent of Lyme disease (see specific memo card).
- **Viruses**, responsible for tick-borne encephalitis.

ACARIDS



DIAGNOSIS

Based on the **observation of ticks** crawling on the haircoat or attached to the skin.

During tick seasons and in tick areas, owners must always be advised to search for ticks, even if the antiparasitic treatment is up to date.

ZOO NOTIC RISK

Ticks infest humans directly from the environment (there is no risk of direct transfer from an animal to a human being).



CONTROL MEASURES

TREATMENT OF AN EXISTING TICK INFESTATION

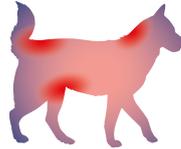
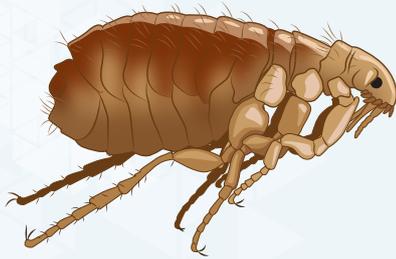
When ticks are observed, they must be immediately and carefully removed with an appropriate device, and **an acaricidal treatment should be applied** to the animal.

PREVENTION

The **tick control is based on regular treatments** of the animal with acaricides approved for use in dogs. The main ones are:

- **Isoxazolines** (e.g., afoxolaner, fluralaner, lotilaner, sarolaner): **systemic** acaricidal effect (oral or spot-on formulations).
- **Phenylpyrazoles** (e.g., fipronil): acaricidal effect through **contact** (spot-on formulations).
- **Pyrethroids** (e.g., flumethrin, deltamethrin, permethrin): acaricidal & repellent effects through **contact** (collars and spot-on formulations).

INSECTS

FLEAS ^{1/2}*Ctenocephalides felis*, *Ctenocephalides canis*Adults
3-6 mm

Visible with naked eye

Eggs
0.5-1 mm

- Fleas are small insects, orange to brown, wingless, laterally compressed, measuring 3-6 mm in length depending on the species, sex and status of engorgement.
- The main genus infesting dogs is *Ctenocephalides*.
- *Ctenocephalides felis*, the 'cat flea', is **found worldwide** but prefers warm areas. In cold areas, they have mainly an indoor life cycle (i.e., in house). ***C. felis* fleas are not specific** and feed on various mammals (e.g., dogs, cats, rodents, rabbits, humans).
- *Ctenocephalides canis* fleas are found in temperate and cold climates, mainly in rural areas, and are **more specific**: they take their blood meal on wild and domestic **canids**.
- **Adult fleas** typically **stay on their host** until they die, over a lifetime of approximately 30 days, and rarely move from one host to another.
- They take 4 to 10 blood meals per day and ingest up to 15 times their weight in blood daily.
- Female fleas lay ~ 25 eggs/day for 30 days (around 500 eggs over a lifetime).

FLEAS

Ctenocephalides felis, Ctenocephalides canis

INSECTS



BIOLOGY AND MODE OF INFESTATION

ON THE DOG

Adult fleas are the only parasitic stage found on animals.

Adult

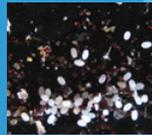


Adult fleas start taking their blood meals on pets very soon after infestation (in 5 to 40 minutes). Females start producing and laying eggs on the host within 36 hours after infestation (sometimes as soon as 24 hours).

IN THE ENVIRONMENT

All immature stages of fleas live in the environment: indoors (carpets, rugs, dog's bedding, cracks on wooden floor, basement...) and outdoors (e.g., garden). Infested wildlife acts as a reservoir, perpetuating the environmental infestation.

Eggs



Eggs laid in the hair-coat quickly drop off the pet into the environment (i.e., indoor or outdoor).

Larvae



Larvae (L1, L2, L3) feed on organic matters such as flea faeces and skin or other organic debris. If humidity is correct (high sensitivity to dry conditions and UV), they evolve in 7-10 days to form the cocoon.

Pupae



Pupae (pre-emerged fleas) develop in silky and sticky cocoons, which are very **resistant in the environment**, and can survive for 6 to 12 months. Various stimuli induce the hatching of young fleas from cocoons, especially vibrations and shadow from the host. Emerged young fleas move close to the host and jump on it, using their developed third pair of legs. If they fail to infest the host, they will die in a few days.

**CLINICAL SIGNS**

Non-allergic dogs: pruritus (scratching, licking and nibbling at themselves), anaemia in case of severe infestation (more common in puppies, old or debilitated dogs).

Allergic dogs: immune reactions to flea saliva, known as Flea Allergy Dermatitis (FAD).

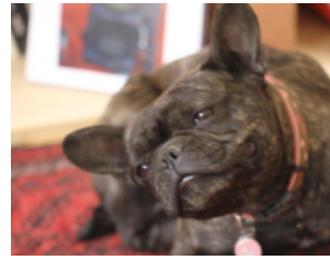
FAD signs: intense pruritus, scratching wounds, excessive licking, hair loss primarily on the lumbosacral area and other inflammatory cutaneous disorders. Bacterial infection may occur.

DIAGNOSIS

Based on clinical suspicion and/or on the observation of fleas or flea faeces on the skin or in the haircoat.

Flea faeces appear as dark 'comma-shaped' grains (up to 1 mm in length when intact): when dampened on white paper, a reddish coloration due to the flea's blood diet appears around the 'flea dirt'.

When the level of infestation is still low, pet owners may have difficulties to observe fleas on their dog because these parasites are well hidden in the coat and run fast from one side to another to escape the search.



Flea-infested dog scratching.



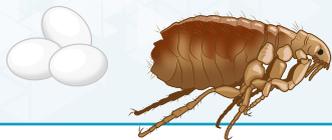
Acute exudative dermatitis in a dog infested by fleas.



Flea dirt.



Flea dirt dampened on white paper.



FLEAS CAN TRANSMIT PATHOGENS TO DOGS

Dipylidium caninum (see specific memo card).

ZOONOTIC RISK

- Fleas may also bite and feed on humans.
- *Dipylidium caninum* can be transmitted to humans, especially to young children, by accidental ingestion of an infected flea.

CONTROL MEASURES

TREATMENT OF AN EXISTING FLEA INFESTATION

1. **Treat the dog with an approved insecticide for at least 3 months** in order to exhaust the environmental reservoir of immature forms which progressively become adult fleas and re-infest the pet.
2. **Treat all the animals of the household** with relevant insecticides.
3. **Regular cleaning of the environment** (vacuum cleaning and washing bedding) is important to help reduce the population of immature flea stages.
4. In case of massive infestation, apply insecticides in the environment with products specifically designed for this usage (preferably handsprayers).

Main insecticides used in dogs are:

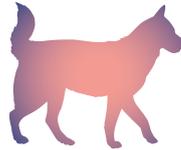
- Isoxazolines (e.g., afoxolaner, fluralaner, lotilaner, sarolaner), acting through systemic activity (oral or spot-on formulations).
- Phenylpyrazoles (e.g., fipronil), acting through contact activity (spot-on formulations).
- Selamectin, acting through systemic activity (spot-on formulations).
- Neonicotinoids (e.g., imidacloprid, dinotefuran), acting through contact activity (spot-on formulations).

PREVENTION

- **Regular treatments with anti-flea products will control the infestation.** The period of administration depends on the risk of exposure to fleas.
- **Insect growth regulators** (e.g., (S)-methoprene, pyriproxyfen, lufenuron) may be used alone or in combination with insecticides, in environmental products, or in veterinary formulations for pets. They **inhibit the egg hatching and/or the evolution of larvae**, thus providing an additional way of controlling fleas.

INSECTS

LICE

Trichodectes canis, *Linognathus setosus*, *Heterodoxus spiniger*Adults
1-6 mmEggs
1 mm

Visible with naked eye



Louse infestation in a dog.

- Dog lice include several species. *Trichodectes canis* and *Linognathus setosus* are distributed worldwide, while *Heterodoxus spiniger* is found in tropical countries.
- Lice are small yellowish to brown insects, measuring 1-6 mm in length, depending on the species. They are wingless and dorso-ventrally flattened.
- Lice are host-specific, and the dog ones do not affect other animal species, nor humans.
- Chewing lice, such as *Trichodectes canis* and *Heterodoxus spiniger*, feed on skin debris, inflammatory exudate, and occasionally on blood (*H. spiniger*).
- The sucking lice *Linognathus setosus* lice feed on blood.
- Lice lay eggs (nits) cemented to hair shafts. The entire life cycle takes place on the dog.
- Louse infestation is rare in domestic dogs, but common in stray dogs.

*Trichodectes canis*.*Linognathus setosus*.

INSECTS



BIOLOGY AND MODE OF INFESTATION

- Females lay around 300 eggs in 6-8 weeks of lifespan, sticking them on hairs (nits). First stage nymphs appear after egg hatching, they moult to second and third stages before final moulting into adults in around 3-4 weeks. Nymphs really look like adult lice, but smaller in size.
- Infestation can occur directly by close contact with infested dogs, or through pet bedding, hair brushed or combed, as immature and adult lice may survive 1-3 days off their host.

CLINICAL SIGNS

Pruritus, scales, crusts, matted coat, hair loss.

Severe infestation with sucking lice may result in anaemia, particularly in young puppies.

DIAGNOSIS

Based on the **observation of whitish nits** (1 mm long) **attached to the base of the hairs**, or of adult lice which move fast and can therefore be more difficult to find.

LICE CAN TRANSMIT PATHOGENS TO DOGS

Trichodectes canis may occasionally act as an intermediate host for the tapeworm *Dipylidium caninum* (fleas are the major ones).

CONTROL MEASURES

TREATMENT

1. Treat the dog with an approved insecticide effective against lice (e.g., fipronil, selamectin, imidacloprid).
2. **Treat all dogs** of the household to prevent reinfestation.

ENVIRONMENT

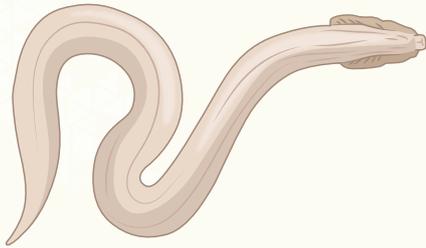
Bedding and grooming material should be washed.



Close-up on a louse egg (nit).

DIGESTIVE
NEMATODES

ASCARIDS ^{1/2}
Toxocara canis, Toxascaris leonina



Adults
5-15 cm



Visible with
naked eye

Eggs
70-90
× 65-75 μm



Visible under
the microscope



T. leonina



T. canis



(*T. canis* only)



Potbelly in a roundworm infected puppy*.

- Ascarids (roundworms) are the **most common intestinal nematodes** infesting dogs. They are particularly frequent in puppies.
- Adult worms measure 5 to 15 cm long and **live in the small intestine** of dogs.
- Ascarids are not hematophagous, they consume intestinal nutrients (e.g., glucose, vitamins, calcium and phosphorous).
- *Toxocara canis* is a zoonotic species, causing *larva migrans* in humans.
- *Toxascaris leonina* is less common and is not zoonotic.



Adult *Toxocara canis*.



DIGESTIVE
NEMATODES

BIOLOGY AND MODE OF INFESTATION

*Toxocara canis***Puppies & young dogs (< 6 months):**

- *In utero* transplacental infestation by reactivated larvae.
- Ingestion of reactivated larvae via the colostrum and milk (transmammary transmission).
- Ingestion of infective eggs from the environment (soiled matters), or through a paratenic host ingestion (e.g., rodents).

Adult dogs (> 6 months):

- Ingestion of infective eggs from the environment, or ingestion of a paratenic host harbouring encysted infective larvae (e.g., rodents).
- Ascarid **eggs are highly resistant** in the environment (up to 5 years).

Toxascaris leonina

- *T. leonina* is found in rural environment, where wild carnivores (e.g., foxes) are present.
- Infestation occurs through the ingestion of infective eggs in the environment, or of encysted larvae harboured by a paratenic host (e.g., rodents).

T. leonina develops directly in the small intestine, without any migration.

The *T. canis* larvae undergo distinct migrations depending on the dog's age.

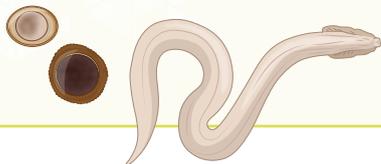
Puppies < 6 months old: entero-pneumo-tracheo-enteral migration.

Larvae pass through the intestine wall, migrate to and through the liver, then to the lungs through the lymphatic and venous vessels. When reaching the pulmonary arterioles, they leave the blood vessels, enter the alveoli, migrate up the bronchi and trachea following the mucosal flow and finally reach the pharynx where they are swallowed and therefore access the digestive tract, where they transform into adults in the intestine.

Dogs > 6 months old: Possibility of entero-pneumo-tracheo-enteral migration but also of a somatic migration.

Larvae migrate the same way to the lungs, but do not enter the alveoli. Instead they go past the vascular pulmonary filter and get distributed throughout the body by the arterial bloodstream until being stopped at capillary level and get encysted in tissues (mainly in muscles). In cases of pregnancy or immune disorder, dormant encysted larvae get reactivated and enter the bloodstream, reach the lungs and enter a pneumo-tracheo-enteral cycle to become adults in the intestine, or reach the placenta and the mammary glands in females.





CLINICAL SIGNS

Toxocara canis

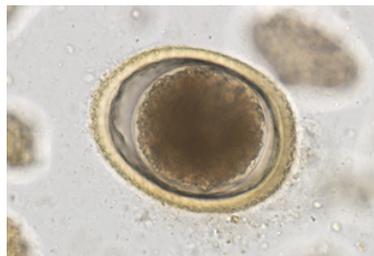
- Puppies (under 6 months old) are more sensitive.
- Dogs over 6 months are more resistant to the infestation, except in case of impaired immunity.
- Low burdens are usually well tolerated and asymptomatic.
- In cases of heavy worm burden, especially in puppies, clinical signs are:
 - Respiratory disorders: coughing (due to the tracheal migration of larvae).
 - Failure to thrive, emaciation, dull coat, joint pain...
 - Intestinal disorders: diarrhea, constipation, pot-belly appearance, vomiting, irregular appetite. Worms can be found in the vomitus or in the faeces.
 - Risk of intestinal obstruction.

Toxascaris leonina

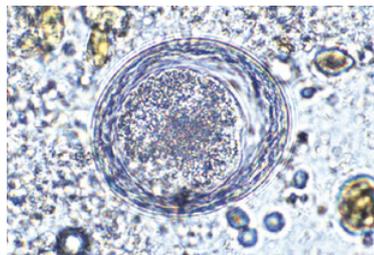
- Infestation can occur at any age.
- Generally well tolerated and asymptomatic.

DIAGNOSIS

Based on clinical signs and on the identification of eggs through faecal examination.

*Toxocara canis* egg

Globular egg; thick-shelled with an alveolar external layer (thimble-like) and smooth internal layer.
Contents: a single, brownish-black cell filling almost all the shell.

*Toxascaris leonina* egg

Globular egg; smooth thick shell with concentric layers.
Contents: a single, yellowish-brown cell filling almost all the shell.



DIGESTIVE
NEMATODESZOOLOGICAL RISK RELATED TO *TOXOCARA CANIS*

- If infective eggs are ingested by humans, the released larvae will migrate through tissues, before dying (visceral *larva migrans*).
- The *larva migrans* phase is usually asymptomatic, the larva will be encysted in an eosinophilic granuloma and killed. In rare cases it can be medically serious, especially if a larva reaches the brain or the eyes. **Children are at the highest risk** because larvated, infective eggs may be found in their environment, such as public parks and gardens, sandboxes, or private gardens.

CONTROL MEASURES

TREATMENT

The majority of anthelmintics are active against ascarids. It includes avermectins-milbemycins (e.g., milbemycin oxime, moxidectin), emodepside, benzimidazoles (e.g., fenbendazole), and pyrantel pamoate.

PREVENTION

Regular deworming will prevent dogs from being heavily infested and decrease the environmental contamination.

Puppies: deworming should begin at 2 weeks of age and then be repeated every 2 weeks until weaning. Thereafter, puppies should be dewormed once a month until 6 months of age.

Pregnant and lactating bitches:

- Females should be dewormed during heat.
- Pregnant bitches should be dewormed at the start of gestation, 15 days before farrowing, and in the week after farrowing.
- Lactating bitches should be treated every two weeks during milking period until the weaning of puppies.

Adults: frequency of endoparasiticide administration depends on the risk of exposure to roundworms and should be determined by the veterinarian depending on the dog's lifestyle ([see the dog anthelmintic treatment card](#)).



DIGESTIVE NEMATODES

DOG ENDOPARASITES

HOOKWORMS

Ancylostoma caninum, *A. braziliense*, *A. ceylanicum*, *Uncinaria stenocephala*



Adults
(at necropsy)
1-2 cm



Visible with
naked eye

Eggs
60 x 40 µm



Visible under
the microscope



Ancylostoma spp. anterior end showing cutting teeth.

- Hookworms are strongylid nematodes commonly infesting dogs, particularly puppies, hunting dogs and dogs living in communities (e.g., kennels).
- *Ancylostoma caninum* is mainly found in warm areas, worldwide. *A. braziliense* is a major hookworm in tropical areas, mainly Central and South America. *A. ceylanicum* is also found in tropical areas, but mainly Asia and Pacific. *Uncinaria stenocephala* infests dogs in worldwide temperate and cold regions.
- Adult worms measure around 1-2 cm long and live in the small intestine of dogs.
- They are blood-feeding nematodes and are attached to the intestinal mucosa.



Ancylostoma egg.

Strongyle type = Oval, colourless egg, with a thin and smooth shell.
Contents: a morula with 4 to 8 cells when released.



DIGESTIVE NEMATODES

DOG ENDOPARASITES

HOOKWORMS

Ancylostoma caninum, *A. braziliense*,
A. ceylanicum, *Uncinaria stenocephala*

BIOLOGY AND MODE OF INFESTATION

- The female worms located in the small intestine shed eggs which are eliminated with the dog's faeces. Eggs hatch in the environment and release first-stage larvae, which evolve to third-stage larvae after two moults.
- **Infestation occurs mainly by direct larval penetration through the skin**, but ingestion of third-stage larvae from the environment is possible (especially for *Uncinaria*).
- After infestation, the hookworm larvae reach the lungs through the lymphatic and venous vessels. Starting from here, they undergo either a pneumo-tracheo-ental and go back to the intestine, or a somatic migration. (for more details about these migrations, [see memocard 'Ascarids dogs'](#)).
- The **prepatent period varies from 2 to 4 weeks** depending on the hookworm species.
- Puppies can be infested via the colostrum and milk.

CLINICAL SIGNS

- **Cutaneous signs:** related to skin penetration and start of L3 larvae migration: **pruritus and papular lesions** covered with scales, on the legs and ventral areas.
- **Respiratory signs:** coughing, loss of smell in hunting dogs, change in the bark (rising to a higher pitch) and nose bleeding.
- **Intestinal disorders:** diarrhoea, bloody diarrhoea, anaemia.
- **General disorders:** weight loss, amyotrophy and cachexia in chronic forms.

DIAGNOSIS

Based on the **identification of eggs by faecal examination**.

Diagnosis can be **challenging in young puppies** as clinical signs appear before eggs are excreted in faeces.

ZOONOTIC RISK

***Ancylostoma* spp. are zoonotic** and can cause **cutaneous larva migrans** after penetration through the skin. *A. ceylanicum* can also develop into an adult worm in the intestine of humans. *Uncinaria stenocephala* exceptionally infest humans.

CONTROL MEASURES

TREATMENT

Some macrocyclic lactones (e.g., milbemycin oxime, moxidectin), emodepside, benzimidazoles (e.g., fenbendazole, oxfendazole) and pyrantel pamoate are active against hookworms.

PREVENTION

- **Frequent deworming for puppies is essential** as the prepatent period may be as short as 14 days: every 2 weeks, from 2 to 8 weeks of age, as well as their mothers.
- Pregnant bitches should be dewormed 15 days before farrowing.
- In adults, the frequency of deworming should be determined by the veterinarian depending on the risk of exposure to hookworms and the dog's lifestyle ([see the dog anthelmintic treatment card](#)).

Adults
(at necropsy)
3-8 cmVisible with
naked eyeEggs
40 × 10-15 µmVisible under
the microscopeAdult *Spirocerca lupi* extracted from nodules.

- *Spirocerca lupi* is widespread in tropical and sub-tropical regions but can be seen sporadically in cold or temperate countries.
- Adult worms measure around 3-8 cm and **live in nodules formed in the walls of the oesophagus and stomach.**
- *Spirocerca lupi* is a highly pathogenic nematode. The infestations may be life-threatening if left untreated.

Oesophageal *Spirocerca* nodules.

OESOPHAGEAL WORM

*Spirocerca lupi*DIGESTIVE
NEMATODES

BIOLOGY AND MODE OF INFESTATION

After being ingested along with intermediate hosts (dung beetles) or paratenic hosts (e.g. lizards, chickens, mice), **third-stage larvae** leave the **dog's stomach** and **migrate along the arteries to the oesophagus, where they form nodules** and develop into adults. The nodules have an opening where the females lay their eggs.

The life cycle takes approximately 4 months.

CLINICAL SIGNS

After a silent phase, various clinical signs may appear:

- **Intestinal signs:** hypersalivation, regurgitation, swallowing difficulties, vomiting, nausea.
- **Respiratory signs:** coughing, dyspnoea, syncope.
- Chronic spirocercosis leads to cachexia, anaemia and to the development of oesophageal neoplasia.
- **Sudden death is possible** due to aortic rupture and fatal haemorrhage.

DIAGNOSIS

Based on **clinical suspicion** and on the visualisation of the pathognomonic fibrous nodules by endoscopy.

Faecal examination is possible but the eggs are laid irregularly, often only in small quantities, which may lead to false negative results.

CONTROL MEASURES

TREATMENT

Macrocyclic lactones (e.g., milbemycin oxime, moxidectin) and **nitroxinil** have been proven to be active against *S. lupi* in dogs.

PREVENTION

Macrocyclic lactones (e.g., milbemycin oxime, moxidectin) are used for the prevention of *S. lupi* infestations in dogs.



Spirocerca lupi egg.

DIGESTIVE
NEMATODES

THREADWORM

Strongyloides stercoralis

Adults
(at necropsy)
2-9 mm



Visible with
naked eye

Egg
(30 × 40 µm)
Larva (300 µm)



Visible under
the microscope



Strongyloides spp.

- Threadworm infestation is a **rare intestinal nematodosis** in dogs.
- **Young dogs are more commonly infested than adult animals**, but infestation is possible at any age, especially in breeding facilities and kennels with low levels of hygiene.
- *Strongyloides stercoralis* is found throughout the world but with a **higher prevalence in countries with hot and humid climates**.
- Threadworms are more common in **areas of unsanitary conditions**. Humans and dogs are usually infested in the same place.
- Adult worms measure around 2-9 mm and **live in the small intestine**.
- Only parthenogenetic females are parasites. Males only exist in the environment where they mate with free-living females.

THREADWORM

*Strongyloides stercoralis*DIGESTIVE
NEMATODES

BIOLOGY AND MODE OF INFESTATION

- Dogs are **mainly infested through direct larval skin penetration**, as infective third-stage larvae (L3) are found on damp surfaces or in damp soil. Ingestion of L3 larvae from the environment is possible but less common.
- After host infestation, larvae reach the bloodstream and pass into the lungs. From the trachea, they are coughed up and swallowed down into the small intestine where they become mature adults.
- Females shed eggs containing first stage larvae (L1) in the faeces. Eggs hatch in the soil and L1 moult in L2 then L3 larvae. The life cycle takes 4-6 weeks to complete.
- Puppies can get infested through their mother's colostrum and milk.

CLINICAL SIGNS

- **Cutaneous signs: papular lesions** on the legs and ventral parts of the dog, related to the skin penetration of L3 larvae.
- **Respiratory signs:** coughing (due to larval migration).
- **Intestinal disorders:** profuse diarrhoea, anaemia.
- **General signs:** fever, tremors, and lethargy.

DIAGNOSIS

Based on the **identification of eggs and larvae by faecal examination.**

***Strongyloides* egg**

Small, light coloured and rectangular egg with parallel sidewalls and a thin shell. Contents: a larva, not always clearly visible.

ZOOBOTIC RISK

Humans are the natural hosts of *S. stercoralis*, dogs are rather considered as a secondary host.

Immunocompromised people are more susceptible and **may present an auto-infectious cycle** with threadworms multiplying in their body. This may lead to an hyperinfective (sometimes called disseminated) form of stongyloidosis.

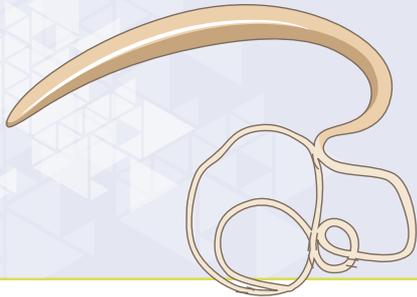
CONTROL MEASURES

TREATMENT

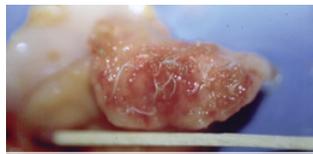
Treatment is usually more difficult than against other gastro-intestinal worms. **Macrocyclic lactones and benzimidazoles** are active against threadworms.

DIGESTIVE
NEMATODES

WHIPWORM

Trichuris vulpisAdults
(at necropsy)
3-5 cmVisible with
naked eyeEggs
60-85
× 40-45 µmVisible under
the microscope

- Whipworm infestation can be observed worldwide.
- These worms are host-specific: in canids, infestation is caused by *Trichuris vulpis*.
- Adult dogs are more commonly infested than young animals, but infestation is possible at any age.
- Whipworms measure around 3-5 cm and **live in the caecum and colon**.
- They attach themselves to the mucosa with their anterior end, by embedding it in the tissue, and **feed on blood**, tissue fluids and mucosal epithelium.
- **Eggs are highly resistant** (> 5 years) in the environment. Therefore, recurrent infestations may be observed in rescue shelters or breeding kennels.

*Trichuris vulpis* attached to the mucosa.

DIGESTIVE
NEMATODES

BIOLOGY AND MODE OF INFESTATION

- **Ingestion of infective eggs** (containing first-stage larvae) from the soiled matters in the environment.
- Following egg ingestion, larvae are released. They migrate to the large intestine and develop into adults within 10 to 12 weeks.
- Females lay non-infective eggs which are shed in the dog's faeces.
- **Eggs become infective within one month** in the external environment.

CLINICAL SIGNS

- Often asymptomatic.
- **Intestinal disorders:** diarrhoea, sometimes streaked with mucus and fresh blood.
- **Chronic infestation:** anaemia (especially in association with *Ancylostoma* species), weight loss.

DIAGNOSIS

Based on the identification of eggs by **faecal examination**, as clinical signs are not very specific.

*Trichuris vulpis* eggs

Orange-brown, elongated lemon-shaped egg with a smooth and thick shell and two polar plugs.
Contents: a single cell.

CONTROL MEASURES

TREATMENT

- **Whipworms are usually less sensitive to anthelmintics than other gastrointestinal worms.**
- Some macrocyclic lactones (e.g., milbemycin oxime, moxidectin spot-on at 2.5 mg/kg), emodepside, benzimidazoles, pyrantel and oxantel are approved for the treatment of hookworm infestations in dogs.
- Frequency of administration depends on the risk of exposure and should be determined by the veterinarian depending on the dog's lifestyle ([see the dog anthelmintic treatment card](#)).

PREVENTION

- **Hygienic measures help limit the contact with eggs** when the environment is contaminated. Hard surfaces can be cleaned with high-pressure jet hoses.
- Loose soil can eventually be dug over or covered with gravel or pebbles, thus burying the eggs out of reach.
- Regular deworming of exposed dogs may be necessary (see above).

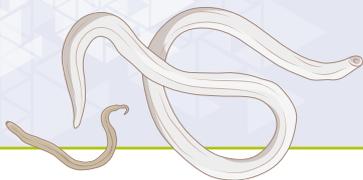


NON DIGESTIVE
NEMATODESLUNGWORM
Angiostrongylus vasorumAdults
(at necropsy)
10-25 mmVisible with
naked eyeStrongylid
1st stage larvae
300-330 µmVisible under
the microscope

- ***Angiostrongylus vasorum*** is the most common lungworm in dogs.
- Angiostrongylosis cases are described on a regular basis in many countries of Europe, more sporadically in North America and South America, with a patchy distribution.
- Adult worms are **thin nematodes** measuring 10-25 mm in length and **live in the pulmonary arteries**.
- **Canids** are the **definitive hosts** of *Angiostrongylus vasorum*, and wildlife species such as foxes act as reservoirs.



In situ location of adult *Angiostrongylus vasorum* in the lung of a dog.



NON DIGESTIVE NEMATODES

DOG ENDOPARASITES

LUNGWORM

Angiostrongylus vasorum

BIOLOGY AND MODE OF INFESTATION

Ingestion of intermediate hosts (snails, slugs...) or paratenic hosts harbouring L3 larvae.

The L3 migrate to their final location and become adults within 8-10 weeks.

The female worms eliminate embryonated eggs which hatch rapidly in the pulmonary capillaries. The first stage larvae (L1) penetrate the alveoli and migrate to the bronchioles and trachea.

They are then coughed up, swallowed and excreted in the dog's faeces.

CLINICAL SIGNS

• **Early stage of the disease:**

Respiratory signs: chronic cough, dyspnoea, exercise intolerance.

• **Late stage of the disease (i.e., chronic infestation):**

Anorexia, anaemia, weight loss, depression, pulmonary hypertension, and bleeding disorders.

• **Final stage of the disease:**

Cardiac signs: tachycardia, oedema, accumulation of fluid in the abdomen (ascites), and rarely, sudden death.

DIAGNOSIS

• **Identification of first stage larvae by microscopic coproscopy.**

The standard techniques (sedimentation and floatation) providing a poor sensitivity, the **specific Baermann technique** is therefore preferred.

• **Serological tests** to detect specific *A. vasorum* antigens: a rapid in clinic test is available.

CONTROL MEASURES

TREATMENT

- Some products containing either milbemycin oxime or moxidectin are licensed for the treatment of *A. vasorum* infestation in dogs.
- Symptomatic and supportive treatment include cardiorespiratory analeptics.
- Prognosis is poor if the infestation is left untreated.

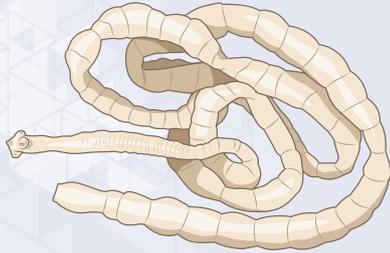
PREVENTION

- Controlling garden slugs (and snails) can eliminate a source of infective L3 larvae.
- **Regular, if not monthly deworming of dogs with moxidectin or milbemycin oxime is essential to prevent lungworm infestations in enzootic areas.**
Frequency of endoparasiticide administration depends on the risk of exposure and should be determined by the veterinarian depending on the dog's lifestyle ([see the dog anthelmintic treatment card](#)).



First stage *Angiostrongylus vasorum* larva.
Microscopic coproscopy.

PLATHELMINTHS

DIPYLIDIUM CANINUM
TAPEWORM

Adults
(or proglottids)
15-70 cm
(0.5-1 cm)



Visible with
naked eye

Eggs
50 x 40 µm



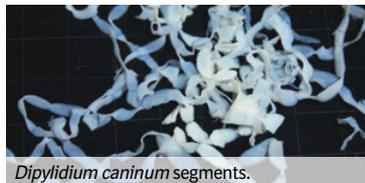
Visible under
the microscope



(rare)



- *Dipylidium caninum* is common worldwide, but less frequent in dogs than in cats.
- *Dipylidium caninum* are flat, white and **segmented worms** (i.e., cestode class). They measure 15 to 70 cm long and 2 to 3 mm wide. Adults **live in the dog's small intestine**.
- The **most frequent intermediate host** of the life cycle of *D. caninum* is the **flea**, and the other one is the louse (rarer).
- Genetic and biological studies have demonstrated that two distinct genotypes exist worldwide: one infesting dogs, and the other infesting cats, with no hybridisation. The dog genotype may be thus considered as a different species than in cats.



Dipylidium caninum segments.

DIPYLIDIUM CANINUM
TAPEWORM

PLATHELMINTHS



BIOLOGY AND MODE OF INFESTATION

- Dogs get infested by **ingesting an infested flea** (i.e., containing a cysticercoid larva of *Dipylidium*) during grooming. The tapeworm develops within 6 weeks. Mature tapeworms continuously shed the latest segments (proglottids) containing eggs in egg packets (around 10-20 egg packets of 20-30 eggs each).
- **Dogs very rarely excrete gravid segments in faeces.** These proglottids are active: they usually move out of the anus and around the perianal region by themselves, then fall off in the environment (e.g., on the floor, in carpets, sofa, pet bedding...). Over time, they desiccate and shrivel up, resembling whitish, uncooked small rice grains of 3-5 mm long.
- Proglottids and/or egg packets (oviferous capsules) are thus present in the same places as flea larvae which will ingest them as food. **The tapeworm larva first develops in the flea larva and becomes fully infective in the young flea around 36 hours after flea infestation of the host.**

CLINICAL SIGNS

- **Generally well tolerated.**
- **Intestinal disorders:** perianal itching, licking and nibbling at the base of the tail, variable appetite, diarrhoea.
- **General signs:** weight loss (in puppies or severely infested dogs).

DIAGNOSIS

- Based on the **observation of proglottids** by macroscopic examination **in the perianal region, on the ground ground, or less commonly, in the faeces.**
- Eggs can exceptionally be found in the faeces if a segment has been destroyed before being expelled.

*Dipylidium* mature proglottid.

ZOOBOTIC RISK

The **accidental ingestion of a flea by a child**, which is unusual, can result in a human case of dipylidiosis.

CONTROL MEASURES

TREATMENT

- **Praziquantel** is the cestodicide of choice to treat dogs against tapeworms.
- Treatment against *D. caninum* is **advisable in dogs with flea infestations.**
- Frequency of cestodicide administration depends on the risk of exposure to tapeworms and should be determined by the veterinarian depending on the dog's lifestyle ([see the dog anthelmintic treatment card](#)).

PREVENTION

- **Regular use of insecticides to prevent flea infestations will limit the risk of infestation with *D. caninum*** ([see memocard 'Fleas'](#)).



PLATHELMINTHS

ECHINOCOCCUS TAPEWORMS

Echinococcus multilocularis, *Echinococcus granulosus*



Adults
(at necropsy)
3-6 mm



Visible with
naked eye

Eggs
30-40
× 20-30 μm



Visible under
the microscope



(rarely observed)



Echinococcus multilocularis.



Echinococcus granulosus.

- ***Echinococcus* spp. are tapeworms** (i.e., adult cestodes) belonging to the family of **Taeniidae**.
- Dogs can be infested with *Echinococcus granulosus sensu lato* and *Echinococcus multilocularis*. Adult worms attached to the wall of the small intestine are responsible for taeniosis.
- *E. granulosus* and *E. multilocularis* are **small worms**, 3 to 6 mm long, with only 4 or 5 segments, the latest being the sole mature proglottid.
- ***Echinococcus granulosus* is described worldwide for all latitudes. *Echinococcus multilocularis* is only described in the northern hemisphere, in temperate or cold latitudes.**
- ***E. granulosus* has mainly a domestic and rural ecosystem including dogs and production animals, especially sheep, whereas *E. multilocularis* has a sylvatic ecosystem including voles and wild canids.**

ECHINOCOCCUS TAPEWORMS

Echinococcus multilocularis, *Echinococcus granulosus*

PLATHELMINTHS



BIOLOGY AND MODE OF INFESTATION

- The **life cycles** of these tapeworms take 4–6 weeks (*E. granulosus*) or 3–4 weeks (*E. multilocularis*) to complete, and both **require**:
 - a **definitive host**: canids for *E. granulosus*, and foxes, dogs and other canids, cats (rarer) for *E. multilocularis*,
 - an **intermediate host**: sheep, goats, cattle, horses, pigs for *E. granulosus*, and rodents (mainly voles) for *E. multilocularis*.
- Infestations may be limited or sometimes massive, involving several hundred cestodes in the **definitive hosts, which shed mature proglottids containing highly resistant eggs** in the environment.
- **Eggs are immediately infective for intermediate hosts** which get infested through the ingestion of soiled fruits, vegetables, etc.
- **The definitive hosts get infested through the ingestion of intermediate hosts' viscera harbouring larval stages.**

CLINICAL SIGNS (DEFINITIVE HOST)

- **Usually well tolerated.**
- Rarely, diarrhoea can be observed.

DIAGNOSIS (DEFINITIVE HOST)

Eggs are rarely seen in coproscopy as mature proglottids (of 2–3 mm) are eliminated, and these eggs **cannot be differentiated from other Taeniidae eggs.**

The diagnosis is therefore based on the detection of:

- **Parasite antigens** in faeces (coproantigens, for which ELISA kits are available).
- **Specific DNA fragments** in faeces, using gene amplification techniques (PCR).

ZOOTOTIC RISK

- **Humans can become aberrant/accidental intermediate hosts for both *Echinococcus* species.**
- *E. granulosus* larvae are responsible for hydatid echinococcosis and *E. multilocularis* larvae are responsible for alveolar echinococcosis.
- **Human echinococcoses are major zoonoses which are clinically serious.**

CONTROL MEASURES

TREATMENT

- **Praziquantel is the cestodicide of choice** to treat dogs against tapeworms, including *Echinococcus* species.
- Frequency of cestodicide administration depends on the risk of exposure to these cestodes and should be determined by the veterinarian depending on the dog's lifestyle (**see the dog anthelmintic treatment card**).

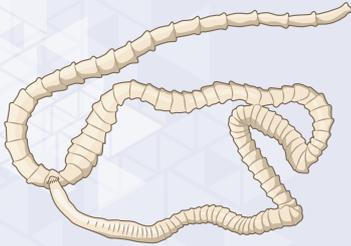
PREVENTION

To prevent infestation by *Echinococcus granulosus*, dogs should not have access to carcasses or offal of ruminants, especially sheep.



PLATHELMINTHS

TAENIA TAPEWORMS

Taenia pisiformis, *T. hydatigena*, *T. multiceps*, *T. ovis*, *T. serialis*

Adults
(or proglottids)
60 cm-2 m
(10-15×6-8 mm)



Visible with
naked eye

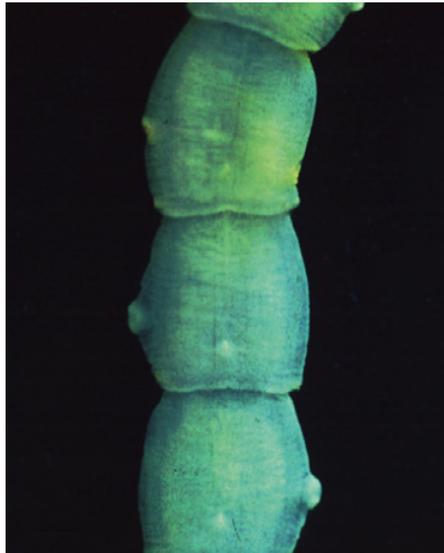
Eggs
30×45 μm



Visible under
the microscope



(rarely observed)



Taenia sp. proglottids: characteristic rectangular shape with a unique lateral genital pore.

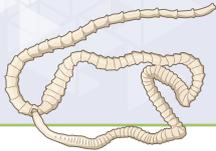
- *Taenia* species are tapeworms (i.e., adult cestodes) belonging to the family Taeniidae.
- They are **widely distributed**, but infestations are **predominantly seen in rural areas** where **farm dogs and hunting dogs may eat raw viscera or meat** from intermediate hosts **harbouring** the infective metacestodes:
 - **Cysticercus-type larvae** (small, fluid-filled cyst with a thin shell containing a single invaginated scolex) for *T. pisiformis* (in the liver and peritoneum of rabbits), *T. hydatigena* (in the liver and peritoneum of ruminants) and *T. ovis* (in muscle tissues of small ruminants or pigs).
 - **Coenurus-type larvae** (large, fluid-filled cyst with a thin shell containing multiple invaginated scolices) for *T. serialis* (in the subcutaneous tissues of rabbits), and *T. multiceps* (mainly in sheep central nervous system).
- These tapeworms measuring 60 cm to 2 m long, **live in the dog's small intestine**. They **attach to the gut mucosa** using their scolex (formed by an armed rostellum and four suckers) and each proglottid **absorb nutrients** from the intestinal tract.



TAENIA TAPEWORMS

Taenia pisiformis, *T. hydatigena*, *T. multiceps*, *T. ovis*, *T. serialis*

PLATHELMINTHS



BIOLOGY AND MODE OF INFESTATION

- After ingestion of raw viscera or meat from an infested intermediate host, it takes about **6 to 8 weeks for the infective larval stages to develop into adult tapeworms** in the dog's digestive tract.
- **Mature proglottids detach from the end of the tapeworms and are shed in the dog's faeces**, but these motile gravid segments can also pass out of the anus actively.
- The segments disintegrate in the external environment, releasing thousands of **resistant eggs** that can remain infective for intermediate hosts for months.

CLINICAL SIGNS

- *Taenia* tapeworms cause an intestinal cestodosis (taeniosis) which is **usually asymptomatic** and well tolerated in carnivores.
- **Moderate intestinal disorders** may occur: varying appetite (generally increased), colic, diarrhoea.
- **Anal pruritus** may be observed, with the animal dragging its rear end on the ground.

DIAGNOSIS

- **Based on the visualisation of segments in the faeces.**
- Microscopic faecal examination for eggs will be negative if no segments have been fragmented in the gastro intestinal tract: diagnosis of tapeworm infestation is challenging. Underdiagnosis is due to the intermittent shedding of proglottids and the poor sensitivity of the microscopic coproscopy (flotation technique).
- Importantly, ***Taenia* sp. eggs cannot be differentiated morphologically from *Echinococcus* sp. eggs.** Any farm or hunting dog diagnosed positive in coproscopy should be considered as **potentially infested by *E. granulosus* or *E. multilocularis***, with all protective measures necessary for the vet clinic team handling the dog and the samples.

CONTROL MEASURES

TREATMENT

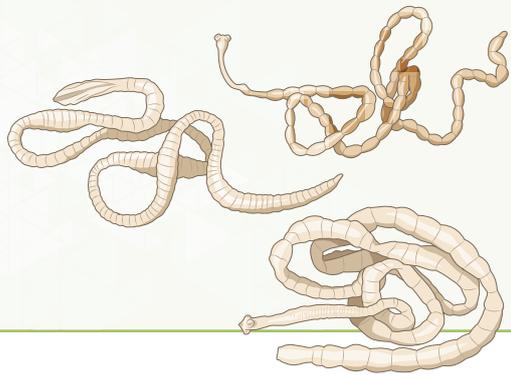
Praziquantel is the cestocide of choice to treat tapeworm infestations in dogs.

PREVENTION

- **Deworming does not provide protection against new infestations.**
- Dogs shouldn't be allowed to feed on raw viscera or meat from lagomorphs, small ruminants, and pigs.
- If sanitary prevention is not possible, **regular treatment with praziquantel may be necessary**, based on the parasite's life cycle. The frequency of administration depends on the risk of exposure to tapeworms and should be determined by the veterinarian based on the dog's lifestyle (**see the dog anthelmintic treatment card**).



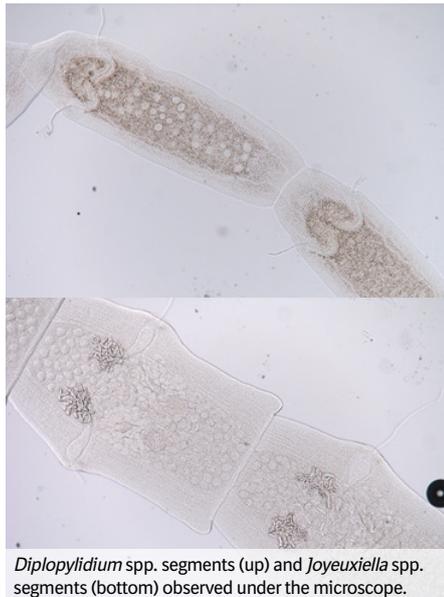
Taeniid egg: thick, striated shell wall containing a developing embryo with 6 hooks.



Visible with
naked eye



Visible under
the microscope

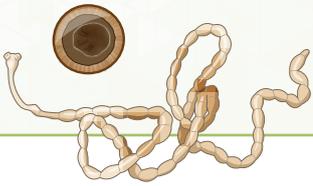


Diplopylidium spp. segments (up) and *Joyeuxiella* spp. segments (bottom) observed under the microscope.

Besides *Dipylidium* and *Taenia* tapeworms, other much rarer tapeworms can infest dogs:

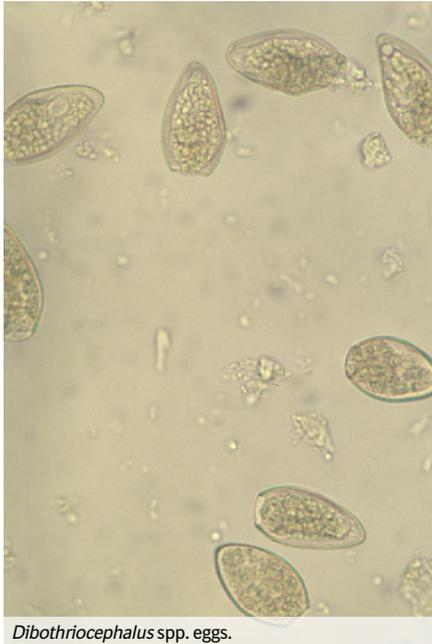
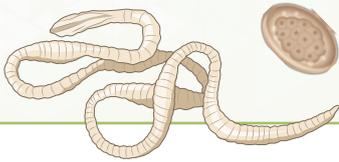
Diplopylidium spp. and *Joyeuxiella* spp.

- These tapeworms are **very similar in morphology to *Dipylidium caninum*** (see specific memo card) but smaller in size.
- Their **intermediate hosts are reptiles** (snakes and lizards).
- These tapeworms are **generally well tolerated**.
- **Praziquantel** is the cestodicide of choice to treat infested dogs.



Mesocestoides lineatus and *Mesocestoides literatus*

- These tapeworms measure **20-50 cm in length**. Their segments are as wide as they are long and have rounded edges.
- **Carnivores become infested by ingesting the second intermediate hosts** which are insectivorous vertebrates (**amphibians, reptiles or birds**) infested by the tetrathyridium larvae.
- The infestation **can be asymptomatic**, but in some cases, the **carnivores can act as intermediate hosts** with a multiplication of larvae in the abdominal cavity. It may evolve to a **peritonitis**, but the **diagnosis is often made accidentally during surgery**, when lots of larvae looking like semolina are visible.
- **Praziquantel** has been used successfully to treat *Mesocestoides* spp. infestations.



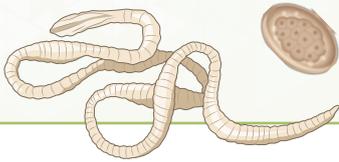
Dibothriocephalus spp. eggs.

Dibothriocephalus latus and *Spirometra* spp. (‘broad tapeworms’)

Dibothriocephalus latus

- *D. latus* (formerly *Diphyllobothrium latum*) is found in the lake regions of Europe. Other *Dibothriocephalus* species are **described worldwide**.
- Dogs become **infested when eating freshwater fishes** (second intermediate hosts or paratenic hosts) harbouring plerocercoid larvae, the first intermediate hosts being small crustaceans.
- *D. latus* is **probably the most pathogenic tapeworm**: it causes **intestinal disorders**, abdominal discomfort, diarrhoea and anaemia.
- Diagnosis is based on the **identification of eggs in the faeces**, as proglottid shedding is rare: eggs are eliminated directly through a tocostoma*.
- **Praziquantel** has been used successfully against *Dibothriocephalus* spp. in dogs, but it must be used at **8 times the regular dose**, as in humans.
- Preventing infestation includes avoiding to feed dogs with raw fish or with the viscera of fish caught in lakes.
- *D. latus* is **zoonotic** and medically significant, due to the size of the adults (up to 12 meters in length), and the depletion in vitamin B12 inducing anaemia.

*Tocostoma = egg-laying orifice in segments.



Spirometra spp.

- Cestodes of the *Spirometra* genus, especially *Spirometra mansoni*, are mainly found in **Asia and in the Pacific islands**.
- **Dogs become infested by ingesting amphibians** (second intermediate hosts or paratenic hosts) infested by the plerocercoid larvae. The first intermediate hosts are crustaceans.
- Intestinal infestations of dogs with *Spirometra* spp. **rarely cause any disturbances**.
- Like for *Dibothriocephalus* spp., **praziquantel** has been used successfully at **high doses** to treat infestations.
- *Spirometra* tapeworms are **zoonotic parasites**. Humans become infested by drinking water, by eating tissues of an intermediate host, or by direct contact with the amphibian skin. These tapeworms do not develop in humans, but the plerocercoid larvae **induce a larva migrans that can be severe**.

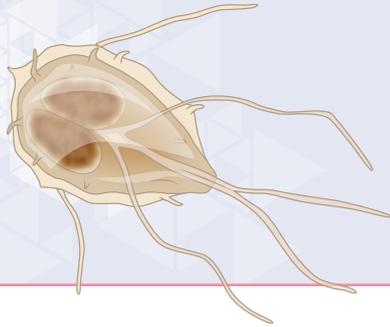
DIGESTIVE
PROTOZOANS**GIARDIA**
Giardia duodenalis

Mobile stage
(rarely seen)
6-8 × 12-15 μm

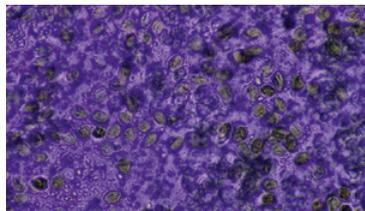


Visible under the microscope

Cysts
8 × 12 μm



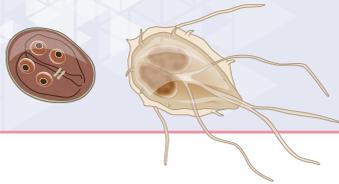
- *Giardia* spp. are protozoans belonging to the class of flagellates, infecting the epithelium of the small intestine (and stomach for a few species).
- *Giardia duodenalis* (syn. *Giardia intestinalis*) is mostly found in the duodenum, jejunum and anterior ileum. *Giardia* are fixed to the surface of the brush border of intestinal cells, mainly at the base of the villi.
- This parasite has two active stages:
 - Trophozoite, which is the motile stage in the small intestine,
 - Cyst, which is the resistant stage eliminated in the environment.
- Giardiasis occurs worldwide, as there is a great number of healthy carrier dogs, representing the parasitic reservoir.



Giardia cysts (Lugol's iodine stain).

Cysts are more or less rounded with a thin and smooth shell. Lugol's iodine stain make *Giardia* cysts take on a very clear orange hue.

DIGESTIVE PROTOZOANS



BIOLOGY AND MODE OF INFECTION

- The infection occurs by the **ingestion of *Giardia* cysts** from faecal-contaminated water, food, fomites or through self-grooming.
- After ingestion, the **cysts hatch and release two trophozoites**. These trophozoites form a ‘carpet’ on the intestinal epithelium and **multiply by binary division**. Some trophozoites may form cysts that are detectable in faeces 7 days after infection.

CLINICAL SIGNS

Giardiasis is more common in dogs with altered immunity, and young animals (up to 2 years old) are more sensitive.

- The **acute form** is characterised by watery diarrhoea which is resistant to treatment, colic and bloating.
- In the **chronic form**, dogs can be asymptomatic carriers or present a maldigestion-malabsorption syndrome, with **yellowish, fatty, pasty, foul-smelling, chronic diarrhoea**.

DIAGNOSIS

- **Identification of *Giardia* cysts** in the faeces through coproscopy, which is sensitive in clinical cases of giardiasis, due to the intense proliferation of the protozoans. Healthy carriers shed cysts intermittently: a negative result in faecal examination may thus be a false negative. The test needs to be repeated. A negative result does not mean that the dog is not infected.
- **Direct immunofluorescence assay (IFA)**.
- **ELISA kit** to detect the coproantigens in faecal matter from infected individuals.

ZOO NOTIC RISK

Giardia duodenalis may infect humans. *Giardia* are genetically divided in genotypes called Assemblages, which are more or less adapted to some species, and do not have all the same zoonotic potential.

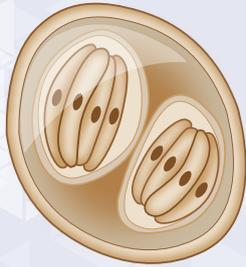
CONTROL MEASURES

TREATMENT

- **The treatment is challenging due to the environmental cyst contamination which causes relapses**, and because giardiasis is often linked to an underlying condition. Recommended treatments consist of **daily administrations of metronidazole, or certain benzimidazoles** (fenbendazole, oxfendazole, febantel) during at least 3 weeks.
- Thorough environmental cleaning and disinfection are key to decrease the number of cysts.

PREVENTION

Prevention is based on hygienic measures: keeping cages clean, frequent removal of faecal matter and disinfection of floors.



DOG ENDOPARASITES

DIGESTIVE PROTOZOANS

ISOSPORA COCCIDIA

Isospora canis, *Isospora ohioensis*



Oocysts
(in faeces)
38 × 30 µm
(*I. canis*)

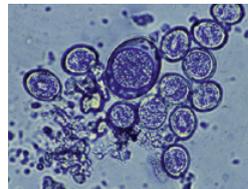
Oocysts
(in faeces)
23 × 19 µm
(*I. ohioensis*)



Visible under the microscope



- ***Isospora* spp. are protozoans** belonging to the class Apicomplexa and sub-class of Coccidia, grouping intestinal parasites.
- Coccidiosis caused by *Isospora* is both widespread and common. It **generally affects young animals living in a communal environment** (breeding facilities, kennels), or those that have just been acquired from one of these sources.
- *Isospora* spp. sporozoites multiply in the intestinal tract by invading intestinal cells.
- **Infected dogs are carriers and shed oocysts** in their faeces for a limited period of time.
- **Oocysts are very resistant** in the environment where they can survive for 1 to 2 years. They must undergo sporulation to become infective.



Isospora canis [large cysts] -
Isospora ohioensis [small cysts].

Typical oocysts: smooth and thin shell,
oval shaped with one rounded end (basal)
and one pointed end (conical).

**BIOLOGY AND MODE OF INFECTION**

- **Ingestion of sporulated oocysts** (containing 2 sporocysts, each containing 4 sporozoites) from a contaminated environment.
- The **sporozoites invade the intestinal cells** and undergo an **asexual multiplication** (= schizogony). The infected cells die and expulse thousands of new sporozoites that will repeat the same action.
- After the schizogony phase, **sexual multiplication occurs** (= gametogony) to form oocysts which are excreted in the dog's faeces.
- The infection is followed by immunity.

CLINICAL SIGNS

- Asymptomatic form in well-kept breeding facilities.
- **In clinical forms**, the initial signs may appear at around 3 weeks of age and are often observed after a stress (weaning, sale, transport). Clinical signs are more severe in animals with impaired immunity:
Gastrointestinal disorders: foul-smelling, mucoid-to-haemorrhagic diarrhoea, abdominal pain, anorexia.
General disorders: poor general condition, weight loss, dehydration, stunted growth.

DIAGNOSIS

Based on the **detection of oocysts in the faeces**, which is relatively sensitive using coproscopy with a **floatation technique**.

CONTROL MEASURES**TREATMENT**

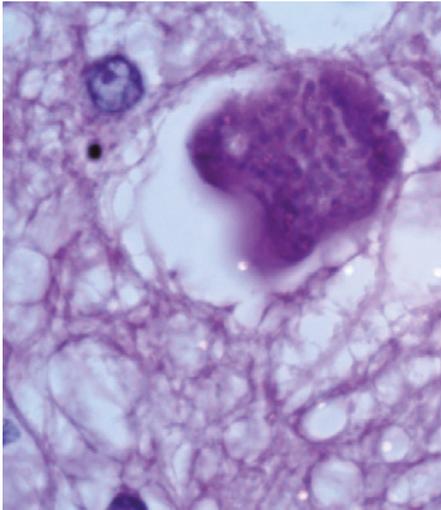
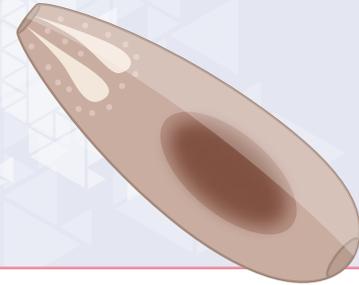
- Treatment consists in the administration of **anti-coccidial drugs** like sulphonamides (e.g., sulfadimethoxine, combinations of trimethoprim and sulfadiazine), toltrazuril or diclazuril.
- A **symptomatic treatment** is also added (rehydration...).

PREVENTION

- **Prevention is limited to hygienic measures** to eliminate oocysts in the environment.
- The housing in breeding facilities and kennels should be kept clean and dry (daily removal of faecal matters), and surfaces should be disinfected regularly (ammonia-based products).

DIGESTIVE
PROTOZOANS**NEOSPOORA**
Neospora caninumTachyzoites
(in host cells)
3-7 x 1-5 µmOocysts
(in faeces)
13 x 11 µm

Visible under the microscope



Neospora cyst containing bradyzoites in the brain tissue of a puppy with clinical signs of neosporosis (Courtesy of Laboratoire Territorial de Diagnostic Vétérinaire de Nouvelle-Calédonie).

- ***Neospora caninum* is an Apicomplexa protozoan** belonging to the Coccidiasina sub-class, including all coccidia, and **closely related to *Toxoplasma gondii***.
- **Neosporosis predominantly affects dogs aged a few weeks old** (mainly less than 3 months old). Cases resulting from congenital transmission are the most severe.
- ***N. caninum* infection is reported in dogs, wild canids (e.g., coyotes) and herbivores.** It is responsible for **two distinct clinical entities**:
 - **Intestinal coccidiosis in the definitive hosts** (canids).
 - **Neosporosis in the intermediate hosts** (cattle, sheep, goats, cervids, canids and horses): the sporozoites are non-cell specific and can multiply in several tissues, especially neurons. In cattle, it is responsible for abortions.
- Under certain circumstances, canids can be systemically infected: **dogs can act as intermediate and definitive hosts.**
- **Many animals are healthy carriers.** Their **immune status plays a role** in vertical transmission, the risk of abortion, and post-natal congenital neosporosis. **Infected females can transmit *Neospora* to their offspring at each pregnancy, which is not the case for *Toxoplasma*.**



DIGESTIVE
PROTOZOANS**BIOLOGY AND MODE OF INFECTION**

- **Infection occurs in 3 ways:**
 - **Ingestion of sporulated oocysts shed by definitive hosts, from a contaminated environment.**
 - **Ingestion of meat from contaminated intermediate hosts.**
 - **In utero contamination** of the foetus, by tachyzoites released from activated cysts in infected females.
- In canids, *Neospora* first multiplies asexually through schizogony, then undergoes the sexual reproduction (merogony), producing the oocysts.
- In intermediate hosts, sporozoites released from the oocysts evolve into tachyzoites that replicate rapidly in many tissues and cells, and into bradyzoites that concentrate in the nervous system and eyes at a slower pace, forming cysts.

CLINICAL SIGNS

- Intestinal coccidiosis: **asymptomatic in dogs.**
- **Classic form of neosporosis: in young puppies after congenital infection.** Progressive paresis of posterior limbs makes the animal adopt the so-called 'seal position'. The disease progression results in complete paralysis, trembling, and death in most cases.



Typical 'seal position' in a young dog with neosporosis (Courtesy of Magali Charve).

The prognosis is poor, as paralysed limbs nearly never recover.

- **Cutaneous form of neosporosis: solely in adult dogs,** due to

disseminated infection. It leads either to few painless ulcerated nodules without any health deterioration, or to a more severe and extensive nodular dermatosis with a drastically altered general state and even death.

DIAGNOSIS

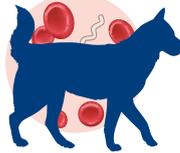
- In dogs with intestinal coccidiosis, **oocysts may not be detected in the faeces, due to a low level of excretion.**
- Neurological disorders like paresis can be signs of **neosporosis**, but the **diagnosis is made by confirming parasites' presence** in bronchoalveolar or cerebrospinal fluid or through histology following biopsy. **Coproscopy is always negative in these cases.**
- Serology can also be used.

CONTROL MEASURES**TREATMENT**

- **There is no approved treatment for *Neospora* infection.** Reducing the tachyzoites multiplication can be obtained through the administration of oral **clindamycin** every 12 hours for 4 weeks minimum and until 2 weeks after clinical signs have plateaued.

PREVENTION

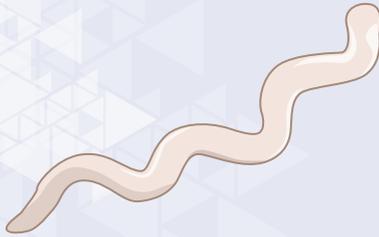
- **Prevention of the disease is difficult.**
- **To avoid foetal contamination:** clindamycin twice a day from the 15th to the 25th day of gestation can be administered to pregnant females with a history of contaminated puppies.

VECTOR-BORNE
DISEASES**BORRELIA***Borrelia burgdorferi sensu lato*
(including *B. burgdorferi sensu stricto*, *B. afzelii*, *B. garinii*)

0.3 × 5-20 μm



Visible under the microscope

Microscopic view of *Borrelia* sp.

- *Borrelia burgdorferi* complex species are spirochete bacteria parasites of vertebrates including birds and mammals (e.g., humans, dogs, ruminants...), transmitted by ticks.
- *Borrelia burgdorferi* s.l. are **exclusively transmitted by ticks** belonging to the **genus Ixodes**. There is no transovarial transmission in ticks, therefore **only nymph and adult ticks can transmit the agent**.
- The first reservoir of bacteria is the rodent population, the second one being wild cervids.
- **Co-infection of ticks with both *Borrelia* species and *Anaplasma phagocytophilum* is common. The etiological diagnosis is therefore challenging** in co-infected hosts, as borreliosis and anaplasmosis clinical signs are similar.
- **Borreliosis is not of major clinical importance in dogs** but is a **major concern for humans**. Due to its first clinical description in humans in the county of Lyme (Connecticut, USA), it is classically named 'Lyme disease'.

VECTOR-BORNE
DISEASES**MODE OF INFECTION**

- Infection during *Ixodes* tick feeding, **transmission occurring usually 36 to 72 hours after tick attachment.**
- Once transmitted, *Borrelia* spp. are disseminated through the skin and bloodstream and invade various tissues, such as synovial fluid of joints, heart and nervous system.

CLINICAL SIGNS

- **Most infected dogs remain asymptomatic.**
- Fever, lameness and kidney failure may be observed, mainly in the USA due to the infection by *B. burgdorferi sensu stricto*.

DIAGNOSIS

Based on the detection of antibodies against *Borrelia* spp. by serology, but only if done on the indication of presumptive clinical signs.

ZOOBOTIC RISK

- Lyme disease is a zoonotic disease considering the wild reservoir of the bacteria (rodents and cervids), but **domestic animals play no role in the transmission.**
- It is the most common vector-borne disease of humans in the USA and in Europe.
- **Symptoms include erythema migrans, fever, headache, muscle and joint pain.** They can persist months to years after inoculation and can be severe.

CONTROL MEASURES**TREATMENT**

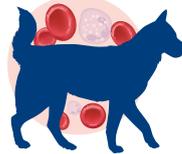
Antibiotic therapy (**doxycycline**, amoxicillin) is advisable but does not always clear the infection.

PREVENTION

- Removal of ticks after a walk.
- Tick control based on regular acaricidal treatments of the dog (**see memocard 'Ticks'**), and tick repellents.
- Vaccines are available in some countries.



Erythema Migrans.

VECTOR-BORNE
DISEASES**EHRlichia spp.
AND ANAPLAsma spp.***Ehrlichia canis*, *Anaplasma phagocytophilum*, *Anaplasma platys*Rickettsial organisms
Bacteria in white blood cells
or platelets

Visible under the microscope

(mainly
A. phagocytophilum)

Epistaxis (nose bleeding) in a dog.

- *Ehrlichia* spp. and *Anaplasma* spp. are obligate intracellular rickettsial bacteria, transmitted by ticks.
- *Ehrlichia canis* is the agent of canine monocytic ehrlichiosis (CME), transmitted by the brown dog tick *Rhipicephalus sanguineus*. It infects mainly monocytes (and lymphocytes). Chronically infected dogs are the reservoir.
- *Anaplasma platys* is the agent of thrombocytotropic anaplasmosis, transmitted by the brown dog tick *Rhipicephalus sanguineus*. It infects mainly platelets.
- *Anaplasma phagocytophilum* is the agent of canine granulocytic anaplasmosis and infects mainly neutrophil granulocytes. It is transmitted by *Ixodes* forest ticks, mainly *Ixodes ricinus* in Europe and *Ixodes scapularis* in the USA. Infected rodents or wild ruminants are the reservoirs.

VECTOR-BORNE
DISEASES

MODE OF INFECTION

- Inoculation during the tick feeding, within 3 to 24 hours after tick attachment.

CLINICAL SIGNS

They are **not very specific**, but some may be suggestive.

- **Canine monocytic ehrlichiosis and thrombocytopenic anaplasmosis** (frequent co-infection):
 - Fever, lethargy, depression, anorexia and weight loss.
 - Abnormal lymph node size.
 - Haemorrhages: petechiae, ecchymoses or epistaxis.
 - Thrombocytopenia.
 - Clinical signs may self-resolve or become chronic.
- **Granulocytic anaplasmosis** (frequent co-infection with *Borrelia burgdorferi* sensu lato):
 - Fever, lethargy, anorexia.
 - Lameness, joint pain.

DIAGNOSIS

- **Blood smear:** detection of *Ehrlichia* spp. or *Anaplasma* spp. morulae is possible but **difficult**.
- **Serology:** detection of specific antibodies (possibility of rapid **in-clinic tests**).
- **PCR on blood sample:** highly sensitive, when performed before any treatment.

ZOO NOTIC RISK

- *A. phagocytophilum* can affect humans. Direct transmission from infected dogs to humans has not been reported.
- Several genotypes exist within the species, each of them having a tropism for different hosts (ruminants, horses, dogs, humans).

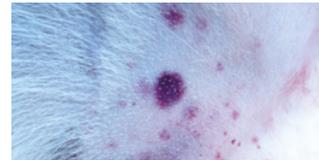
CONTROL MEASURES

TREATMENT

Anti-rickettsial agents: mainly doxycycline.

PREVENTION

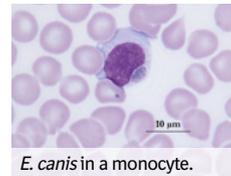
- When **ticks** are observed, they must be **immediately and carefully removed** with an appropriate device.
- Regular tick control with acaricides (see memocard 'Ticks') and repellents.



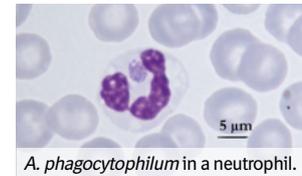
Canine monocytic ehrlichiosis petechia.



CME petechia.



E. canis in a monocyte.



A. phagocytophilum in a neutrophil.



VECTOR-BORNE DISEASES

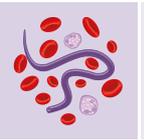
HEARTWORM

Dirofilaria immitis



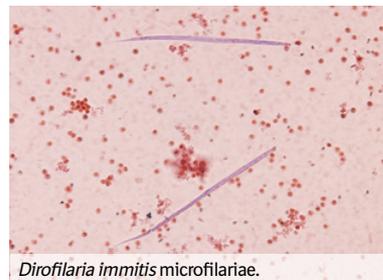
Adults (at necropsy) 12-30 cm
 Visible with naked eye

Microfilariae 290-330 µm
 Visible under the microscope

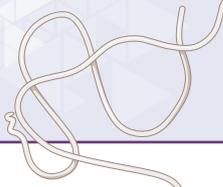


Adults of *Dirofilaria immitis* in the right heart of a dog.

- **Dirofilariosis is enzootic in warm and humid areas worldwide, especially between the tropics (e.g., Americas, Mediterranean Europe, Asia, Africa, Australia, and in the tropical Islands).**
- **Adult *Dirofilaria immitis* are long filarial nematodes living in the pulmonary arteries and the right heart ventricle of dogs.**
- **Adult worms may live for 5 to 7 years in dogs: their death can cause inflammatory reactions that may be fatal.**



Dirofilaria immitis microfilariae.



VECTOR-BORNE DISEASES

DOG ENDOPARASITES

HEARTWORM

Dirofilaria immitis

BIOLOGY AND MODE OF INFESTATION

Dirofilaria immitis third stage larvae are transmitted by female mosquitoes (*Aedes*, *Culex*, *Anopheles* genera) during a blood meal. They are deposited onto the skin which they penetrate through the bite wound.

The immature worms migrate through tissues and reach the pulmonary arteries possibly via lymphatic or venous circulation. The prepatent period (complete development) is around 6 months.

Mature female worms lay microfilariae in the blood.

Microfilariae are ingested by mosquitoes in which they evolve to L3 infective stages within 2-3 weeks.

CLINICAL SIGNS

The severity of clinical signs depends on the worm burden and the occurrence of reinfestations.

The disease is mainly characterised by **cardio-pulmonary and general signs** such as: cough, fatigability, reduced appetite, exercise intolerance, difficulties to breath, abnormal heart and lung sounds, tachycardia, dyspnoea, syncope, fluid accumulation (ascites) in the abdominal cavity, sudden collapse, blood disorders...

DIAGNOSIS

- **Imaging:** X-rays, echocardiography (possibility to visualise the parasites).
- **Laboratory diagnosis:**
 - **Detection of microfilariae** in the blood (blood smear, Knott test).
 - **Antigen tests** through serology (rapid diagnostic tests detecting antigens from the female worm).
 - Antibody serology.

ZOONOTIC RISK

Humans may become infested on rare occasions, through mosquito bites as in dogs.

The human infestation is mostly asymptomatic.

Pulmonary nodules (granulomas formed around dead migrating larvae) may incidentally be detected on chest radiographs.

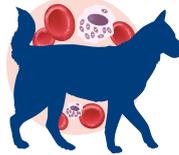
CONTROL MEASURES

TREATMENT

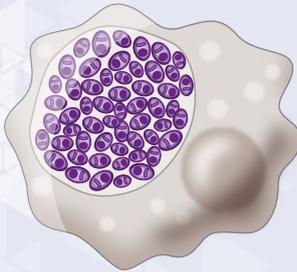
- **Treatment of asymptomatic infested dogs is not always advised**, but they **must receive regular preventive treatments** to avoid repeated infestations and accumulation of worms.
- **Adulticide treatment (melarsomine)** kills adult worms and **must be combined with a preventive treatment** (macrocyclic lactones) to eliminate newly introduced larvae.
- Surgical removal can be performed in dogs with severe disease and poor prognosis.

PREVENTION

- **Monthly or long acting macrocyclic lactone** use (e.g., ivermectin, moxidectin, milbemycin oxime) during the mosquito season is indicated for the prevention of cardiopulmonary dirofilariosis in dogs.
- Using **pyrethroids** (e.g., permethrin, deltamethrin) as repellents **against the mosquito vectors** during the season **can be considered as an additional mean**.

VECTOR-BORNE
DISEASES**LEISHMANIA** ^{1/2}
Leishmania infantumAmastigotes
in dog
3-4 × 2 μmPromastigotes
in sandfly
15 × 5 μm

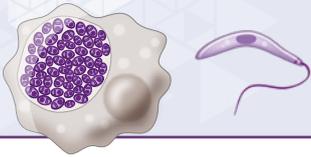
Visible under the microscope



Ematiation due to leishmaniasis in a dog.

- Canine leishmaniosis is enzootic in the Mediterranean basin, Central and South America, Mexico, Middle East, Central Asia and some areas in south-east Asia. The prevalence may be very high in endemic countries, frequently exceeding 10% and reaching up to 60%.
- The agent, *Leishmania infantum*, is transmitted by sandflies as vectors: *Phlebotomus spp.* in the Old World, and *Lutzomyia spp.* in the New World. The transmission period usually spans from spring to fall, when sandflies are active.
- The disease is due to *L. infantum* infection of phagocytes in many tissues and organs, and to induced immune disorders.
- *L. infantum* is both dermatropic and viscerotropic.
- The **incubation period** in dogs is **highly variable**, between 3 months to more than 1 year and depends on the immune response of the infected dog.



VECTOR-BORNE
DISEASES**MODE OF INFECTION**

- Dogs get infected during the sandfly blood meal, by flagellate forms of *Leishmania* called promastigotes.
- Promastigotes are phagocytosed by macrophages, turn into the amastigote forms and multiply.

CLINICAL SIGNS

The time needed for the development of the disease is variable. The disease is **highly polymorphic** in terms of both severity and clinical signs.

- Asymptomatic form: 10% of dogs remain healthy carriers.
- Most common clinical signs:
 - Papular to ulcerative **cutaneous lesion**, called 'inoculation chancre' at the sandfly bite location, before dissemination occurs.
 - **Visceral form**: anaemia, splenomegaly, polyadenopathy, anorexia, amyotrophy, weight loss, depression, apathy, renal failure, polyarthritis, and ocular signs.
 - **Muco-cutaneous signs**: epistaxis, dry dermatosis with squamosis, hair loss, onychogryphosis, hyperkeratosis, ulcers.



Inoculation chancre.

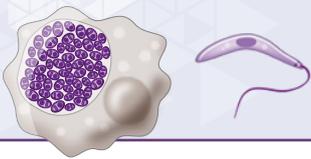


Onychogryphosis.



Dry dermatosis.



**DIAGNOSIS**

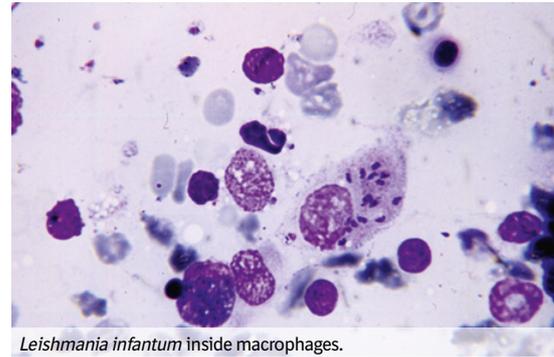
- **Suspicion** is based on **clinical signs**, blood and biochemical investigations as well as **epidemiological information** (living or travelling in endemic areas).
- Definitive diagnosis can be direct or indirect:
 - **Direct diagnosis:** microscopic detection of *Leishmania* from **lymph node puncture**, tissue swabs, and very rarely blood smears. PCR tests on these samples are highly sensitive.
 - **Indirect diagnosis:** detection of a **specific antibody response**.

ZOONOTIC RISK

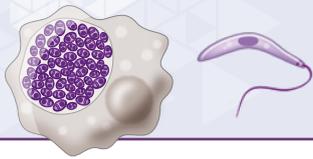
Leishmania infantum can affect humans and especially immunocompromised patients in endemic areas.

As in dogs, the route of infection is the vector bite.

Direct transmission from infected dogs to humans is not reported.



Leishmania infantum inside macrophages.



VECTOR-BORNE DISEASES

DOG ENDOPARASITES

LEISHMANIA

Leishmania infantum



Repelling the vector is the very first preventive measure.

CONTROL MEASURES

TREATMENT

The **prognosis of leishmaniosis is poor**. Clinical cure is costly, long, and relapses are common.

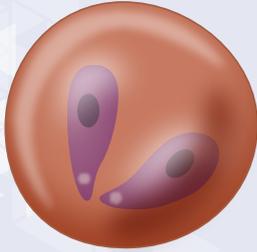
Leishmanicides such as **meglumine antimoniate** (injectable formulation) and **miltefosine** (oral formulation) are used alone or in combination with **allopurinol (leishmaniostatic)**, together with supportive therapies.

PREVENTION

Prophylaxis is essential as it is difficult to treat infected dogs.

The use of **repellent insecticides in combination with vaccination** represents the best way to limit the transmission of the pathogen:

- Collars, spot-on or spray **formulations containing pyrethroids** (e.g., deltamethrin, flumethrin, permethrin).
- **Vaccination does not avoid infection** but reduces clinical signs and limits infection capacity to vectors.
- As phlebotomes are exophilic species and only active at night, **keeping the dog inside houses**, or in flying insect-protected enclosures **from dusk** is an additional way to limit the risk.

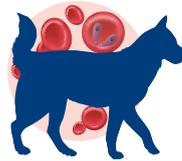


DOG ENDOPARASITES

VECTOR-BORNE DISEASES

PIROPLASMS (*BABESIA* spp.)

Babesia canis, *Babesia vogeli*, *Babesia rossi*,
Babesia gibsoni, *Babesia vulpes*, *Babesia conradae*

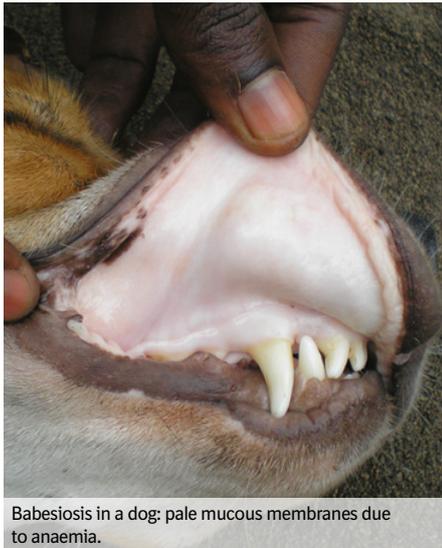


Babesia spp.
Piroplasms in
red blood cells



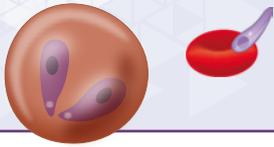
Visible under
the microscope

Infective
sporozoite
(in ticks)



Babesiosis in a dog: pale mucous membranes due to anaemia.

- *Babesia* species are protozoan parasites of the red blood cells, which are transmitted by tick bites, usually 48 to 96 hours after the tick attachment.
- The majority of babesiosis cases occur from spring to autumn. However, piroplasmosis can be diagnosed all year round if the tick vectors are active.
- Based on the size of the sporozoites (superior or inferior to the semi-diameter of the red blood cell), the piroplasms infecting dogs are classified in large and small forms.
- **Large forms** include:
 - *Babesia canis*, transmitted by *Dermacentor reticulatus* in western and central Europe.
 - *Babesia vogeli*, transmitted by the brown dog ticks *Rhipicephalus sanguineus*, has a worldwide distribution, especially in warm areas.
 - *Babesia rossi*, the most pathogenic species, transmitted in Africa by *Haemaphysalis* ticks.
- **Small forms** include:
 - *Babesia gibsoni*, transmitted all over Asia by *Haemaphysalis longicornis*, but also, by dog's bites during fights and blood transfusion.
 - *Babesia vulpes* (formerly *Theileria annae*), transmitted in Europe by *Ixodes* ticks.
 - *Babesia conradae*, described in eastern USA, but its vector remains unknown.



VECTOR-BORNE DISEASES

PIROPLASMS (*BABESIA* spp.)

Babesia canis, *Babesia vogeli*, *Babesia rossi*,
Babesia gibsoni, *Babesia vulpes*, *Babesia conradae*

BIOLOGY AND MODE OF INFECTION

Infection occurs during the last part of the tick feeding.

Piroplasm infects the red blood cells, divides and induces hemolysis.

The sporozoites released infect new red blood cells, and so on.

Some circular forms are infective for ticks. The sexual reproduction takes place in ticks which are the definitive hosts, vertebrates being intermediate hosts.

Babesia are transmitted trans-stadially and through tick eggs. Therefore, ticks are a reservoir of parasites.

CLINICAL SIGNS

• Acute form (most common):

- **Pyretic syndrome:** high fever (40°C for at least 48 hours), polypnea, tachycardia.
- **Hemolytic syndrome:** pale mucous membranes (anaemia), orange to red colored urine ('rusty urine' due to hemoglobinuria).
- **General signs:** prostration, apathy, anorexia.

• Atypical forms: paralysis, encephalitis, ocular signs, digestive signs.

• Chronic form: moderate depression, intermittent fever, anaemia, arthritis, renal insufficiency.

DIAGNOSIS

- **Direct through blood smear:** observation of piroplasm in red blood cells.
- **Serology:** based on the detection of specific antibodies.
- **PCR:** highly sensitive, allows the identification of species and subspecies of the piroplasm.

CONTROL MEASURES

TREATMENT

- With piroplasmicides: **imidocarb** is the most widely used against large forms. Diminazene, atovaquone, azithromycin may be used in small *Babesia* infections.
- Symptomatic treatment (perfusion, transfusion...) is important.

PREVENTION

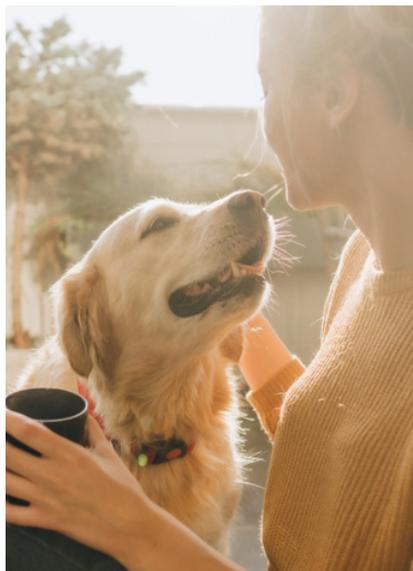
- **Regular tick control on dogs** (see memocard 'Ticks').
- Acaricidal treatment of the environment is possible in kennels to control *Rhipicephalus sanguineus*.
- Vaccination against *Babesia canis* is available in some countries. It does not prevent the infection but reduces the severity of the clinical signs.



Babesia canis observed in a blood smear.

ANTHELMINTIC TREATMENT IN DOGS

RECOMMENDATIONS FROM THE ESCCAP GUIDELINE 01 EDITION MAY 2021



DESCRIPTION	ESCCAP RECOMMENDED DEWORMING FREQUENCY
PUPPIES	From 2 weeks of age: every 14 days up to 2 weeks after weaning and then monthly until 6 months of age
ADULT DOGS	
Dog living indoors only or going outdoors but having no direct contact with other dogs, parks, sandpits, playgrounds, snails and slugs, raw meat or prey animals	Deworm 1-2 times / year against nematodes*
Dog going outdoors and having direct contact with parks, sandpits, playgrounds, and other dogs	Deworm against nematodes and tapeworms 4 times / year *
Dog going outdoors and having direct contact with parks, sandpits, playgrounds, and other dogs; and/ or eating prey animals, snails or slugs and/ or hunting without supervision and/ or eating raw meat	Deworm against nematodes and tapeworms 4-12 times / year depending on risk analysis
Dog living in a fox tapeworm (<i>Echinococcus multilocularis</i>) endemic area, eating prey animals and/ or hunting without supervision	Deworm - monthly against tapeworms - 4-12 times / year against nematodes depending on risk analysis
Dogs sharing home with young children (<5 years-old) or immunocompromised people	Deworm once-a-month *

*Or perform a faecal examination at the same frequency and treat according to the results



ISBN : 978-2-9550805-7-3
EAN : 9782955080573

