Fish Health Issues

From the Archives of Maine IF&W

Maine is fortunate in that most of our fish health issues are minor and relatively insignificant as compared to those problems encountered in some other states. In part, much of this fortune is the direct result of having clean waters that naturally promote a general state of wellbeing and good health. Although regulations and educational programs have minimized the risk of introducing new diseases and of spreading existing diseases within our borders, natural movements of wildlife and human activity makes it inevitable that some spreading will occur. When conditions are just right, existing or newly introduced pathogens can result in the occasional discovery of diseased fish or small fish kills from time to time. When such occurrences are experienced, it can sometimes be visually disturbing. However, in the vast majority of cases, there is little need for alarm as most conditions are due to natural phenomenon. Most of the fish diseases which are encountered in the state are not highly infectious, may have complicated lifecycles, or have specific host requirements that limit the ability of it to spread. However there are a few conditions which we classify as being of regulatory concern and when multiple fish are being seen with the same condition, our regional biologists should be notified. Regardless of the classification, if you encounter a diseased fish that you think we should know about, take some photos and contact one of our regional fisheries biologists by email or phone.

For years, Maine IF&W has hosted a series of web links to help educate those interested in these various conditions that may be encountered in the field. For convenience, we have consolidated and re-organized all of the "Fish Health Issues" content into one easy to use reference. One of its main purposes is to dissuade "bucket biologists" from illegally moving fish from one water to the next. In addition to the harm caused by altering the species profile of a water, one could easily introduce one or more of the diseases found within this document.

Sections of this document have been authored by the current and former Fish Pathologists of the Maine Department of Inland Fisheries and Wildlife's Fish Health Laboratory. The material provided herein is for educational purposes only. It should be noted that this archive is not a complete list of that which has been found in Maine. It is not intended as a reference for current disease status for use in making regulatory decisions. Conditions described herein are not representative of all waters within the State. Occurrence from one water to the next should be viewed as being highly variable. Although statements in regards to zoonotic potential and human safety are thought to be accurate, this document should not be considered to be the definitive authority on such subject matter. Some images were made possible in part by a grant from the Maine Outdoor Heritage fund.

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Black Spot *(Apophallus brevis)* in Brook Trout

Updated November 2002. By G. Russell Danner

Sand grain sized black spots on the skin of brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) are usually caused by a small immature larval trematode parasite named *Apophallus brevis (Syn. A. imperator).* “Black grubs,” “Black spot disease,” or “*Neascus* infection” can be found in many different fish species, and is a fairly common; however, the unsightly condition is caused by many different species specific parasites.

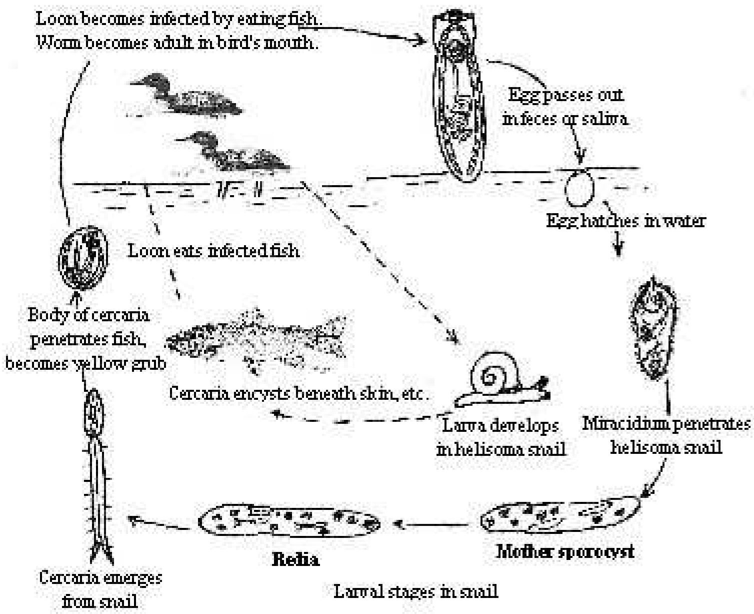


Figure 1. Lifecycle of Black Grub. (modified from Hoffman 1999. Parasites of North American Freshwater Fishes. 2nd Edition. Comstock Publishing. Ithaca NY).

The final host for the digenetic trematode *A. brevis* is naturally the Common Loon (*Gavia immer*); however, a variety of fish eating animals have also been experimentally infected including: cats, pigeons, gulls and muskrats. Adult worms live in the loon’s mouth where they produce eggs. The eggs are swallowed by the loon, pass through the digestive system unharmed, and are released into the water with the loon’s feces. The eggs mature in water and release the ciliated miracidia, which then swim away and penetrate the appropriate molluscs (snails or less often clams), often only those of a certain genus. These molluscs are the first intermediate hosts of the trematode. In the molluscs, the miracidium grows to become a redia (a saclike animal with a pharynx and a gut), which may produce either cercariae or sporocysts (sac-like animals without a pharynx or gut).

Brook trout with heavy black spot infestation.

The cercariae actively penetrate and migrate into the tissues of the second intermediate host, which is most often a fish. When a cercaria penetrates and migrates into the tissues of a fish, it causes obvious mechanical damage and hemorrhaging. The damage caused by one cercaria is negligible, but in greater numbers they may kill the fish. After the cercaria has localized and transformed into a metacercaria, little subsequent damage occurs, unless enough metacercariae accumulate that their collective mass interferes with the fish's metabolism. The infected fish must be eaten by the final host to complete the trematode's lifecycle. When the fish is eaten and digested by the loon, the metacercaria emerges from the fish flesh and migrates to the loon's mouth where it matures to the adult egg producing worm. This completes its lifecycle. The worms are hermaphrodites having both male and female organs.

Special Points of Interest:

- *A. brevis* does not infect humans. Although a related species has been found in humans, several other mammals and birds.
- Black grubs can be found in many different species of freshwater fishes.
- *A. brevis* can live for 4 years in a fish.
- Cooking fish kills the parasite.

Black Spot *(Ululifer amblopltis)* in Bass

Updated November 2002. By G. Russell Danner

Sand grain (or slightly larger) sized black spots on the skin and in the flesh of smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides*), and many other species of Centrarchidae, Cyprinidae, and Esocidae are usually caused by a small immature larval trematode parasite named *Uvulifer ambloplites (Syn. Neascus wardi; U. claviformis; or U. magnibursiger)*. “Black grubs,” “Black spot disease,” or “*Neascus* infection” can be found in many different fish species, and is fairly common and widespread. The unsightly condition may be caused by several different species of parasites.

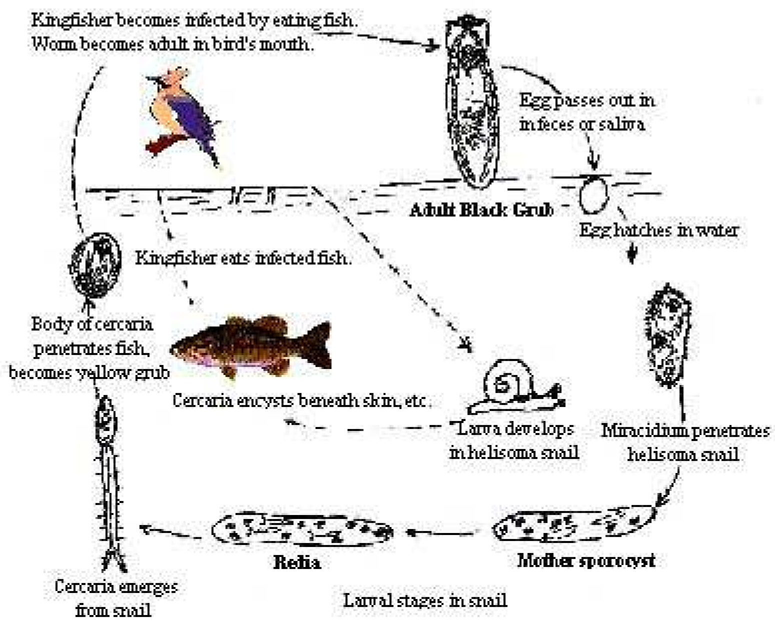


Figure 1. Lifecycle of Black Grub. (modified from Hoffman 1999. Parasites of North American Freshwater Fishes. 2nd Edition. Comstock Publishing. Ithaca NY).

The digenetic trematode parasite lives in three different host animals during it’s life. The final host for the adult trematode *U. ambloplites* is naturally the Belted Kingfisher (*Ceryl alcyon*). Adult worms live in the bird’s mouth where they produce eggs. The eggs are swallowed, pass through the digestive system unharmed and are released into the water with the kingfisher’s feces. The eggs mature in water and release the ciliated miracidia, which then swim away and penetrate the appropriate molluscs (*Helisoma sp.*). These molluscs are the first intermediate hosts of the trematode. In the molluscs, the miracidium grows to become a redia (a saclike animal with a pharynx and a gut), which may produce either cercariae or sporocysts (sac-like animals without a pharynx or gut). The cercariae actively penetrate and migrate into the tissues of the second intermediate host, which is most often a fish. When a cercaria penetrates and migrates into the tissues of a fish, it causes obvious mechanical damage and hemorrhaging. The damage caused by one cercaria is negligible, but in greater numbers they may kill the fish. After the cercaria has localized and transformed into a metacercaria, little subsequent damage occurs, unless enough metacercariae accumulate that their collective mass interferes with the fish’s metabolism. The infected fish must be eaten by the final host to complete the trematode's lifecycle. The worms are hermaphrodites having both male and female organs.

Figure 2. Belted Kingfisher.

Special Points of Interest:

- *U. ambloplites* does not infect humans. Although a related species has been found in humans, several other mammals and birds.
- Black grubs can be found in many different species of freshwater fishes.
- *U. ambloplites* can live for 4 years in a fish.
- Cooking fish kills the parasite.

Black Spot *(Crassiphiala bulboglossa)* in Perch and Pickerel

Updated November 2002. By G. Russell Danner

Sand grain sized (sometimes larger) black spots on the skin of yellow perch (*Perca flavenscens*) and chain pickerel (*Esox niger*) are usually caused by a small immature larval trematode parasite named *Crassiphiala bulboglossa*. “Black grubs,” “Black spot disease,” or “*Neascus* infection” can be found in many different fish species, and is fairly common and widespread. The unsightly condition may be caused by several different species of parasites.

The digenetic trematode parasite lives in three different host animals during it’s life. The final host for the adult trematode *C. bulboglossa* is naturally the Belted Kingfisher (*Ceryl alcyon*). Adult worms live in the bird’s mouth where they produce eggs. The eggs are swallowed, pass through the digestive system unharmed and are released into the water with the kingfisher’s feces. The eggs mature in water and release the ciliated miracidia, which then swim away and penetrate the appropriate molluscs (*Helisoma sp.*). These molluscs are the first intermediate hosts of the trematode. In the molluscs, the miracidium grows to become a redia (a saclike animal with a pharynx and a gut), which may produce either cercariae or sporocysts (sac-like animals with out a pharynx or gut).

The cercariae actively penetrate and migrate into the tissues of the second intermediate host, which is most often a fish. When a cercaria penetrates and migrates into the tissues of a fish, it causes obvious mechanical damage and hemorrhaging. The damage caused by one cercaria is negligible, but in greater numbers they may kill the fish. After the cercaria has localized and transformed into a metacercaria, little subsequent damage occurs, unless enough metacercariae accumulate that their collective mass interferes with the fish’s metabolism. The infected fish must be eaten by the final host to complete the trematode’s lifecycle. The worms are hermaphrodites having both male and female organs. Below: Blackspot in Blacknose dace.

Special Points of Interest:

- *C. bulboglossa* does not infect humans, although a related species has been found in humans, several other mammals and birds.
- Black grubs can be found in many different species of freshwater fishes.
- *C. bulboglossa* can live for 4 years in a fish.
- Cooking fish kills the parasite.

Protozoa: Ichthyophthirius multifiliis

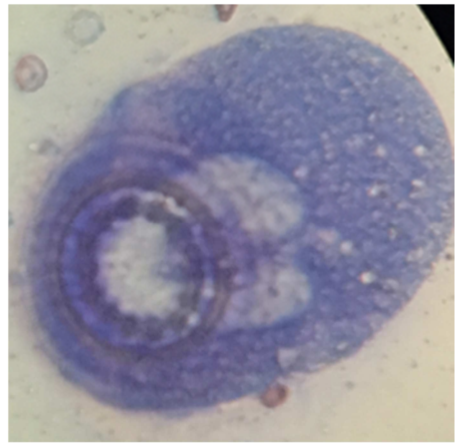
Updated November 2002. By G. Russell Danner

Ichthyophthirius multifiliis (Greek *Ichthyo*, fish; *phthir*, a louse; *mult*i, many; *fil*, a thread). Scientific names sometimes provide a wealth of descriptive information about an organism.

Whitespot caused by Ichthyophthirius multifiliis on young of the year yellow perch. Protozoan unstained. Scale (across top) = 1 millimeter.

This organism commonly known as "*Ich*" or "*Whitespot*," can be found on the skin of many, probably most, freshwater fishes in the world's temperate zones. Grossly the skin of an infected fish displays raised white nodules (50 um to 1 mm). These nodules contain individual *Ich* trophonts. *Ich's* large size and horseshoe-shaped macronucleus are it's best identifying features. These growing parasites feed on the fish's epithelium for between 4 and 40 days depending upon water temperature. When they mature, they release from the fish, drop to the lake or river substrate and metamorphose into a cyst. Each cyst may contain 1,000 new ciliated theronts ready to infect another fish.

When fish are severely infected with growing trophonts, they may have their epithelium eaten to the extent that the skin necrosis and sloughs off. These fish rapidly die. Because *Ich* can reproduce so quickly and kill fish so rapidly, it may be the most important fish parasite in the world. New hosts are continually being discovered and currently include (at least): salmonids, perch, bass, and ornamental fishes. *Ich* has been found on fish in North America, Africa, South America, Australia, Asia, and Europe. The first reported case of *Ich* occurred in 1876 and was reported by Fouquet.



Ichthyophthirius multifiliis. Left unstained; Scale (across top) = 1 millimeter. Right giemsa stained Ich trophont with trichodina out of focus in foreground (Maine IF&W 2017).

The *Ich* lifecycle is greatly influenced by temperature. Epizootics occur with relative predictability. For example, in Maine, Ich outbreaks occur in waters immediately after ice melts. In other parts of the United States, it has been reported in early spring when water temperatures reach between 16°C and 19°C.

Treatment of *Ich* in the wild is not practical. Treatment of *Ich* in aquaculture facilities can be difficult and successful treatment requires early detection and treatment. *Ich* has been implicated as a vector in spreading other fish diseases such as *Myxidium*. Myxosporidean parasites cause disease in many fishes and many fish tissues.

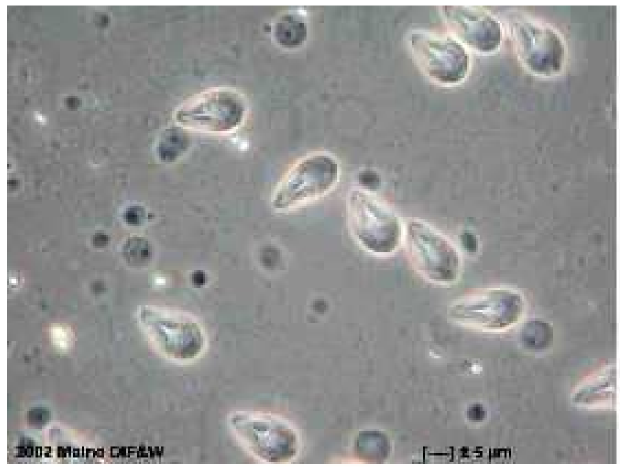
Special Points of Interest:

- Fish with *Ich* cannot transmit the disease to people.
- *Ich* is a protozoa.
- *Ich* infects many species of fish and is highly contagious.

Protozoal Parasite: Myxobolus subtecalis

August 2002. By G. Russell Danner

Parasitic protozoa probably cause more disease in fish culture than any other type of animal parasite. Under environmental circumstances, minor protozoan infestations produce little obvious damage, but in large numbers they can cause extensive internal and external injury and death. Protozoan parasites have been found in nearly every fish tissue.



Left: Mummichug with four epidermal Myxobolus xenoma near tail. Right Myxobolus subtecalis salvelinus 1000x phase contrast microscopy. Protozoa unstained

Myxobolus subtecalis spores were found in the grossly visible creamy white epidermal xenomas on the sides of a mummichug (*Fundulus heteroclitus*). Each white xenoma contained thousands of mature and immature spores. The life cycle of *M. subtecalis* likely resembles that of other Myxosporidia parasites: *Myxobolus sp., Henneguya sp., Ceratomyxa sp., and Kudoa sp.*

The spores remain viable in the water and sediments for many years. When the spores are ingested by a tubificid worm, they further develop into a *Triactinomyxon*. The *Triactinomyxon* completes its own developmental cycle inside the oligochaete, producing spores with long caudal appendages which after contact with the trout host initiate a new infection. After ingestion, myxosporean spores extrude the polar filaments in the fish's digestive tract, the shell valves open and the sporoplasm escapes. The sporoplasm probably migrate across the intestinal wall and reaches the bloodstream or lymphatic duct and through them, the final site of infection (skin). There is a period of endogenous cell division where a single cell multiplies into tens if not hundreds of new parasites.

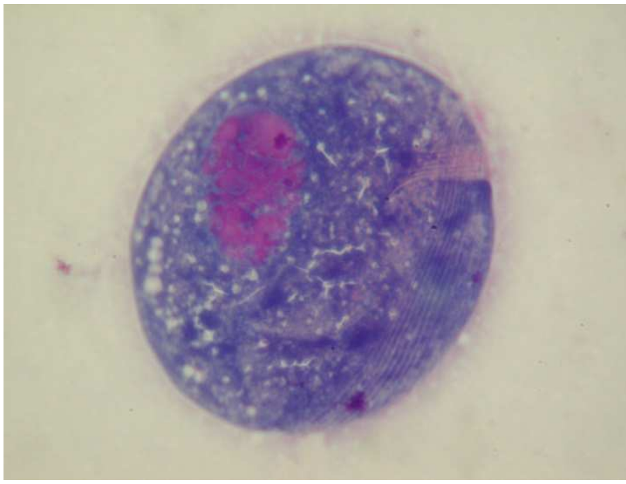
Mummichugs are common baitfish in Maine. Anglers using live bait should be careful not to use baitfish infected with parasites like *Myxobolus subtecalis*.

Special Points of Interest:

- Fish with *Myxobolus* cannot transmit the disease to people.
- *Myxobolus* is a protozoan parasite.
- *Myxobolus* infects many species of fish

Protozoa: Chilodonella salvelinus

Updated November 2002. By G. Russell Danner



Chilodonella sp. have been reported as responsible for fish kills since 1902. They are opportunistic pathogens, taking advantage of otherwise compromised fish. This epizootic may have been triggered by overcrowding, environmental gill diseases, and/or microscopic mineral crystals injuring the fry's gills.

This is a fascinating protozoan. In the Spring of 2001 this *Chilodonella* species was isolated from Lake trout fry *Salvelinus namaycush* fry, Splake fry *Salvelinus hybrid*, and Brook trout fry *Salvelinus fontinalis* at a hatchery in Augusta, Maine. The organism was living and reproducing on the gills and gill arches of these small fish. Although primarily a free-living freshwater organism, these *Chilodonella* were living on mucous and secretions from the fish. The warm water temperatures of the hatchery's well (9°C) was the perfect conditions for this epizootic. There were thousands of organisms on each fish. They were so numerous that they were killing fish. Microscopic examination of the fish's gills showed these tiny *Chilodonella* sweeping along the gills like the "scrubbing bubbles" animated television commercial for Tub & Tile Cleaner.

Note: This may be *Chilodonella cyprinii* or another closely related species. The organism responsible for this epizootic had 12 kinetics on the left and right side of the macronucleus. It also had a very small posterior indentation, a prominent oral opening.

Reports of fish health professionals treating fish indicate that formalin is an effective treatment. In this epizootic, formalin was not effective at treating these Chilodonella.The epizootic continued for about 6 weeks until the fish were treated with 100 ppm hydrogen peroxide for 30 minutes every other day for 3 treatments.

Special Points of Interest:

- Chilodonella are free-living organisms.
- Chilodonella are easily stained with crystal violet and can be seen unstained with phase contrast microscopy.
- For more information read: Thorp & Covich. 1991. Ecology and Classification of North American Freshwater Invertebrates

Gyrodactylus salmonis

2017 By David Russell

There are many Gyrodactylus species, but one common species in Maine is Gyrodactylus salmonis. Although this endemic monogenic trematode can be visible without a microscope, the immune response to the parasite may hide it from view. Fish that are severely infected visually exhibit excessive mucous production, epidermal hyperplasia and thickening on body and fin surfaces as an inflammatory response to the parasite. Gyrodactylus species secrete enzymes to facilitate surface browsing of epithelial cells and mucous.

Infection, as with other skin parasites, is often visually apparent as white/grey/bluish covering or film on the body and fins. Erosion of pectoral and caudal fins is also typical in the severely infected as these areas tend to more frequently parasitized. In young fish, damage to the mucosal barriers of the skin can result in osmotic imbalance resulting in renal failure, darkened coloration, and a general wasting condition as fish stop eating. The parasite can infect multiple salmonids, but brook trout are one of our more susceptible species. However, within brook trout, there are significant differences in susceptibility between strains. The parasite is viviparous, meaning that it bears live young. It is also hermaphroditic, meaning that it is both male and female. The combination allows for rapid population increase, and thus under the right conditions, the infection can quickly become severe.

Haptor and site of attachment on left of photo is the posterior end.

Its hooked haptor and pair of large anchor hooks (hamuli) are readily seen in fresh wet mounts of skin scrapes under 10X magnification.

Special Points of Interest:

- There are many species of Gyrodactylus
- Most species have a narrow host range
- Smaller fish are more vulnerable than larger fish
- Parasitization of the nares my impair olfactory function
- Gyrodactylus is non-infectious to people

Trichidina species

2017 by David Russell

Trichodina are ciliated protozoans which are spherical in shape as seen with a microscope as in photos below. They can cause substantial epidermal and gill irritation and even death in the severely infected. Excessive mucous production from irritation can appear as a light blue/grey film on fish. Gill hypertrophy or swelling is also commonly seen. Trichodina are more prolific in eutrophic lake systems and in other nutrient rich conditions. Under such conditions their numbers may proliferate rapidly. Schooling and overcrowding in captivity promote spread. Fish may be observed "flashing" as they attempt to scrape or itch body surfaces on various objects. Such action results in abrasions, fin erosion, and wounds for secondary bacterial infections. Osmotic imbalances from damage to mucosal surfaces and respiratory distress can result in mortality, especially in juvenile fish.

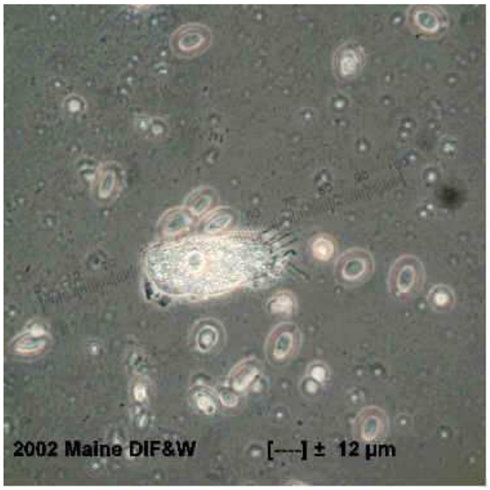
Special Points of Interest:

- Trichodina does not feed upon fish, but rather feed on detritus on the surface of fish
- Colonization on gill and skin surfaces provokes an inflammatory response
- Trichodina is seen easily with phase contrast microscopy (photo above on right)
- Trichodina is easier to see with giemsa staining (photo above on left)
- Trichodina is non-infectious to humans

Protozoa: Trichophyra piscium

June 2002. By G. Russell Danner

Trichophyra piscium belongs to a Phylum of protozoan organisms all of whom possess cilia (‘hairs”) during at least one stage of their lifecycle. Most species are free-living aquatic organisms that feed on bacteria, some are commensal organisms, living on but not harming the host, and cleaning bacteria off the host’s body.



Left: Trichophyra piscium 400x phase contrast microscopy. Right: Lake trout with Trichophyra

Several species of *Trichophyra* have been identified as commensal organisms living on the gills of freshwater fishes. Large numbers of *Trichophyra* may cause gill irritation, or may cause the fish to secrete excessive gill mucous decreasing it’s respiratory and osmoregulatory efficiency. Some *Trichophyra* have been found parasitizing blood from the fish’s gills.

In April 2002, 14-month old lake trout (*S. namaycush*) at the Maine Department of Inland Fisheries & Wildlife Enfield fish hatchery were acting as though they had gill parasites. Fish with gill parasites will rub their heads, and bodies against hard surfaces presumably to dislodge the organisms. Upon examination of the affected fish, *Trichophyra piscium* was identified in large numbers infesting the fish’s gills.

Trichophyra have a direct life cycle, reproducing on the host by simple cell division. The sessile forms are transmitted from fish to fish via motile dispersal forms that can either be produced by budding from the parent, or by detachment of the trophozoite and subsequent transformation into a motile form.

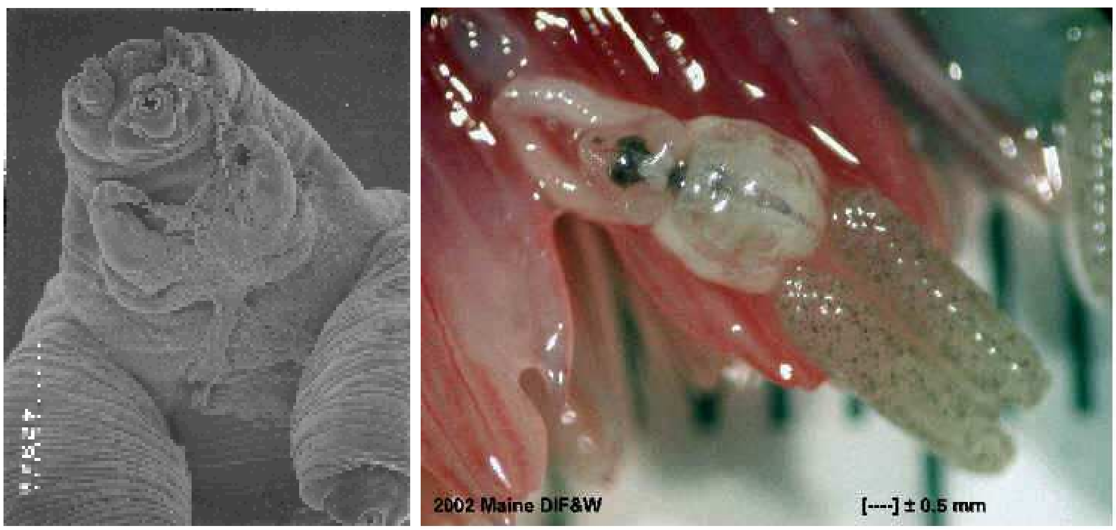
Special Points of Interest:

- Fish with *Trichophyra* cannot transmit the disease to people.
- *Trichophyra* is a bacteria-eating protozoan.
- *Trichophyra* can be considered an ecto-commensal organism rather than a parasite

Fish Louse or Gill Louse *(Salmonicola sp.)*

Updated November 2002. By G. Russell Danner

Brook trout *Salvelinus fontinalis* and Atlantic salmon *Salmo salar* in Maine with an unsightly white-cream-tan organism attached to their gills, fins or mouths are occasionally caught by anglers. These copepod organisms are *Salmonicola edwardsi* but they are commonly referred to as a “fish louse” or “gill lice.” They are Crusteaceans related to lobsters, crayfish, sowbugs and amphipods. Salmonicola attach to fish by burrowing an attachment organ called a “bulla” beneath the skin or gill tissue. This bulla anchors the young salmonicola organism in place generally to a part of the fish’s bone or cartilage. It lives its entire life then in that spot on the fish.



Left: Head, mouth and arms of Salmonicola. Right: On gills of land locked Atlantic salmon

Damage to gill tissues can be extensive, and result from attachment , feeding, and the mechanical presence of the parasite. The parasite feeds on the fish’s body tissue and body fluids. As the parasite grows, the females develop two caudal egg sacs. These can be easily seen with the naked eye. In some species of salmonicola the egg sacs are dark brown to black in others they are cream to tan in color.

Salmonicola have a direct life cycle. The egg sacs on the caudal portion of the female’s body release eggs into the water column. The eggs develop into larva within the egg shell and then hatch ready to infect a new fish. The young parasites die within a day or two of hatching if they do not find a suitable fish host. Many young parasites are eaten by other small fish and aquatic organisms. Many young fish feed for a time on copepods and some such as herring, sardines and smelts, continue to feed upon them throughout life.

Salmonicola generally only infect a specific species of fish. *Salmonicola edwardsi* will selectively infect brook trout over lake trout or brown trout even in the same tank or pond. Once the young salmonicola attaches to a new fish, it burrows its bulla into the fish’s skin and connective tissue and begins to feed on its flesh and body tissues.

Control Measures
Don’t transport fish from one water to another without an IF& W stocking permit.
Don’t dispose of fish parts into water - it can spread the parasites eggs.
Clean boats and equipment before moving between different waters.

Special Points of Interest:

- Gill lice infect specific species of fish.
- Gill lice are related to lobsters and crayfish.
- Gill lice do not infect or harm humans.

Images: Thanks to Colin Widener, Colby College, Waterville, Maine. Scanning Transmission Micrograph of head, mouth and arms of salmonicola.

Fish Louse, Fish Crab *(Ergasilus sp.)*

Updated May 2002. By G. Russell Danner

Left: Ergasilus female removed from rainbow smelt gill. Right: Male

Ergasilus sp. is a member of a small group of parasitic crustaceans that prey upon freshwater and marine fishes. I may be found on the skin, fins, and gills of fishes, but is most frequently found on the gills. They can cause significant morbidity and mortality when heavily infesting fish. They have also been implicated as vehicles for other fish diseases.

Ergasilus has a direct life cycle using only the fish as a host. *Ergasilus* can spend prolonged periods swimming free, and mating takes place while the male and female are swimming. The male then dies. Egg incubation occurs while the egg clusters are attached to the female.

The offspring hatch and are broadcast into the water. The offspring undergo four molts before becoming adults. There are several species of Ergasilids and none is too host specific. Ergasilids infect eels, gars, herrings, killifishes, paddlefishes, perches, pirate perch, smelts, sticklebacks, sunfishes, temperate basses and troutperch.

Affected fish have patches of hemorrhagic and edematous affected skin, gills or fins.The parasite causes these injuries by attaching to the fish with its modified antenna turned hooks. Its feeding apparatus further injures the host fish when it inserts the stylet into the epidermis and underlying host tissue causing hemorrhage. Ergasilus feed on the host's blood and body fluids. The feeding apparatus also may release digestive enzymes which can cause systemic illness similar to Argulus.

Special Points of Interest:

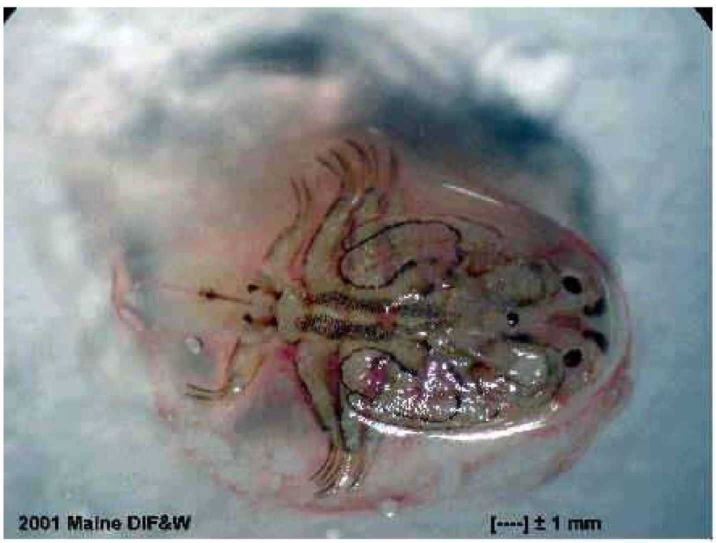
- *Ergasilus* does not infect humans.
- *Ergasilus sp.* can be found on the gills of many different species of freshwater fishes.
- Cooking fish kills the parasite.

Fish Louse *(Argulus americanus)*

Updated May 2002. By G. Russell Danner

Argulus americanus is a member of a small group of parasitic crustaceans that prey upon freshwater and marine fishes. Argulus can be found on the skin, fins, and gills of fishes. They can cause significant morbidity and mortality when heavily infesting fish. They have also been implicated as vehicles for other fish diseases.

Argulus americanus has a direct life cycle using only the fish as a host. *Argulus* can spend prolonged periods swimming free and mating takes place while the male and female are swimming. Clusters of *Argulus* eggs are deposited on submerged objects and after hatching, juveniles must locate a suitable host within a couple of days or they will expire. This is not a difficult task, however, since *Argulus* aren't too fussy about their hosts. *Argulus* have been found parasitizing: bowfins, drums, gars, herrings, killifishes, perches, pikes, sticklebacks, sturgeons, sunfishes, salmonids, and temperate basses.



Live Argulus from skin of largemouth bass.

Argulus can be seen moving rapidly around on the surface of the fish, but will often swim away as soon as the fish is netted out of the water. Affected fish have patches of hemorrhagic and edematous affected skin, gills or fins. The parasite causes these injuries by attaching to the fish with its curved hooks and sucker. Its feeding apparatus further injures the host fish when it inserts the stylet into the epidermis and underlying host tissue causing hemorrhage. *Argulus* feed on the host's blood and body fluids. The feeding apparatus also releases digestive enzymes

Special Points of Interest:

- Argulus americanus does not infest humans.
- Argulus can be found on many different species of freshwater fishes.
- Cooking fish kills the parasite, but most will voluntarily leave the fish when it is removed from the water.

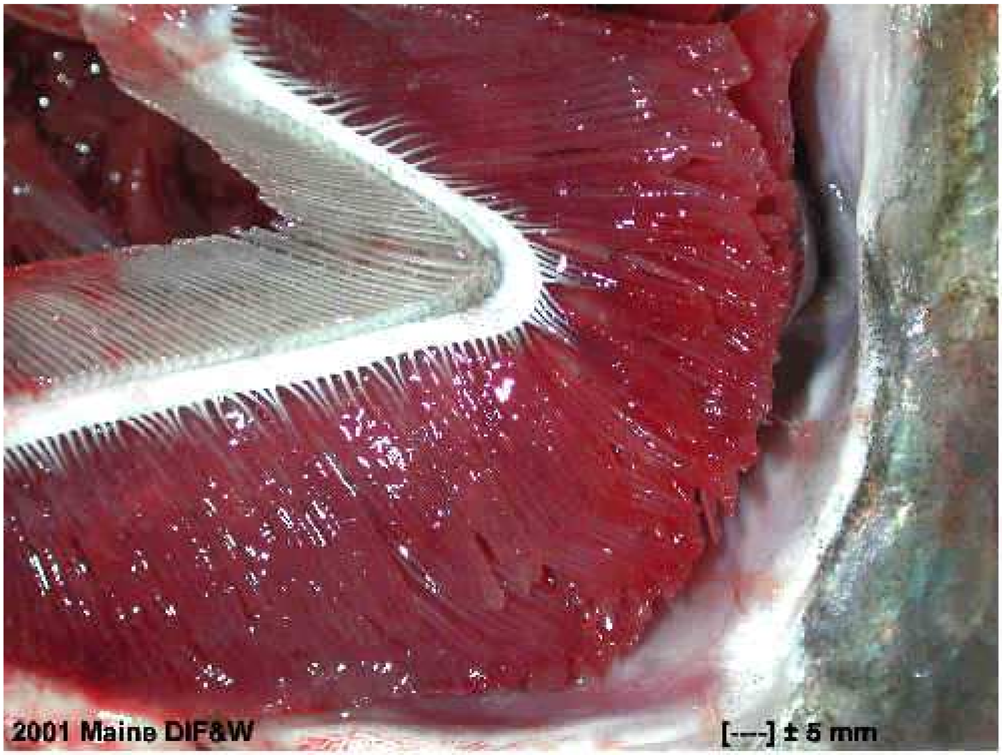
Mollusc Larva: Glochidiasis

March 2002. B G. Russell Danner

Left: Glochidia look like small mussel or clam shells attached or beneath the gill epithelium.
Right: Glochidia on fin of chain pickerel 2016

The larvae of most, but not all, freshwater clams and mussels must go through a parasitic stage on the gills or fins of fishes (Coker et al 1921). The larvae become attached in the epithelium of the gills or epidermis of the fins. Close examination of the larvae reveals them to look like tiny clams, and some have large hooks that they use to attach to the fish. The larval clams use the fish as a means of transportation, and as a food source by absorbing organic molecules and plasma from the fish. Some species of molluscs use specific species of fish to transport their offspring, others have very little host specificity. Molluscs that use a specific host species may time their spawning with fish migrations. The glochidia remain attached to the fish for usually 10-30 days during which time they undergo metamorphoses to their adult anatomy. The glochidia then drop off the fish and colonize the benthos.

Most glochidiasis is of only minor concern to the fish, however, sometimes when glochidia burdens are too numerous, fish may succumb. The glochidia are irritating to gill tissue causing hemorrhage and excessive mucous excretion. In Maine, American shad *Alosa sapidissima* can have heavy burdens of glochidia during the spring spawning migration. Sometimes it can be fatal.



American shad gill hemorrhaging and slime covered because of heavy infestation by tens of thousands of glochidia.

As in other parasitic species, glochidia are shed in huge numbers to ensure the maximum potential for host contact and attachment. Fecundity in many molluscs can range from 200,000—17,000,000 glochidia/female/breeding season. Young and Williams 1984 studied glochidia survival. They concluded that in a natural population of *Megalonaias margaritifera*, 1 out of 100,000,000 glochidia lived to become a settled juvenile.

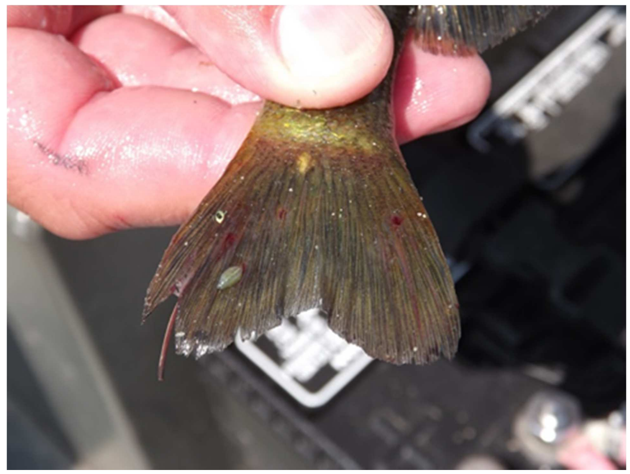
Some female molluscs also attract fish with vermiform (i.e.., worm-like) mantle flaps, luring fish closer. Fish that grasp the flap mistaking it for an easy meal get a mouthful of glochidia.

Special Points of Interest:
- Fish with glochidia cannot transmit the disease to people.
- Glochidia infest many species of fish.

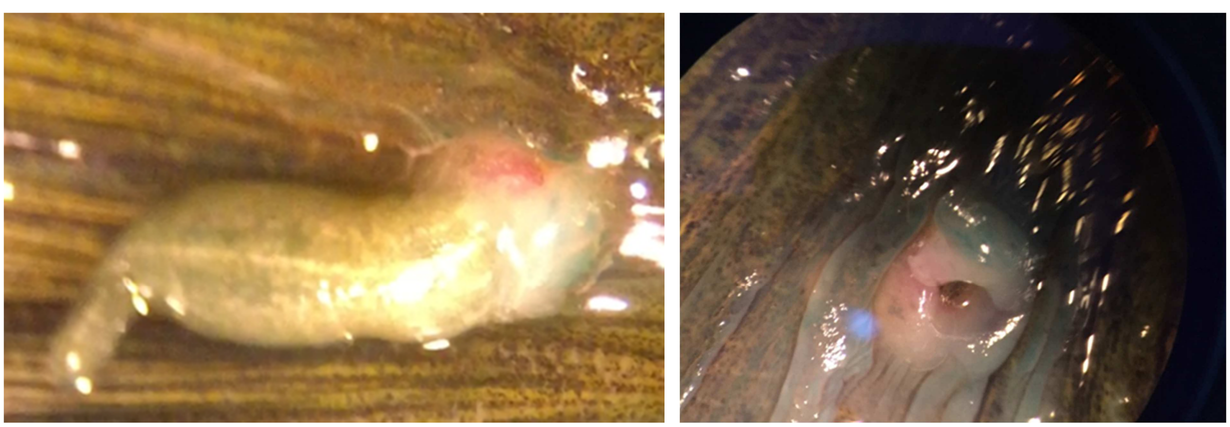
Fish Leeches

2017 By David Russell

Leeches of the family Piscicolidae are the true leeches of fish. In addition to direct tissue damage at sites of attachment and feeding, fish leeches can also be a vector for hemoflagellates and viruses. Open sores at sites of attachment and sites of feeding are vulnerable to secondary infection. Light infestations, which generally cause little harm, are fairly common. Occasionally heavy infestations capable of causing significant stress in fish do occur.



Fish leeches have both an anterior and posterior sucker. Myzobdella species, as in the photos below, are common and of wide distribution in North America. They are known to attach with their posterior sucker which can become imbedded and result in epidermal hyperplasia of the surrounding tissue from prolonged attachment. Areas of lower hydraulic shear and those areas protected from physical removal from rubbing behavior are typical sites of attachment. The posterior end of the leech is usually oriented toward the anterior end of fish. The anterior end is narrower than the posterior. Typically areas of attachment include the caudal fin and the inside of the pectoral fins and the main body right behind the pectoral fins.



Left: Leech embedded into caudal fin with anterior end on left. Right: Area of epidermal hyperplasia seen at site and areas surrounding the site of attachment.

Photos below. Left: Anterior end of Myzobdella species pointing upwards. Right: Yellow perch with leech on pectoral fin and an area of ulceration on body behind the pectoral fin. Yellow perch and a few other species taken from a lake in 2017 associated with a small fish kill were covered with dozens of leeches each.

Left: Yellow perch with ulceration from leech attachment. Such areas are vulnerable to secondary bacterial infection.

Special Points of Interest:

- Myzobdella species are not known to parasitize humans
- Fish leeches are known to be vectors for hematoflagellates and viruses
- Fish leeches have been shown to carry fish pathogens such as Aeromonas and Flavobacterium
- Fish leeches can cause anemia in heavily parasitized fish

Yellow Grub *(Clinostomum complanatum)*

Updated November 2002. By G. Russell Danner

Clinostomum complanatum (Syn. C. marginatum) is a fairly common, unsightly yellow grub found on many different fish species. It can be located in the flesh, gills, operculum and just under the skin of virtually any species of North American freshwater fish. Infected fish exhibit large yellowish nodules. The yellow grub has a complicated lifecycle involving several developmental stages each infecting a different animal.

The final host for the digenetic trematode *C. complanatum* is the Great Blue Heron (*Ardea herodias*). Adult worms live in the heron's mouth where they produce eggs. The eggs are swallowed by the heron, pass through it's digestive system unharmed and are released into the water with the heron's feces. The eggs mature in water and release the ciliated miracidia, which then swim away and penetrate the appropriate molluscs (snails or less often clams), often only those of a certain genus. These molluscs are the first intermediate hosts of the trematode.

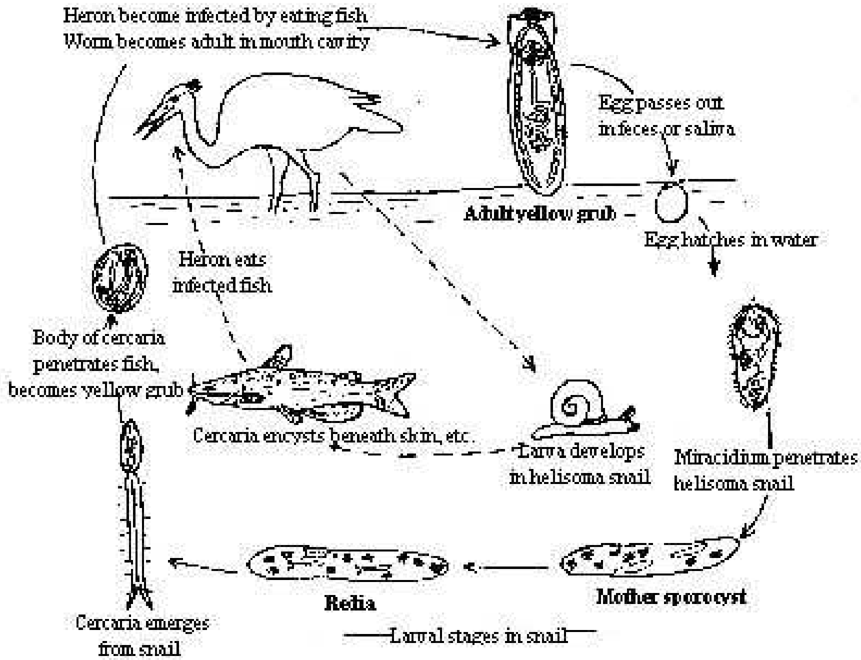


Figure 1. Lifecycle of Yellow Grub. (from Hoffman 1998. Parasites of North American Freshwater Fishes. 2nd Edition. Comstock Publishing, Ithaca NY).

In the molluscs, the miracidium grows to become a redia (a saclike animal with a pharynx and a gut), which may produce either cercariae or sporocysts (sac-like animals without a pharynx or gut). The cercariae actively penetrate and migrate into the tissues of the second intermediate host, which is most often a fish. When a cercaria penetrates and migrates into the tissues of a fish, it causes obvious mechanical damage and hemorrhaging. The damage caused by one cercaria is negligible, but in greater numbers they may kill the fish. After the cercaria has localized and transformed into a metacercaria, little subsequent damage occurs, unless enough metacercariae accumulate that their collective mass interferes with the fish's metabolism. The infected fish must be eaten by a blue heron to complete the trematode's lifecycle. When the fish is eaten and digested by the heron, the metacercaria emerges from the fish flesh and migrates to the heron's mouth where it matures to the adult egg producing worm. This completes its lifecycle. The worms are hermaphrodites having both male and female organs..

Special Points of Interest:

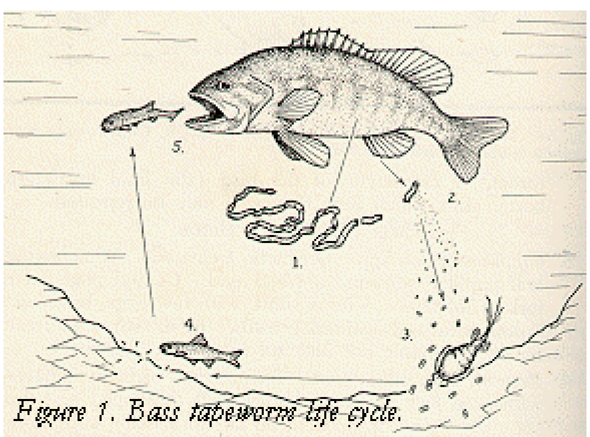
- C. complanatum does not infect humans. Although a related species has been found in humans and other animals in Asia.
- C. complanatum can be found in many different species of freshwater fishes.
- C. complanatum can live for 4 years in a fish.
- Cooking fish kills the parasite.

The Bass Tapeworm (*Proteocephalus ambloplitis)*

Updated November 2002. By G. Russell Danner
Updated by David Russell 2017

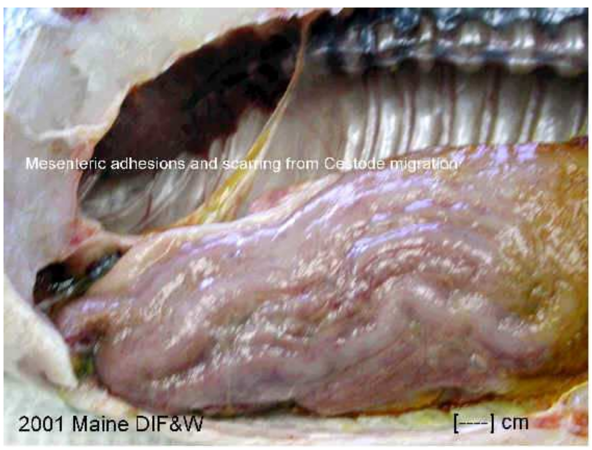
Smallmouth bass (Micropterus dolomieu) and Largemouth bass (M. salmoides) in some Maine lakes, rivers, and ponds are infected with a cestode parasite. The unsightly parasite is of no human health concern, but can be a serious health problem for bass, perch, and other freshwater fishes.

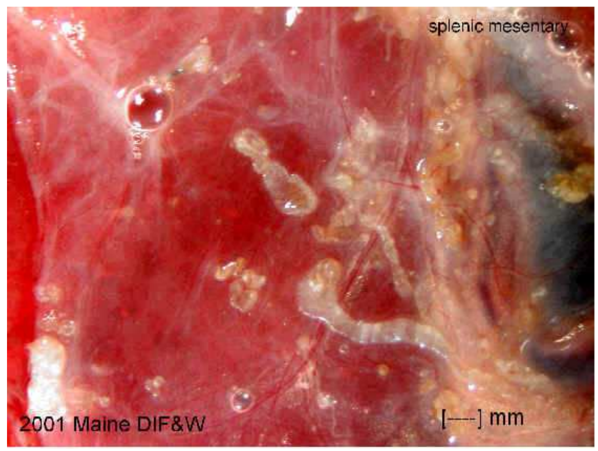
The Bass Tapeworm (Proteocephalus ambloplitis) is a member of a large group of segmented parasites that infect many different species. The adult P. ambloplitis tapeworm infests the intestine of the black basses. Here it attaches to the inner intestinal wall with four suckers on its anterior end or scolex. A single worm is both male and female. The adult worm sucks nutrients from the host bass using the nutrients to produce egg filled body segments called “proglottids.” These egg filled proglottids are released from the adult worm and pass with the fish’s feces into the water. Once in the water the proglottid hatches and the eggs are dispersed into the water. The eggs are eaten by a variety of crustacean organisms. Within the body of the crustacean, the egg hatches and develops into blunt shaped larvae, called a “proceroid.” When the crustacean is eaten by almost any fish, the proceroid larvae bores through the wall of the fish’s digestive tract and invades it’s abdominal organs. It is during this migration and the tapeworms transformation from a procercoid to a plerocercoid that the gross internal abdominal damage is done to the host fish. Small mouth bass infected with plerocercoids typically have liver, spleen, and reproductive organs damaged.



Left: Lifecycle. Right: Scolex of Proteocephalus species with four oral suckers. This photo is from a specimen taken from juvenile white perch.

Fish with chronic infections also have scar tissue adhesions. Their internal organs grossly appear as a single mass. Many times the mass of internal organs is firmly attached to the fish's inside body wall. These fish have pot bellies, are often sterile, and have stunted growth. This is the stage of bass tapeworm that is most often noticed by fishermen and makes the bass unappealing for food even though the eating quality of the fish is not affected and there is no human danger. The plerocercoid infected fish must then be eaten by a smallmouth or largemouth bass in order to complete the bass tapeworm's lifecycle. During digestion of the small fish in the larger fish's stomach and intestine, the plerocercoid transforms into an adult P. amblopitis, embeds it's scolexes into the intestinal wall of the host, and begins making egg filled proglottids to be released into the water with the host fish's feces. A small mouth bass can be infected with more than one tapeworm and more than one life stage simultaneously.





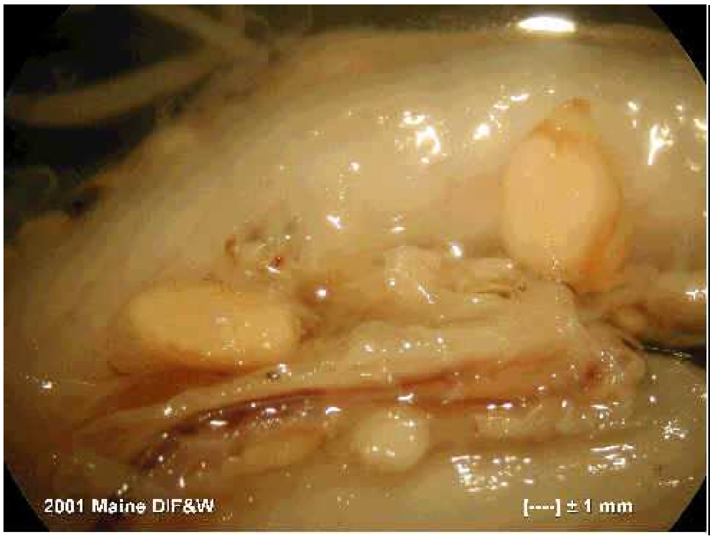
Left: Ceolomic cavity of largemouth bass scarred by a chronic bass tapeworm infestation. Adhesions caused by the body's reaction to migrating larvae can make the fish sterile. Right: Largemouth bass splenic mesentary infested by bass tapeworm plerocercoids

Control Measures
Don't transport bass from one water to another without an IF& W stocking permit.
Don't release live baitfish into water.
Don't dispose of fish entrails into water.

Special Points of Interest:
- Adult tapeworms live in smallmouth bass intestine. Here they produce eggs.
- Eggs are eaten by crustaceans and develop into procercoid.
- Crustaceans are eaten by fish and pass the immature tapeworm to the fish.
- A smallmouth bass must eat the infected fish to complete the tapeworm's lifecycle
- Reproductive organ damage caused by this cestode is suspected of causing small mouth bass population declines in certain waters

Salmon Tapeworm: Diphyllobothrium dendriticum (sebago)

January 2002. By G. Russell Danner
Updated by David Russell 2017



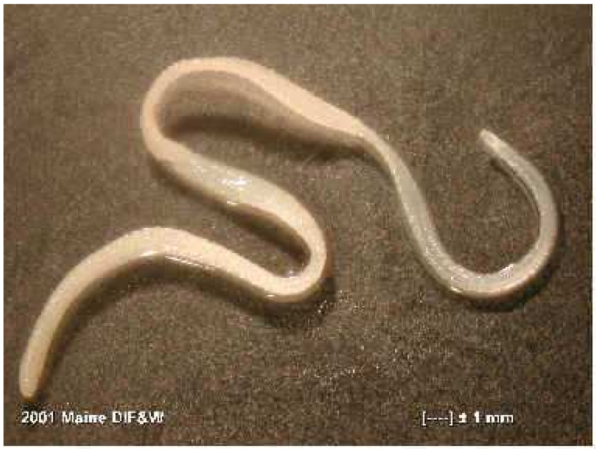
Diphyllobothrium dendriticum cysts on the stomach & intestine of an Atlantic salmon. Cysts contain immature cestode larvae (plerocercoids). Anglers may see these 1-3 mm yellow and cream colored cysts in salmon and trout viscera when cleaning their catch. Free or non-encysted plerocercoids look much different.

Wild Atlantic salmon *Salmo salar* caught by anglers in Maine are sometimes infested by the salmon tapeworm. This cestode parasite lives in the pyloric caeca and small intestine of adult salmon. The number of these segmented worms found in an individual fish can vary from a few to hundreds. This parasite can be fatal to salmon and brook trout if infestations overwhelm the fish. The adult *D. dendriticum* release eggs in the gut of the fish which are excreted into the water with the fish's feces. The eggs hatch and release free swimming coracidium which are eaten by copepods where they then develop into procercoids which are in turn eaten by small fish where they then develop into plerocercoids. Small fish such as smelt are eaten by gulls or by larger fish such as salmon where plerocerocoids mature into adult tapeworms. The cycle repeats when gulls or salmon defecate into water.

Unlike many fish parasites, *D. dendriticum* can infect other animals including dogs, cats, guinea pigs, fox, rat, squirrel, terns, other salmonids, and humans. Most animals are paratenic hosts, which means that the parasite lives in the animal's body, but cannot complete it's lifecycle.

Unlike in salmon, plerocercoids in smelt are not likely to be encysted but instead can lie unencapsulated within various organs, musculature, and the viscera. In pre-spawning and spawning smelt, these plerocercoids may be found just beneath the skin and may be visible externally as a blister or raised bump.

Photos below are plerocercoids in pre-spawning rainbow smelt. Left: Plerocercoid seen just below the skin. Right: Extracted plerocercoid. The host immune response can result in the infection looking much different in one species over another (encysted vs free).



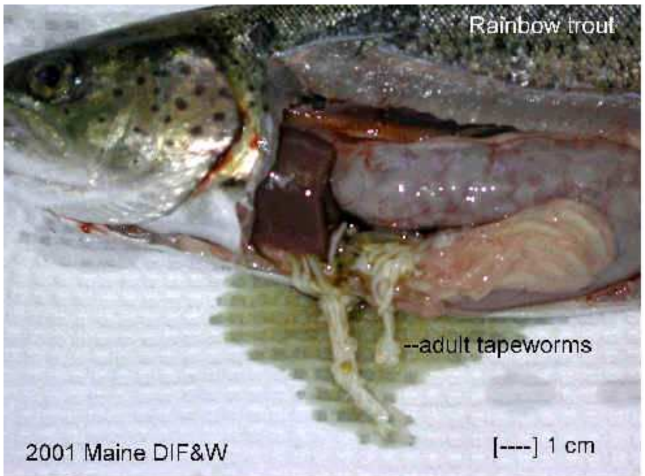
Left: Diphyllobothrium dendriticum adult Cestode from the intestine of an Atlantic salmon and closeup of Cestode’s scolex (head) on right.

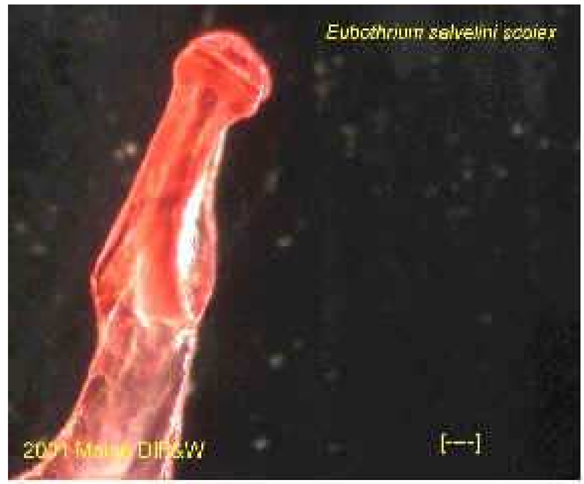
Special Points of Interest:

- If eaten uncooked fish with D. dendriticum can transmit the parasite to people.
- *D. dendriticum* is also called D. sebago.
- *D. dendriticum* infects many species of fish, birds, and mammals.
- Smelt are thought to be the natural host reservoir

Tapeworm: Eubothrium salvelini

Updated November 2002. By G. Russell Danner
Updated by David Russell 2017





Left: Tapeworms crawling out of the pyloric caeca of a yearling rainbow trout. Right: Extended scolex (head) of E. salvelini stained red and magnified approximately 100x.

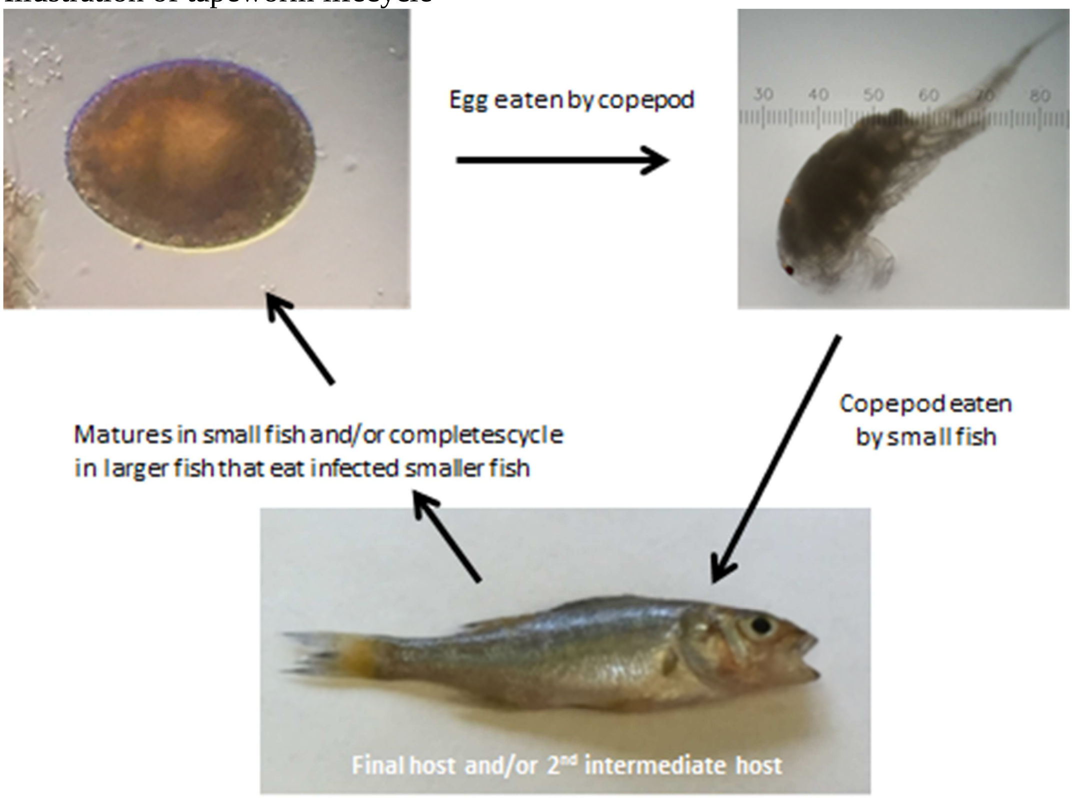
Cestodes can be common in trout and salmon in nature and sometimes in aquaculture. Adult cestodes, like *Eubothrium salvelini* for example, can be readily identified in salmonids by gross examination of intestines and pyloric caeca. Adult cestodes are cream-white color, come in a variety of widths, and most have long soft flat noodle like bodies that break apart easily into segments.

Generally, adult cestodes cause little or no detectable damage in their host, however, some species of cestodes can cause morbidity and mortality in fish, other animals, and humans. Therefore, it is important that tapeworm infected fish be thoroughly cooked before being eaten.

Adult *E. salvelini* inhabits the intestine and pyloric caeca of many different salmonids (e.g., rainbow trout, brook trout, Pacific salmon, Atlantic salmon, and char). *E. salvelini* has been found throughout North America. Heavy infestations of *E. salvelini* cause reduced growth in trout and salmon, reduced condition factor in trout and salmon, and are aesthetically repulsive and disgusting to many anglers.

It has a very simple lifecycle. Adults produce millions of eggs in their segmented body (called a strobilia). *E. salvelini* are hermaphrodites. Each individual proglottid (segment of the strobilia), contains both ovary and teste. The fertilized unoperculated, unembryonated eggs are released from the proglottids into the fish's intestine and then is excreted into the water with the fish's feces. Eggs are eaten by freshwater copepods and begin to develop inside the copepod's body. In turn, the copepod is eaten, directly or indirectly, by a salmonid; attaches to the salmonid's intestinal wall and begins the metamorphosis into a new adult. *E. salvelini* can live over 2 years in a trout. In that time span, it can produce millions and millions of eggs.

Illustration of tapeworm lifecycle



Special Points of Interest:

- Fish with certain Cestodes can transmit the parasite to other animals and people.
- Tapeworms have segmented bodies.
- *E. salvelini* infects many species of trout, salmon, and char. It can decrease growth and body condition.

Nematode: Philonema agubernaculum

November 2002. By G. Russell Danner

Figure 1. Brook trout female with severe visceral adhesions involving all internal organs including complete liquifactive necrosis of its left ovary and scar tissue preventing spawning of eggs in the right ovary, caused by Philonema agubernaculum. This fish has lost 100% of its reproductive ability.

Landlocked Atlantic salmon and brook trout in some waters are infected by the animal parasite, *Philonema agubernaculum*. This nematode parasite can cause severe visceral adhesions. Severe infections bind all the internal organs into a single mass. Affected fish lose the ability to extrude egg/sperm at spawning time and become functionally sterile. Retained eggs/sperm rot in the fish's abdomen forming a larger liquid abscess as in photo above.

The life cycle of *Philonema agubernaculum* is not well documented; however, it is thought that the adult nematode's eggs are either extruded from the brook trout's (or salmon's) gastrointesinal tract and/or coelomic cavity into the water. Eggs are eaten by freshwater crustaceans (copepods). Brook trout become infected directly when they eat infected copepods or indirectly when they eat rainbow smelt that have eaten infected copepods.

Male brook trout with Philonema cysts.

Philonema agubernaculum can be recognized in brook trout and salmon without special equipment. The nematodes cysts are imbedded amongst the adhesions and beneath the mesenteric lining. They are whitish in color, flat and thin, and the round worm is visible through it. The small worm is very delicate and will rupture quickly if placed in water spilling thousands of eggs.

Some species of round worms can be transmitted to humans. They can cause severe intestinal upset. Cook fish to kill the nematodes before eating it.

Special Points of Interest:

- Some nematode can be transmitted to people if the is not cooked before eating.
- Philonema is a parasitic animal.
- Do not put fish entrails back into the water it can spread this parasite’s eggs.

Acanthocephalan: Pomphorhynchus bulbocilli

July 2002. By G. Russell Danner

Hundreds of yellow bodied *Pomphorhynchus bulbocilli* were found attached to the intestine of white suckers *C. commersoni*.

Thorny-headed worms or hookworms (Acanthocephalins) are easy to recognize attached to the inside of the intestine of some fishes because of their proboscis (spiny attachment organ). The worm uses the proboscis to secure itself to the fishes intestinal wall, and many species can be identified by the number and pattern of chitin hooks on the proboscis.

The lifecycle of the hookworm *P. bulbocilli* begins when an adult sheds eggs into the intestine of the host. Thorny-headed worms are both male and female, each individual has both ovaries and testes. The fertilized eggs are shed into the water with the fish's feces. Eggs are eaten by a variety of aquatic crustaceans (copepods, ostracods, amphipods, or isopods). The eggs hatch and the tiny "acanthor" migrates through the intestinal wall of the crustacean into it's body cavity. Once within the crustacean's body cavity, the acanthor metamorphoses into a second stage larva called an "acanthella." Typically once the second stage larva has formed (about 30 days), it rests in the crustacean waiting to be eaten by a fish.

Figure 2. Proboscis of Pomphorhynchus bulbocilli 4x microscopy. The literal Latin translation of their species name means: “bulb neck.”

If the crustacean is eaten by a suitable host fish, the “acanthella” emerges into the fish’s intestinal tract and attaches. Here it matures into an adult and begins shedding eggs for the next generation. If the acanthor is eaten by a fish unsuitable to be an adult host or before it can become an acanthella, it may finish becoming an acanthella in the fish and wait hoping the unsuitable host is eaten by a suitable host.

Hookworms can cause considerable damage to the host, reduce their fitness, rob them of energy resources, and may even spread other diseases.

The *Pomphorhynchus bulbocilli* proboscis pictured in Figure 2 has a large bulb near the tip of it’s long proboscis and it has 12-20 rows of 10-14 hooks. It has been reported to infest a variety of fish species including: temperate basses, Atlantic salmon, rainbow trout, minnows, white suckers, pike and pickerel, smelt, perch, and even snakes.

Special Points of Interest:

- Hookworms found in fish cannot infest people.
- Hookworms can harm the host by sucking blood, or other nutrients from the host.
- Hookworms infect many species of fish.

Acanthocephalan: Leptorhynchoides thecatus

September 2002. By G. Russell Danner

Left: Leptorhynchoides thecatus from the gi tract of a largemouth bass. Right: Proboscis

Hookworms belong to the Phylum-Acanthocephala which translated from Greek means "thorny-head." Hookworms are animal parasites of many different animal species. Adult hookworms can be found in the intestines of many species of freshwater fishes. The acanthocephalan life cycle involves the eggs being first shed by the adult worm in the fish intestine and then eaten by a small freshwater crustacean (ostracod, copepod, amphipod, or isopod).

The first larval stage, acanthor, migrates through the intestinal wall of the crustacean, localizes in the body cavity and develops into the second larval stage, the acanthella. When the crustacean is then eaten by a fish, the hookworm develops into a cystacanth or develops into an adult in the fish's gastrointestinal tract completing the hookworm's life cycle. It is reported to take about 3 months for the hookworm to complete it's life cycle.If hookworms are numerous, their hooked proboscides may inflict serious damage to the intestine; in some cases, this damage may be exacerbated by the worms' retracting the spined proboscis and reinserting it in another place.

Hookworms have no mouth or digestive tract. They absorb nutrients directly through their body surface. Normally, adult hookworms live in the lumen of the digestive tract only, but occasionally adult worms bore through the wall of the digestive tract and come to lie in the body cavity.

Leptorhynchoides thecatus can infect many species of Maine fishes including: suckers, whitefish, salmonids, cusk, minnows, pike and pickerel, bass and sunfish , perch, smelt, and bullheads.

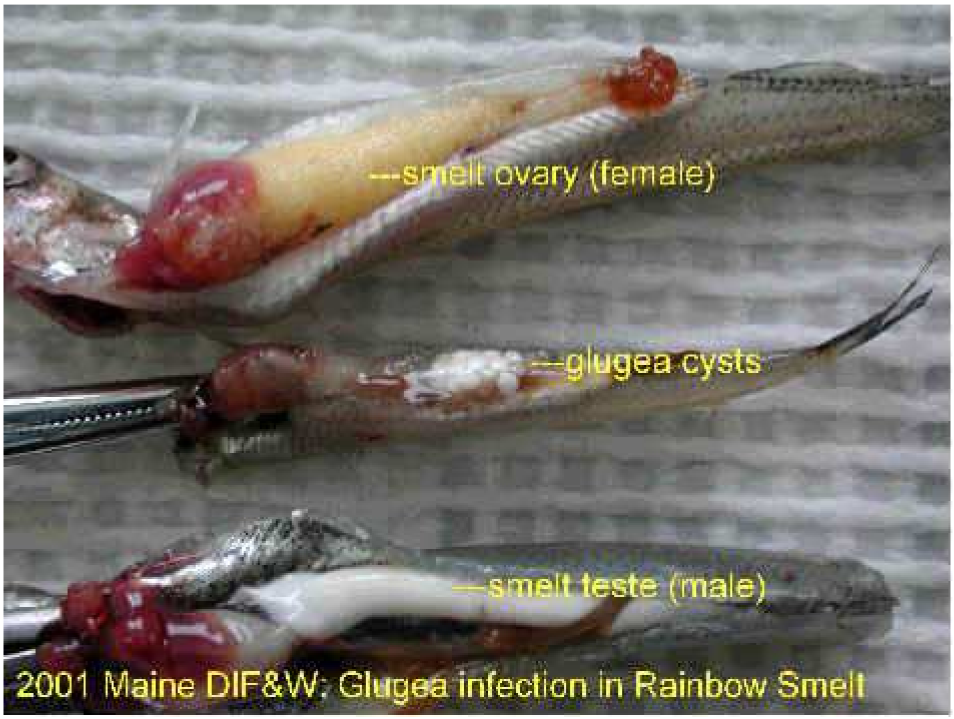
Special Points of Interest:

- Fish with hookworms cannot transmit the disease to people.
- Hookworms are parasitic animals.
- Hookworms can harm fish by damaging the fish with their spines.

Microsporiasis *(Glugea hertwigi)*

Updated November 2002. By G. Russell Danner

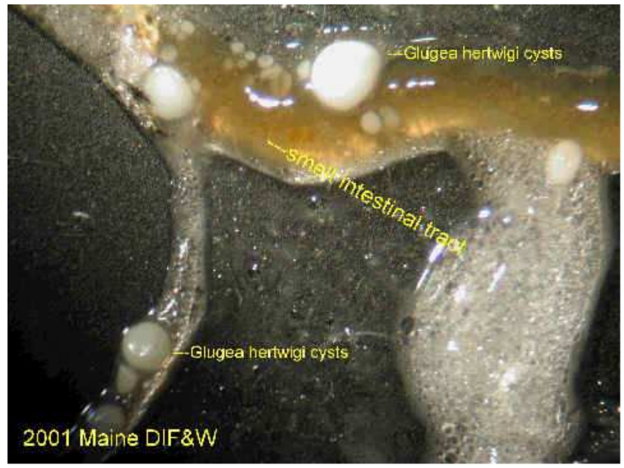
Glugea hertwigi is one species of several intracellular microsporans found to infect freshwater, marine, and anadromous fishes. The phyla, Microspora, includes the following genera of similar organisms infecting fish: *Glugea, Ichthyosporidium, Loma, Microgemma, Microsporidium Mrazekia, Nosema, Pleistophora, Spraguea, Tetramicra, and Theragra*.



G. hertwigi, like G. stephani, is probably an obligate intra-cellular parasite with a direct life cycle needing only fish. Crustacean prey may act as reservoirs of infection. Ingested spores hatch in the gut and enter epithelial cells for development or transport to the developmental site. A minute tube, the polar filament, then everts through the spore wall and penetrates a host cell. The infective agent, or sporoplasm, passes via the filament to the host cytoplasm, where multiplication or merogony occurs. The second development stage, sporogony, produces two spores packed in vesicles. Glugea spores may be released from the skin, in feces, in urine, or on death of the host. Juvenile fish are particularly susceptible to infection.

The gross diagnosis of microsporiasis is made by the appearance of tumor-like cysts (called xenomas) in the fish's tissue. *G. hertwigi* xenomas are usually found on internal organs including the gastrointestinal tract, liver, and reproductive organs. The xenomas contain many microscopic spores of the *G. hertwigi* parasite which are approximately 7.5µm long by 3.5 µm wide.

G. hertwigi has been associated with large Rainbow smelt (*Osmerus mordax*) fish kills on several occasions. It has been found in Maine waters, Lake Erie, Lake Ontario, and eastern parts of Canada.



Control Measures

There is no current practical way of removing Glugea sp. from a wild fish population without complete extirpation of all fishes in the entire water body. The Maine Department of Inland Fisheries and Wildlife screens populations of rainbow smelt and other fishes for parasites, bacterial pathogens, and viral pathogens prior to live fish or egg transfers. Rainbow smelt transfers commonly are fertilized egg movements which reduces the likelihood of transferring sick or infected fish. Individuals fishing in Maine can help prevent the spread of Glugea and other fish pathogens by following these simple good fishing practices:

Don't release live baitfish into water.

Don't dispose of fish heads, skeletons or entrails in any body of water. Fish parts should be disposed of in the garbage, by deep burying or by total burning.

Don't transport live fish between bodies of water. This practice could spread disease and is strictly illegal.

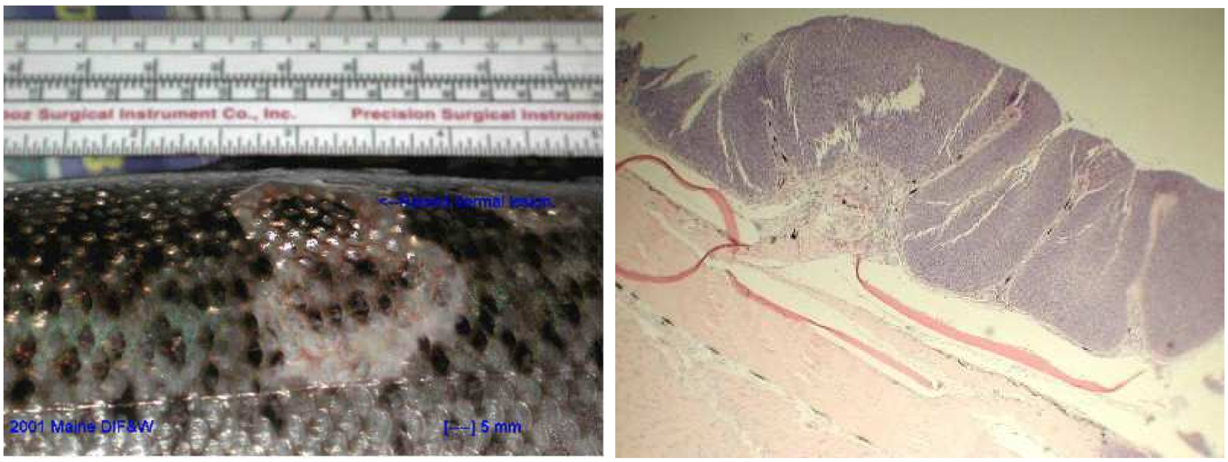
Special Points of Interest:

- Glugea exists in Maine.
- There is no cure for Glugea in Rainbow smelt.
- Glugea hertwigi will not cause disease in humans.
- Fish with xenomas may have Glugea sp. or one of several other Microspora.

Atlantic Salmon Papillomatosis *(retrovirus)*

Updated November 2002. By G. Russell Danner

Atlantic salmon *Salmo salar* living in Maine, Great Britain, Norway, Sweden, and possibly other parts of the United States and Canada can occasionally be caught with a benign epidermal tumors growing on their skin and scales.



Left: Gross appearance of Atlantic salmon skin lesions from Atlantic Salmon Papillomatosis virus infection. Lesions are commonly circular, but they may coalesce. Right: Histological appearance of virus lesion.

The tumors appear as single or multiple proliferations that have a smooth to nodular texture and are translucent to white. They may occur at any site on the body surface and are 2 to 5 mm thick and up to 4 cm in diameter. The tumors are relatively harmless to the fish and eventually fall off allowing the skin to heal. Sometimes fish that are heavily infested with the tumors can succumb to other secondary bacterial, viral, or fungal infections.

In nature, the prevalence of papillomatosis may approach 55% in 1 to 2-year old freshwater hatchery salmon, 10% in 2 to 3-year-old salmon captured in salt water, and 1.5% in spawning adults. The tumors have also been found in feral Atlantic salmon. In younger, freshwater fish, the epidermal papilloma appears in lake summer and regresses in autumn.

In the older, saltwater fish, the tumor persists for up to a year. No methods of treatment or control are known. The tumors are caused by a retrovirus. This has made research on the condition very difficult and expensive. Consequently not much is known about the virus's pathogenicity. The name, Atlantic salmon papilloma is a misnomer. "Papilloma" is the medical term for "warts;" and warts are really caused by papilloma viruses. Nevertheless, "papillomatosis" is certainly a fun word to say.

Special Points of Interest:

- Fish with Atlantic Salmon Papillomatosis cannot transmit the disease to people.
- A papilloma is like a wart.
- Fish with Atlantic Salmon Papillomatosis are safe to eat.
- Papillomas eventually fall off.

Blue Spot Disease of Northern Pike Esox lucius

Updated November 2002. By G. Russell Danner

Illegally introduced populations of northern pike in the Belgrade Lakes region of Maine have been caught during the spring spawning season and found to be covered with pale bluish-white, granular skin lesions 3-10 mm in diameter and 0.25 mm thick. These spots occur mostly over the dorsal skin and fins of spawning age (→ 2 years old) adult fish.

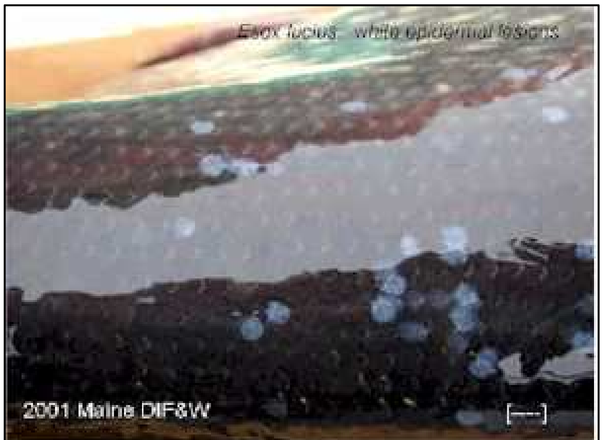


Figure 1. Northern pike female with EHV-1 characterisite skin lesions during spring spawning season in Maine. Bracketed area is 1 cm.

This condition was first described in 1983 by Yamamoto in northern pike in several waters of central Canada. The cause of these white-blue spots is esocid herpesvirus-1 (EHV-1). The prevalence of EHV-1 in central Canada was 1-7% of the northern pike population. Margenau 1995 reported the disease in both northern pike and muskellunge *Esox masquinongy* in Wisconsin. The prevalence in Wisconsin was as high as 34%.

The blue spots appear during the spring spawning season as water temperatures increase between 2° and 13°C. The lesions then disappear when water temperature increases above 14°C. The etiology of the virus is not known. The prevalence of the blue spot lesions differs among lakes, and is reported generally higher in female northern pike. It is hypothesized that EHV-1 may cause more severe morbidity and mortality in young pike and muskellunge, although this has not yet been proven. The observable blue skin spots appear to be less prevalent on older fish, however, these affected fish may remain lifelong carriers of EHV-1, similar to channel catfish herpesvirus that infects channel catfish *Ictalurus punctatus*.

EHV-1 is likely very contagious amongst northern pike populations. Individuals fishing for northern pike should disinfect angling equipment and personal gear between waters.

Special Points of Interest:

- Fish with EHV-1 cannot transmit the disease to people.
- EHV-1 is caused by a herpesvirus.
- For more information read: Margenau et al. 1995. Blue spot disease in Wisconsin Esocids. J. of Aquatic Animal Health 7:29-33

Lymphocystis Disease

Updated October 2002. By G. Russell Danner

Lymphocystis Disease is a chronic and benign infection caused by an iridovirus that results in uniquely hypertrophied cells, typically on the skin and fins of more advanced orders of fishes. Lymphocystis literature spans more than 100 years and initially misdiagnosed the virus as the parasite: *Lymphocystis vitrel*. About 1925, fish pathologists concluded that Lymphocystis Disease was caused by an "ultra-visible virus." Lymphocystis virus still remains the largest iridovirus ever discovered at 200 ± 50 nm.

Figure 1. Lymphocystis infected cells in fin of redbreast sunfish. Large hyaline (white circles) coated cells with a large macronucleus in center (lighter pink), nucleolus (c shaped white in center of bottom left cell) and large cordlike inclusion bodies (purple) around periphery of the cell's cytoplasm.

The virus is spread by physical contact between fish. Factors such as high population density and external trauma enhance transmission. The virus has an affinity for connective tissues and consequently manifests its tumors many times in fins, gills, or skin. Incubation times and lesion durations vary with species, however, cold water species can carry visible tumors for several months up to a year; while warm water species may have the lesions for only a few weeks. At 25°C, sunfish can develop this lesion in 10 days.

The disease has been found in many species of fishes including: herrings, smelts, temperate basses, sunfishes, perch, flounder, sole, and many others. It has not been diagnosed in salmonids although smelt are in the same Order and have been infected. The geographic range of lymphocystis virus is probably global. Most accounts of the disease are from Europe, the British Isles, and North America.

Figure 2. Massive Lymphocystis tumor on second dorsal fin of redbreast sunfish. Image courtesy of Maine Atlantic Salmon Commission personnel.

Research on bluegills infected by Lymphocystis indicated that the fish could be repeatedly infected with the virus, but the tumors were smaller after the first infection. This is evidence that the fish developed some immunity to the virus.

Lymphocystis Disease seldom causes serious injury to the fish, however, these unsightly infections can lower the value of fish sold for human consumption or aquariums. There is currently no treatment for the disease, no vaccines to prevent the disease, and no reporting requirements. The best control measure is avoidance of infected fish. Infected fish should be culled from broodfish stocks. In the United States, some commercial producers of yellow perch and largemouth bass have had populations of fingerlings with infections that deterred prospective buyers.

Special Points of Interest:

- Fish with Lymphocystis Disease cannot transmit the disease to people.
- Lymphocystis Disease is caused by a virus.
- Lymphocystis Disease infects many species of freshwater and marine fishes.
- For more information read: K. Wolf. *Fish Viruses and Viral Diseases* 1988, 389-398.

Esocid Lymphosarcom

Updated December 2002. By G. Russell Danner

Figure 1. Northern pike from Lake Champlain, VT showing external tumors caused by *Esocid Lymphosarcoma*. Image from T. Jones, Vermont Fish and Wildlife Department.

Lymphosarcoma of pike has been recognized for over 80 years. It affects pike and muskellunge in Europe and North America. External signs of tumors include protruding growths on the flank, fins, and head that are several centimeters in diameter and have irregular surfaces. Tumors can also occur on internal organs including muscle, kidney, liver, and heart. External tumors can be present during any season, however, they are most commonly seen in the fall and winter months. Tumors vary in color from grayish-white to pink or red depending on the amount of vasculature associated with the mass. Young tumors are usually more white and as they mature and grow, they must attract blood vessels to supply their nutritional demands.

There is not much information available regarding the effect the tumors have on pike behavior. It kills pike that have severe infections; however, many of the pike observed with Esocid Lymphosarcoma are caught by anglers. A 2002 northern pike fish kill on Lake Champlain, VT was caused by Esocid Lymphosarcoma. Research on the virus has been unable to determine the morbidity and mortality characteristics of this virus. No research to date has been able to culture the virus *invitro*. Histologically, tumor cells resemble lymphocytes but are usually twice as large.

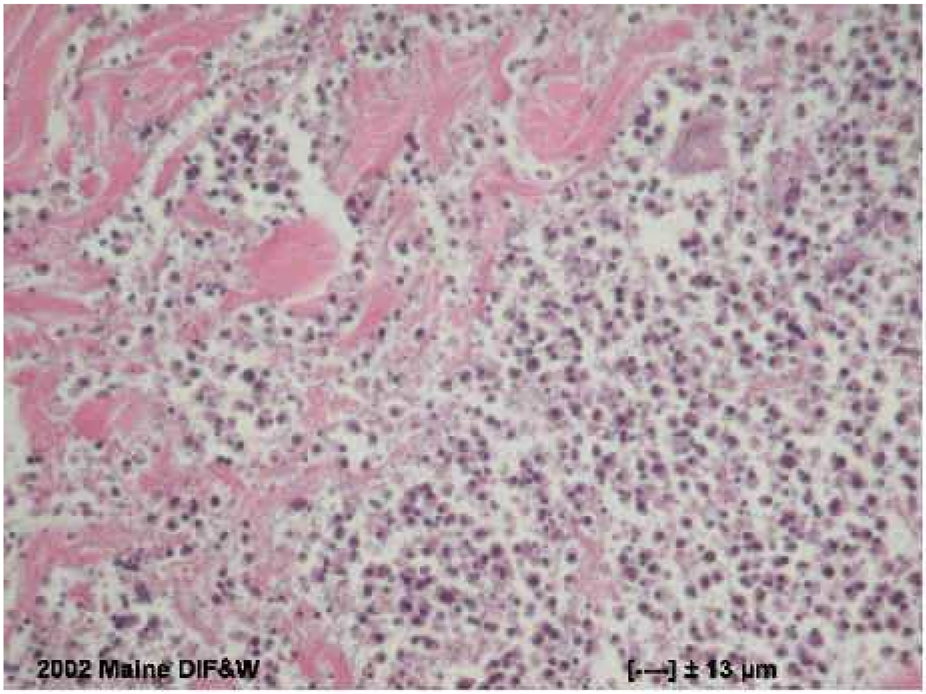


Figure 2. Histological section from tumor of Northern Pike . Lymphocytes (black) multiplying and invading fish's dermis (red whorls).

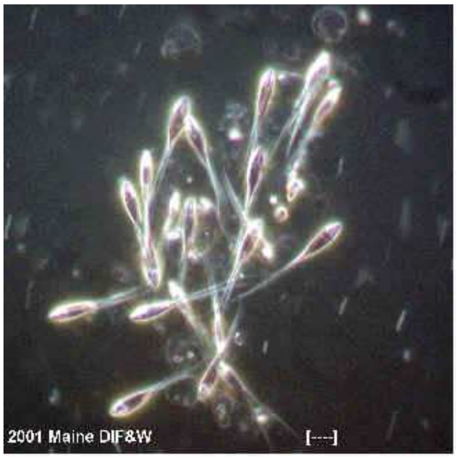
It is not known if the disease can affect other species of esocids like Maine's popular chain pickerel (*Esox niger*). There is no treatment for the disease in pike or muskie. Preventing the spread of Esocid Lymphosarcoma means preventing the spread of infected northern pike and muskellunge.

Special Points of Interest:

- Fish with Esocid Lymphosarcoma cannot transmit the disease to people.
- Esocid Lymphosarcoma is caused by a virus.
- Esocid Lymphosarcoma has not been found in Maine.
- For more information read: K. Wolf. *Fish Viruses and Viral Diseases* 1988, 389-398.

Myxosporidiosis: Henneguya sp. infestation

Updated May 2002. By G. Russell Danner



Left: Henneguya spores 1000x phase contrast microscopy. [–] approximately 5 μm. Right: Chain pickerel gill arch with Henneguya xenoma.

Henneguya is a fish parasite that seldom causes severe harm to the host. A wide variety of freshwater fishes have been reported with infections of *Henneguya sp.* Some susceptible species in Maine include, brook trout (*S. fontinalis*), landlocked Atlantic salmon (*S. salar*), rainbow trout (*O. mykiss*), chain pickerel (*E. niger*), northern pike (*E. lucius*) , and brown bullheads (*I. nebulosus*) . Henneguya is among the most cosmopolitan of all the Myxosporidian parasites. Species in this genus have been found worldwide, infecting hundreds of different fish species.

Various *Henneguya* species produce different lesions in different hosts. Henneguyiasis is suspected when an opaque mass is found in various tissues of the fish's body.External examination may reveal cysts in the skin and gills; whereas, internal lesions may be found on the liver, heart, kidney, spleen or any other organ. Microscopic examination of the *Henneguya sp*. "xenomas" reveal tadpole shaped unicellular organisms with two eye-like polar capsules inside. Infections are usually not life threatening to the fish unless they impair the function of a vital organ.

Henneguya spread through the water. When a xenoma ruptures, millions of *Henneguya* spores are released. The spores drift in the water and attach to a new host with a grappling hook-like organ called a polar filament. Once attached to a new host, the organism forms a new xenoma and begins to multiply. Fish veterinarians, culturists, biologists and others concerned with fish health may treat infected fish with chemotherapeutic agents or surgical removal. Unfortunately, many parasites, including *Henneguya*, are not easily controlled by any therapeutic procedure, thus prevention remains the best medicine.

Special Points of Interest:

- Henneguyiasis is caused by a Myxosporidian parasite.
- *Henneguya* infects many species of fishes, but does not infect people. People may spread the parasite unwittingly on fishing equipment, or by improper disposal of fish entrails.
- For more information read: Hoffman 1999 *Parasites of North American Freshwater Fishes.*

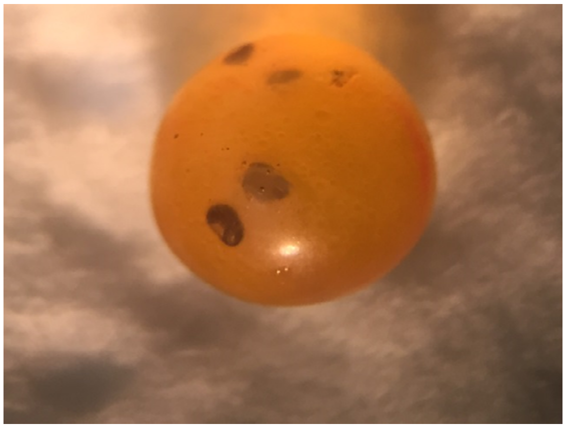
Parasitic Twin

2017 By David Russell


Left: Parasitic twin on underside of brook trout. Right: bottom view of same growth

Conjoined twins can occur in fish just as they do in other species. Usually such a condition will place a fish at a disadvantage for survival, thus they are rarely seen or encountered by anglers. Sometimes one of the conjoined twins will cease development early in development to become a vestigial growth to a mostly normal fish which does have the ability to thrive. The undeveloped twin or vestigial growth is non-viable and dependent on the healthy twin. In this regards, it is defined as parasitic.

The parasitic twin in photos above had remnants of a vertebral column protruding from the abdominal cavity. Internally the fish had a second liver, extra splenic tissue, and various tissues fused to functional organs of the healthy twin. Below: photos of twins (fry and embryo).



Special Points of Interest:

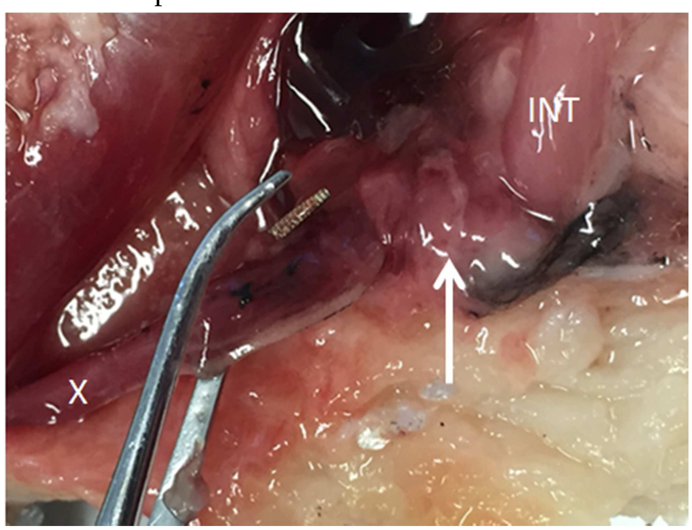
- Conjoined twins occur regularly in fish in small numbers
- Conjoined twins usually die in early life
- A fish with a parasitic twin may be more likely to survive than a conjoined twin

Fistulas and Eviscerated Hernias

2016 by David Russell

Fish can be highly resilient and capable of surviving a number of traumas that should ordinarily be fatal. Among the more survivable type of injuries which may be seen are those caused by bird predation. Similar wounds may also be caused by spear fishing activity. Fish that survive such attacks are usually those with only minor lacerations or surface scratches. Puncture wounds and deep lacerations which penetrate the abdominal cavity to expose internal organs are usually fatal, but surprisingly some fish are able to survive, heal, and resume feeding such that they may be caught by an angler.

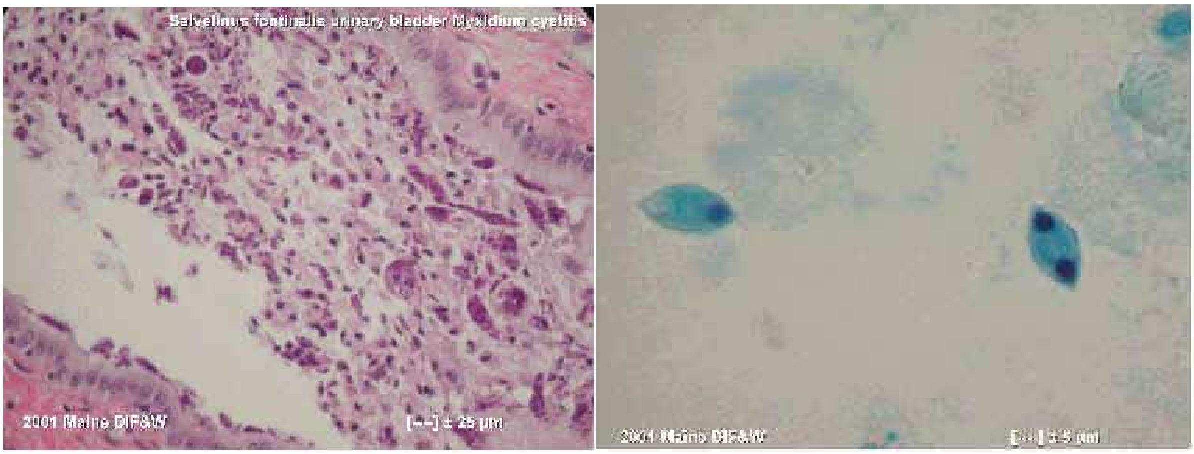
Photos below: Intestinal fistula in land locked salmon. “INT” marks the functional section of the intestine leading to the fistula marked with the arrow. The atrophied section of intestine leading to the anus which is no longer in use is held by the forceps. At some point this fish had an eviscerated hernia which became incarcerated, strangulated, and subsequently ruptured to create a fistula and a “new” anus. Bird predation is a suspected cause.



Left: Salmon with an eviscerated hernia showing tissue growth suggestive of a wound well into the process of healing. This fish was feeling good enough to show enough interest in feeding as to be caught. The wound may have been caused by illegal spear fishing activity thru the ice. The fish with the fistula may have had a wound that started like this one. Cold clean waters of low bacterial CFU may enhance the ability to survive such wounds.

Protozoal parasite: Myxidium salvelini

Updated February 2002. By G. Russell Danner



Left: Urinary bladder epithelium infested with multinucleate, polysporic plasmodia of M. salvelini. Right: Myxidium salvelini isolated from S. fontinalis urine and ovarian fluid

The life cycle of *M. salvelin*i likely resembles that of other Myxoxporidia parasites: *Myxobolus sp., Henneguya sp., Ceratomyxa sp., and Kudoa sp.* Spores are released from the fish during urination. The spores remain viable in the water and sediments for many years. When the spores are ingested by a tubificid worm, they further develop into a *Triactinomyxon*. The Triactinomyxon completes its own developmental cycle inside the oligochaete, producing spores with long caudal appendages which after contact with the trout host initiate a new infection. After ingestion, myxosporean spores extrude the polar filaments in the fish's digestive tract, the shell valves open and the sporoplasm escapes. The sporoplasm probably migrate across the intestinal wall and reaches the bloodstream or lymphatic duct and through them, the final sight of infection (kidney, bladder). There is a period of endogenous cell division where a single cell multiplies into tens if not hundreds of new parasites

Left: S. fontinalis kidney from fish infested with Myxidium salvelini Cysts containing large numbers of Myxosporea are grossly visible.

Special Points of Interest:

- Fish with *Myxidium* cannot transmit the disease to people.
- *Myxidium* is a Myxozoan.
- *Myxidium* species infest many fish species some cause disease others are seem benign.