



*Larbi Ben M 'hidi University, Oum El Bouaghi  
Faculty of Exact Sciences and Natural and Life Sciences  
Department of Natural and Life Sciences*

## *Bee and Fish Parasites Courses*

*Dr. TOLBA Mounia*

*MCA, SPECIALITY : PARASITOLOGY*

**(Intended for students of the Master 1 LMD: Parasitology)**

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Flagellates

Ciliates

Sporozoa

##### 2. KINGDOM ANIMALIA-HELMINTHES

Plathelminths (Flatworms)

Digenes (Trematodes)

Monogenes

Cestodes (Tenia)

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Acanthocephalus (Worms with head with spines)

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## Chapter I. Bee Parasites:

### 1. La Varroas

Varraose is a parasitic disease that is caused by a Varroa destructor mite. It is parasitic on brood and adult bees. It is the biggest threat to beekeeping worldwide. Several means of treatment exist but the threat persists

Common name: Varroa

Scientific name: *Varroa destructor*

Family: Arachnids

Habitat: Terrestrial

Origin: Southeast Asia

Introduction: Accidental by importing European bees (*Apis mellifera* strain) into territories occupied by the Asian bee (*Apis cerana* strain), late 19th century, early 20th century.



**Description** Varroa is a bee ectoparasite visible to the naked eye; it exhibits significant sexual dimorphism.

**1.1.- The female** It is 1.1 to 1.2 mm long and 1.5 to 1.6 mm wide. It is light brown to dark brown in colour. Its body is elliptical in shape and covered with more or less long or wavy bristles. The body is composed of a dorsal shield and chitinous and hard plates. It is strongly flattened, which allows it to infiltrate and fix itself between

abdominal tergites of adult bees. On the ventral side, the female has four pairs of short legs that end in a suction cup. These legs are constantly folded under the body with the exception of the first pair which is permanently stretched forward and wears senses. The oral appliance is of the sucker-pricker type. He wears two pointed chelicerae that perforate the bee's cuticle.

**1.2.- The male** It is present only in the cells of the brood. It is smaller than the female, it measures 0.75 to 0.92 mm long by 0.70 to 0.91 mm wide. Its body is rounded in shape and light yellow to white in color. His oral appliance is not adapted to the suction of the hemolymph. The modified chelicerae allow the transport of spermatophores.

**1.3.- Immature forms** Just like the male, immature forms are found inside the cells of the bee brood. Three immature stages are usually distinguished: the larva, the protonymph and the deutonymph.

**The larva** The larva is the first stage after the egg. It is enclosed in the membrane of the latter and begins its development 24 hours after laying. It is inactive and immobile, it is spherical in shape and measures 0.5mm in diameter.

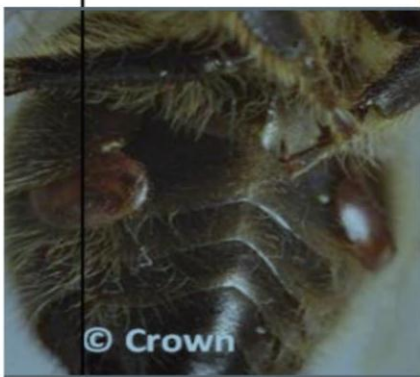
- **The protonymph** It is white in color and rounded in shape. It has four pairs of legs stretched outward and forward. This protonymph moves little and is able to pierce the cuticle of the bee pupa and feed on the hemolymph thanks to the development of its chelicerae. At this stage, it is difficult to distinguish the male from the female.

- **The deutonymph** The deutonymph takes the general aspect specific to his sex. The legs remain rigid and point forward. It moves a little more than the protonymph and it does not stop feeding



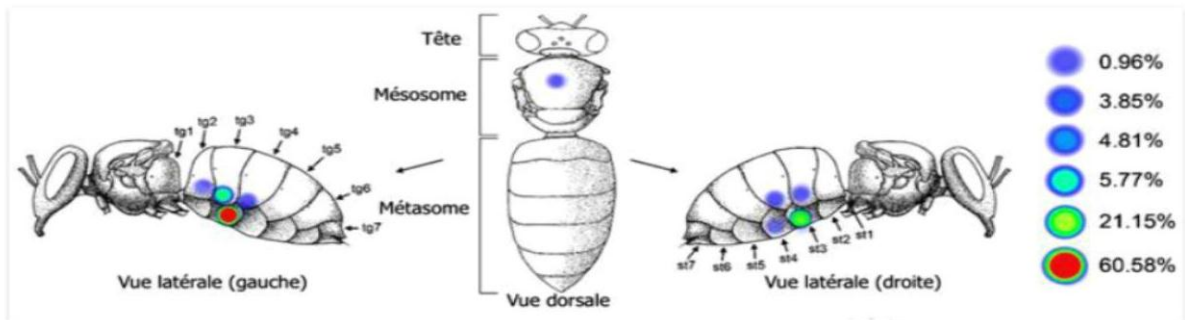
**Varroa inséré entre les plaques squelettiques de l'abdomen**

Orientation de la coupe ci-contre



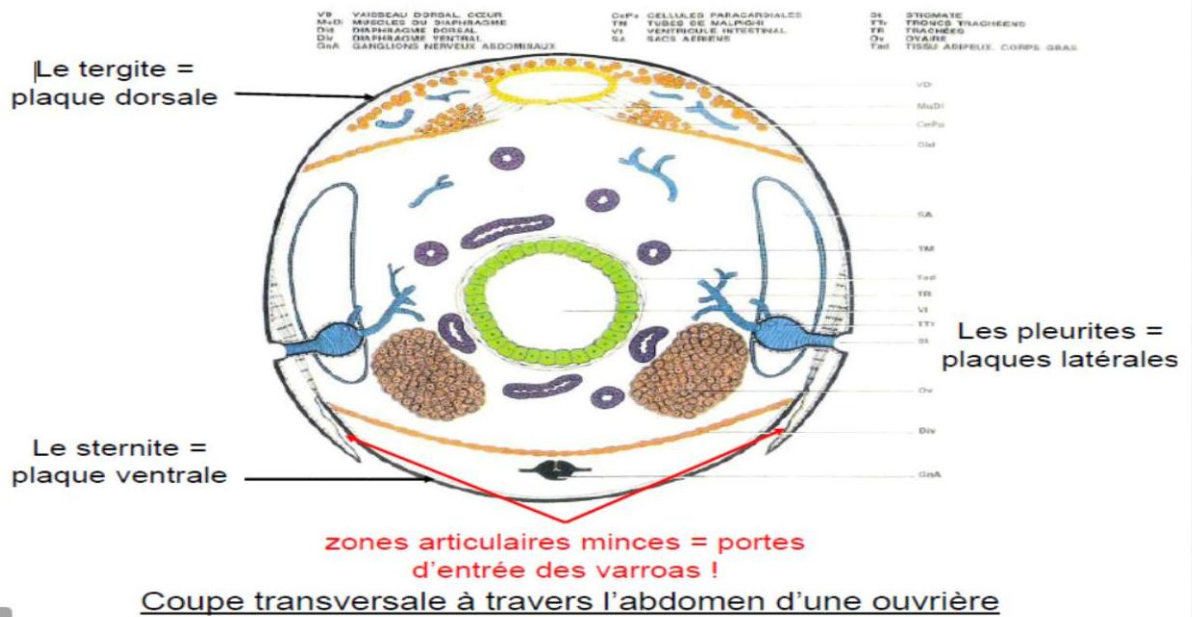
**Ecology** Only the female varroa attaches to the adipose tissue of bees and feeds on the reserves accumulated there. Sting absorption of the bee hemolymph was not the feeding mode of the female varroa. She preferably chooses the nurses who take care of the brood, which allows her to be locked in a cell to lay her eggs. She will sometimes find congeners brought by other nannies.

### Etude de la zone de fixation des varroas phorétiques sur les abeilles nourrices



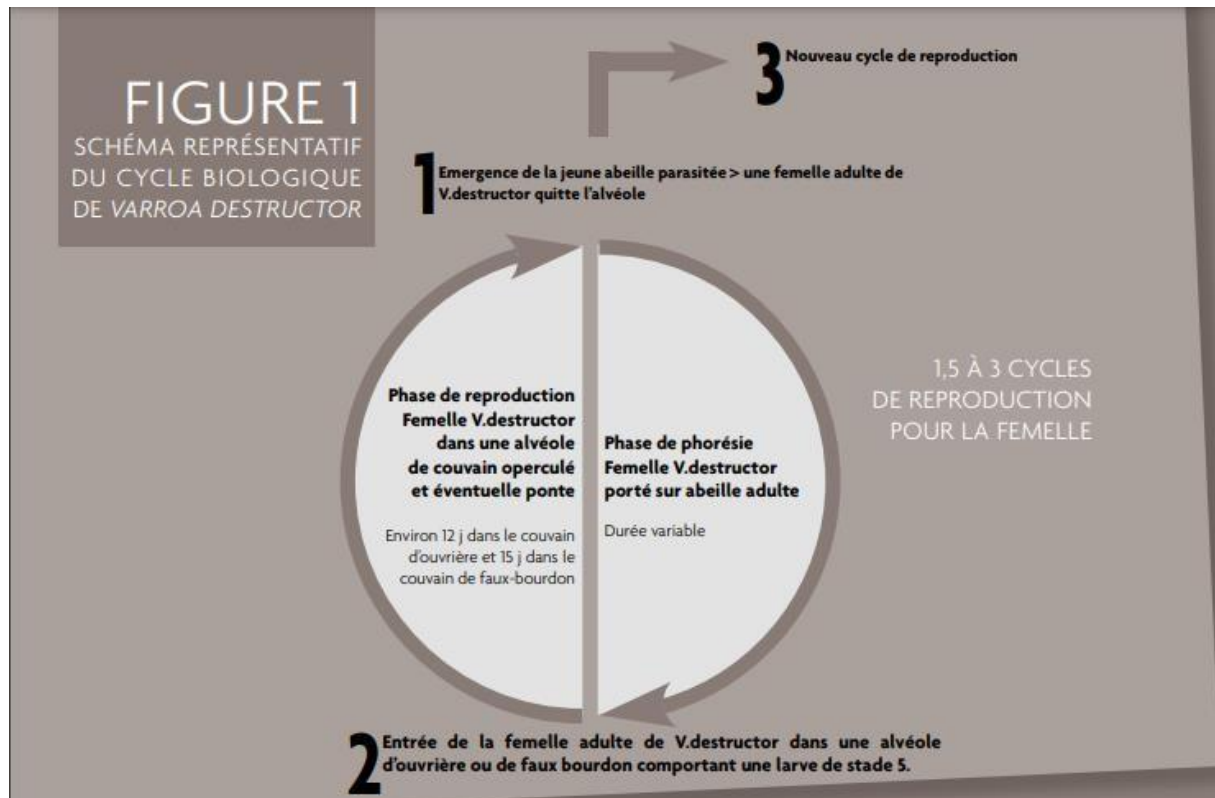
- La surface ventrale interne de l'abdomen est l'endroit où se situent les plus gros dépôts de tissus adipeux.
- Le 3<sup>ème</sup> segment abdominal est le plus convoité, c'est aussi le plus long ce qui lui permet de dissimuler la majeure partie de son corps échappant ainsi au toilettage.

### Les plaques squelettiques de l'exosquelette des insectes



- **The reproductive cycle** only takes place in the brood of hymenoptera. The Varroa life cycle has two phases (see Figure 1):
  - **A phase of phoresis**, on the adult bee (see photo 1),
  - **A phase of reproduction**, in the sealed brood cells (see photo 2). The phoresis phase corresponds to the

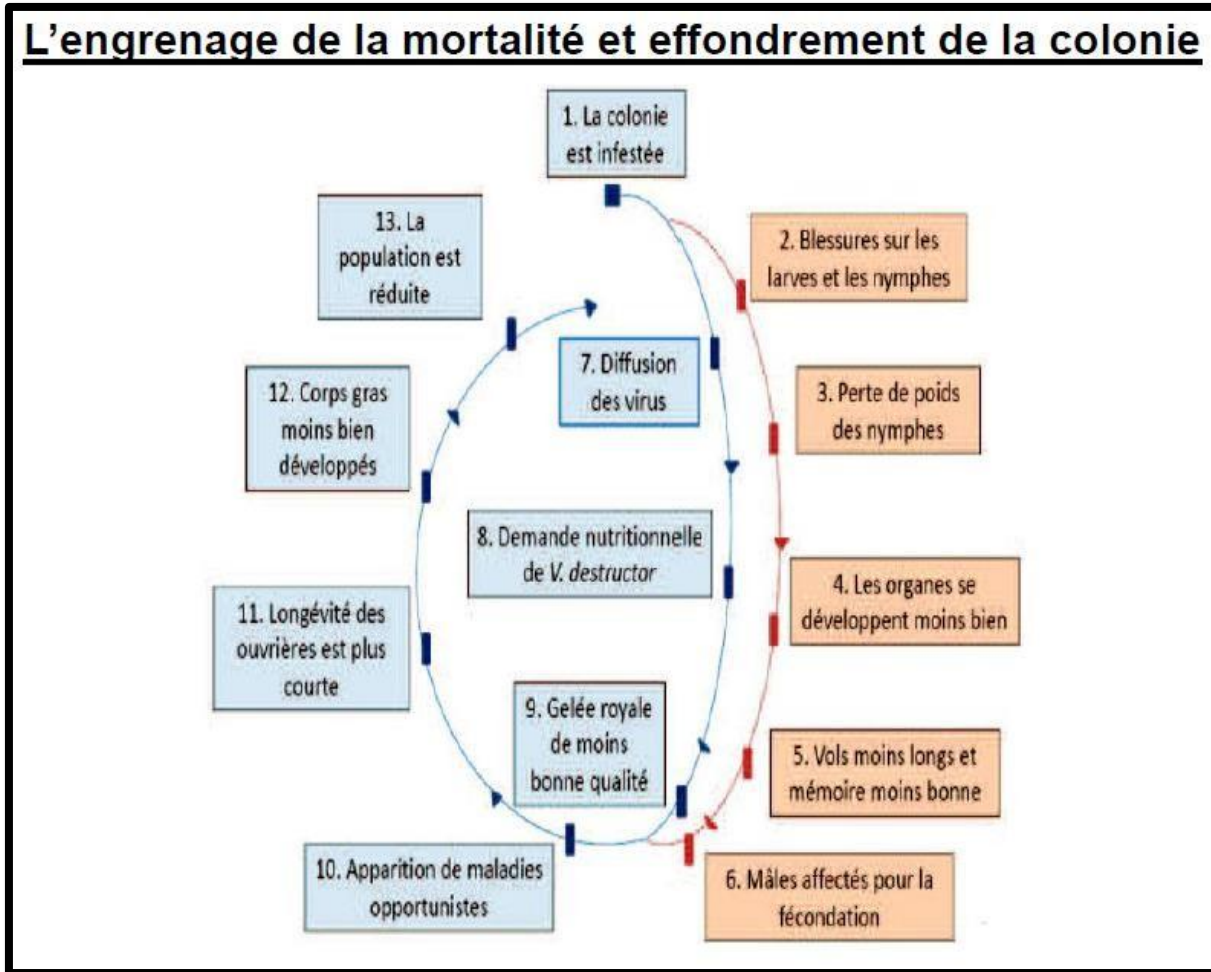
phase of transport of the parasite to the brood, in order to carry out its reproductive phase. It also allows the dispersal of the mite by foraging. After the emergence of the young bee, the Varroa females preferentially infest the 12-14 day old workers (nurses). They are then positioned between the sternites\* or tergites\* of the bee but also on its thorax or abdomen. In winter, in the absence of brood, the female has the ability to survive. It can thus resume its cycle the following spring. Larvae of stage L5 have an attractive effect (by diffusion of chemical substances) on parasites in the phoretic phase, which promotes the entry of the female Varroa into a brood cell, just before its operculation. The cells of drones are much more attractive than the cells of workers because they are more frequently visited by nurses and the duration of operculation is longer. The first female entering the alveolus is called the founder. It slides between the walls of the cell and the larva in order to protect itself from the cleaning bees by immersing itself in the larval jelly, until the operculation. The founder then begins to feed on the haemolymph of the larva, after having pierced its cuticle. This site is the unique feeding site for all parasites evolving in the cell during the reproductive phase. The laying of the first egg takes place about 3 days after the operculation. It allows the hatching of a male, haploid\*. Thereafter, an egg is laid approximately every 30 hours. They correspond to diploid females \*. The male, sexually mature before the female, waits for the arrival of his first sister at the site of faecal accumulation, the place of mating. Several matings take place until the arrival of another adult sister on the site. The adult female *V. destructor* then positions herself on the young bee, before emergence. At the end of the latter, the immature females and the male die. Thus, for each reproductive cycle, each female spawns 2 to 3 fertilized adult females in the bumblebee brood and 0.8 to 1.5 adult females in the worker brood.



### Clinical/Pathology

**Couvain:** the brood of drones is preferably affected. During the control of the covered brood, mites at different stages of development are noticed. False bumblebees and workers parasitized during their development are often malformed, have a shortened abdomen, wings and atrophied limbs. This is mainly due to the transmission of the deformed wing virus (DWV) of which the mite is a vector. These young bees die early and contribute to a weakening of the colony. Adult bees are also weakened by the removal of hemolymph and fat. They become agitated, maintain the brood poorly and appear disturbed in their behavior during their outings and harvests. On bees, parasitic mites are difficult to see, but if the infestation is large, it is possible to distinguish them under the ventral and dorsal plates of the abdomen. Affected colonies have a strong tendency to contract secondary diseases, such as viral diseases

□ The main environmental impact of varroa affects wild bee colonies and causes large population losses, with damaging consequences for ecosystems dependent on the pollination of these hymenoptera.



- **The fight against Varroa** To fight against varroa, it is imperative to examine the brood as well as the adult bees in order to detect it in the colony under consideration. Different steps can be considered:

- **Screening Varroa control** should begin with screening to determine the presence or absence of the parasite and also to assess the rate and level of infestation in some cases. Screening methods vary and some require the beekeeper to have a good knowledge of varroa and bee biology.

This involves assessing the rate of parasitism in a colony before and after treatment. However, several methods are available and they each have their level of sensitivity Among these methods:

- **Visual inspection:** Following the opening of the hive, bees must be observed on the brood frames. Varroas can be seen between the abdominal segments of the bee.

- **Examination of the brood:** This method consists of removing mites that are found in the cells of the covered brood (preferably those of males). This method gives an idea

on the rate of brood parasitism or the rate of infestation of the brood. - Examination of bees: This method makes it possible to evaluate the infestation rate of adult bees. It consists of taking a sample of bees (about 200 bees), placing them in a jar containing alcohol at 70° to 80° or water to which detergent has been added. After shaking well, the fallen varroa is counted. Their percentage in relation to the bees collected tells us about the degree of infestation of the colony.

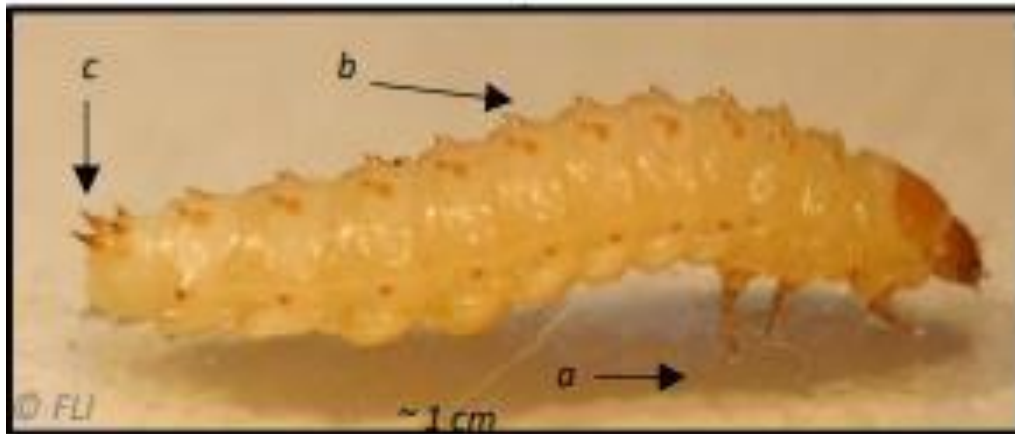
|||UNTRANSLATED\_CONTENT\_START|||2-Le petit coléoptère des ruches *Aethina tumida*|||UNTRANSLATED\_CONTENT\_END|||

Latin name: *Aethina tumida* (Murray)

Common name: The small hive beetle (SHB)



**The larva** is the most harmful stage for the colony. It is about 30 × 45 cm in size. It is cream-white in colour and may, at first glance, resemble the larvae of false moths (*Galleria mellonella* and *Achroia grisella*). However, further examination makes it possible to distinguish the presence of three pairs of long legs on its anterior part (a), dorsal spines on each segment (b) and two protruding spines at the rear (c).



**Adult** Adults measure 5 to 7 mm (one-third the size of an adult bee). Light in color after the pupa emerges, the beetle darkens to brown to black. The head, pronotum and abdomen are well separated. A characteristic of the beetle is that its elytra (d) are shorter than its abdomen so that the end of the abdomen is clearly visible. The club antennas have a typical shape (f).



**Life cycle** *Aethina tumida* can perform several generations per year (1 to 6), depending on environmental conditions.

**The female** lays fertilized eggs (1.5 x 0.25 mm) in clusters, for example in the cracks of the wood or directly in the cells of the brood (g – the alveolus has been removed).

Females can lay a thousand to two thousand eggs in the hive during their lifetime. The larval stage lasts from 10 to 16 days.

The larvae are omnivorous and feed on brood, bee bread and honey. Mature larvae metamorphose after 15-60 days. Nymphosis takes place in the soil outside the hive, usually at a depth of 1 to 30 cm and within 20 m of the hive.

In rare cases, larvae moving up to 200 m to find soil suitable for puposis have been observed. Soft, moist soil and a temperature of at least 10°C are required to allow the larva to complete its development cycle, although it can survive for short periods in the soil at a lower temperature (less than 3 weeks).

Adult beetles emerge after 3-4 weeks on average. This duration can vary between 8 and 84 days depending on the temperature.

Adults can fly several kilometers to infest new colonies. They can also survive up to 9 days without water or food, 50 days in used frames and several months in fruit.

**Modes of propagation.** Its dissemination occurs naturally since the small beetle can fly long distances.

The dissemination of the small beetle of the hive is favoured by the movements of bees, colonies, swarms, wax or beekeeping equipment. Soil, fruit or occasional host movements (such as bumblebees) can also be pathways for the introduction of the beetle.



### **Consequences of an infestation for the colony**

#### **Clinical signs of a small beetle infestation :**

- Presence of galleries in the frames (dug by larvae)
- Destruction of brood (eaten by beetle larvae)

- Modification of the colour and fermentation of the honey.

### Prevention

Detecting a low number of beetles, larvae or eggs is very difficult. Regular inspection of colonies in apiaries is paramount to ensure early detection of beetles and atypical larvae.

There are also several types of traps for beetle detection.

An easy-to-use trap is made of corrugated plastic 4 mm in diameter; it is placed at the bottom of the hive through the flight hole (h). Adult beetles will hide from bees in the trap tunnels. If you don't have corrugated plastic, you can examine your hive for two particular signs:



1. The presence of adult beetles running to the bottom of the hive
2. In the worst case (strong infestation), you will see malodorous and fermented honey flowing from the entrance of the hive, creeping larvae, or dark traces outside the hive corresponding to dried larvae

**National registration of beekeepers.** It is very important that all beekeepers are registered with the health authorities so that they integrate the national database. If the geographical location of colonies at risk for the small beetle is not known, the chances of detecting its introduction and eradicating it are seriously compromised. It is also necessary to be able to carry out long-term control of the colonies in the event of an introduction.

### Mites of the genus *TROPILAEELAPS* spp. Latin

**name:** *Tropilaelaps* spp. (bee acariosis)

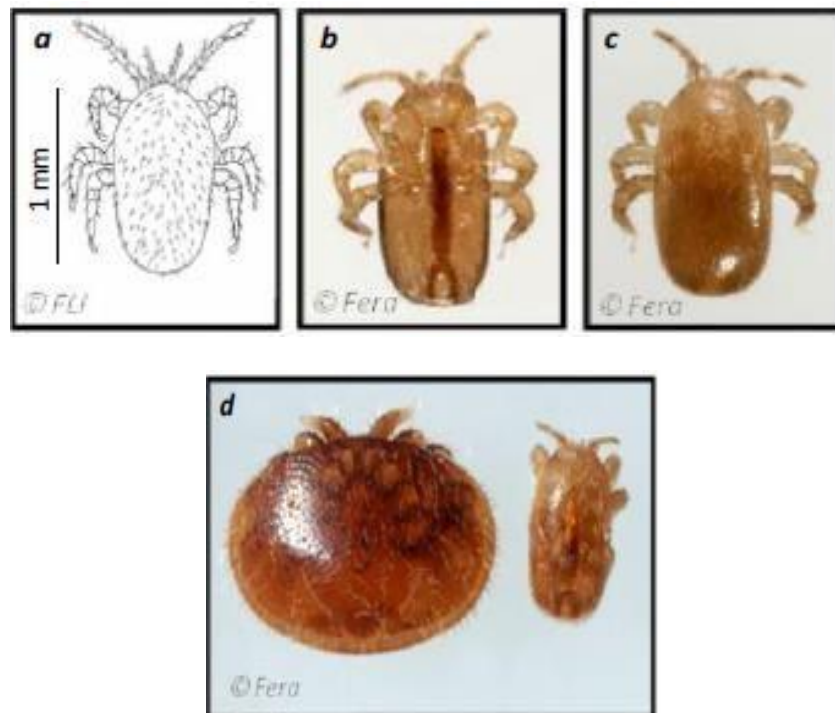
Parasitic mite of adult bees and their brood, attacking the latter. The parasites feed on larvae and pupae; they lead to poor brood development and loss of bees that can cause decline or swarming of the affected colony.

Stages affected are the larval and pupal stages of drones and workers (brood), adult bees.

There are 4 different *Tropilaelaps* species: *Tropilaelaps koenigerum*, *Tropilaelaps thaii*, *Tropilaelaps clareae* and *Tropilaelaps mercedesae*. Only the latter two, *T. clareae* and *T. mercedesae*, infest the honey bee.

The mite has 4 pairs of legs. The first pair is arranged vertically, like antennae.

- The body appears unsegmented, in a single region (a, b, c) and is red-brown in colour (b, c).
- Size: approx. 1mm x 0.5mm (a). *T. mercedesae* is slightly wider than *T. clareae*. The
- parasite is visible to the naked eye. It is smaller than *Varroa destructor* (d).
- *Varroa* is wider than *Tropilaelaps* and moves relatively slowly. *Varroa*, wider than long, has a crab shape. Conversely, *Tropilaelaps*' body is longer than it is wide and the mite moves quite quickly on the brood frames.



### Life cycle

The life cycle of *Tropilaelaps* is similar to that of *Varroa*. Mites reproduce in the brood. The duration of the development cycle is one week. The reproduction rate is higher than that of *Varroa*. Adults lay their eggs on the

larvae in brood cells. The resulting mite larva feeds on the hemolymph (blood) of developing bees. *Tropilaelaps* feeds exclusively on brood. Mites cannot feed on the adult bee, as they are unable to pierce its cuticle. Thus, experiments show that they cannot survive more than nine days without bee brood at colony temperature.

Females lay one to four eggs on mature bee larvae just before operculation; the parasite's nymphs feed on the bee larvae, causing serious damage. The development of the mites lasts about a week, then the adult parasites, including the female founder, leave the alveolus when the bee emerges and go in search of new hosts. Up to 14 mites and 10 nymphs were observed in one cell. A short passage on the bee (phoretic phase, about 12 h) has the consequence of shortening the time per complete cycle which allows *Tropilaelaps* to grow faster than varroa, but its survival on bees is limited to 1 or 2 days. A direct consequence is that the mite cannot survive the winter, as there are no broods in this season. If no action is taken, the colony dies within 3-5 months.

### **Clinical/Pathology**

Reaching the brood of drones and workers. The parasite causes the death of many bee larvae, resulting in a mosaic brood with larval corpses partially protruding from the alveoli. The bees that hatch from this brood are often malformed, with distorted abdomens, wings, and even atrophied legs. The parasite transmits viruses, such as Deformed Wings Virus (DWV). Cell lids are often perforated due to worker cleaning activities removing parasitized larvae or young bees. Some of the colonies are affected essentially, thus dispersing the parasite.

**Means of propagation.** Dissemination between colonies occurs through adult bees (phoresis) during the natural processes of drift, flight, and swarming. The mite can also be spread by beekeeping practices *through* the spread of infested bees and brood. Moving infested *A. mellifera* colonies to new geographical areas is the main mode of mite spread. It is essential to check that the bees are healthy before moving the colonies.



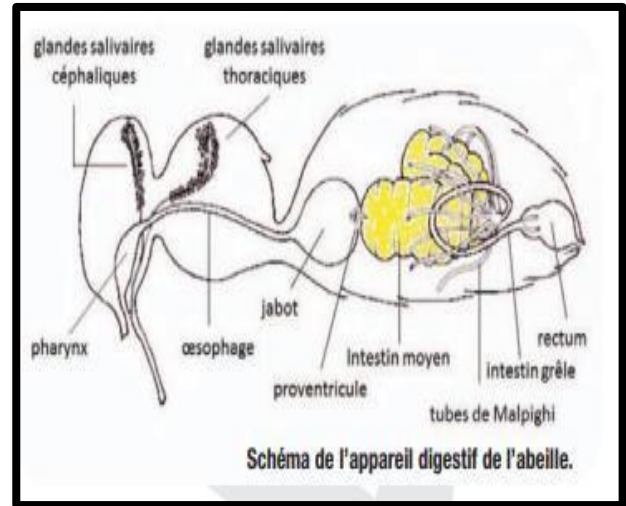
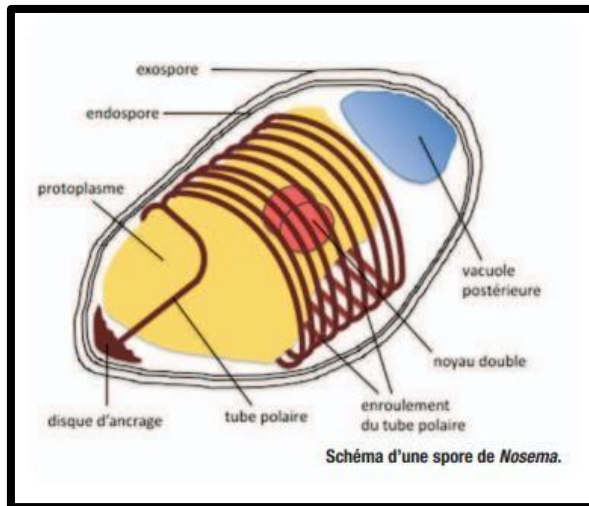
The clinical signs of a *Tropilaelaps* infestation are similar to those of varroasis:

- Distorted and shortened wings and legs
- Distorted abdomen
- Operculae with small holes
- Mosaic cover (irregular brood)
- brood
- It is possible to see creeping bees at the entrance of the hive

**Nosemosis:** It is a contagious disease of the honey bee, due to a microsporidia (parasitic fungus) of the genus *Nosema*, (protozoan): An obligate intracellular parasite that multiplies in the cells of the intestinal wall. It reaches all adult bee castes. Two species of *Nosema* have been identified in *Apis mellifera*: *N. apis* and *N. ceranae*. They can be found simultaneously or separately in the colonies.

During its evolutionary cycle, *Nosema* can be found in two forms. At the vegetative stage, the parasite reproduces in the body of the bee and at the spore stage, a passive and infectious form responsible for the transmission of the disease. The spore is ovoid in shape and 6  $\mu\text{m}$  long, 3  $\mu\text{m}$  wide. More recently, another microsporid, *Nosema ceranae*, has been identified in Europe. The spores of *Nosema ceranae* are slightly smaller than those of *Nosema apis*.

*N. apis* seems to develop more easily in regions with cold winters while the multiplication of *N. ceranae* seems to be favoured in regions with very hot summers.



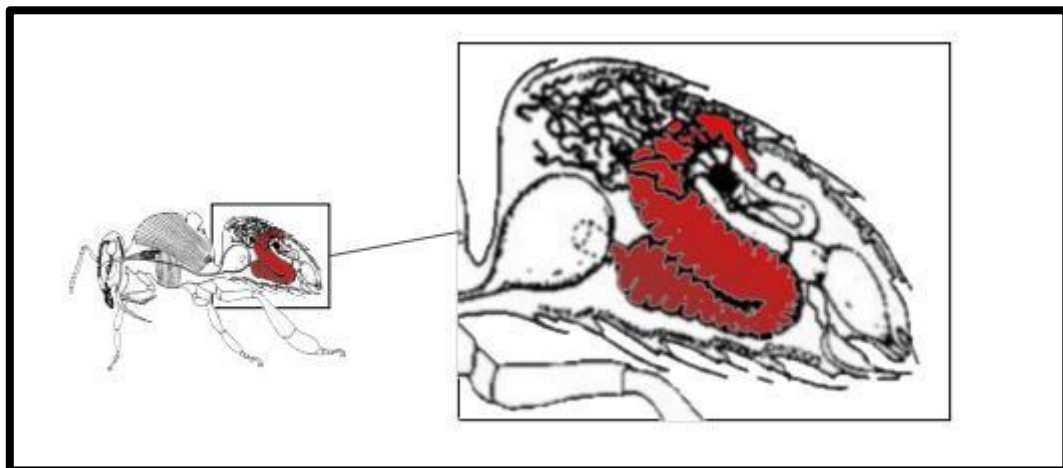
**Life cycle:** The target of *Nosema* is the adult bee: all three castes can be reached: males, workers and queens. The brood is not affected, but may suffer, as we will see, collateral damage.

Bees become contaminated orally, during cleaning work and/or by trophallaxis, and the spores germinate in their middle intestine if conditions are favorable. At the end of the multiplication cycle that takes place in the cells of the middle intestine (part of the digestive tract where the digestion of food takes place), the fungus produces spores that are elements of resistance, dissemination and contamination.

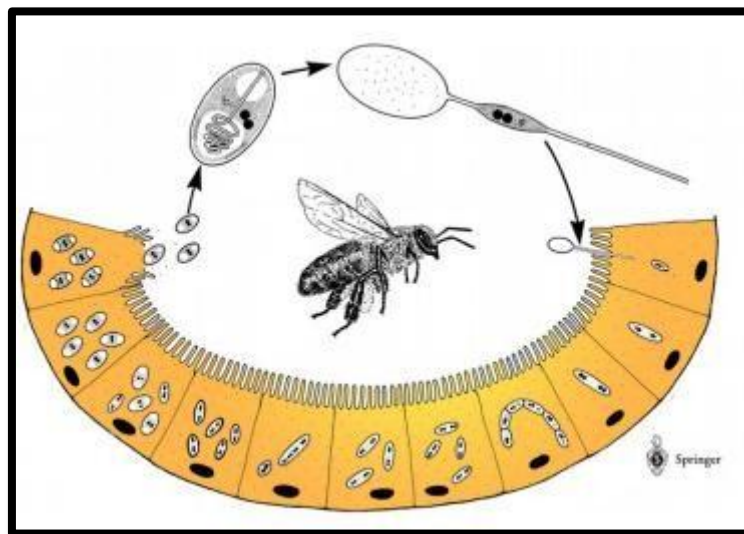
To schematize the development of *Nosema* in bees, let's say that there are 3 stages:

1. Penetration (germination) 2. Multiplication and 3. Production of spores.

1. Penetration Everything happens in the ventricle of the bee: part of its "intestine". Before it can multiply in the cells of the bee's ventricle,



Nosema already has to cross two microscopic barriers to penetrate it: The peritrophic membrane, which is a kind of chitin film made by the cells of the wall of the ventricle and which acts as a filter. Then the wall of the digestive cell. In the diagram, it is the "brush" border of the cells, "central side". In the ventricle of the bee, the conditions in the "intestinal fluid" allow the germination of the spore: it is short and brutal: less than 2 seconds. The pressure increases rapidly in the spore, the micropyle breaks and the polar filament comes out like a devil from its box, or rather like a missile. It thus crosses the peritrophic membrane and the membrane of the cells of the wall of the ventricle. The needle is stuck... remains to be injected. The polar filament is hollow and will allow the contents of the spore to be injected into the digestive cell. The posterior vacuole, acting as a "plunger", increases in volume and gradually pushes the contents of the spore, called the amoeboid germ, into the digestive cell of the bee. Penetration operation completed



2. Multiplication Once penetrated into the cell, Nosema diverts the metabolism of the parasitized cell to its advantage and multiplies.

Nosemosis: presentation and cycle 4/5 Normally, an attacked digestive cell should swell and destroy itself quickly, by a kind of "suicidal" response to aggression but Nosema "defuses the alarm", prevents this suicide and can thus multiply quickly in the cell. Gradually, the parasites resulting from this multiplication occupy more and more space inside the cell and the cell's reserves eventually run out.

3. Spore formation This exhaustion triggers the transformation of Nosema multiplication forms into spores. It is interesting to note that two types of spores are produced : mature, thick-walled spores, which are released into the intestine by destruction of the parasitized cell. They will then be dispersed when the bee defecates. Spores called immature: their wall is not as thick as that of mature spores and these spores "unpin" (germinate) in the parasitized cell: the polar filament that is ejected thus allows the contamination of neighboring cells and thus the extension, step by step, of the lesions of the digestive wall. The multiplication of Nosema at

the infested bee does so quickly and a bee can end up harboring several hundred million spores. These spores are released with the droppings of the bee, ensuring the contamination of other bees. Things have come full circle.

**Epidemiology and mode of spread** Bees affected by nosemosis will defecate on the frames inside the hive while their excretions contain millions of spores. Their congeners become infected by cleaning or eating contaminated food. The situation is aggravated during the lockdown period. This infection can spread through bee drift, looting, the purchase of bees and through the use by the beekeeper of material soiled with contaminated feces, water or honey. Pest insects like the false moth *Galleria melonella* can also transmit spores

**Favorable causes** The causes that promote the development of this pathology are mainly linked during long winters to the prolonged confinement of the bee inside the hive. Other factors can also contribute to the development of the disease such as the inadequate establishment of colonies in wetlands deposited directly on the ground. According to a study done in South Africa, the highest incidence of the disease appears in forest areas because of the lack of direct sunlight on the colonies placed in these wooded areas, which could interfere with the proper regulation of heat and humidity inside the nests and suffocate the colonies. Poor artificial feeding to bees also promotes the onset of pathology.

**Symptoms** Highly infected bees cannot properly digest their food since the epithelial cells of the intestine have been damaged by Nosema.

This results in a form of diarrhea in the bee, which can then defecate in the hive or on the flight deck. A more or less significant soiling of the hive will then be observed. These stains contain millions of spores that become a source of contamination for cleaning bees. This pathology causes a weakening of the colonies and an increase in the number of foragers: the colony dies with large supplies of honey and pollen. Nosemosis also causes a change in the posterior part of the abdomen.

In diseased bees, it is whitish, dilated and has no usual constriction, whereas in healthy bees, it is yellow to reddish in colour and marked with constriction. The infection caused by *Nosema cerana* is different from that induced by *Nosema apis*. *Nosema cerana* disrupts bees in several ways: energy stress, decreased lifespan and flight capacity, disruption of foraging behavior.

**Prevention**, we must aim to create optimal conditions for a solid development of the colony throughout the season. In the case of wintering, a careful selection of wintering sites must be made. While in the production season, apiary sites must be dry and sunny. Disinfection of beekeeping equipment will be an effective measure to destroy *Nosema* spores and reduce the development of microorganisms in general

## Chapter II. Fish Parasites

### 1. PROTOZOA

❖ Protozoa belong to the reign of protists who are unicellular organisms, with a nucleus surrounded by a membrane: eukaryotic organisms.

1. Protozoa are Protophytes; Protomycetes; Protists

- Protos (first), zoon (animal), eukaryotes;
- Heterotrophs, can be free, commensal or parasitic,
- eukaryotic unicellular,
- sexual or asexual reproduction,
- most are microscopic size between 1-500  $\mu\text{m}$  and 4 mm,
- mobile organisms (eyelashes, flagella, pseudopods);
- Endoparasites, Parasites of blood, muscle

2. Phylum(Emb ) of Protozoa: Sarcomastigophora, Apicomplexa, Microspora, Ciliophora

### Reproduction

It is generally asexual; by simple binary division, schizogony (or merogony), budding, endodyogenesis (two daughter cells form inside the mother cell). It is sometimes sexual (copulation and sporogony, conjugation).

### Nourishing elixir

- Passive or active passage of small molecules through the plasma membrane;
- Phagocytoses
- Ingestion of food at the cytostome.
- Breath
- anaerobe
- Category
- Protozoa systems are based on the nature of the musculoskeletal system and the characteristics of development cycles.

### Identification of Protozoa Sarcomastigophora:

### Flagellae and pseudopods Apicomplexa:

### Coccidia( oocysts, sporozoites) Microspora:

### Microspores

## Ciliophora: Eyelashes

### 1. Sarcomastigophora phylum

(sarkodes: fleshy, mastigos: whip, phoros: who carries)

□ Protists equipped with flagella or pseudopods, having only one type of nucleus, their reproduction is essentially asexual.

A direct life cycle (single host), e.g. amoedae;

An indirect life cycle (tenene cycle), e.g. trypanosoma

#### Example

##### 1.1. Flagellate

##### 1.1.1. Esp: *Cryptobia iubilans*

*Cryptobia iubilans* (or new nomenclature *Trypanoplasma iubilans*) is a Sarcomastigophora of the class Zoomastigophora. There are more than thirty species belonging to the genus Trypanoplasma.

Measuring from 10 to 30  $\mu\text{m}$ , this flagellate, devoid of chloroplasts, is characterized by the presence of two flagella: one free and the other connected to the undulating membrane).

Its essentially asexual mode of reproduction.

It is a hemoparasite or blood parasite (plasma in reality). It is only found in freshwater fish (definitive hosts). Laboratory diagnosis is carried out by microscopic observation of a blood smear, highlighting the parasite and its two flagella.

*Cryptobia ubilans* is the only known representative present in the intestines of freshwater fish. Unlike *Spironucleus sp.*, *Cryptobia eubilans* has only 2 flagella extending from the front end of the cell, but as one flagella is directed along the cell backwards, it looks like one comes out from the front and the other from the back.



### **Pathology and life cycle.**

Infection with *Cryptobia ubilans* occurs directly (without the need for intermediate hosts) through water, feces, and the consumption of fish carcasses. Once inside the fish's intestines, the number of parasites increases. As the parasite population in the intestine increases, the fish may exhibit inflammation, accompanied by abundant mucus secretion and the appearance of long, translucent or whitish stools. In the later stages of infection, fish develop granulomatous gastritis when granulomas can form in the intestinal wall that resemble mycobacterial granulomas (Ziehl-Neelsen staining can help establish the observed origin of granulomas, whether bacterial or parasitic). Granulomatous gastritis and gastroenteritis, accompanied by inflammation of the mucous membrane of the stomach and intestines, result in impaired digestive and absorption function of the digestive tract.

*Cryptobia ubilans* can cause the development of significant necrotic changes in the parenchyma of the liver and spleen. The general pathological examination reveals hemorrhages, intestinal necrosis and edema of the gastric wall, and the microscopic examination reveals a large number of *Cryptobia ubilans* in the intestinal submucosa and in the liver. Infected fish stop feeding, often stay close to the surface or bottom of the aquarium, their movements are slow. The appearance is edematous, unilateral or bilateral exophthalmos (pop-eye) and abdominal ascites (bloating) may occur. Due to a disruption of intestinal function, the body does not receive enough nutrients. This is one of the reasons for the formation of erosions on the head and body – and a symptom of hole in the head disease. One by one, the fish die.

Infection with *Cryptobia ubilans* is most commonly seen in cichlids such as *Apistogramma*, *Astronotus*, *Cichlozoma*, *Discus*, *Geophagus*, *Angelfish* and others.

### **Processing**

*Cryptobia ubilans* can cause the development of cryptobiosis. So far, no treatment for cryptobiosis is known to completely eradicate the parasite, however eSHa HEXAMITA will reduce the number of parasites, prevent mass mortality, and allow fish and their immune systems to recover and cope with this parasite. Normally, fish live perfectly well with a small amount of *Cryptobia*

## **2. Kingdom Animalia-Helminthes**

### **1- The metazoans**

**Introduction:** Metazoans are Triploblastic animals: they are animals with three leaflets: the ectoderm and the endoderm in between there is the mesoderm. (In diploblastics there is the mesogle between the two sheets). Depending on the mesoderm and the coelomic cavity, there are three groups of triploblasts: Acoelomata: Having a body without a cavity between the digestive tract and the body envelope, the mesoderm is compact and constitutes only a filling tissue (the parenchyma). This group is represented by only the flatworms.

Pseudocoelomata: Have a cavity but it is not entirely surrounded by mesodermal tissue; a false or incomplete cavity). Among the branches of this group;

### **Branching of the Plathelminths**

The branching of the Plathelminths has long occupied the base of the phylogenetic tree of life as triploblastic acoelomata, placed between diploblastic animals (after the acquisition of the mesoderm) and coelomata animals (deuterostomians, then Protostomians).

Recent work in molecular phylogeny has highlighted the hypothesis that flatworms are derived from a coelomate ancestor, meaning that they have, at some point in evolution, possessed a coeloma, as well as segmentation and a complete digestive system. There are therefore several reversions that characterize this phylum and which are: loss of the coeloma, loss of the anus and segmentation. The Plathelminthes are therefore acoelomate protostomian organisms, placed above the Arthropods and close neighbors of the Annelids. The branch line has several classes:

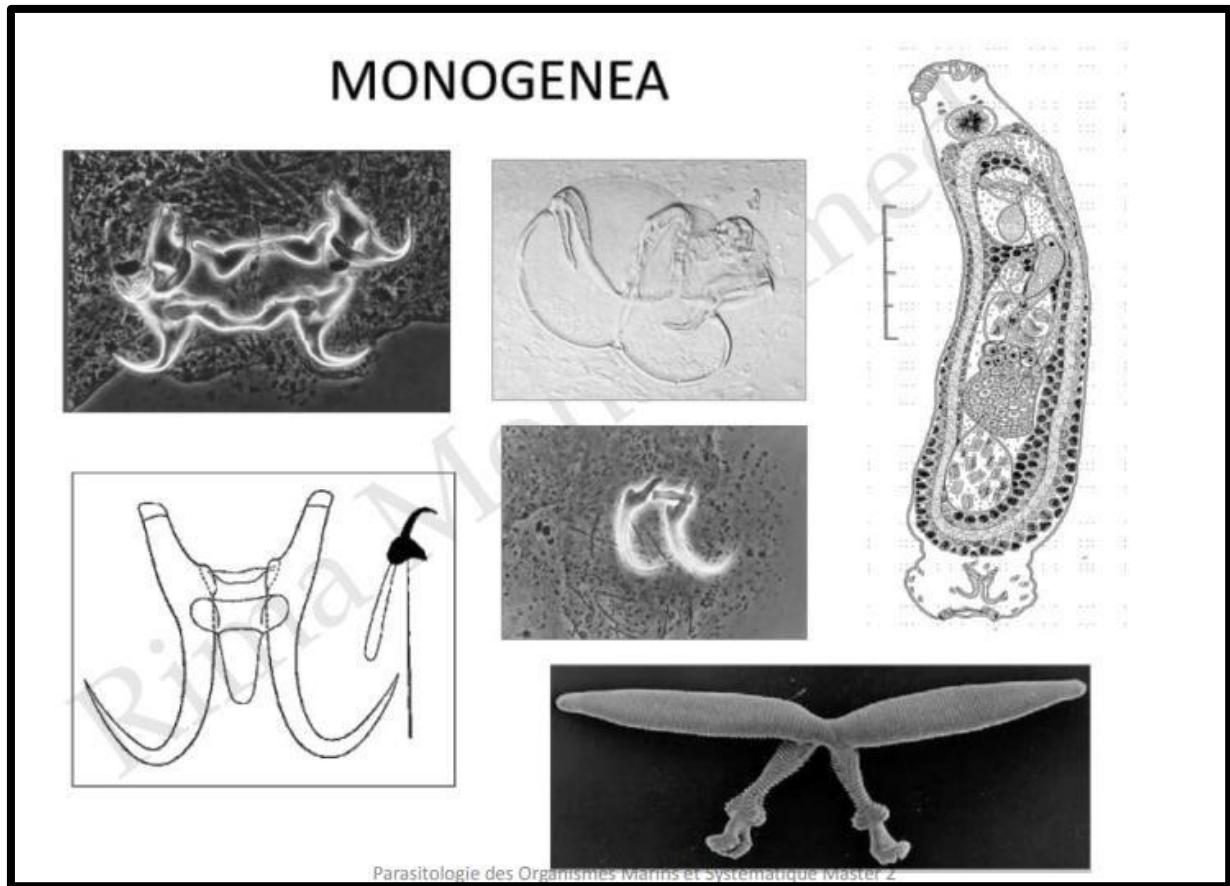
Cestodes: parasites of humans and some mammals (pigs, beef, etc.), class to which the genus *Taenia* (tapeworm) belongs

Les Turbellariés: Marine flatworms (non-parasitic) commonly known as "Planaires"

Trematodes: parasites of vertebrates with heteroxene cycles (several hosts), including the group of Digenes (Digenea)

Monogenes: aquatic vertebrate parasites with monoxene cycles (single host) .

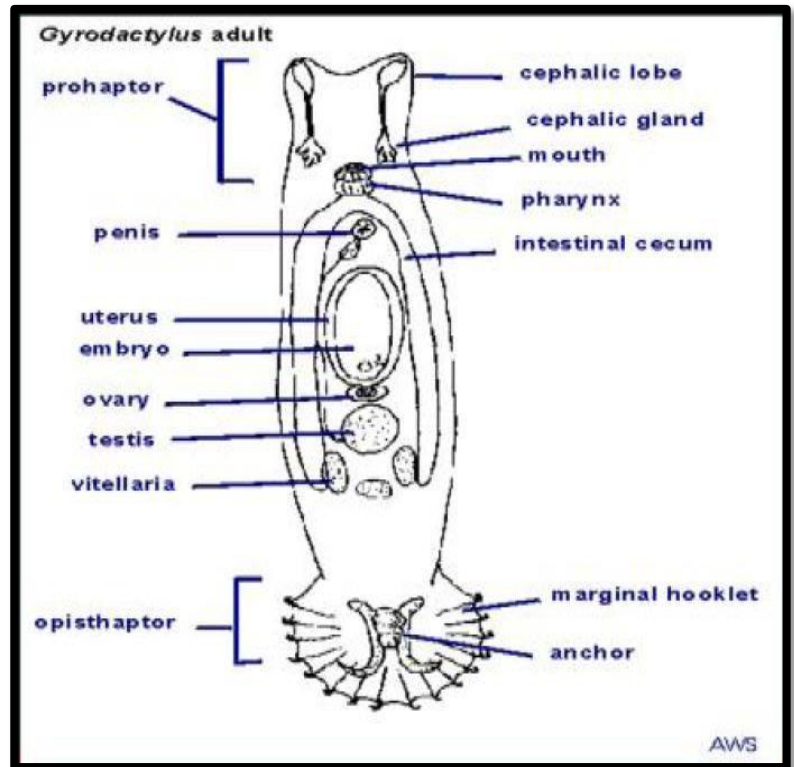
Monogenes or Monogenea (BYCHOWSKY, 1937) are a class of the fork of the Plathelminths; they are acoelomate triploblastic metazoans characterized by a non-metamerized body, dorsoventrally flattened and bilaterally symmetrical. They are mostly ectoparasites of aquatic organisms, mainly fish, where they live fixed on the skin, gills, in the cloaca and even in the urinary bladder. Monogenes are hermaphroditic and typically range in size from 0.5 mm to 6 mm. They have a holoxene or direct development cycle with a single host. *Dactylogyrus* represents the most dominant genus among the Monogenea. this genus includes more than 900 nominal species, the majority of which are gill ectoparasites of freshwater fish.



□ La classe des Monogènes est traditionnellement divisé en 2 sous-classes: *Monopisthocotylea* qui possèdent un haptour comprenant une seule Unité de fixation, et *Polyopisthocotylea* avec plusieurs unités de fixation

## *Gyrodactylus derjavini*

### Morphology



**Taxonomy:**

Branch: Plathelminths . Monogenea

class

Subclass: Monopisthocotylea .

superorder

Order: Gyrodactyloidea .

Family: Gyrodactylidae .

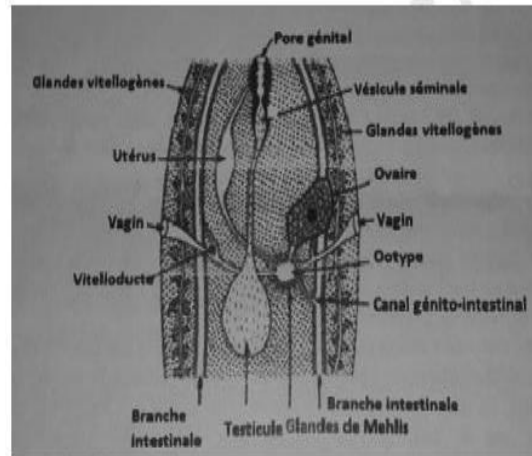
Subfamily: Gyrodactylinae .

Genus: Gyrodactylus .

Species: *Gyrodactylus derjavini*

## systeme génital comportant

- un appareil mâle testicules (un à plusieurs), d'un canal déférent, Vésicule séminale



- un appareil femelle

- Ovaire, d'un oviducte qui rejoint l'ootype, celui-ci est entouré de glandes de Mehlis et reçoit un vitellooducte qui arrive des glandes vitellogènes (vitellarium),  
 - d'un canal génito-intestinal qui relie les deux branches de l'intestin à l'oviducte ; il sert à évacuer l'excès de cellules vitellines ,  
 - d'un utérus plus ou moins long (contenant des œufs), qui débute dans l'atrium génital. Celui-ci s'ouvre à l'extérieur par un pore génital unique

### The Merchandise Lifecycle

*Gyrodactylus derjavini* is relatively simple. It goes through several stages, including egg, larva and adult. Adult parasites attach to host fish, usually on the skin, fins or gills . The eggs are then laid on the fish or in its environment.

After the eggs hatch, the larvae seek to attach to a new host .This cycle can be repeated , resulting in a multiplication of parasites on infected fish. Infestations can cause health problems in fish , such as skin irritation , lesions and alterations in gill functions.

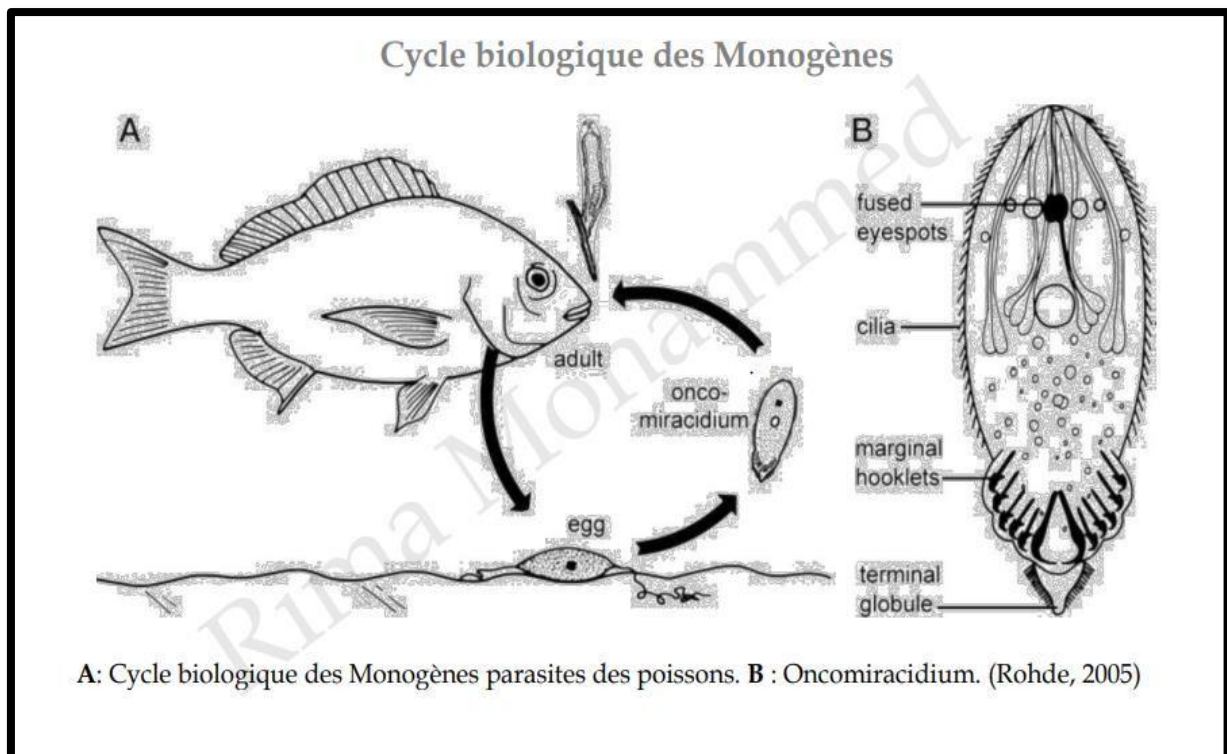
1-Eggs: Eggs of *Gyrodactylus derjavini* are laid on the host fish or in its aquatic environment.

2-Hatching: Eggs hatch, releasing mobile larvae ready to find a new host. 3-Host Search: Larvae swim in search of a suitable host fish.

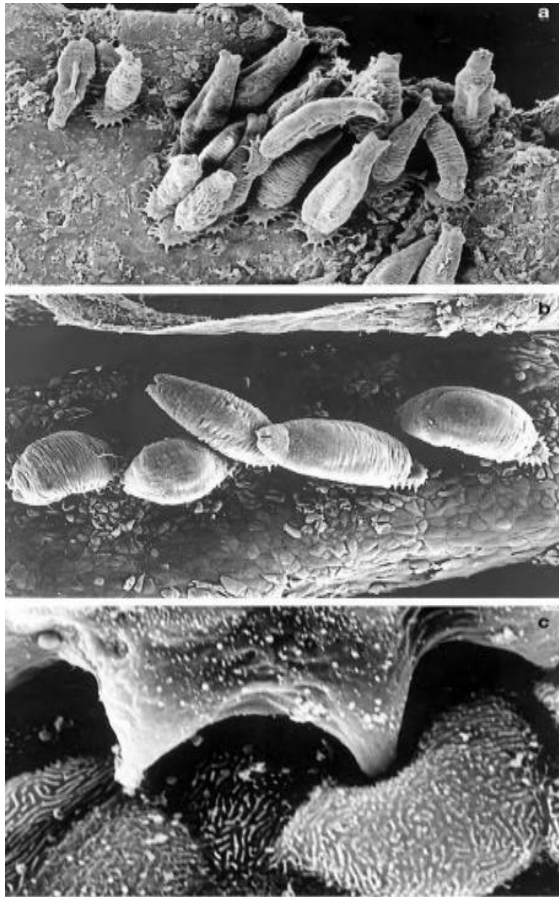
4-Attachment to the host: Once they find a fish, the larvae attach to its skin, fins or gills.

5-Development: Larvae develop into adult parasites on the host.

6-Reproduction: Adult parasites reproduce by producing eggs, thus completing the life cycle.



**Clinical:** Infestation of fish with *Gyrodactylus derjavini*, may include symptoms such as skin lesions , itching , behavioral changes and , in severe cases, respiratory problems



Les effets des Gyrodactylidae (Monopistocotylea) sur les nageoires des salmonidés.

- a. *Gyrodactylus* sur la nageoire du saumon atlantique  
 b. *Gyrodactylus derjavini* sur la nageoire de la truite  
 c. petits crochets marginaux de *G. derjavini* penetration dans les cellules épithéliales de la nageoire

## Nematodes,

Fish parasitic nematodes represent the most important endoparasite taxon, both from a taxonomic and a practical point of view. They are indeed much more robust, easier to handle, and do not require long tedious coloring processes such as the other groups of parasites (Trematodes and Cestodes). But despite their importance, they are the subject of less and less work. This growing lack of interest could be justified by the fact that there are currently very few specialists in nematology, who moreover would be able to identify new material

Fish parasitic nematodes present problems of taxonomy and systematics, the solution cannot be obtained solely by their morphological study but also by the study of their ecology, immunology, biochemistry and also by the data of the paleontology and biogeography of their hosts. Nevertheless, morphology remains the main means of identification of these parasites and forms the basis of their taxonomy.

## .1- Morpho-anatomy of Nematodes

### 1.1. External characters

Fish parasitic nematodes generally have a long cylindrical body which in cross section appears circular, there are two body shapes: fusiform and filiform. The fusiform Nematodes have the appearance of a long spindle widened in the middle and tapered at the ends (Figure 1), the caudal end being more pointed than the anterior end. This type is represented by many species of fish parasitic Nematodes such as Anisakidae and Cucullanidae. Filiform nematodes are less common and are similar to a wire whose diameter remains equal from the anterior end to the posterior end, such as Capillaridae, Cystidicolidae and some Philometridae.

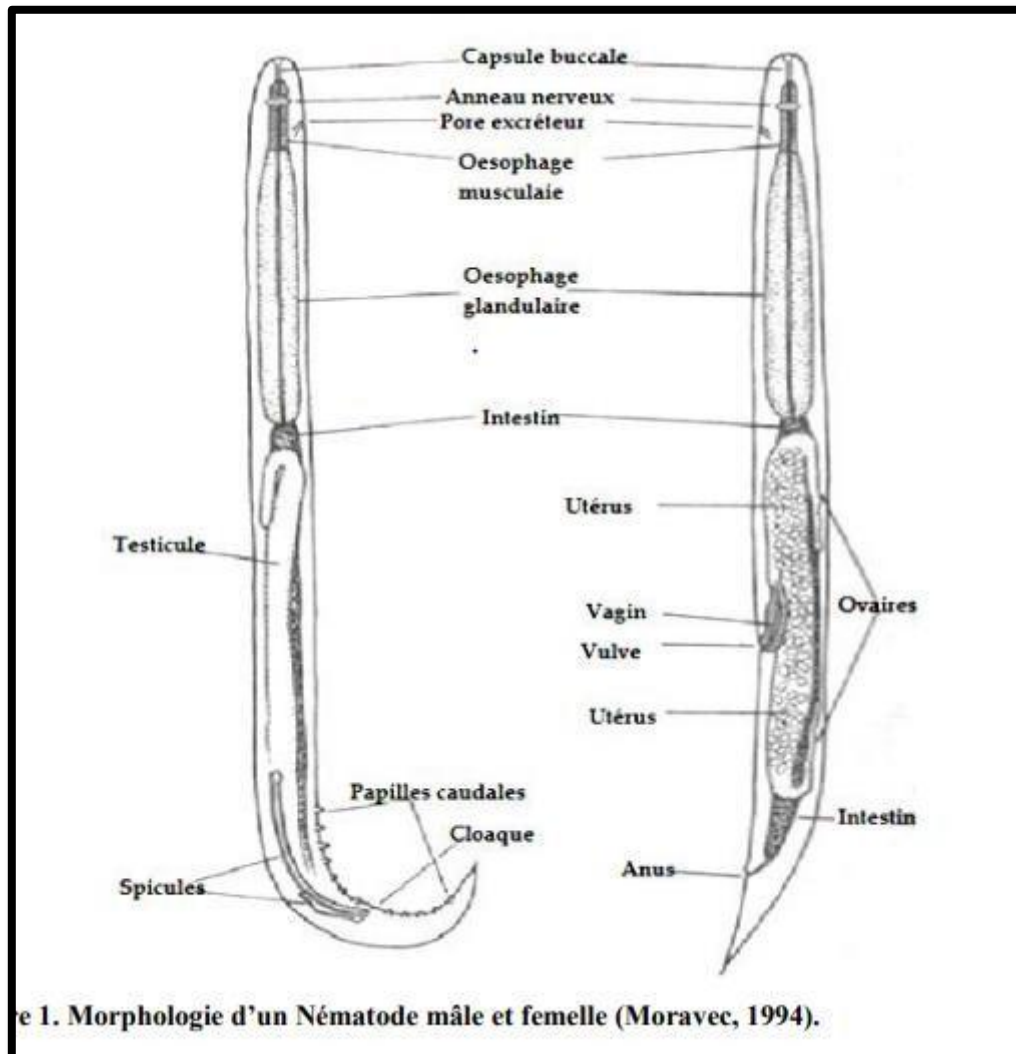


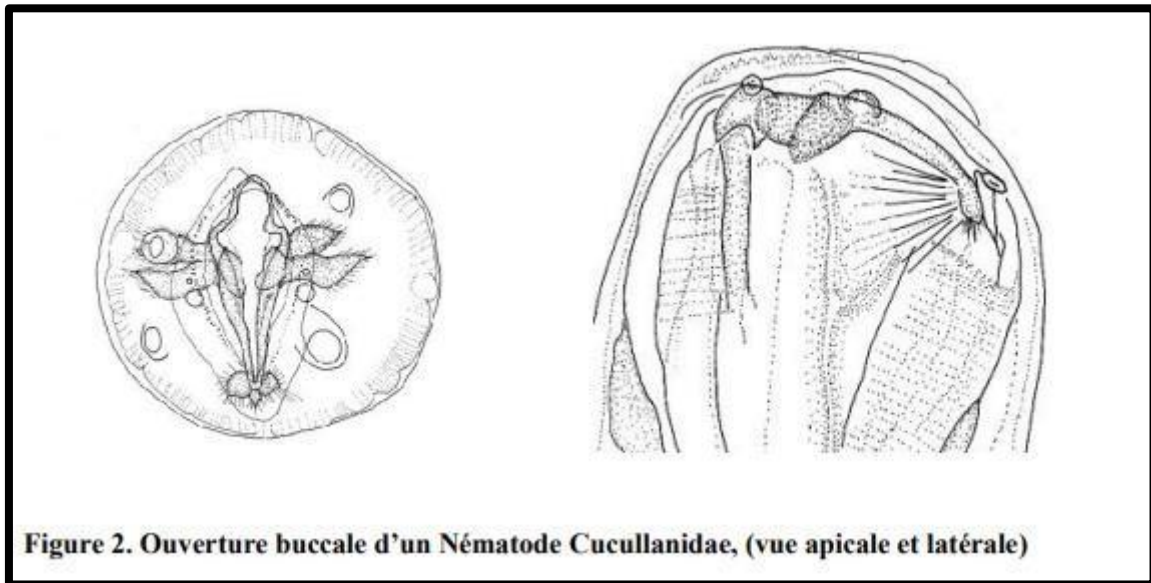
Figure 1. Morphologie d'un Nématode mâle et femelle (Moravec, 1994).

The body length of Nematodes can be extremely variable (from nearly 1mm in free-living Nematodes to almost 10 meters in parasitic Whale Placenton patterns). The

the majority of fish parasitic nematodes range in length from 1mm to a few cm. The females of Philometridae parasites of marine fish can nevertheless reach 45 cm like the *Philometra managatuwo* species. The body of Nematodes is covered with a thick, elastic and tough cuticle, it is sometimes smooth but usually scratched with fine transverse grooves at regular intervals, called striations. When deep and pronounced, the striations are called cancellations, there may also be longitudinal striations.

On the cuticle, different structures can exist: spines, cords, tubers, ridges and bacillary bands. The cuticle can be longitudinally thickened in order to form beads on either side of the body, these are the longitudinal lateral wings, which run along the entire body. The cervical or caudal wings are limited to the anterior or posterior part, in reality, the caudal wings of males are not part of the longitudinal lateral wings, they are used in copulation, they often carry genital papillae modified into a genital bursa (the bursa copulatrix).

The mouth opening occupies the center of the anterior end (Fig. 2). It is usually circular, oval or slit surrounded by two or three lips which are sometimes rudimentary. In some Anisakidae, there is also a cuticular growth called interlabia, starting at the base of the lips and then extending between them. Lips often carry different cuticular structures such as small teeth, papillae, amphids...

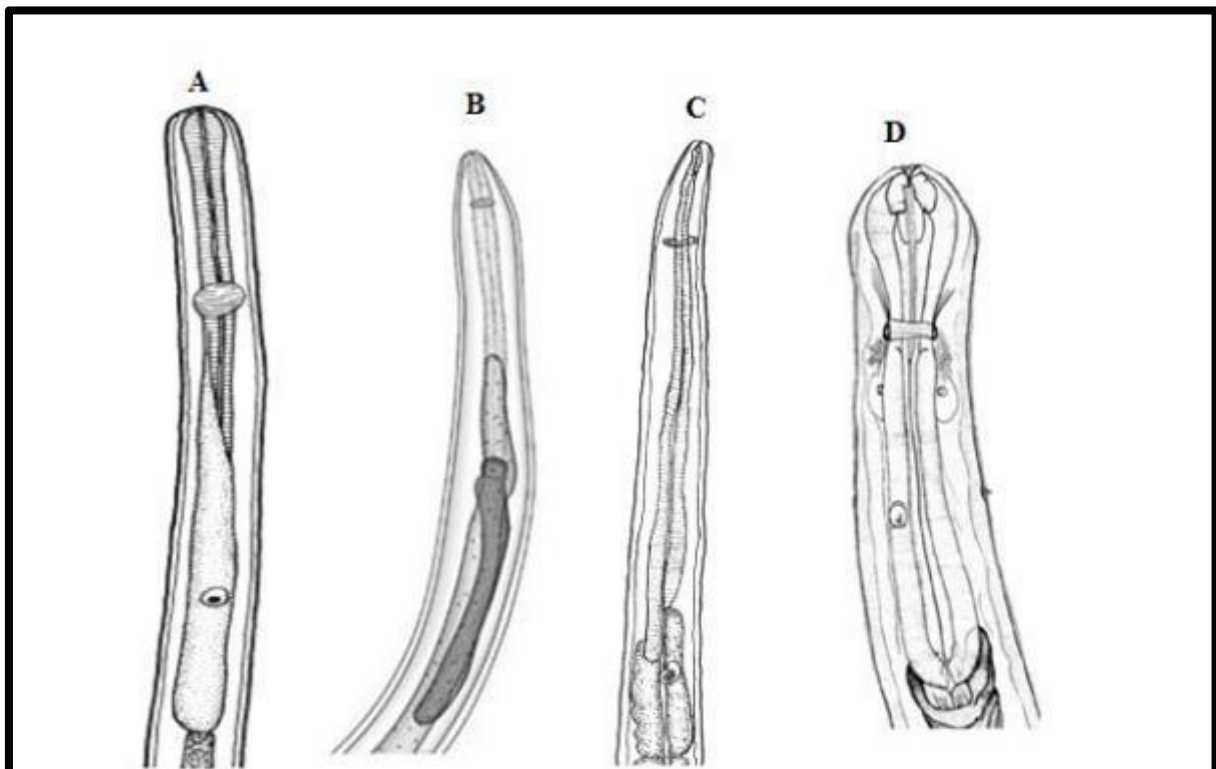


The ventral face of Nematodes is recognizable by the presence of the excretory pore, the gonopore (vulva in females) and the anus. The excretory pore has an anterior position, the vulva is located in the half of the body but can be anywhere on the ventral line. The anus serves as a cloaca for the male and is near the caudal end, all this

post-anal region is commonly referred to as the tail. In some groups of Nematodes, the anus can be very rudimentary as in pregnant females of *Philometridae*.

**2.Internal characters** The mouth opening leads to the oral cavity whose thick wall gives it the name of buccal capsule (vestibule). This part may contain sclerotic structures in the form of small teeth. The oral cavity is followed by the esophagus whose structure differs according to the groups of Nematodes, it can be cylindrical or claviform (*Cucullanidae*), entirely or partially muscular. The esophagus is sometimes subdivided into a narrow and muscular anterior part: the muscular esophagus, and a broad and globular posterior part: the glandular esophagus.

The structure of the esophagus and its ancillary glands is a very important taxonomic criterion, the term esophagus is actually the pharynx but is used as such in nematology (Figure 3). The intestine is generally a straight tube sometimes provided at its anterior end with a cecum extending ventrally to the esophagus. The rectum is lined with a cuticle and is more or less distinguished from the intestine by its thickness, it opens ventrally in the posterior end. In males, the ejaculatory ducts also open into the rectum, thus forming the cloaca.



**Figure 3. Extrémités antérieures et structures œsophagiennes caractéristiques de Nématodes (Anderson et al., 2010).**

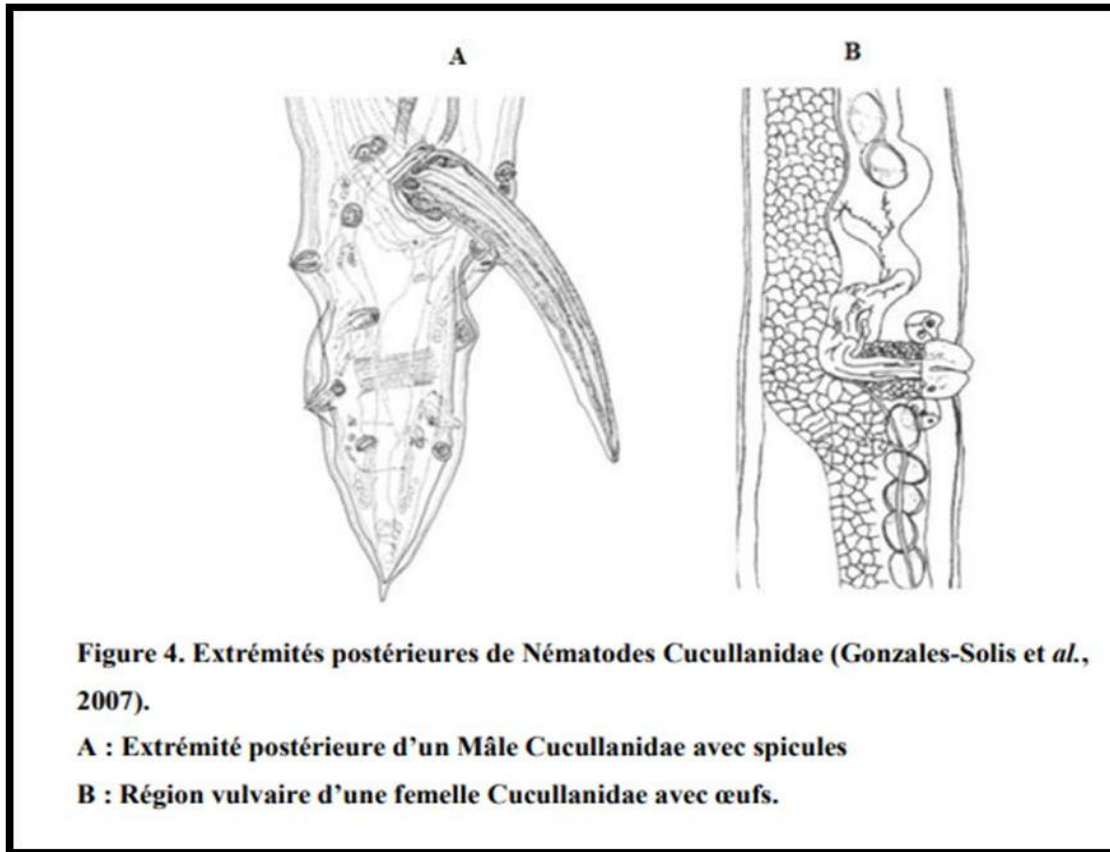
**A : *Philometridae* ; B : *Anisakidae* ; C : *Capillaridae* et D : *Cucullanidae*.**

**The central nervous system** consists of a nerve ring surrounding the esophagus. It consists of central nodes and a number of anastomoses connecting the longitudinal nerve cords that run along the entire body of the animal. The excretory system varies according to the different species, generally only its mid-ventral position is used in the identification of Nematodes. Fish parasitic nematodes are gonochoric, males are easily recognizable from females by their external appearance. They are generally smaller than females, with a curved tail (Figure 1). Some species show a very marked sexual dimorphism, not only in size (Philometridae) or shape (Cystoopsis), but also by the structure of the buccal capsule or that of the esophagus.

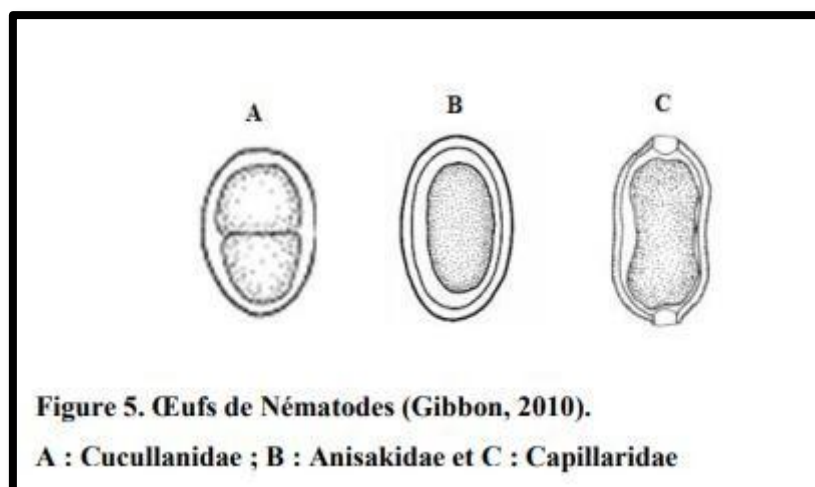
### **l'appareil reproducteur.**

The reproductive organs of males are often odd and consist of a simple tubular testicle, a vas deferens, a seminal vesicle and an ejaculatory duct, the latter two are often inseparable. The ejaculatory duct joins the ventral part of the rectum, and opens into the cloaca. At this level are copulatory organs, these are: spicules, copulatory plates, gubernaculum, caudal wings, copulatory bursa, genital suction cup or genital papilla...etc. Unlike the testicle, the seminal vesicle or the ejaculatory duct, copulatory equipment is of great systematic importance. It is generally well developed in intestinal parasites and may be rudimentary or even absent in parasites of the skin, sinuses, blood or nervous system. The internal copulatory organs are often represented by one or two sclerosed and elongated structures: the spicules, surrounded by a spicular sheath (called cirre by some authors), they constitute the essential copulatory equipment of Nematodes, in some species the spicules are provided with a sclerosed organ: the gubernaculum which connects their proximal ends and directs their movements (Figure 4.A)

**The female reproductive system:** The female reproductive system usually consists of two tubular ovaries, two oviducts, a uterus, a vagina and a vulva. There may exceptionally be only one set of organs, the reproductive system is then called monodelphic; didelphic (with two sets of organs); polydelphic (with more than two sets of organs), or amphidelphic (with two sets of organs oriented in the opposite direction). The opening of the vulva is located on the ventral face of the body but at varying levels depending on the species, it may appear prominent on the surface or simply provided with a cuticular fold (Figure 4.B Only the appearance and position of the vulva are taken into consideration in taxonomy



**Eggs:** They have different sizes and shapes depending on the group (Figure 5). Their shells formed of several layers, can be smooth or rough, their two poles (animal or vegetative), can carry a cap or stopper called polar stopper. The eggs of some fish nematodes may be attached to the uterine lining by one or more filaments, also called polar filaments. Inside the eggs, there may be either unsegmented eggs or a fully formed larva, as is the case with Philometridae. Eggs can sometimes hatch inside the body of some species of Nematodes that are then called Ovoviviparous Nematodes (Dracunculoides, Camallanides)



## 2. *Hysterothylacium* sp

They are nematodes with a robust body, whose esophageal structure has the characteristics of the genus *Hysterothylacium*, namely, the presence of an esophageal appendage and an intestinal cecum; the longitudinal lateral wings are not very marked, they begin slightly below the anterior end and thus run along the entire body.

The anterior end is thinned; the lips are as wide as they are long, they are connected to the body by a wide base. The nerve ring at a position identical to that observed in *Hysterothylacium* manufact, however the excretory pore is located well below.

The muscular esophagus is very small over most of its length and slightly enlarged posteriorly; The ventricle is roughly spherical; the intestinal cecum is twice as long as the esophageal appendix which in turn is a little shorter than half of the muscular esophagus (see plate III: A). The tail, devoid of spines, is long, straight and conical, its end is provided with an end appendage (see plate III: B).

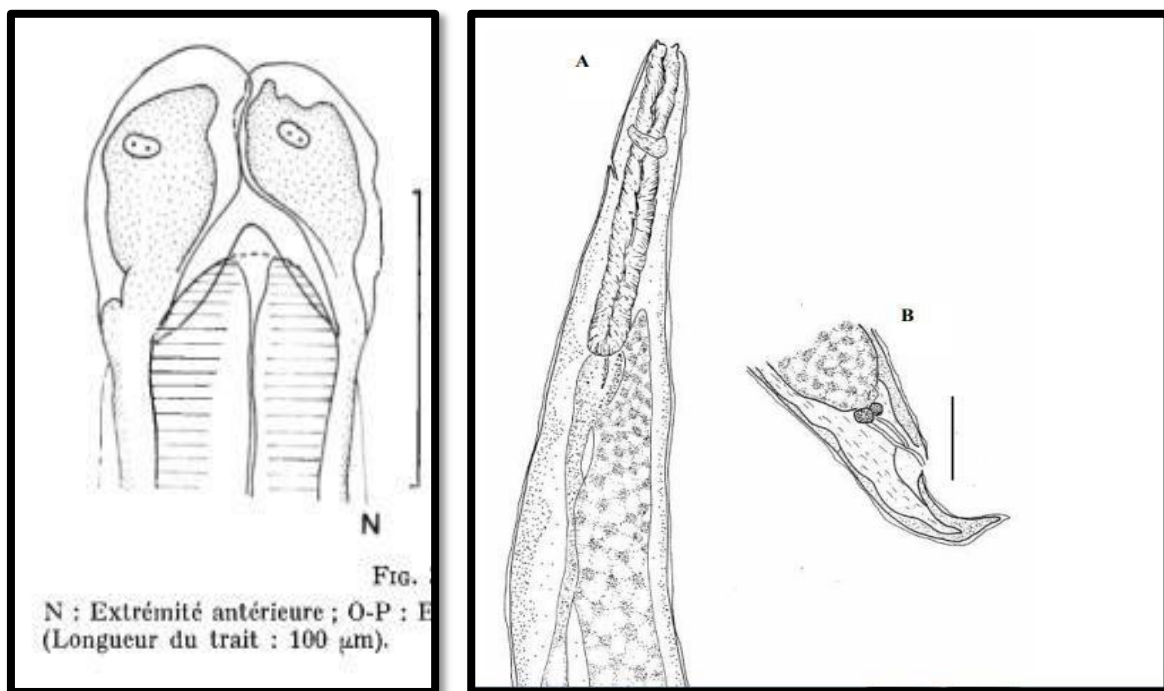


Planche III. *Hysterothylacium* sp. Stade larvaire.

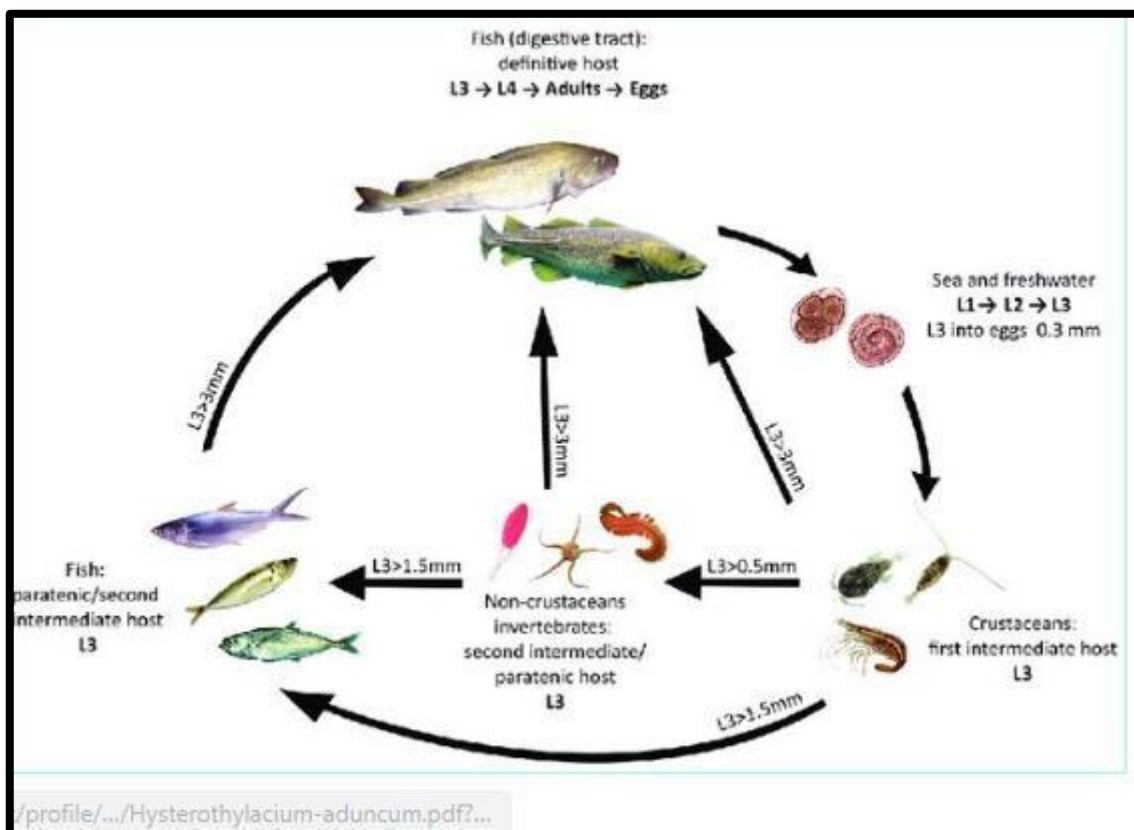
A: Région antérieure, vue latérale ; B : Extrémité postérieure, vue latérale  
(barre=250µm).

**Development and transmission** Nematodes of the genus *Hysterothylacium* live as adults in the digestive tract of marine teleost fish. However, their larvae

can be found in invertebrates, they are often encapsulated in the viscera.

The life cycle of *Hysterothylacium sp.*

the eggs released into the sea water develop very quickly three days later, at a temperature of 20°C and a salinity of 0.7%, they already contain a very mobile larva. The same result is observed when the eggs are placed in fresh or distilled water. At a temperature of 5 to 6°C, the development of the larva inside the egg will take 16 to 19 days. *Hysterothylacium sp* eggs hatch not in water but within their first intermediate hosts: Crustaceans (*Acartia tonsa*), Harpacticoid Copepods, Amphipods, Isopods and Mysids. The larva that emerges is that of the 3rd stage. The first two moults therefore occur inside the egg and the last two in the definitive host. This explains why molts have never been found in intermediate hosts. The development of the larva inside the final host fish will depend exclusively on the length of the latter, larvae less than 1mm in length do not survive in fish, on the other hand, larvae more than 3mm survive and reach the 4th stage. Depending on the size of the larva, some invertebrates other than Crustaceans will only act as transport hosts.



In whiting, sardine, horse mackerel, mackerel and red grondin, *Hysterothylacium* larvae are the most numerous (from 65 to 98% of the total number of larvae),

*Hysterothylacium* species are adult parasites of fish unlike the other three genera which are parasites of mammals or birds. It is therefore likely that *Hysterothylacium* larvae do not encounter a temperature favourable to their survival in humans. In our experiment, we found in fish not only *Hysterothylacium* L3s, but also L4s and adults.

At 10° C, the larvae are very active, some L3 have molted and become L4. When the temperature rises above 25° C, these larvae are less active or even immobile (but some "wake up" if they are put back in the cold). They die if the temperature exceeds 30° C. The survival of these larvae therefore seems to require low temperatures. Our rat infestation tests remained negative, consistent with similar experiments by Oishi et al. (1974), Norris and Overstreet (1976) and Deardorff et al. (1982). Therefore, we consider that *Hysterothylacium* larvae are not responsible for human gastrointestinal eosinophilic granulomas

### **Les Cestodes**

Adult cestodes parasitize the intestines of their fish hosts; they are usually large and numerous; they almost exclusively affect siluriform fish, more commonly Clariidae and Polypteridae. Only monozoic (unsegmented) cestodes, Caryophyllaeidae occur in a broad category of fish families. However, even so, siluroid hosts are predominant. In Africa, no less than 40 species have been reported in fish belonging to 13 genera and 5 families (Amphilinidae, Caryophyllaeidae, Bothriocephalidae, Ptychobothriidae and Proteocephalidae). The methods of fixation, preservation, staining and mounting are similar to those used for trematodes.

Cestode larvae (pseudophyllido-pleurocercoids and dilepoiddocysticercoids) occur in a wide range of host fishes including cyprinids (*Barbus* sp.) and cichlids. The definitive hosts of these cestodes are apparently piscivorous birds, mammals or reptiles.

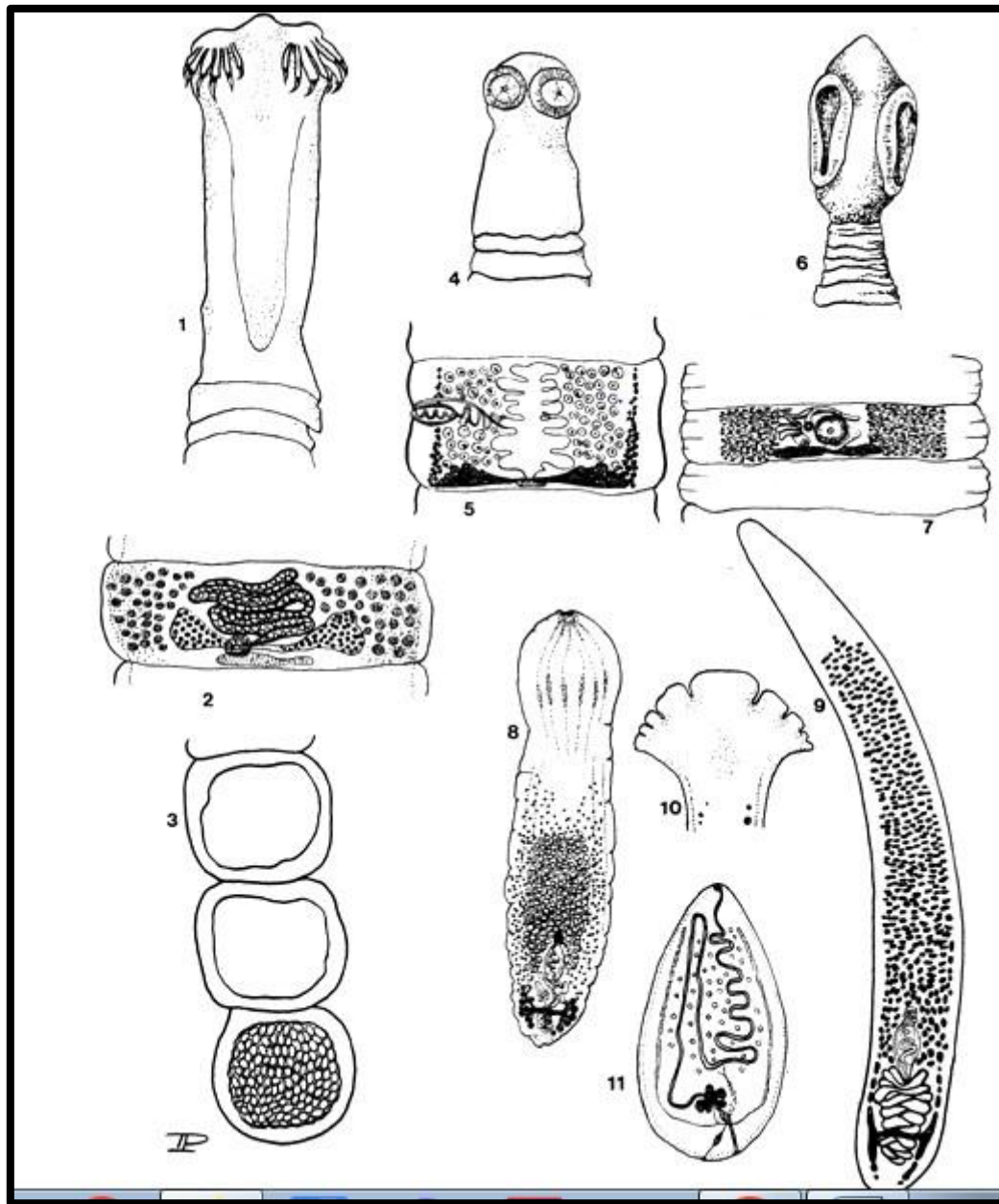
Pleurocercooid ligulids (noted in some papers as pleurocercooids of *Ligula intestinalis* although they may as well belong to different species or genera of Ligulids), are worthy of attention among the larvae of cestodes. They can reach 100 mm long and 10 mm wide. They settle themselves in the abdominal cavity of small fish such as cichlids and cyprinids from 100 to 150 mm long.

**Cycle and biology:** All cestodes thrive on intermediate hosts. Copepods are the first definitive host of polyzoic (segmented) cestodes hosted by families of fish represented in Africa. The first definitive host of *Caryophyllaeus monozoicus* is an annelid of the genus *Tubifex* (or related genera); that of amphilinid cestodes is an amphipod.

Eggs discharged into the water with the faeces of the definitive host are ingested by the intermediate host (in caryophyllaeids) or incubated (in pseudophyleid cestodes) and the ciliated larva - the coracidium - is ingested by the intermediate copepod-host.

The only African species studied is *Bothriocephalus aegypticus*. The coracidiums obtained from the incubated eggs were ingested by *Mesocyclops leuckarti*. In the intestines of the copepod, the larva, onchosphere, emerges from the ciliated mantle of the coracidium and enters through the intestinal wall into the body cavity where it transforms into a proceroid.

The biocycle of some species of bothriocephalid cestodes includes a larval stage in fish while in other species this stage is absent. Both types of biocycles exist among bothriocephalidae infesting African fish. The second stage of larval development is absent in most proteocephalid cestodes. The larval development of the ptychobothriid cestodes of African fish has not yet been studied. The incubated eggs of *Polyonchobothrium clarias* yielded coracidiums.



## Cestoda

1. *Polyonchobothrium polypteri* - scolex (x 80)
2. Structure générale des organes génitaux dans un proglotide de *Polyonchobothrium* adulte (x 80)
3. Proglotide gravide de *Polyonchobothrium* (*P. clarias*) (x 80)
4. *Proteocephalus largoproglotis*, scolex, d'après Troncy (x 80)
5. *Proteocephalus largoproglotis*, proglotide adulte, d'après Troncy (x 25)
6. *Bothriocephalus aegypticus*, scolex, d'après Rysavy et Moravec (x 15)
7. *Bothriocephalus aegypticus*, proglotide mature, d'après Rysavy et Moravec (x 28)
8. *Monobothrioides woodlandi*, Caryophyllidés, d'après Mackiewicz et Beverly-Burton (x 18)
9. *Lytocestus marcuseni*, Caryophyllidés, d'après Troncy (x 16)
10. Tête de *Caryophyllaeus*
11. Structure d'*Amphilina*

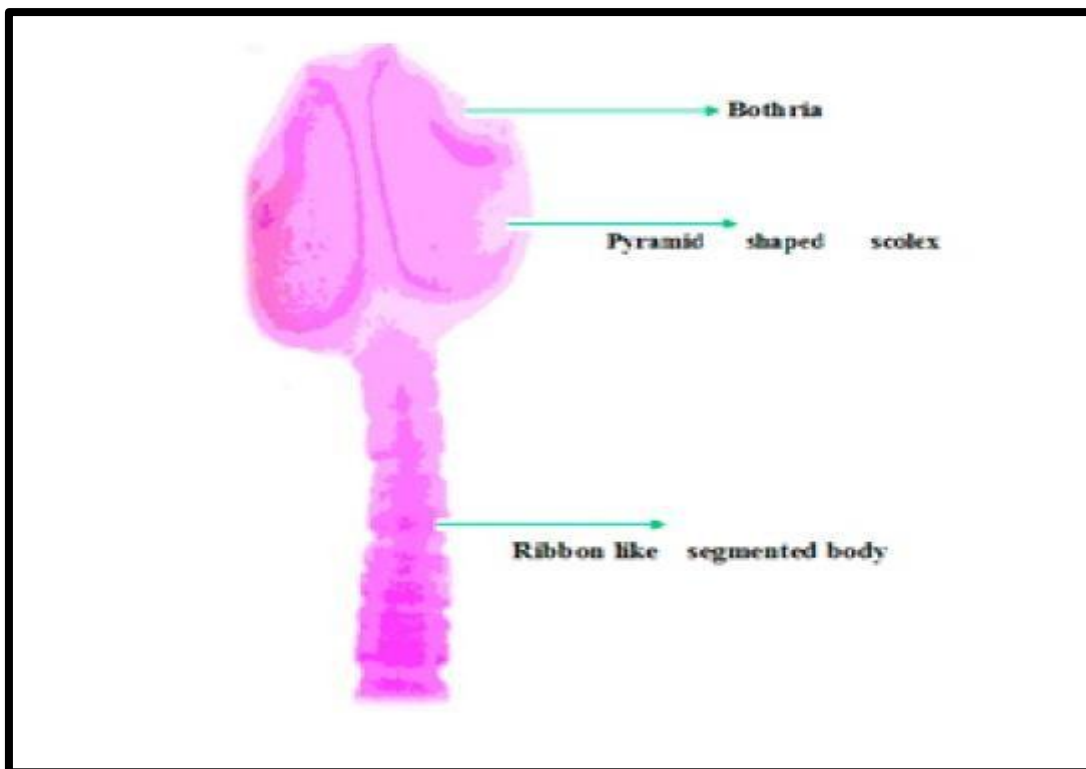
**Intoduct on Botheriocephalus.**

*Bothriocephalus acheilognathi* was first described by Yamaguti (1934) from cyprinids in Japan. It was later reported in southern China as *B. gowkongensis*, which was later synonymized with *B. acheilognathi*. It was known to originate from the herbivorous carp of the Amur River in the 1950s. Beginning in the 1950s, it was detected in the western regions of the former Soviet Union, largely because infected carps were moved to and between fish farms. As a result, it has become common and widespread in farmed and common carp.

**Morpholpgy**

Mature *B. acheilognathi* have a segmented body with an arrow or heart-shaped scolex (head) that ends in a weak apical disc. The bothries (slit-shaped openings) are located along the axis of the dorsal and ventral surfaces of the scolex.

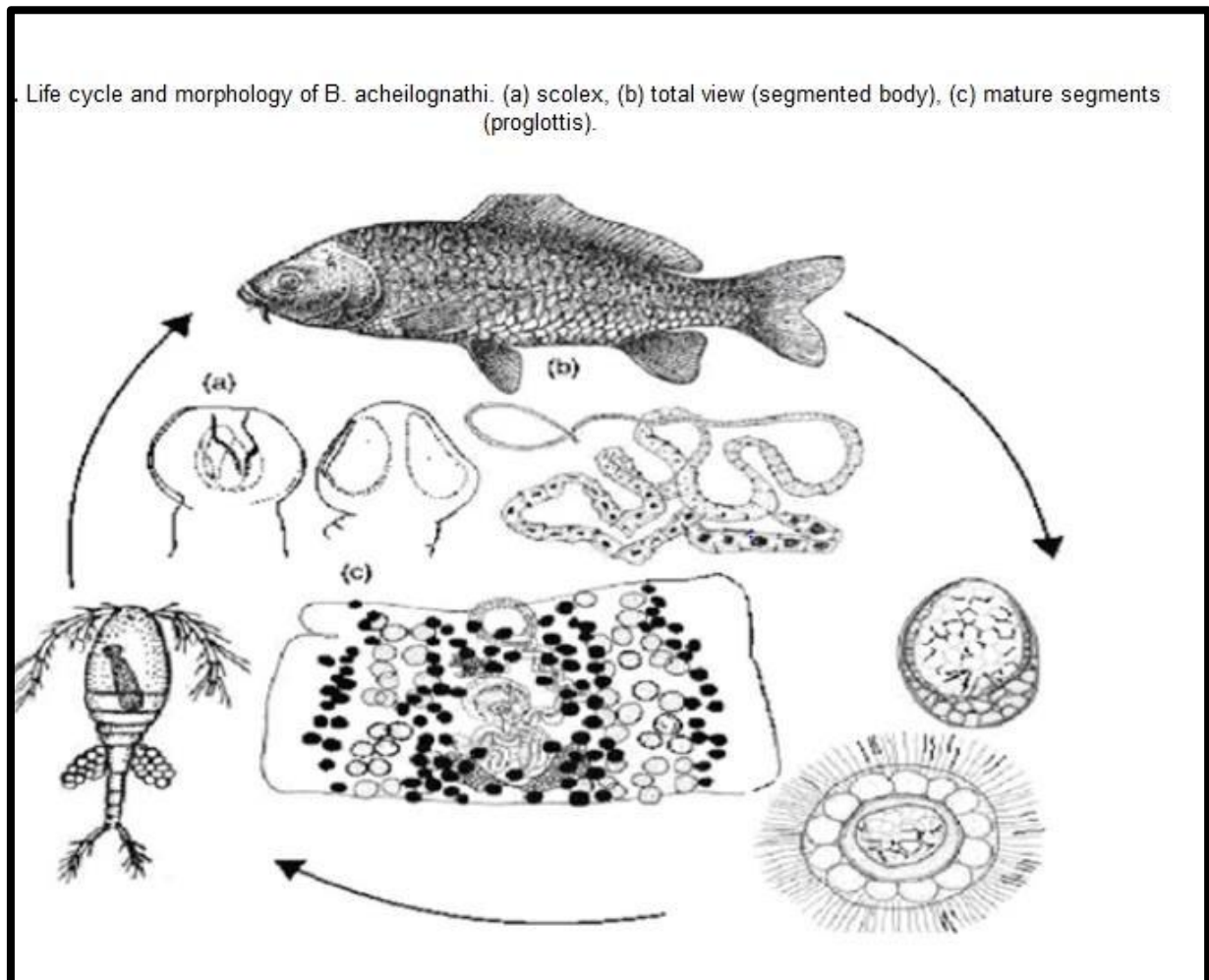
1. There is no neck and proglottids (body segments) start directly behind the scolex. The proglottis is much narrower than the scolex.
2. The total length of the tapeworm varies depending on the host, the ecological environment, the age of infection and the number of worms, but is generally between 3.5 and 8 cm. Specimens up to 1 m long have been reported.



### Life cycle

Adult *B. acheilognathi* are hermaphroditic, each possessing a complete set of male and female reproductive organs. The eggs are produced by self-fertilization and are released into the water with the host's excrement.<sup>2</sup> Hatching takes place at water temperatures between 12 and 37°C and larvae with six hooks emerge. Hatching takes 1-5 days at 28-30°C and 10-28 days at 14-15°C.<sup>2</sup>

The freely swimming larvae, the coracidia, are consumed by copepods where they transform into a second larval stage called proceroid. This stage also depends on temperature - 11-18 days at 29-31°C and 49 days at 20°C.<sup>2</sup> Fish are normally infected by consuming copepods, although predatory fish may also consume infected fish. Once in the fish's intestines, the larvae transform into adult worms in 21-23 days at 28-29°C.

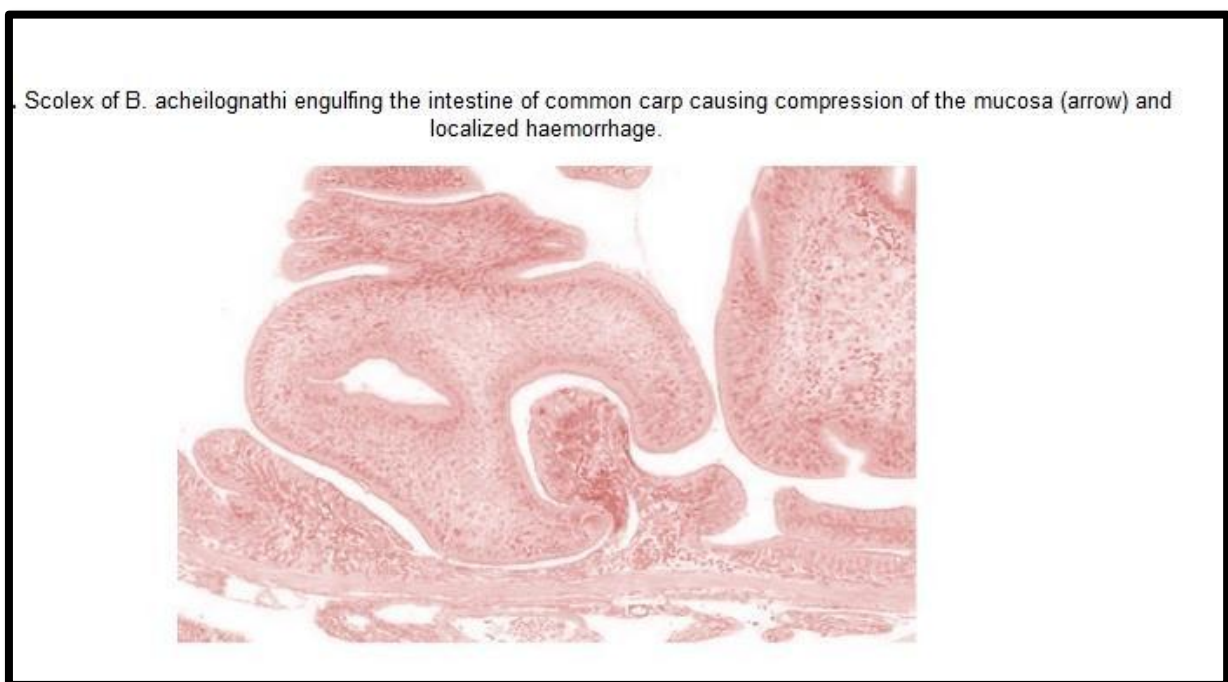


### Pathology

Fish farms will face economic losses due to fish mortality, decreased fitness, disinfection of facilities and fish processing costs. Any decline in native sport fish populations due to tapeworm infection could impact recreational activities and tourism.

Infection with *B. acheilognathi* reduces a fish's ability to cope with reduced food availability and may result in decreased fitness, growth, and temperature-dependent mortality, particularly in juveniles. The infection also causes intestinal inflammation, protein depletion and impairs the activity of digestive enzymes.

Scolex-associated lesions depend on the force exerted by bothria to maintain attachment. The scolex is often pushed firmly against the intestinal wall, causing compression and the formation of localized pits, extending to the muscularis. These attachment sites result in pronounced bowel thinning at these locations.



Pathological changes caused by *B. acheilognathi* strobila usually exceed those associated with scolex fixation. The extent and severity of this damage may vary depending on the size of the host, the size of the parasite, and the intensity of

infection. In small cyprinids, the pathological changes are characterized by distension of the intestine, compression of the intestinal folds and pronounced thinning of the intestinal wall

Transverse section of common carp showing attenuation of the gut and partial occlusion from tapeworms within.



### Prevention:

*B. acheilognathi* can be spread by infected fish or contaminated water containing infected eggs or copepods. It can also be transmitted by infected baitfish.

1 Dispose of fish viscera, unused bait and other waste in landfills. Koi carp and goldfish are cyprinids that can be vectors of the Asian tapeworm.

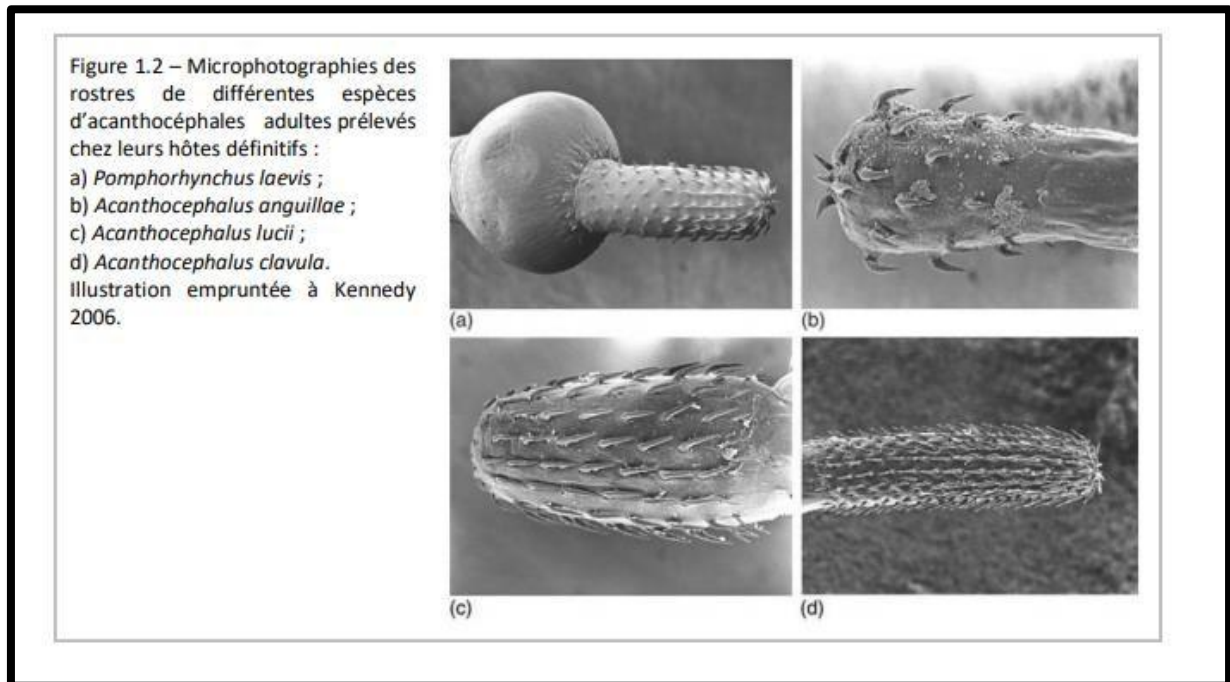
2- Never release fish or empty aquariums into natural waters.

3- Carefully drain boat motors, bilge, transom, fish ponds and bait pails of any water likely to harbour infected eggs or copepods.

### Acanthocephales.

Acanthocephales are hooked worms that live in the gut of fish. There are several species whose common characters are as follows: They are from a few millimeters to a few centimeters in length, their trunk is in the shape of a suction cup, they have a hook fastening device, no mouth, no intestinal canal, no anus; they feed by osmosis through the surface of the body. They lay a large number of eggs. In the genera *Echinorhynchus*, *Acanthocephalus*, *Corynosoma* and *Rhadinorhynchus*,

finds six to sixteen rows of hooks on the trunk. The larvae choose as hosts small crustaceans such as Gammarus, insect larvae, fish, leeches and limneas; then they grow into the fish that ingested these intermediate hosts. The infestation can be dangerous in case of a strong attack. In Trout slimming, bulging eyes, clogged pylorus, are the symptoms of *Echinorhynchus truttae* infestation. On trout of 21 to 31 cm. some 43 to 121 *Echinorhynchus truttae* of 0.5 to 1.9 cm. were found, some *Neoechinorhynchus* and *Proteocephalus*.



## DIAGNOSIS

The infection is revealed by examination of the inside of the intestine. The worms are elongated, bag-shaped, with a retractable proboscis armed with a variable number of spines. The number and arrangement of spines on the proboscis are important taxonomic criteria. For diagnosis at the species level, the worms must be fixed with their proboscis developed. Before fixing in the AFA or in the 4% formalin solution, the worms should therefore be soaked in distilled (or running) water until their proboscis has completely relaxed and developed.

## DIFFERENTIAL DIAGNOSIS

*Acanthocephalus* are differentiated from all other helminths by the presence of spines on their proboscis.

## BIOCYCLE AND BIOLOGY:

All acanthocephali need an intermediate host. Eggs released into the definitive host's intestinal lumen and defecated in water, if swallowed by a suitable arthropod-host, will incubate and larvae will encyst as acanthellae in the host's muscles or connective tissue. Intermediate hosts of fish parasitic acanthocephalus are Amphipods, Isopods or aquatic insects. Acanthocephalus larvae, when swallowed by the fish with their arthropod, emerge from the cyst and then transform into adults. Some acanthocephalus (of the genus Pomphorynchus), however, undergo an additional larval stage in a fish before reaching maturity. In this larval stage the acanthor is encysted in the viscera of the fish. The species of the intermediate host fish is usually different from the species of the definitive host but it can also be the same. The biocycle and intermediate hosts of African fish acanthocephals are unknown until now.

#### PATHOLOGY

Acanthocephalus has not been observed to be generally seriously pathogenic to fish. Insertion of the spinous proboscis into the intestinal wall destroys small pieces of mucosa and conjunctiva. Even if severe local damage is evident - necrosis, tissue change, ulceration, granule or capsule formation (particularly evident in Pomphorynchus species that insert their proboscis through the intestinal wall) there is no demonstrated effect on the growth or survival rate of the fish. However, in some infestations, severe and localized gut aggression has a significant effect on fish growth and survival (in Salmonidae infested with *Echinorhynchus salmonis* and *Acanthocephalus jacksoni*). In some infested fish, perforation of the intestine followed by peritonitis was observed. There is no usable information on the effects of infection on African fish.

#### **Annelids: Hirudines, Leeches.**

Leeches have been reported so far on five families of fish: *Bagrus docmac*, *Barbus altianalis*, *Barbus tropidolepis*, carp and *Protopterus aethiopicus*. In Africa, however, leeches apparently attack a wide range of fish species including Cichlids, Clariids, Synodontids, Bagrids, Mormyrids and others. This is demonstrated by the discovery of trypanosomes that are transmitted by leeches in the blood of these fish.

#### VISIBLE SIGNS:

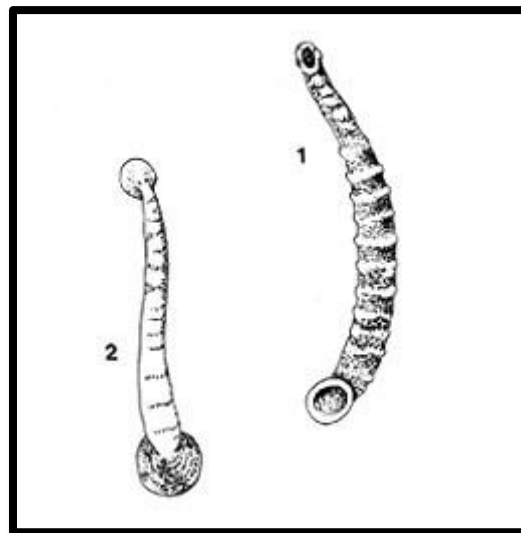
Leeches are easily recognized when attached to the skin or fins. The locations recently abandoned by leeches on the skin come in the form of small, well-defined, round, bloody wounds. In heavy infestations the attachment area is hyperemic and haemorrhagic.

#### CAUSE

Leeches of the families Glossiphonidae (genera *Batrachobdella* in Africa; elsewhere also *Glossiphonia*, *Hemiclepsis* and *Placobdella*) and Piscicolidae (*Phyllobdella* in Africa; elsewhere, also *Piscicola*).

#### DIAGNOSIS

Leeches harvested from fish should be anesthetized prior to fixation by adding menthol crystals to the water contained in the container where the leech is held in order to ensure its complete release. Relaxed individuals are fixed and pressed between two blades. The fixatives used are AFA or 95% alcohol. Individuals are stored in 70% alcohol. Identification of genera and species is difficult and specimens should be referred to the examination of leech taxonomists. Leeches (Hirudines) are annelids in which the anterior end of the body is a sucker while the body ends in a rounded posterior suction cup. The body is divided into rings (which do not correspond to the segmentation of the body, characteristic of the Annelids).



1.-2. *Sangsues piscicolidés, Hirudinea (80–100 mm)*

Glossiphonidae and Piscicolidae belong to the order Rhynchobdella, leeches whose anterior part may be protractile and retractile, in the form of proboscis. The

Glossiphonids have a flat body with an indistinct or nonexistent anterior suction cup. The Piscicolidés have a cylindrical body with a rounded and distinct anterior suction cup, which is wider than the “neck” - the anterior part of the body. This “cervix” is distinctly narrower than the mid-posterior part of the leech.

#### DIFFERENTIAL DIAGNOSIS

Leeches are identifiable by their shape and active movements. **BIOLOGY**

Leeches attack fish for food. Once gorged with the host's blood, they detach and hide under the stones, in the submerged vegetation or in the submerged part of the erect aquatic plants. The eggs are laid in a cocoon attached to the substrate in water. Newborn leeches closely resemble adults.

Glossiphonids exhibit parental instincts. Leeches produce a thin-walled cocoon and, immediately after laying, place their body on top and provide protection. The newly hatched leeches attach themselves in a sort of alveolus (incubator pocket) on the ventral wall of the parents and remain so until the state of their development allows them to live and feed themselves. In temperate waters, this incubation can last from 24 days to four months in different species.

Heavy infestations with *Piscicola geometra* in Eurasian trutticultures and carpicultures cause anemia as well as secondary bacterial contamination of ulcers resulting from sucking bites on fish skin.

Heavy infestations with leeches (*Cystobranchnus virginicus*, *Piscicolidés*) in the oral region of the American catfish, *Ictalurus catus*, lead to epithelial hyperplasia and inflammatory changes: cell infiltration, hyperanaemia and haemorrhages in the dermal and hypodermic layers. Heavy infestation of the eyes and nostrils of carp bred in Ghana results in mass mortality. In *Bagrus docmac* of Lake Victoria, the pathological changes are not obvious, even during very strong infestations of more than 100 leeches per fish, with the exception of bleeding points at the location of the bites on the skin.

#### **Wrestling**

Leeches are easily killed by dry ponds because they only tolerate drought for a very short time. A solution of 1 gr. of quicklime for two liters of water kills them in five seconds as well as the cocoons. These baths are effective even for large quantities of fish.