

COMMON PARASITES
OF ONTARIO FISHES

WITH KEY TO IDENTIFICATION

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About the Front Cover

The cover design of this new manual is somewhat unusual. We asked our staff artist to design a cover that would be both interesting and imaginative, and this resulted in several good ideas. We chose this cover because of its originality and eye-catching appeal.

Each part of this caricature of a fish is composed of some of the parasites described in the text of the manual. Although the parasites are drawn accurately, full artistic license was used in depicting their relative size and position on the fish.



DEPARTMENT OF LANDS AND FORESTS

HON. RENE BRUNELLE, *Minister*

G. H. U. BAYLY, *Deputy Minister*

FOREWORD

This parasite manual has been written as a simple field guide to the more common parasites affecting Ontario fish. It is intended for use by field personnel and by the public. It is not intended to be a comprehensive scientific manual of all Ontario fish parasites.

We would like to thank Dr. T.G. Northcote and the British Columbia Fish and Wildlife Branch for the liberal use they granted us of all information and illustrations in their manual "Common Diseases and Parasites of Freshwater Fishes in British Columbia". All illustrations appearing in this manual, unless otherwise noted, are from the British Columbia manual with modification by our staff artist.

We are also indebted to Dr. R. Freeman of the School of Hygiene, University of Toronto, for the time and assistance he gave in the preparation of this manual and for his critical review of the final manuscript.

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INTRODUCTION

The importance of fish, for both commerce and pleasure, is ever increasing in Ontario. With this increased popularity, is an increased demand for knowledge about the freshwater fish. One aspect of the fish, that of possible parasites and diseases which might affect it, is dealt with in this manual. It does not attempt to review all those that have been reported to occur.

A parasite is defined as an animal, which lives in or upon another animal (the host), drawing nourishment directly from the host without killing it, as does the predator its prey. Parasites are common, and without doubt each species of fish harbours several species of parasites on or within its body. Few fish suffer obvious damage from their parasites. Probably parasites may occur in any organ, the flesh, the viscera, in particular the intestine, and can, in some instances, infect the gonadal flesh so heavily that sterility results.

Parasites are common to fish everywhere; some species are unnoticeable, others become a menace to both the sport and commercial fisherman. In some severe situations man has attempted to reduce the parasite population of a species of fishes. Because such preventive measures must be thorough, they are both difficult and costly to achieve.

The parasites of Ontario fishes do not, in general, parasitize humans. One possible exception is that of the specific tapeworm, *Diphyllobothrium latum*. This parasite occurs in its larval stage in the flesh of fish and as a tapeworm in its adult stage in the intestine of mammals. The destruction of the larvae in fish can be achieved by a thorough cooking of the flesh.

Parasites may infest fish actively by attachment to or penetration of their exterior; on the other hand; they may be taken in passively with food.

The number and types of parasites which may be found in fish depend on such factors as:

1. age . . . the older the fish the longer it has been exposed to parasitism, however, this does not imply that the parasite burden of a species is additive.
2. living space . . . the denser the fish population, the greater are the chances of infection by some species of parasites.
3. diet . . . a fish which feeds chiefly on plankton may be exposed to quite a different array of parasites than a fish of the same age whose diet is composed mainly of other fish. Diet also changes with age.
4. habitat . . . a fish living in a stream may be attacked by different types of parasites than a fish living in a lake.

Tumours, often found in yellow pickerel and maskinonge of Ontario are not attributed to parasitism.

KEY TO COMMON DISEASES AND PARASITES OF FRESHWATER FISH IN ONTARIO

USE OF KEY

The following key consists of a series of paired statements. Only one of each pair of statements should fit or apply to the particular disease or parasite which is being identified.

To use the key always start by checking the statements under 1 against the fish disease or parasite to be identified, and follow directions given at the end of whichever statement is correct. Continue this process until the name of a disease or parasite is found at the end of the statement; this should be the name of the form which is being identified unless a mistake has been made in using the key or the parasite is uncommon and not included in the key.

TERMS USED WITHIN THE KEY AND THE TEXT

A *cyst* refers to a tough protective coating containing a larvae or young parasite. The outer cyst coating is often formed by the *host* (the organism which carries the parasite); the larval parasite is then said to be encysted. When an animal is marked off into a series of more or less similar units it is said to be segmented.

1. If the parasite or disease is visible externally (on body, fins, eyes, mouth, or gills), see 2.
But, if the parasite or disease is visible internally (in the flesh or viscera), see 9.
2. If individual parasites are clearly visible on the body surface, fins, gills, or mouth, or if the marks left by parasites are large and easily discernable, see 3.
But, if individual parasites are not visible, see 5.
3. If parasites are worm-like attached by suckers, see 4.
If parasites are whitish, louse like forms attached to body surfaces, often on or behind fins or gills, or in the mouth, often with pairs of rod-like egg sacs, they are "Fish Lice" (parasitic copepods), see page 7.
If the mark left is large and circular, it was made by the lamprey, see page 10.

4. If they are on the skin, gill cover, or mouth, the parasites are probably Leeches. See page 6.
But, if they are on the gill filaments underneath the gill cover, the parasites are probably Gill Flukes. See page 11.
5. If the eyes are whitish or bulging the parasites are probably Eye Flukes. See page 11.
But, if the symptoms are on the skin, fins, or gills in the form of patches, growths, balls, cysts or spots, see 6.
6. If there are small black spots or lumps about the size of a pin head, on or just under the scales (do not confuse these with normal black pigment cells of the skin), the disease is "Black Spot". See page 5.
But, if there are no small black spots or lumps, see 7.
7. If there are small lumps or cysts (not coloured black) confined to the fins or gills, they are Larval Freshwater Clams (glochidia). See page 8.
But, if there are no small lumps or cysts confined to the fins or gills, see 8.
8. If there are swellings, blisters or open boil-like lesions which are numerous, small, whitish, measles-like and scattered over the body surface, they are "Measle Disease". See page 5.
But, if there are white, fuzzy patches of fungus growth on the skin, fins, or gills, they are "Fungus Disease". See page 5.
9. If the parasites are in the flesh, see 10.
But, if they are on or in the internal organs, see 12.
10. If the parasites are encysted in the flesh, see 11.
But, if they are free, worm-like parasites in the flesh, they are *Diphyllobothrium latum*, see page 16.
11. If the parasites are thin, red round worms, encysted in the flesh, they are "Red Roundworms" (*Eustrongylides sp.*). See page 14.
But, if they are yellow cysts, in flesh immediately beneath the skin, they are "Yellow Grubs" (*Clinostomum marginatum*). See page 13. IF Creamy white cysts up to 1/2" long in white fish they are Tr. Renopharous see pg 20
12. If the parasites are free in the body cavity (between the inner wall of the body and the viscera), see 13.
But, if they are encysted on mesenteries (thin sheets of tissue connecting internal organs to the body wall), surface of internal organs, or occur inside the internal organs, see 15.
13. If the parasites are thin and round in cross-section, thread-like and white or semitransparent, they are probably "White Roundworms", (*Philonema spp.*). See page 15.
But, if they are broad and flattened in cross-section, see 14.

DISEASES AND PARASITES USUALLY VISIBLE EXTERNALLY

14. If the parasites show no distinctive transverse lines (segmentation) across the body, but have a fine groove running along the middle of the body from the anterior to the posterior end, they are Larval Tapeworms (*Ligula intestinalis*). See page 14.
15. If the parasites are encysted on mesenteries or surface of internal organs, see 16.
But, if they are free or attached inside internal organs, see 20.
16. If the parasites are whitish or yellowish cysts in clusters (like sand grains) on the external covering of the heart, they are "Sand Grain Grubs", (*Tetracotyle sp.*). See page 15.
But, if they are encysted on mesenteries and viscera, see 17.
17. If the parasites are red cysts containing red, roundworms they are Red Roundworms (*Eustrongylides sp.*). See page 14.
But, if the cysts are white or cream, see 18.
18. If the cysts contain worms, see 19.
But, if they contain masses of spores they are *Glugea hertwigi*. See page 17.
19. If the cysts contain thin, round, threadlike worms they are "Roundworms". See page 17.
But, if they contain worms which are more flattened in cross-section and not threadlike, they are probably Larval Tapeworms. See page 14.
20. If the parasites are thin, round, threadlike worms within the stomach, they are Roundworms (probably *Metabronema sp.*). See page 17.
But, if they are not in the stomach, see 21.
21. If the parasites are thin, round, whitish or transparent worms within the air bladder, they are Air Bladder Roundworms (*Cystidicola stigmatura*). See page 18.
But, if they are found within the pyloric caeca or intestine, see 22.
22. If the parasites are long, flattened in cross-section, segmented worms, they are tapeworms. See page 18.
But, if they are round in cross-section with no marked segmentation, see 23.
23. If the parasites are thin, often thread-like worms they are *Triaenophorus*. See page 20.
But if they are stout, short (usually less than 1-1/2 inches in length), worms, usually attached to the intestinal lining, they are Spiny Headed Worms (*Acanthocephala*). See page 20.

A. DISEASES AND PARASITES OF GENERAL BODY SURFACE

I. Fungus Disease

Most species of freshwater fishes may become infected by fungus or water mold. Usually the growth first occurs on the site of some external injury or abrasion, from where it may spread to other parts of the body. The common species of fungus *Saprolegnia parasitica*, attacks eggs as well as young and adult fish. Generally the growth is evident in small, fuzzy, white patches occurring almost anywhere on the body surface. If the fish is living in silty water, small particles of sediment may adhere to the growth, giving it a darker appearance. Filaments from the fungus penetrate the skin of the fish and lead to the decomposition of the underlying tissue which may eventually cause death. Fungi constitute one of the most important egg diseases.

See Northcote (1957) and Hoffman (1967)

II. "Measle" Disease

Small measles-like cysts may be produced on the body of fish by a number of agents. Myxosporidians, minute, single-celled animals, have been found to cause the formation of small white cysts within the scales of rainbow trout. These cysts give the fish a somewhat "measly" appearance.

In Canada such fish as the brook trout (*Salvelinus fontinalis*), rainbow trout (*Salmo gairdneri*), coho (*Oncorhynchus kisutch*), brown trout (*Salmo trutta*), perch (*Perca flavescens*), maskinonge (*Esox masquinongy*), pike (*Esox lucious*), catfish (*Ictalurus punctatus*), burbot (*Lota lota*), and carp (*Cyprinus carpio*), have been reported to show infections by the protozoa.

Other small cysts may be produced by a virus or by a dietary deficiency. The presence of measles-like cysts alone does not necessarily indicate Myxosporidians to be the causal agent.

See Northcote (1957) and Hoffman (1967)

III. Black Spot

Small, darkly pigmented spots about the size of a pin head may be evident on or just under the scales of many freshwater fishes (Figure 1).

"Black spot" results from an infestation by larval flukes (possibly neascus), which penetrate the skin of the fish. Once under the external lining of the fish's body the young larvae (metacercaria) form a thin cyst of their own. The connective tissue of the fish forms a double-layered cyst around that of the parasite and black pigment cells accumulate in the outer layer of the cyst wall (Figure 2). Thus, the black colouration of the cyst is not produced by the parasite, but by the host, the fish. If heavily infested, the fish skin may feel rough to touch. Most degrees of "Black spot" infestation seen in the wild are probably not lethal to the fish.

The life cycle of the fluke causing the "black spot" is similar to that shown for another fluke in Figure 10. The adult develops in fish-eating birds, the young, following development in snails, penetrate into the skin of the fish. "Black spot" has been found in the following species of Ontario fishes; brook trout, rainbow trout, largemouth bass (*Micropterus salmoides*), longnose sucker (*Catostomus catostomus*), brown trout, perch, maskinonge, pike, crappie (*Pomoxis nigromaculatus*), and bullhead (*Ictalurus*).

See Northcote (1957) and Hoffman (1967).

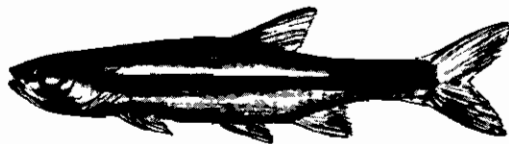


Figure 1: Fish infected with "black spot".



Figure 2: Diagram of section through skin of fish showing "black spot" cyst (Magnified)

B. PARASITES OF BODY SURFACE AND/OR GILLS

1. Leeches

Leeches or "blood-suckers" may be found adhering to the body, gill cover, or mouth of a fish (Figure 3). Occasionally they attach themselves to the gills, or lining, of the mouth cavity. Heavy infestations may cause

mortality. Leeches have been reported on lake trout, (*Salvelinus namaycush*), brook trout, rainbow trout, largemouth bass, smallmouth bass (*Micropterus dolomieu*), whitefish (*Coregonus clupeaformis*), longnose sucker, brown trout, perch, yellow pickerel (walleye-*Stizostedion vitreum*), pike, crappie, catfish, bullhead, burbot, carp and smelt (*Osmorus eperlanus*).

See Hoffman (1967).

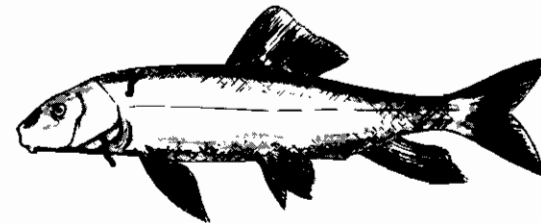


Figure 3: Leeches attached to a young sucker.

II. Fish Lice

Most copepods are entirely free-living and indeed often form an important part of the plankton eaten by freshwater fishes. In the few species which are parasites, the female is the form generally found on the body surfaces, fins, or gills of the host. Nourishment is obtained from the tissues of the fish, but unless infection is extremely heavy, little serious harm is done.

One form of parasitic copepod is the "anchor worm" (Lernaea)



Figure 4: Diagram of Lernaea. The "anchor worm"

(from Hoffman & Sindermann)

which is generally about ½ inch long, cylindrical and whitish in appearance (Figure 4). It is usually found on the gills of the fish and can do considerable harm if present in large numbers. Some Ontario fish found with this parasite are the rainbow trout, largemouth and smallmouth bass, brown trout, pike, crappie, catfish, bullhead, burbot and carp.

See Hoffman and Sindermann (1962), and Hoffman (1967).

Other forms of "fish lice" may be seen crawling over the surface of the animal (*Argulus*, Figure 5) or found attached to the gills (*Ergasilus*, *Achtheres* and *Salmincola*, Figure 5). These copepods have been noted on the lake trout, brook trout, rainbow trout, largemouth and smallmouth bass, whitefish, coho, longnose sucker, kokanee (*Oncorhynchus nerka*) brown trout, perch, maskinonge, yellow pickerel, pike, crappie, catfish, bullhead, cisco (*Coregonus*) and sturgeon (*Acipenser fulvescens*).

See Northcote (1957) and Hoffman (1967).

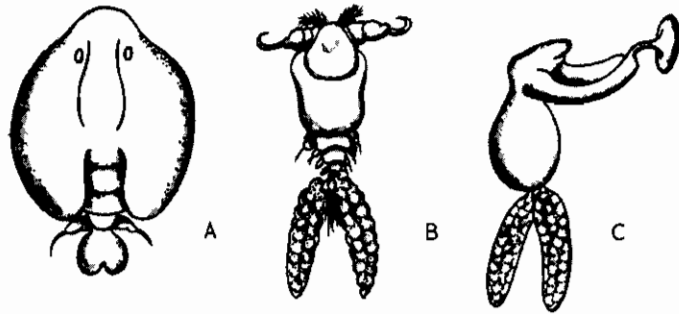


Figure 5: Parasitic Copepods. (All Magnified) A. *Argulus* sp.
B. *Ergasilus* sp., C. *Salmincola* sp.

III. Larval Freshwater Clams

The young of most freshwater clams pass through a temporary parasitic stage attached to the gills or fins of fish where they form small cysts (Figure 6).

Murphey, (1942), found that heavy gill infestation (600 to 1,200 glochidia per fish) resulted in considerable mortality of rainbow trout fingerlings. Most fish died within 48 hours due to reduced blood circulation. Such heavy infestations are not common, however, and usually glochidia do not directly harm fish.

The life cycle of parasitic larval clams is shown in Figure 6. Eggs develop in gill chambers of the clam during the spring. Young larval

clams (glochidia) are ejected from the gill chambers in large numbers; a clam three inches in length may produce over a million. They are extremely small (0.05 mm in length) and are readily carried about by currents before settling slowly to the bottom. There they rest with "jaws" agape, unable to move unless stirred up by a passing fish. If touched, the glochidia immediately snap shut and may, in doing so, clamp onto the fins of a fish. Currents created by fish may stir up and pass the minute glochidia over gill filaments where they also become attached. Epithelial tissue of the gills and skin cover the glochidia in a few hours, giving them the appearance of small cysts within the gill filament or beneath the skin. Encysted glochidia grow rapidly and after a few days (usually 10 to 20) they break free from the fish, settle down to the bottom and again become free living, eventually growing into adult clams.

Glochidia have been found in the following Ontario species; rainbow trout, brown trout, perch, maskinonge, yellow pickerel, pike, bullhead and burbot.

See Northcote (1957).

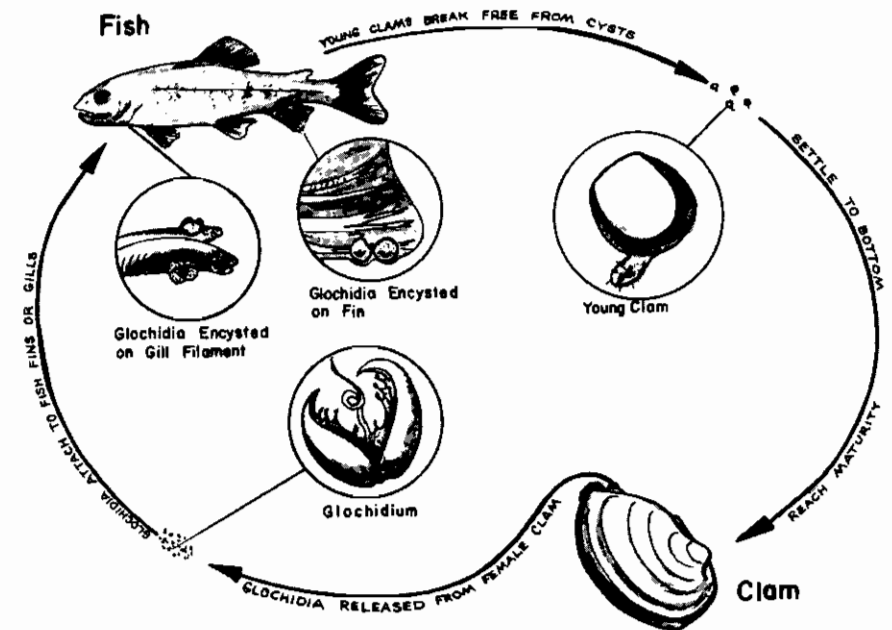


Figure 6: "Life Cycle of Fresh water clams".

IV. Lamprey (*Petromyzon marinus*)

Parasitic lamprey have become a danger to some of the Great Lakes fish species in the recent years, in particular the lake trout.

The largest of the external parasites, the lamprey is provided with a large, sucker-like mouth which is ringed with horny teeth, used for attachment to the body of a fish. The tongue is provided with a rasping surface to scrape through the skin and anticoagulant glands to break down tissue and blood. Though a fish survives the attack of a lamprey, as is evident by the presence of circular wounds which have healed on the fish, if the lamprey is able to reach the internal organs, the attack is usually fatal.

Silver Lamprey - similar life cycle
 car inner row of teeth inner teeth unicuspid
 12 - 20 MONTHS

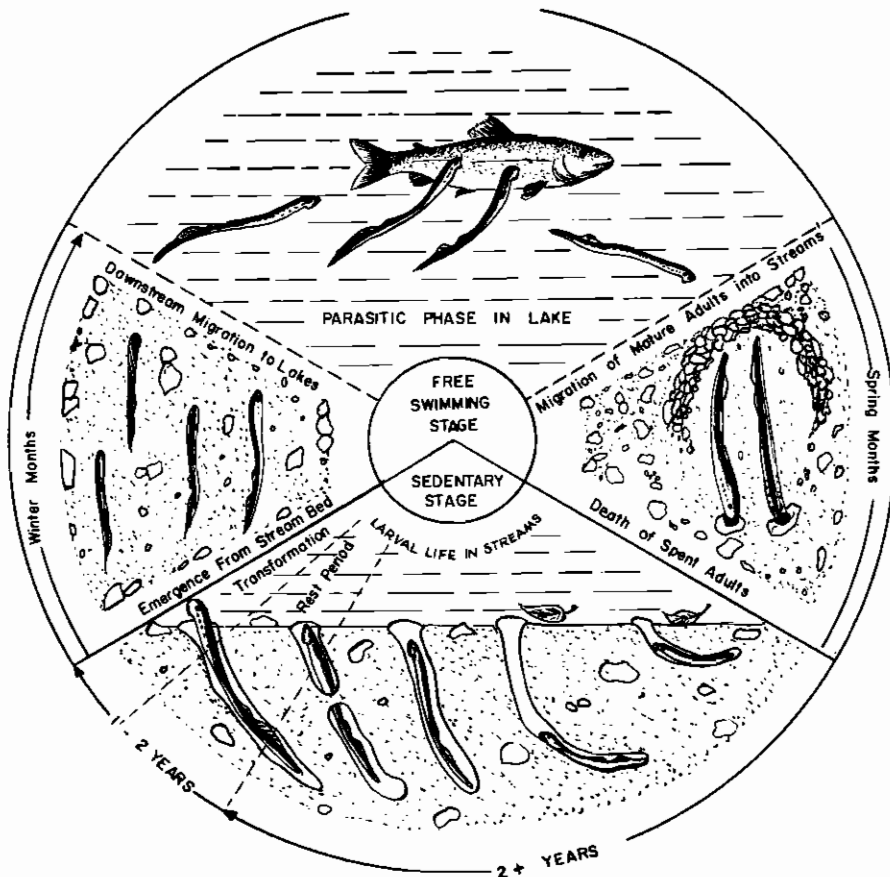


Figure 7: Life cycle of Parasitic lamprey (*Petromyzon marinus*) (after Baldwin)

Newly hatched larvae bury into the bottom of the streams and spend anywhere from 3 to 9 years there, depending on growing conditions in the ammocete stage of their life cycle. Generally they reach a length of about seven inches before becoming parasitic and migrating to the lakes to feed on fish. (Figure 7). Ontario fish more severely affected by this parasite are lake trout, burbot, white fish, and rainbow trout,

See N. Baldwin.

C. PARASITES ON GILLS

I. Gill Flukes

Several species of flukes are known to occur on gills of freshwater fish of Ontario. Most are microscopic, but one in particular, *Discocotyle salmonis* is about 1/4 inch long (Figure 8). This trematode attaches to the gill of the fish by a large rear suckerlike attachment organ.

All gill flukes infest only one host in completion of their life cycles. In other words, eggs or living young produced by adult flukes must become attached to the same or another fish; no other organism is infected by the young before it becomes parasitic on the gills of a fish. In attachment, the fluke generally causes cuts on the gills which may become infected with fungus or some other disease. If abundant, they may bring about the death of their host.

Gill flukes have been recorded from brook trout, rainbow trout, whitefish, longnose sucker, brown trout and cisco.

See Northcote (1957), Hoffman and Sindermann (1962) and Hoffman (1967).

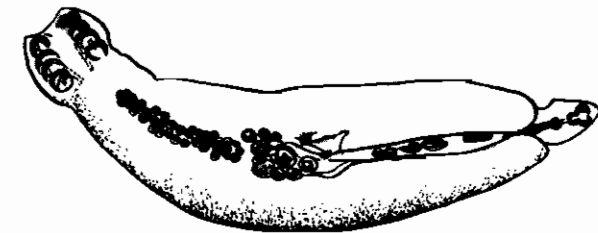


Figure 8: Diagram of *Discocotyle salmonis* (Magnified)
 (from Hoffman & Sindermann)

D. PARASITES IN EYES

I. Eye Flukes

A larval stage of flukes, the metacercaria, is known to infect the eyes of many freshwater fishes. The larval form is found, usually, in the

lens of the eyes and may cause it to become opaque. In the initial stages of infection the eyes may bulge, giving the fish a "popeye" appearance. If large numbers of these larvae accumulate in the lens they may be seen through the cornea as a milky coloured spherical body. However, as the larvae are small, generally less than 2 mm in length, light infections could pass unnoticed in an external examination of the eye. In severe infections the fish may become totally blind and even light infections may interfere with clarity of vision.

The life cycle of an eye fluke is outlined in Figure 9. Adult flukes, occurring in the intestines of gulls or other fish-eating birds, shed eggs which pass into the feces and hatch into "miracidia". These minute, free-swimming larvae penetrate into the body of freshwater snails where they undergo development for several weeks. Then they leave the snail in large numbers as fork tailed "cercariae" which enter the lenses of fish. Here they may remain for months before entering the bird when it eats the infected fish.

It should be noted that these particular forked-tailed cercariae (diplostomula) which are part of the fish eye fluke life cycle, are not related to the fork-tailed cercariae of the disease "swimmer's itch".

These diplostomula of the fish eye fluke have been seen in the following Ontario fish: brook trout, rainbow trout, whitefish, coho, longnose sucker, brown trout, perch, maskinonge, yellow pickerel, pike, crappie, catfish, bullhead, burbot, cisco, carp, smelt and sturgeon.

See Northcote (1957) and Hoffman (1967).

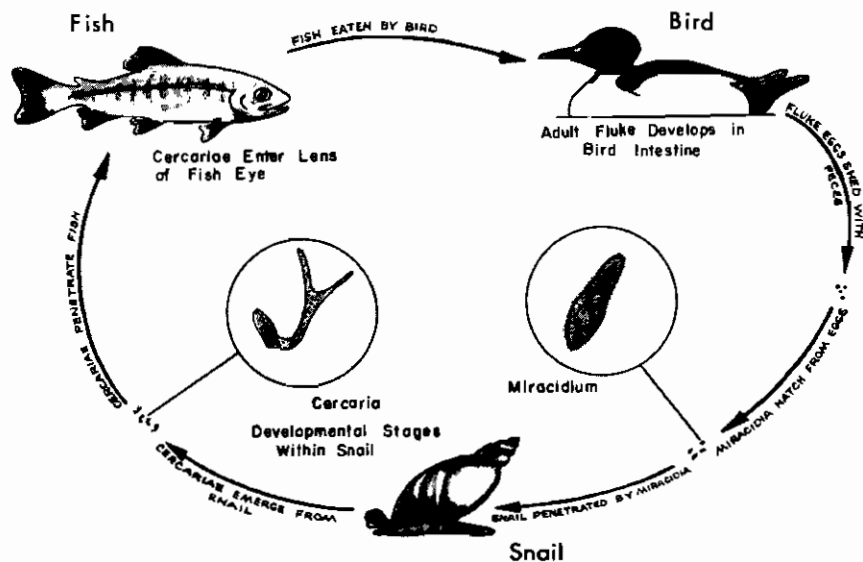


Figure 9: Life cycle of the fish eye fluke.

DISEASES AND PARASITES USUALLY EVIDENT INTERNALLY

A. PARASITES IN MUSCULAR TISSUE

I. Yellow Grubs (Cysts of larval flukes)

The fluke *Clinostomum marginatum* may be seen immediately beneath the skin and often near the base of the fins, as yellow cysts. If the cyst is broken open, a yellow, or whitish larval fluke about ¼ inch long will be found. Apparently, the larvae do no serious harm to fish, although where infestation is heavy the unesthetic appearance of the flesh makes it unsuitable for consumption.

The life cycle of this fluke is shown in Figure 10. Adult flukes in the mouth of the great blue heron or other fish-eating birds shed eggs into the water which soon develop into miracidia. These enter freshwater snails, undergo development, and then leave as free swimming cercariae. The cercariae burrow beneath the skin of fish where they encyst in the connective or muscular tissue. To complete the cycle, the infected fish is eaten by a bird.

Yellow grubs have been found in lake trout, brook trout, bass, perch, yellow pickerel, pike, crappie, bullhead, catfish, and cisco.

See Northcote (1957) and Hoffman (1967).

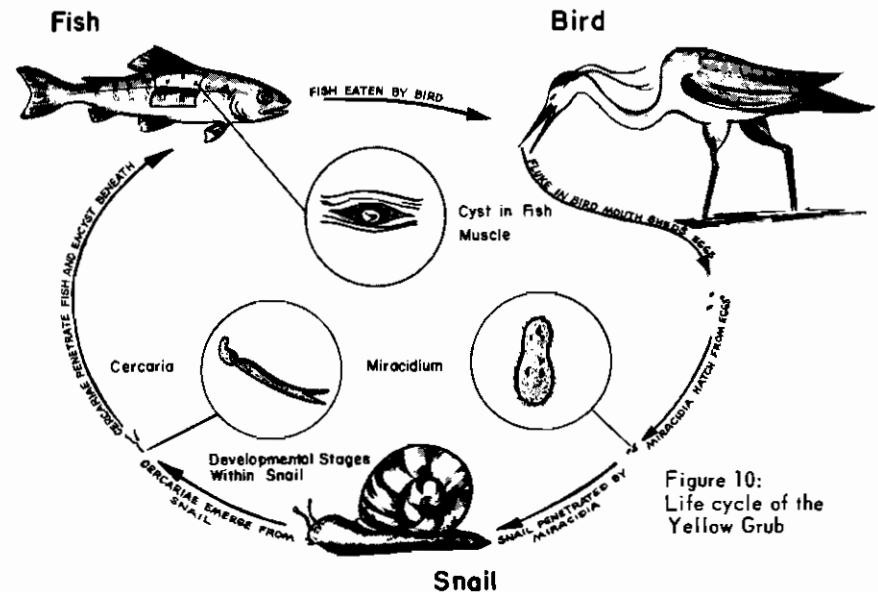


Figure 10: Life cycle of the Yellow Grub

II. Red Roundworm (nematodes)

The red roundworm, *Eustrongylides* sp., may be found encysted in the flesh of fish. It is one of the larger parasites seen in the muscle, the cyst being about ¼ inch in diameter (Figure 11). The life cycle of this roundworm is not definitely known, but larval stages found in fish probably mature in some fish-eating bird.

These roundworms have been recorded from lake trout, whitefish, brown trout, pike, bullhead, and carp.

See Northcote (1957) Hoffman and Sindermann (1962), and Hoffman (1967).

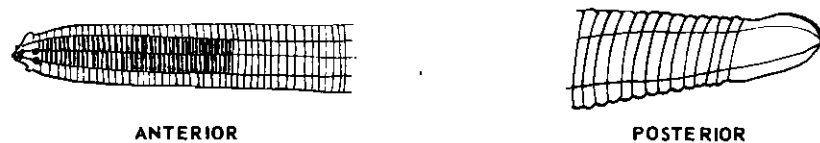


Figure 11: Diagram showing the anterior and posterior portions of *Eustrongylides* (from Hoffman 1967)

B. PARASITES FREE IN THE ABDOMINAL CAVITY

I. Larval tapeworms

The larval stages of the tapeworm may occur free in the abdominal cavity of freshwater fishes. These larvae often grow to considerable lengths completely filling the body cavity. A swollen or distended abdomen on a fish indicates the presence of larval tapeworms within. A fish heavily infected with these large larvae often appears sluggish and inactive. Undoubtedly their presence leaves the fish open to predation by other fish or birds.

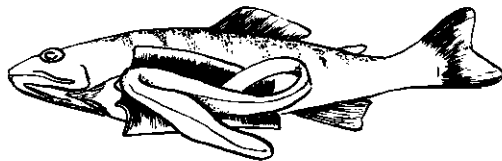


Figure 12: Brook trout infected with *Ligula intestinalis*.

Ligula intestinalis, one type of larval tapeworm, is characterized by the absence of external segmentation and the presence of a median furrow running from the front to the back (Figure 12). Fine transverse grooves and wrinkles may be seen if the whitish body surface is closely examined but no marked segmentation is visible. The size of the larvae

varies with that of the host, but may reach at least 6 inches in length, 1/2 inch in width, and 1/8 inch in thickness, in a large fish. Larval tapeworms have an extended period of development within the fish, then, spend a short time as adults in the intestine of fish-eating birds, commonly the American merganser.

This parasite has been found in the following Ontario fishes: brook trout, whitefish, longnose sucker, perch and smelt.

See Northcote (1957) and Hoffman (1967).

II. White Roundworms (*Philonema* spp.)

Long, thin roundworms may be found in the body cavity or coiled in a mass among the pyloric caeca. The males range up to 1½ inches in length with a spirally coiled posterior end, while females may attain lengths of over 12 inches, appearing glistening white and semi-transparent in the living stage. Large numbers of these nematodes may be found in a heavily infected fish, but apparently no serious damage is done to the host.

White roundworms have been known to infect brook trout, lake trout, rainbow trout, whitefish, coho, kokanee, brown trout, and smelt.

See Northcote (1959) and Hoffman (1967).

C. PARASITES ENCYSTED ON MESENTARIES OR SURFACE OF INTERNAL ORGANS.

A wide variety of larval flukes, tapeworms, and roundworms are known to occur on mesenteries (thin translucent sheets connecting the various organs) and internal organs of freshwater fish. Only a few of the particularly obvious or important forms will be dealt with here.

I. Sand Grain Grubs

Whitish or yellowish cysts about the size of sand grains in clusters on the external covering of the heart are probably caused by encysted larvae of a fluke. They may be found around the viscera as well. Little is known of the importance of life history of these flukes although the adult occurs in fish-eating birds, often gulls.

The "sand grain grubs" have been found in the whitefish, longnose sucker, brown trout, perch, yellow pickerel, pike, crappie, bullhead, cisco, and carp.

II. Larval Tapeworms (*Diphyllobothrium* sp.)

The genus *Diphyllobothrium* is well known and includes one (or more) species including the better known *D. latum*, which infect man and other mammals such as bear and canids. However, other species mature only in the gut of fish-eating birds. There is considerable confusion about species identification and specific details of their life cycles, but those that have been studied most seem to obey the following pattern.

Larval stages of this tapeworm may be found encysted on the viscera or on the mesentery near the stomach and pyloric caeca. Occasionally free larvae may be found on the viscera. The larvae within the cyst are often U-shaped (Figure 13), and when expanded may measure up to 5/16 inch in length and 1/8 inch in width. These cysts can

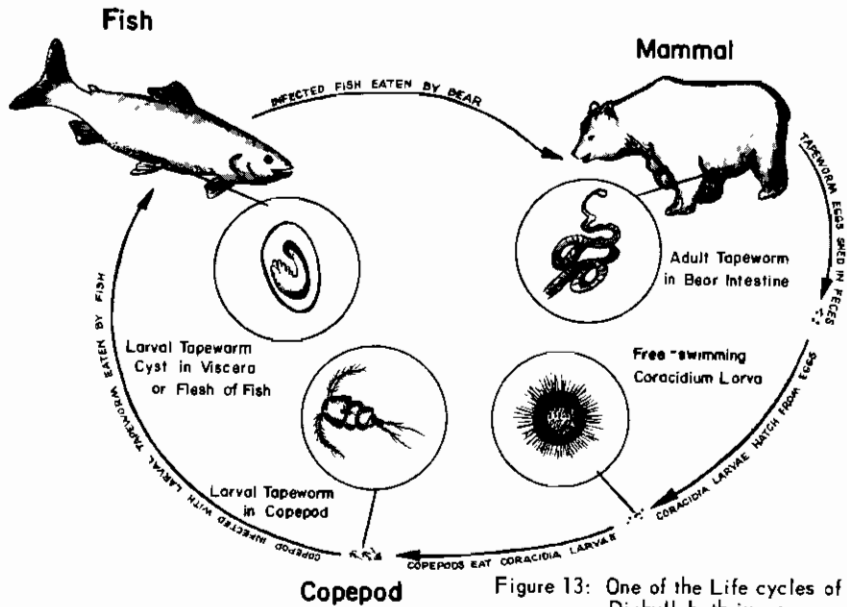


Figure 13: One of the Life cycles of *Diphyllobothrium* sp.

be present in the viscera as well as in the flesh of the fish and only thorough cooking will ensure that all are destroyed. The adult parasite will attain maturity possibly at a length of 30 feet, and will produce millions of eggs, which leave the body of the host via the feces. If they reach fresh water, these eggs will hatch to a small swimming larva or coracidium which are then eaten by "water fleas" or copepods. Small fish feed on the infected copepods and if they, in turn, are preyed upon by larger fish, the life cycle is completed.

Diphyllobothrium latum is unusual in that, in the fish, the larvae occurs in the musculature, gonads, and elsewhere but usually *not* encysted. Other species usually occur in cysts except in some cases where a species may occur free in the body cavity of fish.

Diphyllobothrium latum is not known in eastern and central Ontario, but does occur in northwestern Ontario. Fish of Ontario which act as hosts to *Diphyllobothrium* spp. are lake trout, rainbow trout, whitefish, coho, kokanee, brown trout, perch, yellow pickerel, pike, burbot, carp, brook trout, and cisco.

III. Red Roundworm

The red roundworm, *Eustrongylides* sp., found in the flesh of fish, may also occur encysted in the viscera. See page 14.

IV. Other roundworms

Several other types of roundworms, such as *Philonema* spp. or *Contracaecum* spp., may encyst on viscera or mesenteries.

V. Glugea

These protozoa may appear on the viscera of fish and in fact are a mass of thousands of spores appearing as white nodules or cysts on the viscera. It can occur in sufficient abundance to interfere with re-

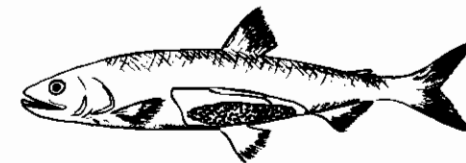


Figure 14: Diagram of fish infected with *Glugea*.
(from Hoffman & Sindermann)

production of the fish. According to Hoffman and Sindermann (1962) it can occur in up to one quarter of the fish sampled in any one area.

In Ontario, this parasite occurs in the smelt, especially in Lake Erie.

D. PARASITES OCCURRING WITHIN INTERNAL ORGANS.

I. Parasites in Air Bladder

Small (1 to 1½ inches in length) whitish or transparent roundworms (*Cystidicola stigmatura*) occasionally may be found within the air bladder. Air bladder roundworms have been recorded in brook trout, rainbow trout, lake trout, whitefish, and cisco.

See Northcote (1957) and Hoffman (1967).

II. Parasites in Pyloric Caeca and Intestines

(a) FLUKES

Several types of flukes are known to occur in the caeca or intestine of freshwater fishes, but most of these are very small and usually escape notice.

(b) TAPEWORMS

Among a number of tapeworms found in the pyloric caeca and intestines of freshwater fishes, the four types, *Proteocephalus*, *Eubothrium*, *Bothriocephalus*, and *Triaenophorus* are particularly prevalent. Three types usually can be distinguished by characteristic features of their segments, (Figure 15), and the fourth by the fact that segments are absent.

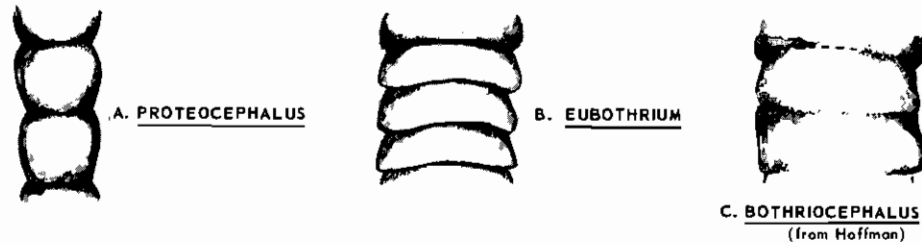


Figure 15: Sections of fish tapeworms.

Proteocephalus

The life history of the tapeworm (*Proteocephalus ambloplitis*), found in largemouth bass is given in Figure 16. The tapeworm body, behind the head attached to the intestinal wall by suckers, is made up of many segments which become larger towards the posterior end. Each segment has its own reproductive system, but no digestive system for food is absorbed directly from the host by each segment. Mature posterior segments break off and pass into the water with feces. These segments disintegrate and shed large numbers of eggs which are eaten by

planktonic copepods ('water fleas'). A larval stage of the parasites then develops within the copepods which are eaten by small fish. The parasite undergoes further development within the young fish and heavy infestations of these parasites may severely damage them. Finally, if the small fish is eaten by a larger one, the larval tapeworms develop into adults attached to the intestine of their host.

Proteocephalid tapeworms have been found in the following Ontario fish: brook trout, rainbow trout, lake trout, whitefish, coho, kokanee, brown trout, bass, perch, maskinonge, yellow pickerel, pike, crappie, catfish, bullhead, burbot, cisco, carp, and sturgeon.

See Northcote (1957) and Hoffman (1967).

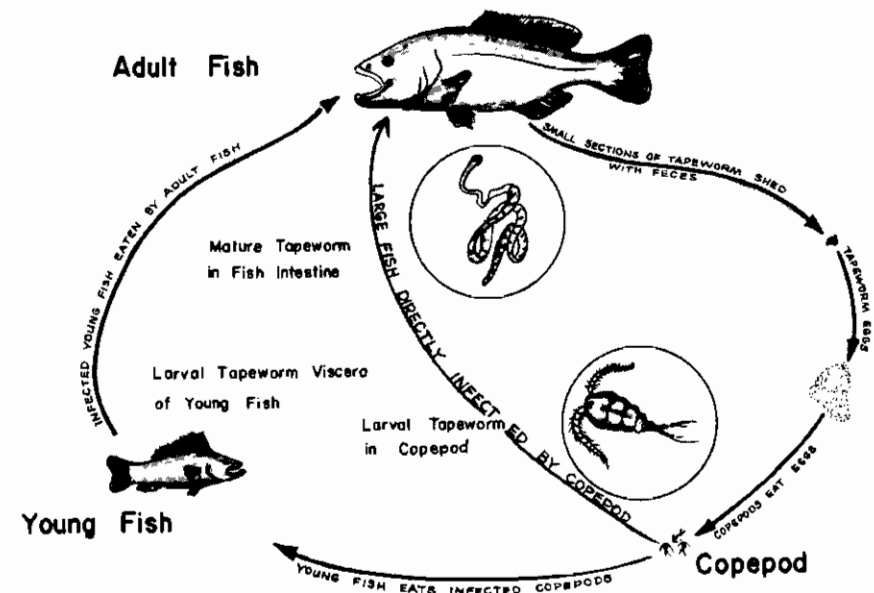


Figure 16: Life cycle of the tapeworm *Proteocephalus*.

Eubothrium

Another common tapeworm of the fish digestive tract is *Eubothrium*, which occurs frequently in pyloric caeca. This tapeworm may retard growth of the infected fish. It has been found in lake trout, brook trout, rainbow trout, bass, whitefish, longnose sucker, kokanee, brown trout, burbot and cisco.

Bothriocephalus

This tapeworm can be distinguished from the previous two by the secondary segmentation of the segments (Figure C). This parasite has been found in perch, whitefish, bass, pike and yellow pickerel.

Triaenophorus Crassus

Triaenophorus as an adult worm, exists in the intestine of fish, is about 1 mm in diameter, up to 130 mm long and generally coiled and white. This parasite may be distinguished from other common cestodes by the lack of segmentation. Heavy infestation of a fish species may result in temporary commercial condemnation of the fish. Adults are found in the intestine of pike, maskinonge, and yellow pickerel.

See Northcote (1957) and Hoffman (1967). *The love in cyst in
Flesh of white fish.*

(c) SPINY-HEADED WORMS (ACANTHOCEPHALA)

Small, (usually less than an inch), unsegmented worms may be found attached to the intestinal wall of freshwater fishes. These spiny-headed worms embed their "heads" into the wall by means of a retractable snout armed with hooks (Figure 17), and in doing so many cause serious infections of the intestinal lining. Many forms are bright yellow or orange. One species (*Pomphorhynchus bulbocollis*) may produce lumps on the external surface of the intestine resulting from the embedded snout within, (Figure 18).



Figure 17: Diagram of spiny-headed worm (Magnified)

Little is known of the life cycle of spiny-headed worms, although they are parasitic during all stages, and pass the early larval stage in crustaceans or insects. In Canada, such fish as brook trout, rainbow

trout, whitefish, coho, bass, common longnose sucker, kokanee, perch, yellow pickerel, pike, crappie, burbot, smelt and carp have been recorded to carry such a parasite.

See Northcote (1957) and Hoffman (1967).

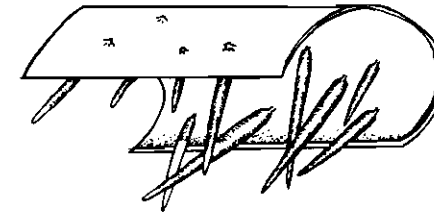


Figure 18: Diagram of fish intestine cut away to show spiny-headed worms. Note small lumps on intestine resulting from embedded snouts.

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