National Fisheries Laboratory Category 2 parasite guide

NATIONAL FISHERIES LABORATORY

Category 2 Parasite Guide

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ENVIRONMENT AGENCY

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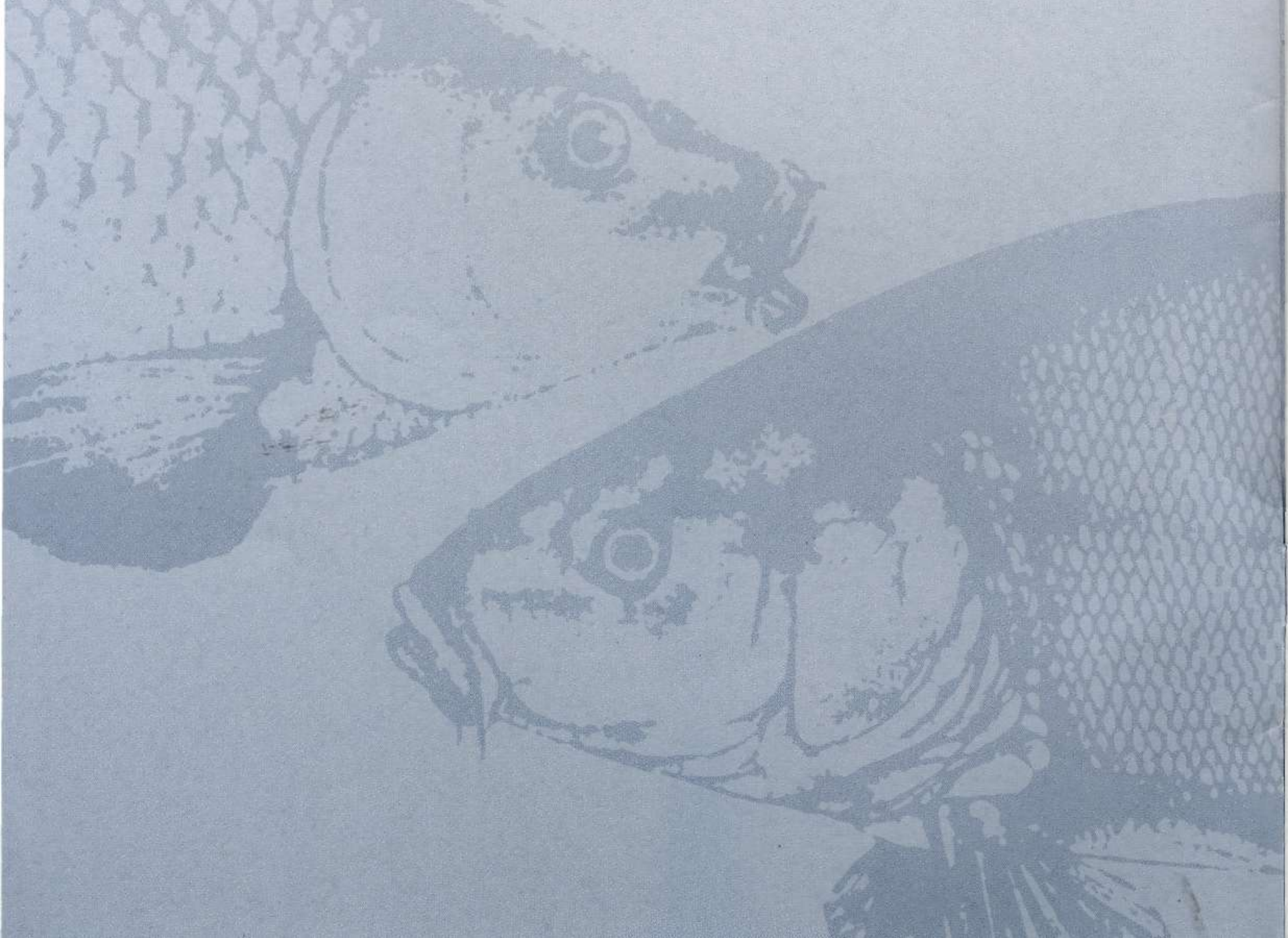


Introduction

This guide has been produced for Fisheries Officers, to help answer many of the questions commonly asked about Category 2 parasites, such as:

- *What is the parasite?*
- *What damage does it cause?*
- *What species of fish may be affected?*
- *Can it be treated?*
- *How widespread is the parasite and how is it transferred?*

Welcome to the National Fisheries Laboratory's Category 2 Parasite Guide. This guide is intended to offer a comprehensive and detailed account of the Category 2 parasites, so that Fisheries Officers have all the necessary information in an easily accessible form when dealing with Section 30 applications.

Although relatively detailed (a glossary is provided to explain some of the terminology used), the guide cannot hope to answer all the questions you may have. Please contact the Fisheries Laboratory directly if you have any questions you feel are not adequately explained in this booklet.

What are Category 2 parasites?

The Category 2 parasites are those diseases or parasites which are considered by the Environment Agency to:

(1) **have a significant disease potential when introduced into waters where the disease or parasites do not already exist; or,**

(2) **be novel, non-indigenous diseases or parasites of unknown pathogenicity and distribution.**

The spread of Category 2 parasites and diseases is controlled by the Environment Agency under the legislative procedures for Section 30 of the Salmon and Freshwater Fisheries Act 1975. This control prevents the introduction of any fish found to be infected with a Category 2 parasite, into any water where a significant risk of infecting the environment exists. The only exception to this would be where the disease agent is already proven to exist in the receiving water. Where the risk to other fisheries and the environment is minimal, it is considered appropriate for the owner/manager of the fishery to take responsibility for any decisions concerning such introductions. However, the Agency would always **strongly** advise against any introduction of fish infected with a Category 2 disease or without a valid health check.

These diseases are proven to damage fisheries through either direct mortality, disruption to spawning behaviour or adverse effects on feeding, leading to poor growth and ecological damage. Any introduction of these parasites would therefore be considered very poor fisheries management. For detailed guidance on Section 30 processing please refer to the "Fish Introductions Process Handbook and the Fish Introductions Guidance".

What are Category 1 diseases?

There are currently eight diseases that make up the Category 1 list. Of these eight diseases, only one is caused by a parasite; *Gyrodactylus salaris*. All the other diseases within the Category are either bacterial or viral pathogens, including the viral disease Spring Viaemia of Carp (SVC). To date, *G. salaris* has never been recorded in the UK.

The Category 1 list of diseases comprises all diseases that are notifiable, and controlled under the Diseases of Fish Act 1937, 1983 and European Community Fish Health Directive 91/67. This includes all diseases that are either;

(1) **Exotic to the EU.**

(2) ***Not present in the EU but considered to hold serious economic consequences.***

(3) **Of a serious enough nature to warrant EU-approved control programmes (although they may be more widespread in the EU).**

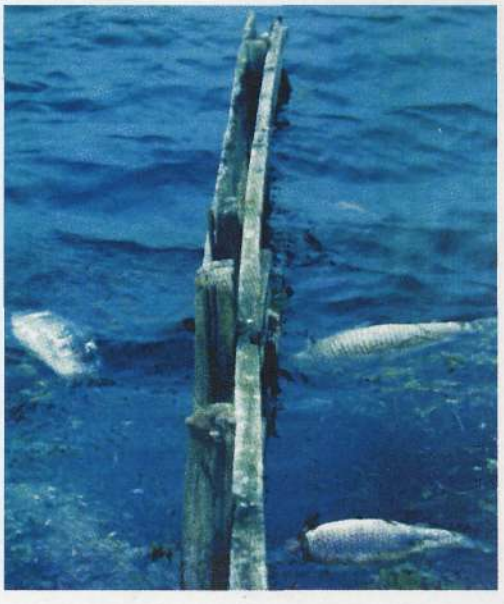
Category 2 Review Group

The Category 2 list of diseases presently contains only macroparasites, but is reviewed regularly by the Category 2 review group, and can have novel disease agents added to it at any time.

This internal Environment Agency review group will:

- ***Review all diseases on the Category 2 list and all those nominated for inclusion on that list on an annual basis.***
- ***Be responsible for establishing and implementing a protocol for actions to be taken in the event of the discovery of a novel parasite.***
- ***Be responsible for the dissemination of information and publicity on the Category 2 list.***

Protocol for Action to be Taken on the Discovery of a Novel (Unrecorded in the UK) Fish Disease.

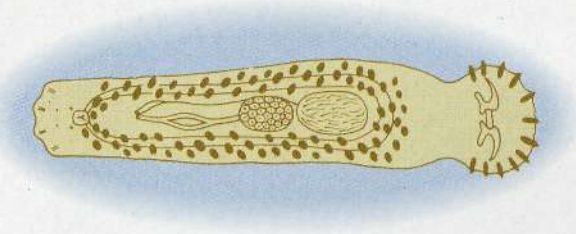


Sequence of events	Comments	Time
1 Identification of possible novel parasite Second identification by appropriate academic expert Literature review and consultation with appropriate experts	No section 30 should be granted during this period	15 working days
2 Decision on status - Is it novel or not? If YES - Notification of site and area office		10 working days
3 1 year as a novel parasite During this time information and comments are gathered 1 year on a decision can be made on the categorisation of the disease	As a novel disease no Section 30 movements should be consented for either Mandatory or Non Mandatory movements	1 year

At stage 2 there may be an identified opportunity to eradicate the disease with suitable culling and disinfection procedures. This could be done on a purely advisory basis (as good fisheries management practice) and would involve a certain level of voluntary contact tracing to assess the likely spread of the disease and, therefore, the possible benefits of disinfecting the one site in the hope of eradicating the disease from the UK.

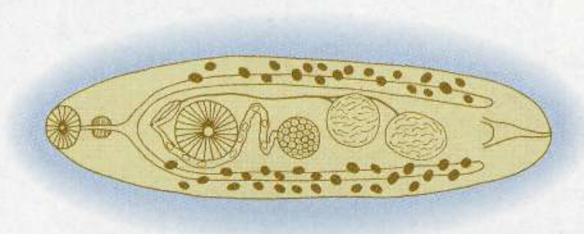
Parasite Groups

The paragraphs below outline the taxonomy of some of the main groups of fish parasites, including an insight in to their biology and effect on the fish host.



Monogenea

Monogenetic flukes are flatworms of up to 2mm in length, externally parasitic on the skin and gills of fish. With a simple direct life cycle, monogenea are capable of increasing rapidly in numbers during favourable conditions. Attachment to the fish host involves the use of characteristic hooks. Once attached monogenea feed directly on skin and gill tissue, often causing irritation, respiratory distress, hyperplasia, haemorrhaging during heavy infections. Mortality may occur during very severe infestations. Some monogeneans may be capable of transmitting other pathogens.

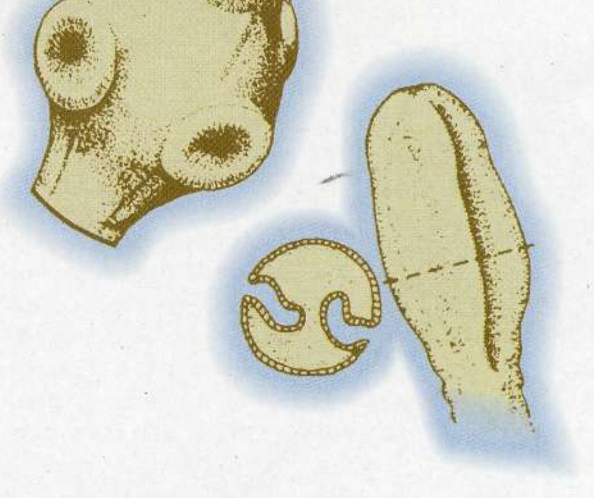


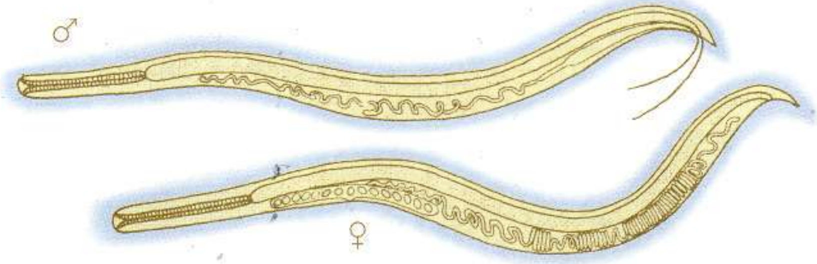
Digenea

Digenetic flukes, are a large group of endoparasitic flatworms (over 1700 species infect fish) often with highly complex, indirect life-cycles. Although found in many organs, including the blood, swim bladder, ovary, kidney, and urinary bladder, adult digenea most commonly infect the gastrointestinal tract. Attachment to the host involves an oral and ventral sucker, with nutrition gained both orally and through absorption across the body wall. Damage to fish is most often caused by migration of the juvenile cercariae through the host, causing necrosis, haemorrhaging and inflammation. Heavy infestations can be debilitating and fatal, especially to small fish.

Cestoda

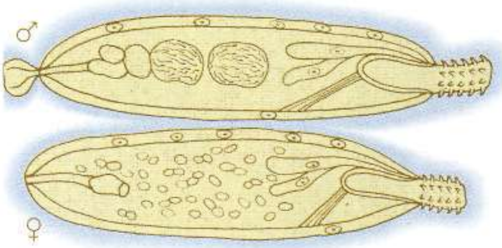
Cestodes or tapeworms of fish are generally relatively large, often segmented and flattened worms, the adults of which infect the intestine of their fish host. Juveniles, or 'plerocercoids' may be found in the abdominal cavity, visceral organs or musculature of fish. With a complex life cycle, requiring one or two intermediate hosts (often copepods), transmission and distribution is dependant on the occurrence and abundance of these hosts. Fish may act as definative or intermediate hosts, or in some cases both. Tapeworms attach to the fishes intestinal tract by means of a 'scolex', bearing suckers, hooks, spines or muscular depressions, with nutrients gained by direct absorption across the body wall. In heavy infections, obstruction and extensive damage to the gut wall may occur, resulting in poor growth, emaciation, nutritional deficiencies, lethargy and mortality.





Nematoda

Nematodes, or 'roundworms' are a very large group of both parasitic and free-living thread-like worms (ranging mostly between just a few millimetres and 2cm). The life cycle of parasitic roundworms may vary considerably in complexity, with fish acting as either intermediate or definitive hosts. Found primarily within the digestive tract, peritoneal cavity and swim-bladder, nematodes may be responsible for reduced growth, chronic wasting and mortality in severe infections.

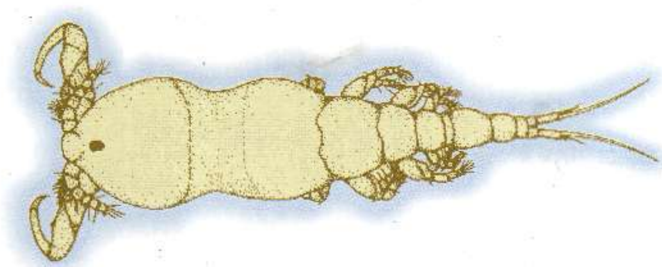


Acanthocephala

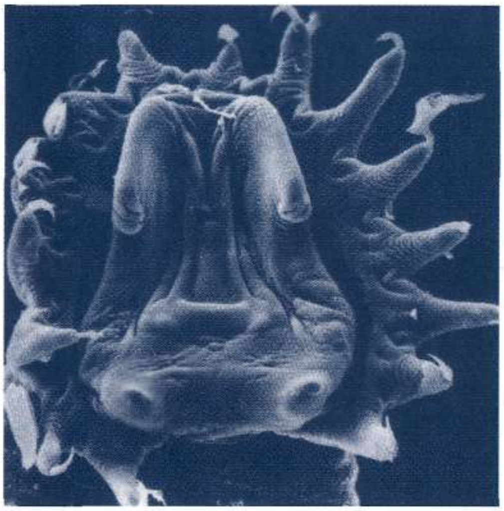
Acanthocephalans, or 'spiny headed worms' are an endoparasitic group (~400 species infecting fish) that live within the digestive system of their fish host. Usually between 20-30mm in length, acanthocephalans attach to the gut wall by means of a long, spiny but contractable proboscis, causing considerable damage and blockage during heavy infestations. They have no mouth or gut, and nutrients are absorbed directly through the body wall. With a complex, indirect life cycle, involving at least one intermediate host (often *Gammarus* sp.), their distribution is dependant on the occurrence and abundance of these hosts.

Crustacea

Parasitic crustacea of fish are a very numerous and diverse group, in both their morphology and effect on their hosts. All are ectoparasites, that generally cause mechanical damage through their feeding or attachment behaviour. Depending on the level of infection, damage may be extensive, resulting in haemorrhaging, lesions, loss of osmoregulatory balance, respiratory distress and reduced growth and condition. In addition, some crustacean parasites (e.g. *Argulus* spp.) may be responsible for the transmission of bacterial, protozoan and viral diseases, including Spring Viraemia of Carp (SVC).



Gyrodactylus salaris



Introduction

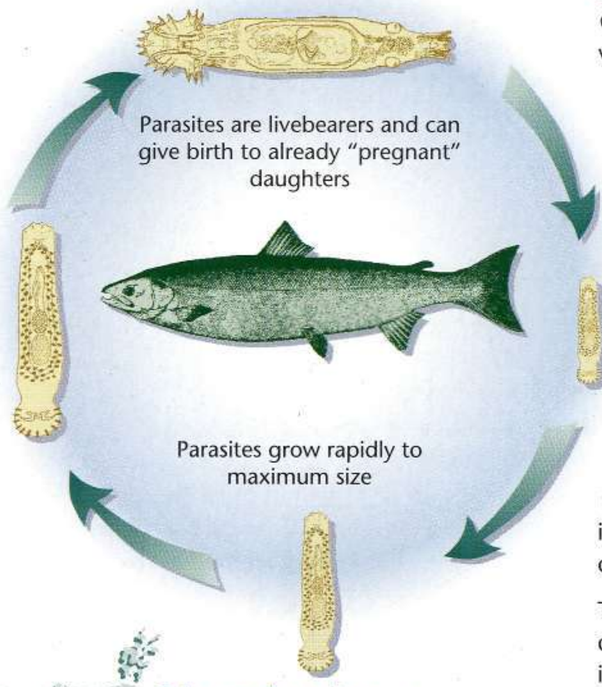
Gyrodactylus salaris is a monogenean parasite belonging to the family Gyrodactylidae. There are over 400 known species of the genus, which are parasitic on the gills and body surface of potentially all fish species. Identification to species level is very difficult and diagnostic DNA probes are being developed. *G. salaris* is a freshwater parasite of Atlantic salmon *(Salmo salar)*. Since first observed in Norway in 1975, the parasite has had devastating effects on Norwegian salmon populations. The parasite is thought to have been introduced by imported salmon parr and smolts. It has never been recorded in the UK and is a Category 1 notifiable disease under the Diseases of Fish Act 1937, 1983.

Fish hosts

The definitive host of *G. salaris* is Atlantic salmon *(Salmo salar);* salmon parr being most vulnerable. There is a notable variation in resistance to the parasite among the three different genetic populations of salmon. Although the Baltic strain is fairly resistant to the parasite, the Western Atlantic and Eastern Atlantic strains are particularly vulnerable to *G. salaris* resulting in mass mortalities of salmon parr and smolts in Norwegian rivers.

Lifecycle

G.salaris requires only a single host to complete its life cycle. Being viviparous, a single parasite can produce 1000's of off-spring. Newly born individuals either attach to the same host as the parent or to another host. Infection of a new host may occur by direct contact or the parasite may detach and find a new host via the bottom substrate. *G. salaris* can't reproduce at salinities of >5 - 7‰ and can survive only a few days at salinities up to 20‰. Optimum temperature for reproduction is 10 - 15°C, with highest infections occurring in spring and summer.



Pathology

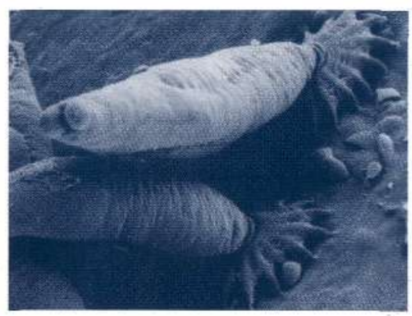
Attachment of the parasite to the host's epidermis with attachment hooks results in superficial damage. Of greater significance, is the epidermal ulceration that may occur as a result of the parasites' feeding activity. The parasite exerts a glandular pharynx through its mouth releasing proteolytic enzymes onto the skin; the resultant "digest" is then sucked into the parasite's gut. In heavy infections, this type of damage leads to osmotic stress and secondary infection.

The lack of innate immunity in Norwegian salmon parr stocks has led to devastating mortalities in hatcheries and river systems. Since first observed in Norway, there has been an estimated loss of ~300 tonnes of fish in Norwegian salmon fisheries. Within 10 years it had spread to 28 rivers and 11 hatcheries. Salmon parr populations in rivers were reduced by 50% within two years and by 96% in five years resulting in a significant decline in the adult salmon fishery.

Dissemination & distribution

Stocking of infected fish represents the most likely means of transfer. Affected Norwegian rivers were stocked with salmon parr from infected hatcheries. However the parasite could be transferred in water, on equipment or by aquatic animals (please refer to the information leaflet "Keep *Gyrodactylus salaris* out of Scottish Rivers" published by the Scottish Office, or "Keep Fish Disease Out" published by MAFF).

Treatment

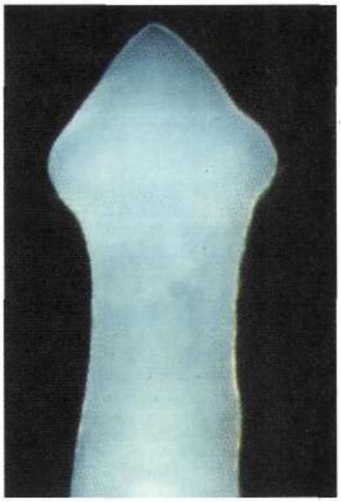


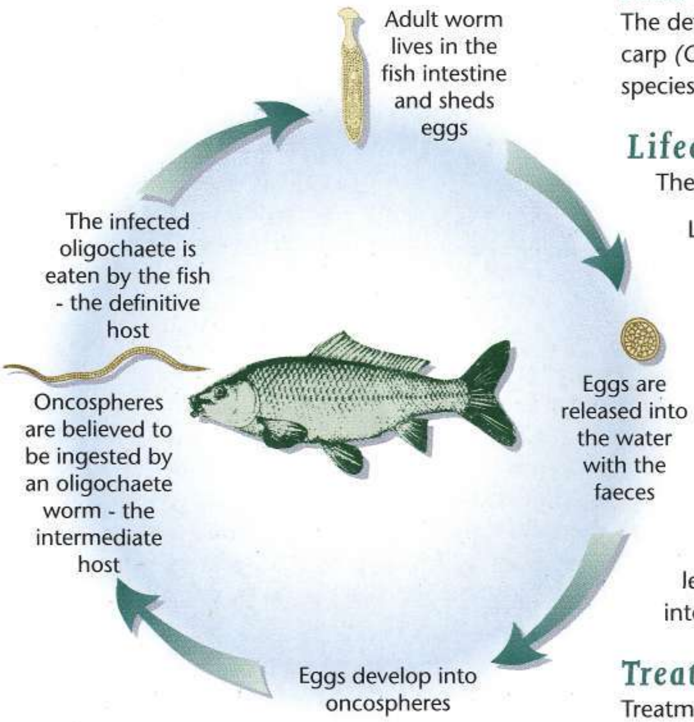
G. salaris has been eradicated from fish farms by de-stocking followed by fallowing and disinfection. Affected Norwegian rivers have been treated with rotenone, killing all fish in the river (and consequently all *G. salaris)*. Although in some cases the fauna has re-established and salmon stocks recovered over a number of years, not all such treatments have been successful and re-infection has occurred in some areas. Complete eradication of *G. salaris* in Norway is being sought.

Atractolytocestus huronensis

Introduction

Atractolytocestus huronensis is a small, white, unsegmented tapeworm (about 25 mm long and 3 - 7 mm wide) belonging to the Lytocestidae family. It's scolex is bulb-like with a pointed apex and characteristic neck. *A. huronensis* is synonymous with *Markevichia saggitata.*





Fish hosts

The definitive host of *A. huronensis* is carp *(Cyprinus carpio).* No other host species have been recorded.

Lifecycle

There is little information on the life cycle of *A. huronensis.*

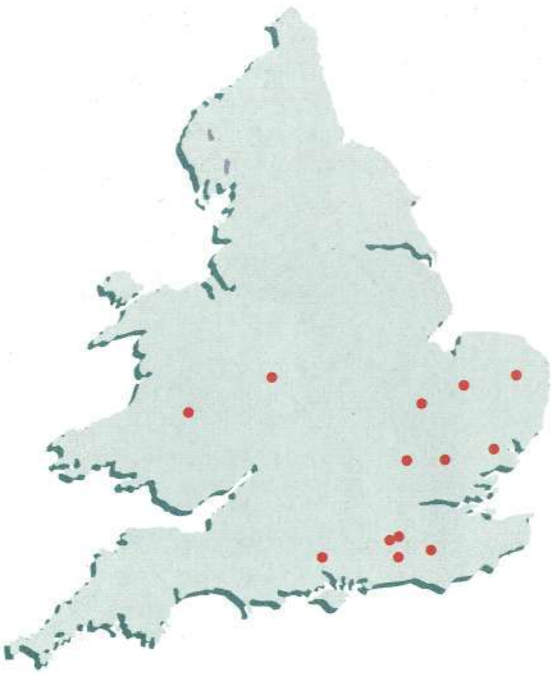
Like most other caryophylleids the intermediate host is believed to be an aquatic oligochaete worm.

Pathology

As with majority of UK tapeworm infections, the scolex attaches and embeds between folds in the intestinal wall, resulting in displacement of the mucosa, hyperplasia of the sub-mucosal layer and haemorrhaging. *A. huronensis* (unlike other UK tapeworms) doesn't appear to be site-specific and is found attached randomly throughout the whole length of the intestine and thus is unlikely to cause intestinal blockage.

Treatment

Treatment of infected fish in wild fisheries is not feasible. The effects of antihelmintics are unknown and the lack of definite information on the life cycle means extreme caution is necessary during any disinfection procedures.



Distribution

A. huronensis was first recorded in the UK in 1993.

To date it has been recorded in 14 UK fisheries. The parasite is indigenous in certain areas of the former USSR.

Dissemination

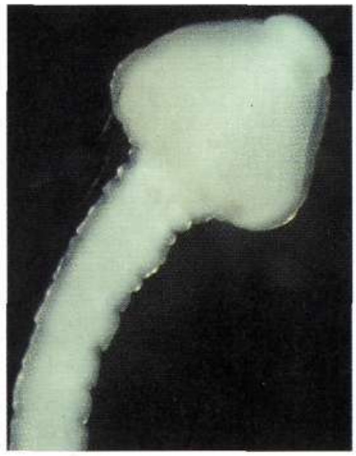
Stocking of fish infected with the adult worm is the most likely method of dissemination. However, infected intermediate hosts and tapeworm eggs may also be transferred on equipment, in water or by aquatic animals.

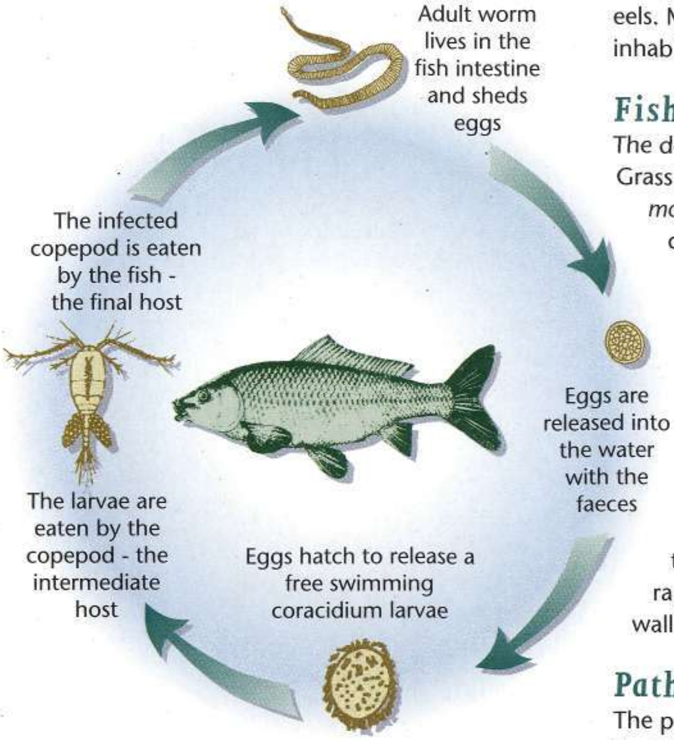
Bothriocephalus acheilognathi

Introduction

Bothriocephalus acheilognathi is a pseudophyllidean tapeworm belonging to the family Bothriocephalidae. It has a ribbon-like, segmented body and a characteristic scolex possessing two long attachment grooves known as "bothria".

The only indigenous member of the family in the UK is *B.claviceps*, found in eels. Most other species in this genus inhabit the intestine of marine fish.





Fish hosts

The definitive hosts of *B. acheilognathi* are Carp *(Cyprinus carpio)*, Grass carp *(Ctenopharyngodon idella)* and Silver carp *(Hypophthalmichthys molitryx)*. In the UK, the parasite has recently also been recorded in crucian carp (Carassius carassius) and golden orfe *(Leuciscus idus)*.

Lifecycle

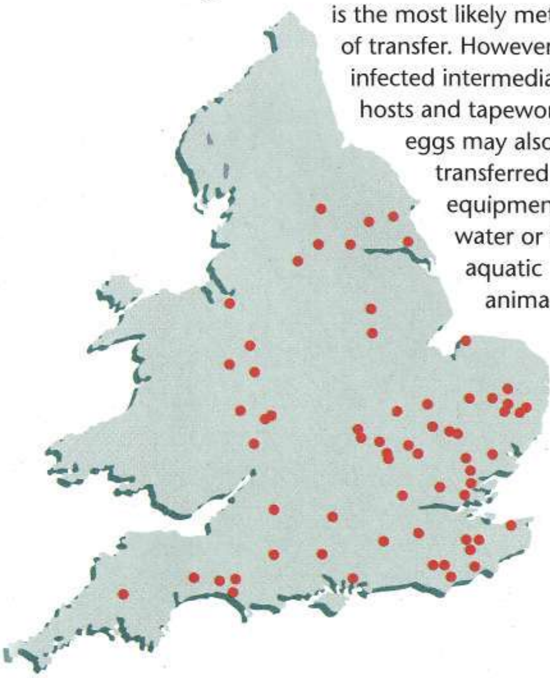
Each segment (proglottid) of the adult worm is hermaphroditic and capable of producing eggs that pass out from the fish in faeces. The eggs hatch after 3 - 5 days, depending on temperature, to produce a free-swimming coracidia which can remain alive for up to 2 days. When the coracidia are eaten by copepods, they penetrate the gut wall and reach the coelom of the copepod, developing into a procercoid in 6 - 10 days. When the infected copepods are eaten by the fish host, the procercoid rapidly passes through the plerocercoid stage and attaches to the gut wall of the fish, developing into the adult parasite.

Distribution

The tapeworm is indigenous to Japan and China and was first reported in the UK in 1979 when it was found in three fish farms. It has subsequently spread throughout the country.

Dissemination

Stocking of fish infected with the adult worm is the most likely method of transfer. However, infected intermediate hosts and tapeworm eggs may also be transferred on equipment, in water or by aquatic animals.



Pathology

The parasite accumulates in the anterior part of the intestine, posterior to the bile duct opening. An aggregation of attached tapeworms in this area may cause blockage of the digestive tract and distension of the intestine wall, which can lead to perforation. The parasite has been associated with reduced body and organ weight of infected fish; this may be due to effects on the host's intestinal enzymes and the uptake of nutrients and vitamins by the parasite. When attached, the bothria engulf intestinal folds and induce local inflammatory responses which lead to haemorrhage and necrosis.

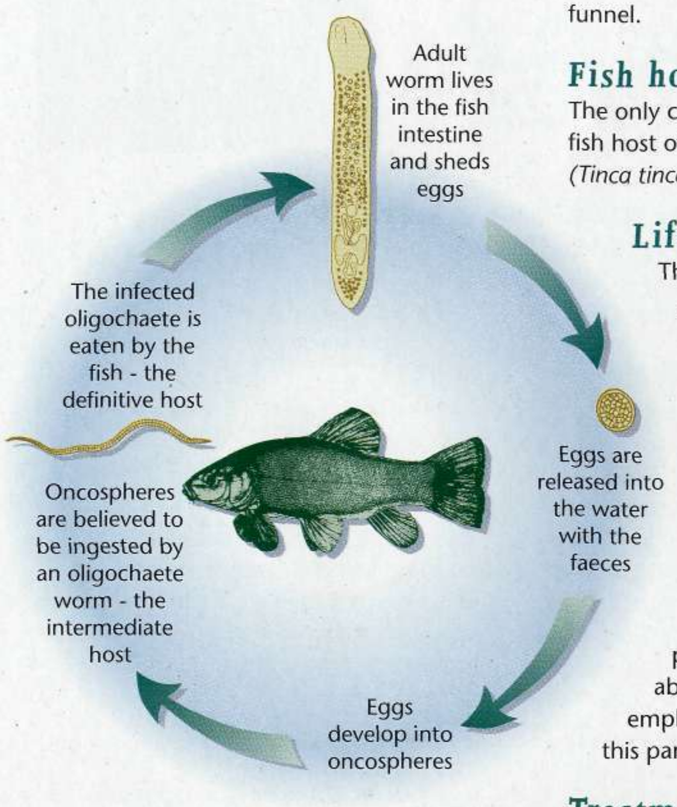
Fish mortalities can occur with infection levels of >80 parasites, and losses of up to 100% have been recorded in juvenile carp in some German fish farms.

The discovery of heavy infections of this parasite in crucian carp is of particular concern as there are no recorded natural tapeworm parasites of crucian carp in the UK. It is likely that crucian carp may have limited immunological defence against this parasite.

Treatment

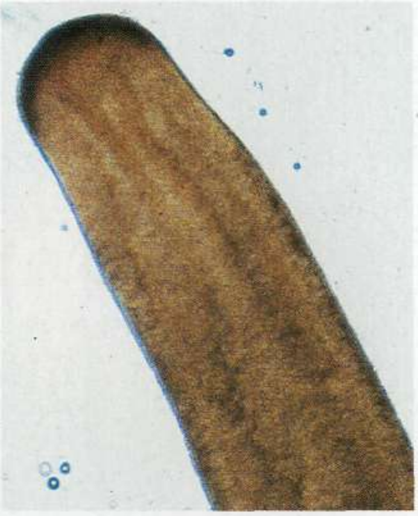
Treatment of infected fish in the wild is not feasible. On fish farms, *B. acheilognathi* may be eliminated from ponds by total fish removal, draining and liming over winter. Antihelminthics have, under veterinary supervision, been shown to have eliminated the parasite under controlled conditions. **This treatment is not applicable to wild populations.**

Monobothrium wageneri



Introduction

Monobothrium wageneri is a small, white, unsegmented caryophyllidean tapeworm about 30 mm long and 1 mm wide and belongs to the Caryophyllaeidae family. Its scolex is bluntly truncated and eversible in the form of a funnel.



Fish hosts

The only confirmed definitive fish host of *M. wageneri* is tench *(Tinca tinca)*.

Lifecycle

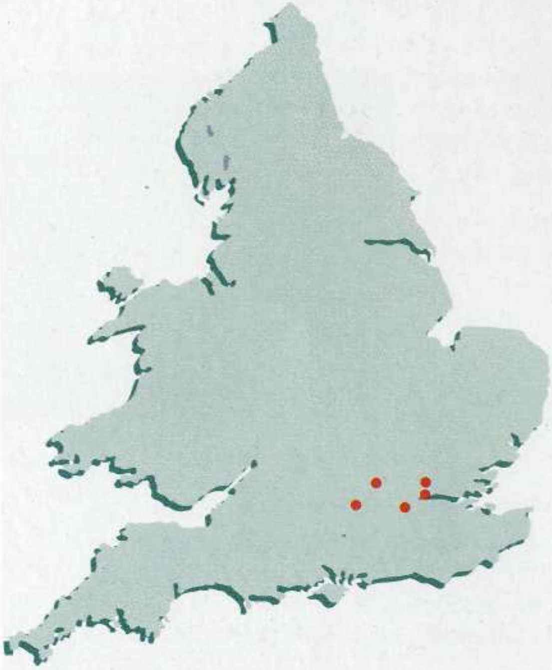
There is little information on the life cycle of this parasite. As with other caryophyllidean tapeworm, the intermediate host is thought to be an aquatic oligochaete. Other species of *Monobothrium* in North America utilise a species of *Limnodrilus*, but the particular species or range of species used by the parasite is not known.

Pathology

The parasite is reported to produce a raised plaque-like formation on the gut wall surrounding the firmly anchored scolex. The extent of pathological effects are unknown, however, the absence of indigenous tapeworms of tench in the UK emphasises the importance of avoiding the spread of this parasite.

Treatment

Treatment of infected fish in wild fisheries is not feasible. The effects of antihelminthics is unknown and the lack of definite information on the life cycle means extreme caution is necessary during any disinfection procedures.



Distribution

It was first recorded in the UK in 1992 and is now present in five UK fisheries. The parasite is indigenous in Eastern Europe.

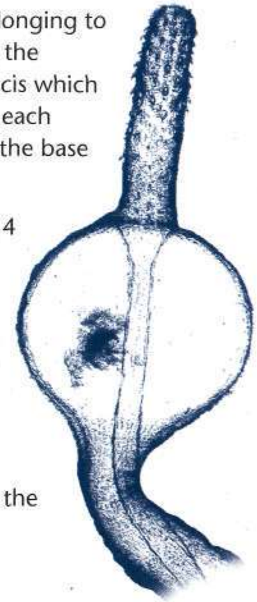
Dissemination

Stocking of fish infected with adult worms is the most likely method of transfer. However, infected intermediate hosts (probably aquatic oligochaetes) and eggs may be transferred on equipment, in water or by aquatic animals.

Pomphorhynchus laevis

Introduction

Pomphorhynchus laevis is an acanthocephalan worm belonging to the Pomphorhynchidae family. The parasite attaches to the intestinal wall of the fish host by a characteristic proboscis which has 13 - 20 longitudinal rows of hooks (8 - 13 hooks in each row). A diagnostic feature of the parasite is a "bulb" at the base of the proboscis which acts as an attachment aid.

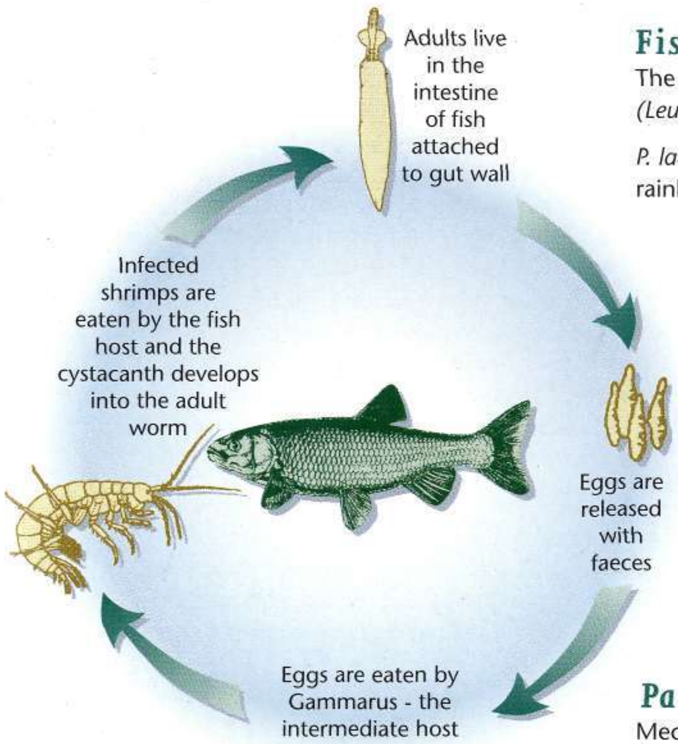


The adult parasites are orange-yellow in colour and are 4 - 25 mm in length.

Strain Variation

There are three distinct strains of *P. laevis* present in the British Isles:

A marine strain found in Baltic and North Sea flounder and plaice; an Irish strain found in rainbow and brown trout and an English strain found in barbel and chub in the Thames, Severn and Hampshire Avon



Fish hosts

The definitive hosts of the "English" strain of *P. laevis* are chub *(Leuciscus cephalus)* and barbel *(Barbus barbus).*

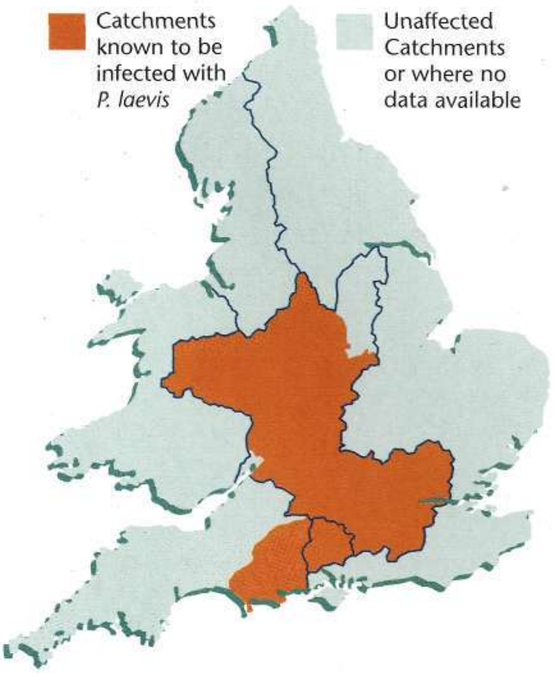
P. laevis is also occasionally recorded in brown trout *(Salmo trutta),* rainbow trout *(Onchorhynchus mykiss)* and grayling *(Thymallus thymallus).*

Lifecycle

Adult parasites live in the intestine of fish attached by their spiny proboscis. The worms have no gut and absorb food from the fish through their body surface. Fertilised eggs (acanthors) pass out with the faeces into the river, where they sink to the bottom. The acanthors are eaten by the intermediate host, the freshwater shrimp *(Gammarus pulex),* and the larvae hatch in their intestine. The larvae bore through the gut wall and into the body cavity of the shrimp, where they develop into an acanthella stage, then finally into an infective form - a cystacanth. When the infected shrimp is eaten, the parasite is released. The spiny proboscis of the adult everts to attach to the intestine wall of the fish, and once established, its proboscis bulb swells to secure the parasite *in situ.*

Pathology

Mechanical damage and inflammation of the intestine wall result from the penetration of the proboscis and formation of the bulb. Heavy infections can destroy the absorptive layers of the gut wall and cause intestinal blockage. The parasite may also perforate the gut wall causing peritonitis. Emaciation and mortality have been recorded. However, where infections of the parasite remain relatively stable, e.g. in the river Avon, fish growth and survival does not seem to be adversely affected.



Treatment

There are no means to eradicate *P. laevis* after it has become established. The intermediate host, *Gammarus,* is an important food source of most freshwater fish and cannot be controlled without damaging the environment, so the life cycle of the parasite cannot be interrupted.

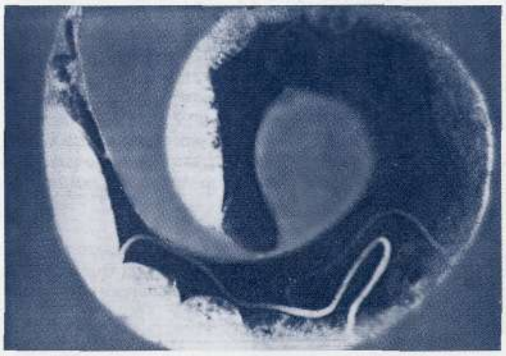
Distribution

The distribution map is probably incomplete.

Dissemination

Stocking of fish infected with adult worms is probably the most common means of transfer. However infected *Gammarus* and eggs may also be transferred on equipment, in water or by aquatic animals.

Anguillicola crassus



Introduction

Anguillicola crassus is a dracuculoid nematode belonging to the Anguillicolidae family. Adult parasites are found in the swimbladder of eels where they feed on blood from the swimbladder wall. Adult females are 20 - 60 mm long and 1 - 3 mm wide (adult males are smaller, only 45 - 70 mm long and 3 - 6 mm wide). They have thick, cylindrical and soft bodies, rounded at the head end with a pointed tail.

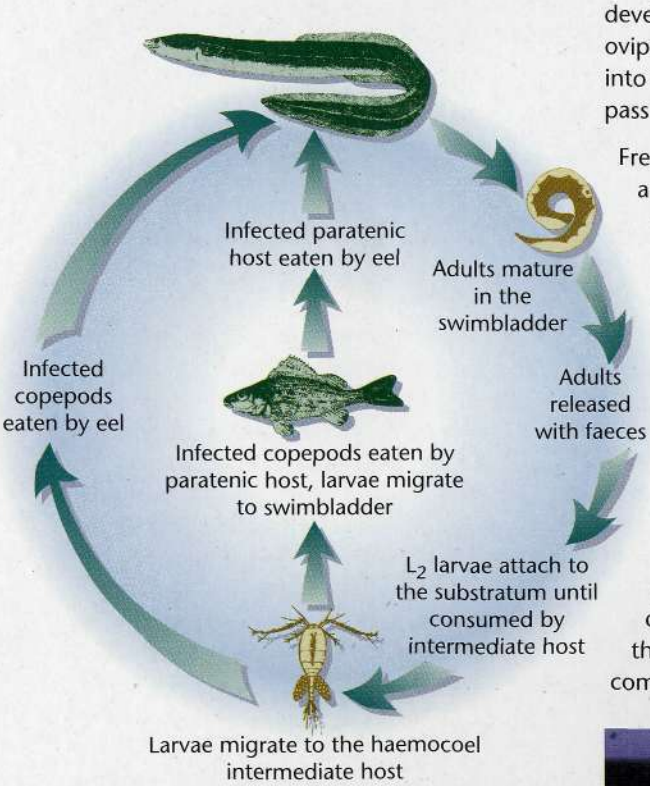
Fish hosts

The definitive hosts of *A. crassus* are: Japanese eel *(Anguilla japonica)* in Southeast Asia; European eel *(Anguilla anguilla)* in Europe.

European eels have less resistance to *A. crassus* than the Japanese eel and consequently the prevalence and intensity of infection is higher.

Lifecycle

Copulation takes place in the swimbladder of the eel. The fertilised eggs develop within the female and the eggs contain L_2 larvae at the time of oviposition. The eggs pass out of the swimbladder via the pneumatic duct into the digestive tract. L_2 larvae may then hatch in the digestive tract and pass with the faeces or may pass out as eggs before hatching in the water.



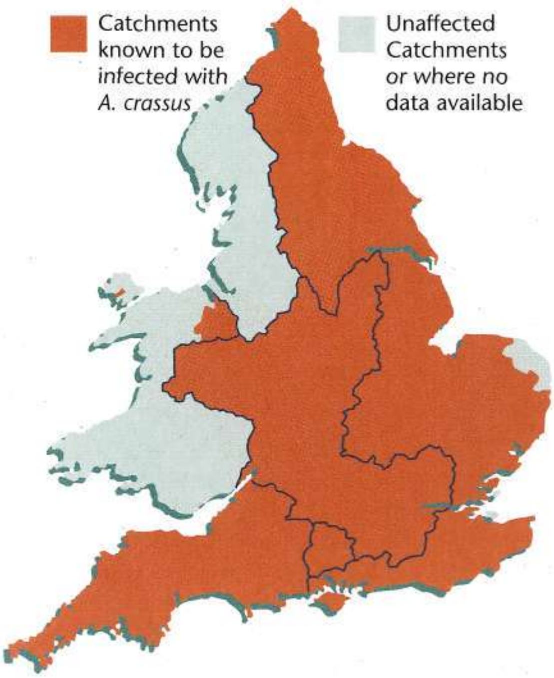
Free-living L_2 larvae live up to four months and attach to the sub-stratum and "wiggle" their bodies to attract predation by a suitable intermediate host. These are usually cyclopoid copepods, but *ostracods and juvenile Gammarus can also be infected.* The L_2 larvae migrate to the haemocoel of the host and moult into a third stage infective larvae (L_3), a process which takes 10 - 12 days. When eaten by an eel, L_3 larvae migrate through the gut wall into the swimbladder, where the larvae moult to larval stage L_4. Pre-adult and adult parasites are situated in the lumen of the swimbladder and feed actively on blood from the capillary network of the swimbladder. The life cycle is estimated to take up to 12 months, but can be completed in as little as two months.

If infected copepods are eaten by another fish species, L_3 larvae migrate into the swimbladder wall and do not mature, only rarely developing into the L_4 stage. The larvae may become encapsulated by the host tissue response, however, larvae that remain alive may complete their life cycle if their host (a paratenic host) is eaten by an eel.

Pathology

The presence of *A. crassus* within the swimbladder wall causes inflammation and the formation of scar tissue. Heavy infections result in the formation of a thick layer of connective tissue, eventually the whole swimbladder being replaced by a hard dark brown mass in which the remains of nematodes can be found. Secondary infection of surrounding tissue may occur. The destruction of the swimbladder may have serious consequences to the eels migration back to the Sargasso Sea to spawn.

Infected farmed eels exhibit reduced growth rates and increased mortality. Mortalities have also been recorded in the wild, e.g. in 1989 over 250 tonnes of eels infected with *A. crassus* died in lake Balaton in Hungary. It was concluded that the eels could not withstand a sudden drop in the dissolved oxygen content (non-lethal to healthy eels) because of the debilitating effects of the parasite.



Treatment

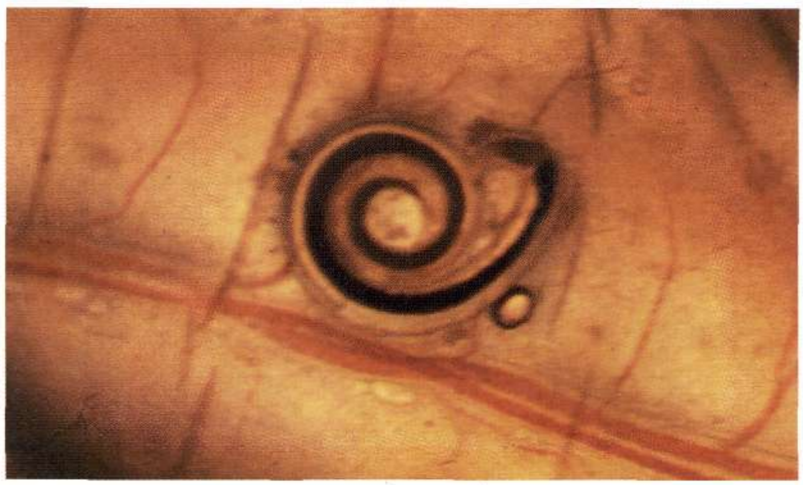
Treatment of infected eels in the wild is not feasible. In aquaculture, it is possible to treat infected eels with nematocides under veterinary prescription. A measure of control may be obtained by eliminating copepods. Raising the temperature to 36.5°C causes death of the nematodes, but is very stressful to the eels.

Distribution

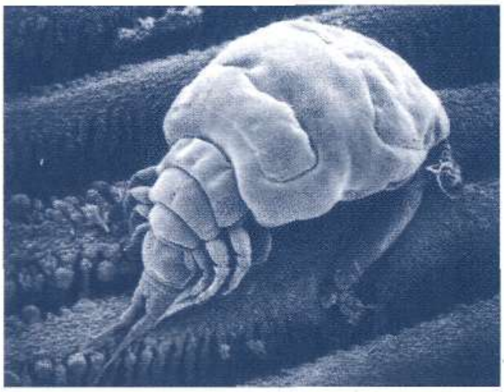
The parasite is indigenous to Southeast Asia and was introduced into Europe in the early 1980's with imports of live eels and has spread rapidly. It was first recorded in the UK in 1987 and is now present in many river catchments.

Dissemination

Introduction of infected eels and paratenic hosts is the most likely cause of transfer. Since most freshwater fish can carry infective larvae, the transfer of any fish between catchments should be avoided. Movement of intermediate hosts and free-living L_2 larvae may take place in water, on equipment and by aquatic animals.



Ergasilus sieboldi

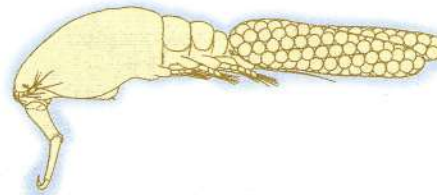


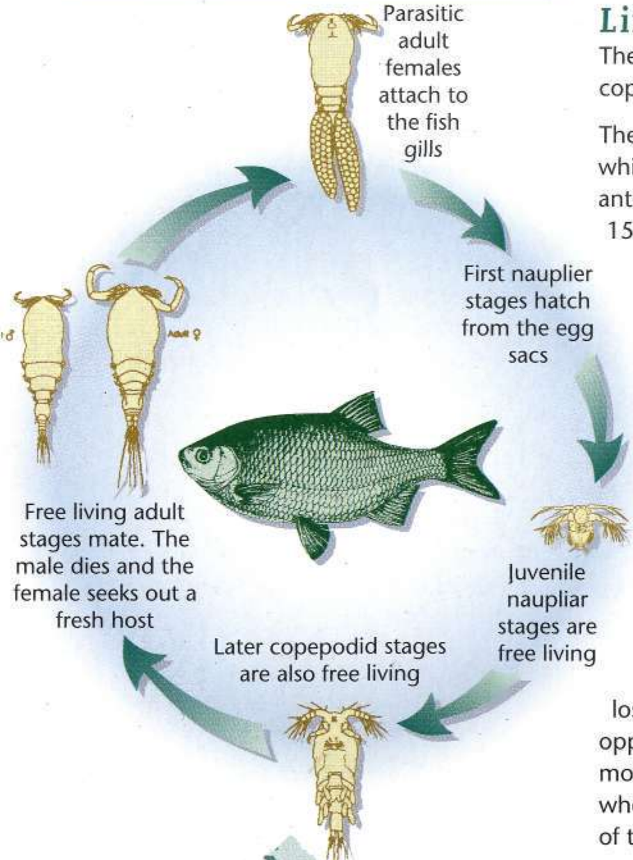
Introduction

Ergasilus sieboldi is a parasitic copepod belonging to the Ergasilidae family. Only adult females are parasitic and measure 1 mm in length. They are generally found attached to the outer surface of the gill filaments of freshwater and brackish fish species.

Fish hosts

All fish species can act as final hosts, however, the most vulnerable hosts are tench *(Tinca tinca)*, bream *(Abramis brama)* and pike *(Esox lucius)*. Since *E. sieboldi* has the ability to infect a wide range of fish species, no fish can be assumed to be uninfected from a fishery where the parasite is present.





Lifecycle

The life cycle of *E. sieboldi* comprises of multiple free-living naupliar and copepodid stages with a free-living cyclopoid adult.

The free-swimming adults mate by the transfer of spermatophores, after which the males die and the females attach to the gills using hook-like antennae. Eggs are produced in two egg sacs and clutch sizes range from 15 - 300. The production of eggs is temperature-dependent, usually occurring between March and November. As a rule, three generations are produced during the season, therefore, highest levels of infection occur in late Summer/early Autumn. Females of the last generation overwinter on fish and commence egg production in the spring.

Pathology

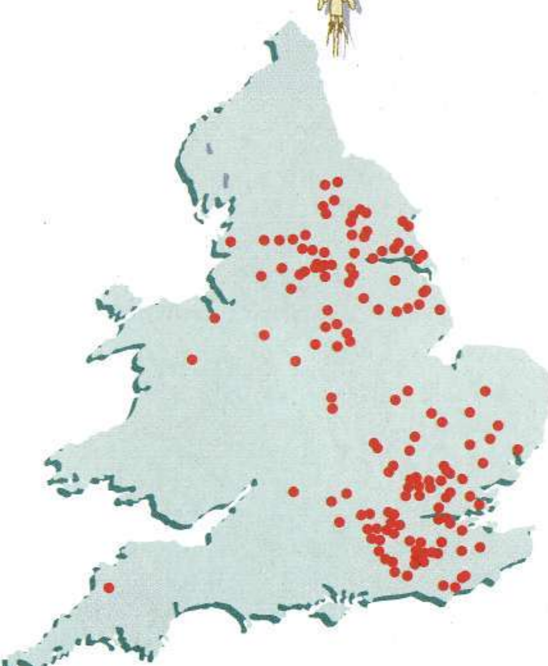
Haemorrhage, reduced blood flow and necrosis of the gill filament result from the attachment and feeding of the parasite. The prevalence and intensity of infection tends to increase with host size. The severity of the pathology is proportional to the number of parasites present on the fish. Heavily infected fish (>100 parasites) experience severe respiratory difficulties, osmoregulation problems, changes in blood parameters, reduced growth rates and a loss in condition factors. Additionally, necrotic lesions of the gill offer opportunity for secondary infections. There are numerous reports of mortalities caused by *E. sieboldi* occurring in late Summer/early Autumn when the intensity of infection is high and the dissolved oxygen content of the water is low.

Treatment

There is no 100% effective treatment for ergasilids.

Distribution

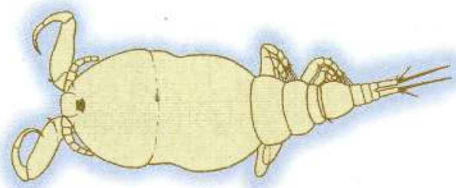
E. sieboldi is widely distributed in Eurasia and was first recorded in the UK in 1967.

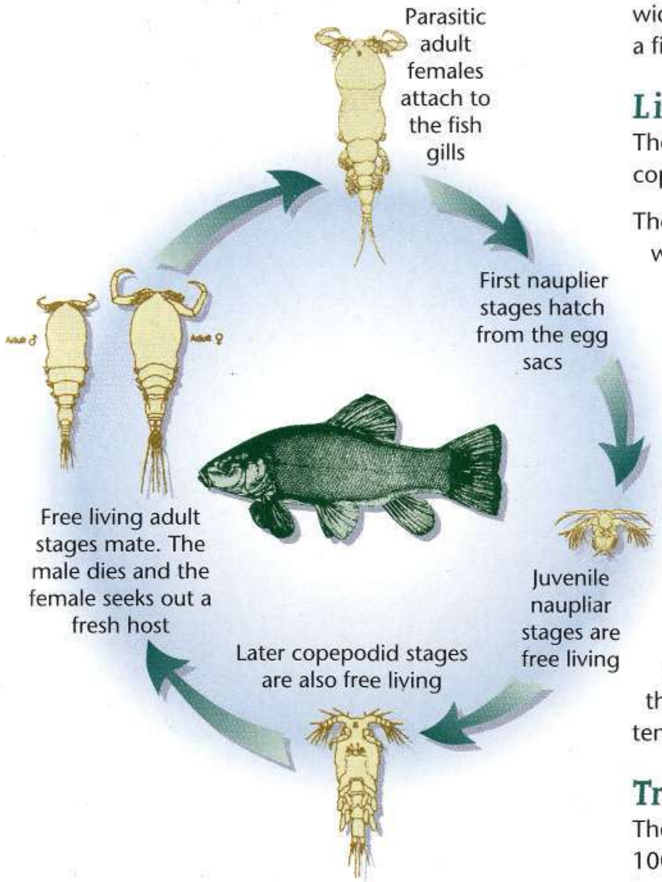


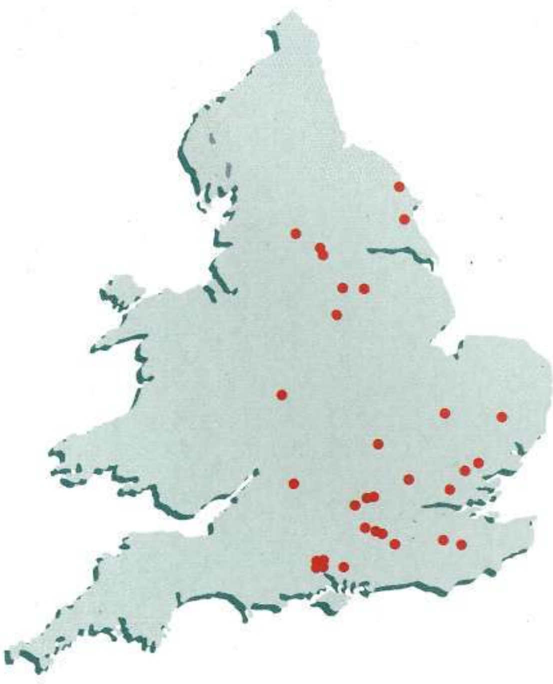
Dissemination

Stocking of fish with adult parasites is the most likely means of dissemination. However free-living stages may also be transferred in water, on equipment or by aquatic animals.

Ergasilus briani







Introduction

Ergasilus briani is a parasitic copepod belonging to the Ergasilidae family. Only adult females are parasitic and measure 0.7 - 0.9 mm in length. The parasites attach to the inner surface of gill filaments, mostly on the second and third gill arches.

Fish hosts

All fish species can act as final hosts, however, the most vulnerable host species are tench *(Tinca tinca)* and bream *(Abramis brama)*. *E. briani* is more prevalent on smaller fish. Since *E. briani* has the ability to infect a wide range of fish species, no fish can be assumed to be uninfected from a fishery where the parasite is present.

Lifecycle

The life cycle of *E. briani* comprises of multiple free-living naupliar and copepodid stages with a free-living cyclopoid adult.

The free-swimming adults mate by the transfer of spermatophores, after which, the males die and the females attach to the gills using hook-like antennae. Eggs are produced in two egg sacs and clutch sizes range from 36 - 64. The production of eggs is temperature-dependent, usually occurring between March and late October. As a rule, three generations are produced during this season, therefore, highest levels of infection occur in late Summer/early Autumn. Females of the last generation overwinter on fish and commence egg production in the spring.

Pathology

Haemorrhage, reduced blood flow and necrosis of the gill filament result from the attachment and feeding of the parasite. The severity of the pathology is proportional to the number of ergasilid parasites present on the fish. The parasite preferentially infects small fish and thus its effect on the host is likely to be more severe. Mortalities of tench, directly related to high infections of *E. briani,* have been recorded.

Treatment

There is no 100% effective treatment for ergasilids.

Distribution

E. briani is widely distributed in Eurasia and was first recorded in the UK in 1983.

Dissemination

Stocking of fish with adult parasites are the most likely means of dissemination. However free-living stages may also be transferred in water, on equipment or by aquatic animals.

Ergasilus gibbus

Introduction

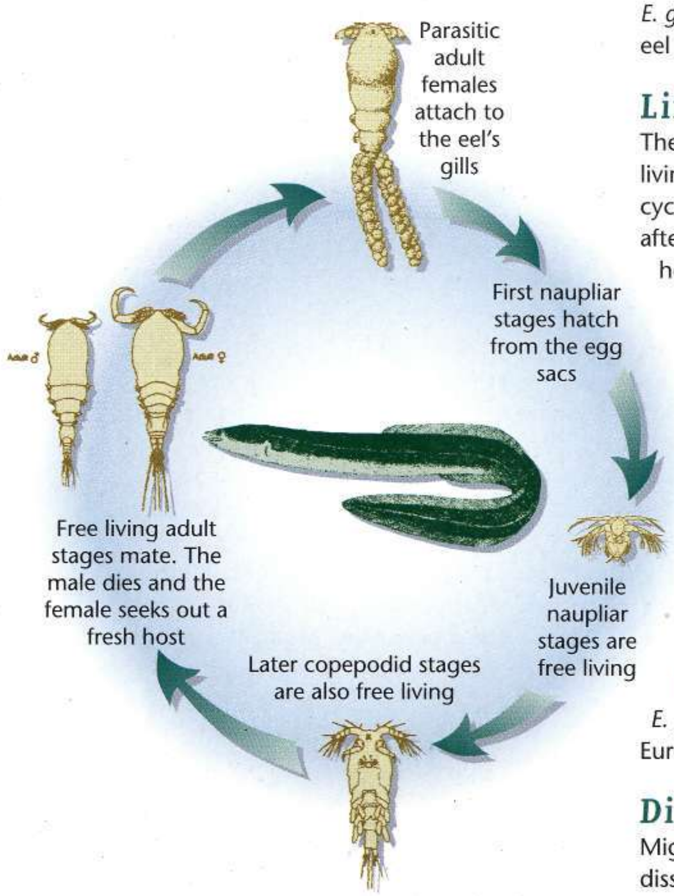
Ergasilus gibbus is a parasitic copepod belonging to the Ergasilidae family. Only adult females are parasitic and measure 1.2 - 2 mm in length. They are generally found attached to the inner surface of gill filaments.

Fish hosts

The definitive host of *E. gibbus* is the European eel *(Anguilla anguilla)*.

Lifecycle

The life cycle of *E. gibbus* is comprised of an unknown number of free-living naupliar and copepodid stages before moulting to free-living cyclopoid adults. Adults mate in the water by transfer of spermatophores, after which the males die and the females attach to the gills of fish using hook-like antennae. Egg production occurs between March and October, with peak establishment of the parasite occurring between July and September.



Pathology

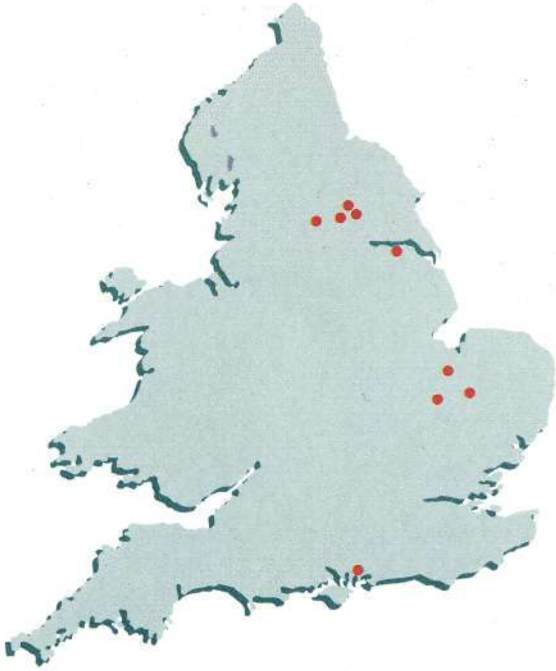
Haemorrhage, reduced blood flow and necrosis of the gill filament result from the attachment and feeding. The severity of the pathology is proportional to the number of ergasilid parasites present on individual fish.

Treatment

There is no 100% effective treatment for ergasilids.

Distribution

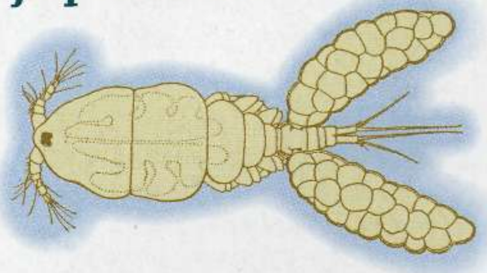
E. gibbus is found in fresh, brackish and coastal waters throughout Europe and North Africa. It was first recorded in the UK in the late 1960's.

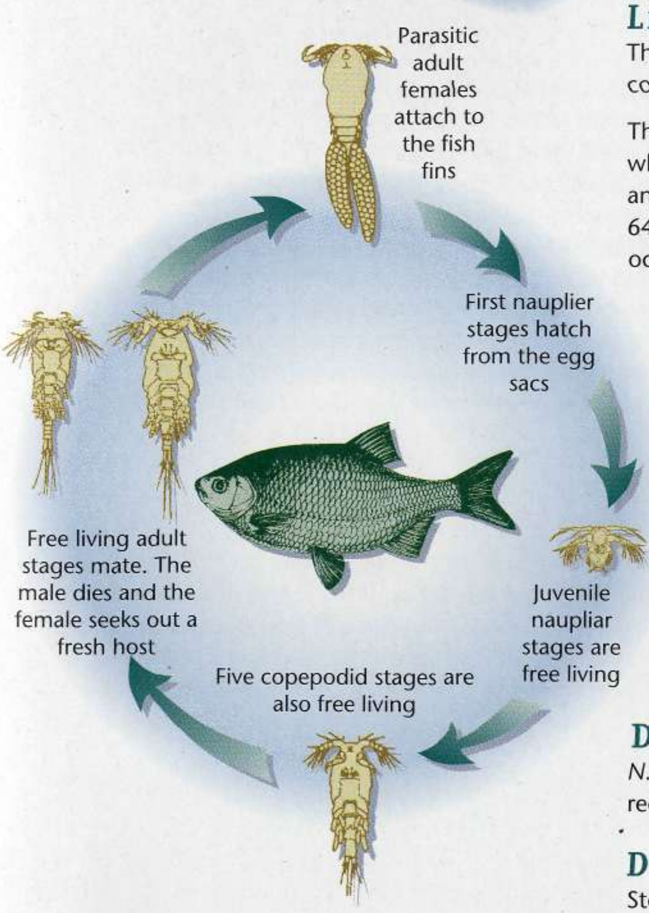


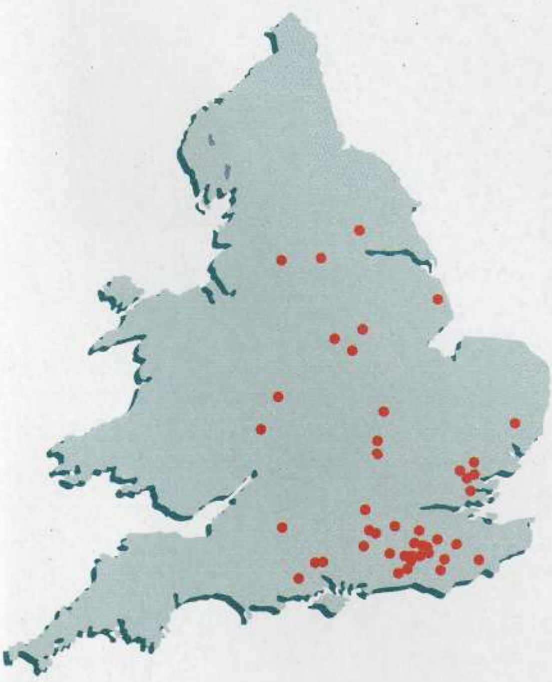
Dissemination

Migration and movement of infected eels is the most likely means of dissemination. However, free-living stages may also be transferred in water, on equipment or by aquatic animals.

Neoergasilus japonicus







Introduction

Neoergasilus japonicus is a parasitic copepod belonging to the Ergasilidae family. Only adult females are parasitic and are 0.5 - 0.85 mm in length with a triangular body shape. They are generally located at the base of fins, and may spread to other parts of the body in heavy infections.

Fish hosts

All fish species can act as final hosts since the parasite has low host-specificity, although rudd *(Scardinius erythrophthalmus)*, crucian carp *(Carassius carassius)* and tench *(Tinca tinca)* appear to be the most vulnerable species.

Lifecycle

The life cycle of *N. japonicus* comprises of multiple free-living naupliar and copepodid stages with a free-living cyclopoid adult.

The free-swimming adults mate by the transfer of spermatophores, after which the males die and the females attach to the fish using hook-like antennae. Eggs are produced in two egg sacs and clutch sizes range from 64 - 78 eggs. The production of eggs is temperature-dependent, usually occurring between March and October, with peak establishment occurring between July and September.

Pathology

The epidermal layer of the fin is pierced by the antennae of the parasite in order to attach to the fish. The parasite uses its legs to break the surface layer of the fishes skin on which it feeds. Damage caused by the activity of the parasite may result in osmoregulatory stress and secondary infections. Mortalities, directly related to high infections of the parasite have been observed.

Treatment

There is no 100% effective treatment for ergasilids.

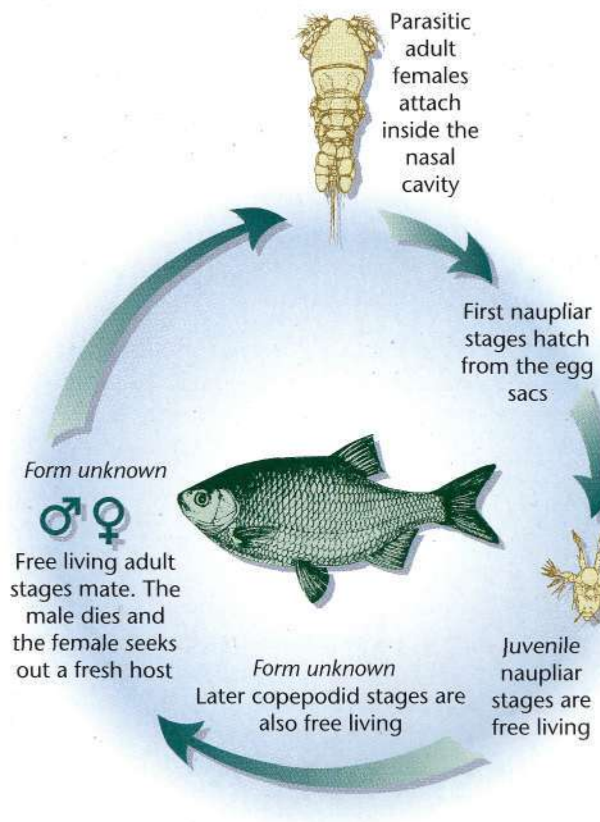
Distribution

N. japonicus is indigenous in Eastern Europe and Asia and was first recorded in the UK in 1982.

Dissemination

Stocking of infected fish is the most likely means of dissemination. However, free-living stages may also be transferred in water, on equipment or by aquatic animals.

Paraergasilus longidigitus



Introduction

Paraergasilus longidigitus is a parasitic copepod belonging to the Ergasilidae family. The parasite is found in the nasal cavities of fish and are occasionally found on the gills and in the oral cavity. Only adult females are parasitic and are 0.4 - 0.5 mm long. Adult males of the species have not yet been described.

Fish hosts

All fish species can act as final hosts, however, the highest intensity of infection has been recorded in bream (>500 parasites). As *P. longidigitus* has the ability to infect a wide range of fish species, no fish can be assumed to be uninfected from a fishery where the parasite is present.

Lifecycle

The life cycle of *P. longidigitus* comprises of an unknown number of naupliar and copepodid stages before moulting to free-living cyclopoid adults. After mating the females settle in the nasal cavity of a host species. At this stage the parasites remain active and are still capable of free swimming. The production of eggs is temperature-dependent, occurring from April to October. The parasite produces relatively few eggs compared to other ergasilids, approximately 8 - 10 per clutch in two egg sacs. The number of generations produced within a season remains unknown. As with other ergasilids, adult females which establish at the end of the season, over winter on the fish and commence egg production in the spring.

Pathology

The delicate olfactory tissues in the nasal cavity are damaged by the attachment and feeding of *P. longidigitus*. The resultant loss of "smell" is thought to affect feeding and spawning habits of the fish host, leading to a loss of condition factor and a potential disruption of fish populations. Therefore, although *P. longidigitus* has not been directly linked to fish mortalities the parasite does represent a serious risk to health of fish populations.

Treatment

There is no 100% effective for ergasilids.

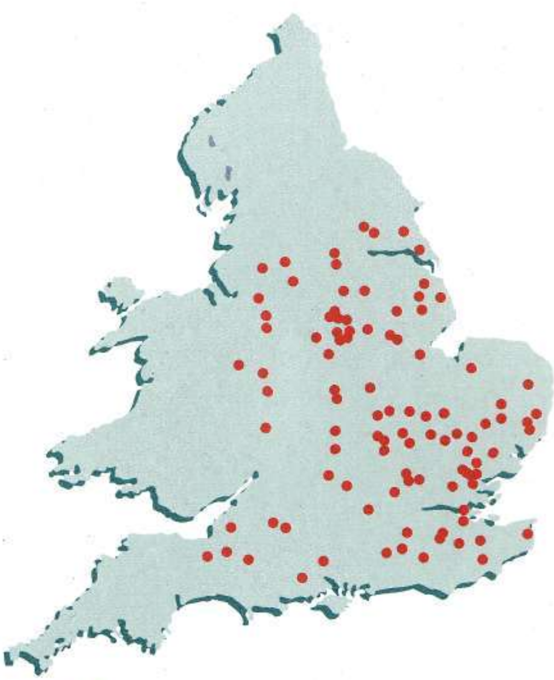
Distribution

P. longidigitus was first described in China in 1954 and is thought to have a wide distribution across Eurasia.

It was first identified in Britain in 1994 and has subsequently been recorded in over 100 UK fisheries.

Dissemination

Stocking of infected fish is the most likely means of dissemination, particularly because of low host-specificity and the range of habitats utilized. However, free-living stages may also be transferred in water, on equipment or by aquatic animals.



Glossary of Terms

Ancanthella Acanthocephalan larva, lacking a proboscis and developing from an acanthor within the intermediate host

Acanthocephalan Spiny-headed worms

Antihelminthic A drug effective against parasitic tapeworms and round worms

Blood fluke A parasitic flatworm living in the blood system of another host

Cercariae Larval stage of a fluke produced in the snail host

Chalimus The modified copepodid stage of a copepod, attached to its host by a filament

Coelom Body cavity

Copepod Minute free-living or parasitic crustacean

Coracidia Ciliated embryo of certain tapeworms, develops into a procercoid within first intermediate host

Crustacean A class of Arthropods, having 2 pairs of antennae and a hard shell

Cystocanth A juvenile acanthocephalan that develops from an acanthella

Definitive host Final host of the adult parasite

Digenean Parasitic flatworms with complex life cycles

Distension Swelling due to pressure from within

DNA probe A diagnostic tool enabling precise identification of micro-organisms and parasites

Ectoparasite A parasite living on the surface of another organism

Endoparasite A parasite living within another organism

Haemocoel The main body cavity in molluscs, filled with blood

Haemorrhage An escape of blood from blood vessels

Hermaphrodite An animal possessing both male and female reproductive organs

Hyperplasia An increase in tissue mass due to an increase in cell number

Indigenous Native to a particular country

Intermediate host A host in which a parasite lives for part of its life cycle, but in which it does not become sexually mature

Miracidia A ciliated larval stage of blood flukes which hatch from the egg and infect the snail host

Monogenean Parasitic flatworms with simple life cycles on one host

Monozoic Producing one gamete only

Naupliar A larval crustacean life cycle stage in which the larva (nauplius) which has a single eye, three pairs of limbs and a rounded, transparent body

Necrosis A localised area of dead cells or tissue

Nematocide A drug which kills nematode worms

Nematode Roundworms

Olfactory A sense of smell, in which there is recognition of molecules suspended in air/water

Oligochaete Annelid worms with characteristic bristles contained on each segment

Oncosphere An embryonic form of a tapeworm consisting of a spherical chitin (polysaccharide) shell

Osmoregulation Regulation of the osmotic pressure of body fluids by the control of amounts of water and salts in the body

Parasite An organism that for all or part of its life derives food from other living organisms (the host) which is usually harmed to some degree by its association

Paratenic host A host which simply acts as a 'carrier', transporting the parasite to the next host. During this the parasite undergoes no development

Pathology Characteristic symptoms and signs of disease

Peritonitis An infection of the body cavity

Plerocercoid A solid, elongated metacestode (larval tapeworm found in intermediate host) of ceratin tapeworms

Praziquantel An antihelminthic drug

Proboscis An elongated mouthpart

Procercoid An early larval stage of certain tapeworms in the first intermediate host

Proglottid An individual segment of an adult tapeworm, containing a set of reproductive organs. Eggs are formed in the posterior proglottids, and shed in the faeces

Secondary infection A bacterial, fungal or parasitic infection which infects fish already stressed and weakened

Scolex The anterior end of a tapeworm which may contain tiny hooks and/or a sucker, by which it attaches to the gut wall of the host

Spermatophore A "packet" of sperm transferred from male to female in certain invertebrates such as crustacea

Sporocyst A larval stage of endoparasitic flukes which develops from the miracidia in the snail host

Tapeworm The common name for cestodes

Viviparous Producing live young