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FISH PARASITES

Ashok B. Khodke
Department of Fishery Science,
Pratishthan Mahavidyalaya, Paithan.

ABSTRACT

A multitude of parasites have been reported in fish, but only a few species are capable of infecting humans. The most important of the helminths acquired by humans from fish are the anisakid nematodes (particularly Anisakis simplex and Pseudoterranova decipiens), cestodes of the genus Diphyllobothrium and digenetic trematodes of the families Heterophyidae, Opisthorchiidae and Nanophyetidae. Seafood-associated infections by acanthocephalans are rarely reported in humans. All of the helminths mentioned above are associated with social-cultural and behavioural factors, in particular the consumption of raw or undercooked seafood. Measures can be taken during harvesting, processing or post-processing (e.g., by the consumer) to mitigate the risks of infection. The seafood industry and government authorities can apply various programmes to reduce these risks, including good manufacturing practices (GMPs) and hazard analysis and critical control point (HACCP) systems. Such measures may include avoiding particular harvest areas, sizes of fish, or even particular species of fish. The method of capture, handling and storage of the catch can directly affect the quality of the seafood with regard to the presence and numbers of parasites. The extent of processing--including heading and gutting, candling and trimming--and the type of product derived (fresh, frozen, salted or pickled) can all contribute to the control of the risks posed by helminths. The most effective means of killing the parasites are either freezing or heat inactivation.

KEY WORDS: *families Heterophyidae, Opisthorchiidae and Nanophyetidae.*

INTRODUCTION

A parasite is an organism that lives in or on another larger organism of a different species (the host), upon which it depends for food. Although the parasite benefits from the association, the host is harmed. Depending on the species, the host/parasite relationship may be temporary or permanent. Bacteria and viruses are classified as parasites in some branches of biology. Parasites generally don't kill their hosts (it's a dumb parasite that kills its free lunch), but some can severely stress fish populations to the point of becoming biological and economical concerns. Parasites have a stake in the survival of their host. Sometimes, when parasites are numerous or the fish is stressed from another cause, the fish will die. Parasites can weaken a fish by:

- destroying tissue
- removing blood and cellular fluids
- diverting part of its nutrient supply
- allowing secondary infections to develop

Yes, in fact, parasitism is natural and normal. It occurs throughout the plant kingdom and in every major group of the animal kingdom. Usually, fish parasites aren't noticeable, but sometimes anglers will catch a fish with obvious signs of infection or parasitism. *It is advisable to thoroughly cook or hot smoke all fish to 140° F for at least five minutes, or freeze them at 0° F for 48 hours. If you are planning to eat an infected or infested fish, see the recommendations in the Parasites Table*.

Although some parasites make fish look and taste unappetizing, very few fish parasites can be transferred to humans. Even when a fish exhibits obvious signs of disease or parasites, most likely the fish is still edible when cooked, hot smoked, or frozen. People have been infected with tapeworms (*Diphyllobothrium latum*) after consuming marinated, uncooked walleye and northern pike. In one incident, anglers marinated freshly caught fish overnight in lemon juice and ate them the next day. They were following a recipe for *seviche*, a South American dish. Generally, Minnesotans don't prepare *seviche*, but they do pickle raw fish. Pickling alone may not destroy a larval tapeworm.

Fish secrete a mucous coating over the entire length of their body that wards off fungal, viral, and bacterial infections. If this mucous coating is damaged, the fish becomes more susceptible to infection. Anglers can help prevent infections by taking extra care when returning fish to the water. To protect the mucous coating, remove the hook while the fish is still in the water or wet your hands before handling the fish. Release the fish gently and as quickly as possible after the hook is removed.

This section describes food safety issues associated with naturally occurring parasites that could be associated with certain types of seafood products. Information on how to select and handle seafood products to avoid foodborne illness is provided.

All living organisms, including fish, can have parasites. Parasites are a natural occurrence, not contamination. They are as common in fish as insects are in fruits and vegetables. Parasites do not present a health concern in thoroughly cooked fish.

Parasites become a concern when consumers eat raw or lightly preserved fish such as sashimi, sushi, ceviche, and gravlax. When preparing these products, use commercially frozen fish. Alternatively, freeze the fish to an internal temperature of -4°F for at least 7 days to kill any parasites that may be present. Home freezers are usually between 0°F and 10°F and may not be cold enough to kill the parasites.

The health risk from parasites is far less than the risk from "unseen" illness causing bacteria which are present in almost all foods.Roundworms called nematodes are the most common parasite found in marine fishes. Some people call these nematodes herring worms or cod worms. Actually, several different species exist and it is hard to distinguish between them. All are in the family Anisakidae and are anisakid nematodes (see information below). Freshwater fish like trout and fish that spend part of their life in freshwater, such as salmon, may carry Diphyllobothrium tapeworm larvae (see information below). These small, whitish, and somewhat flabby worms are common in salmon from some areas of Alaska.

The life cycle of an anisakid nematode begins when seals or sea lions eat infected fish The larval nematodes grow to maturity, and the marine mammal excretes the nematode eggs into the sea where they hatch. Shrimp-like animals eat the larvae, and fish eat the shrimp . The larvae then develop into the form we see in fish.

The life cycle for a tapeworm is similar. Mammals or birds eat infected fish. The eggs hatch in freshwater. Crustaceans eat the eggs, freshwater and anadromous fish eat the crustaceans, and we eat the fish.

Many consumers prefer the delicate flavor and texture of uncooked fish found in sushi and sashimi (thin slices of raw finfish) dishes. But there should be caution in consuming raw fish because some species of fish can contain these harmful worms. Eating raw, lightly cured, or insufficiently cooked infected fish can transfer the live worms to humans. Most of these parasites cannot adapt to human hosts. Often, if an

infected fish is eaten, the parasites may be digested with no ill effects. Adequate freezing or cooking fish will kill any parasites that may be present. Raw fish (such as sushi or sashimi) or foods made with raw fish (such as ceviche) are more likely to contain parasites or bacteria than foods made from cooked fish, so it's important to cook fish thoroughly (at least 145°F for 15 seconds) or use commercially frozen seafood in raw dishes.

Two types of parasitic worms can infect humans:

1. Anisakiasis is caused by ingesting the larvae of several types of roundworm which are found in saltwater fish such as cod, plaice, halibut, rockfish, herring, Pollock, sea bass and flounder.
2. Tapeworm infections occur after ingesting the larvae of diphyllobothrium which is found in freshwater fish such as pike, perch and anadromous (fresh-saltwater) fish such as salmon.

During commercial freezing fish is frozen solid at a temperature of -35°F and stored at this temperature or below for a minimum of 15 hours to kill parasites. Most home freezers have temperatures at 0°F to 10°F and may not be cold enough to kill parasites because it can take up to 7 days at -4°F or below to kill parasites, especially in large fish. Good handling practices on-board fishing vessels and in processing plants can minimize nematode infestation. Many seafood processors inspect seafood fillets of species likely to contain parasites. This process called candling involves examining fish fillets over lights. Candling detects surface parasites. Unfortunately, they cannot always see parasites embedded deep in thick fillets or in dark tissue. Candling is also useful for revealing pinbones in fillets that are intended to be boneless.

Fish is also safe to eat after it is cooked to an internal temperature of 145°F for 15 seconds. Normal cooking procedures generally exceed this temperature. If a thermometer is not available to check the internal temperature of the thickest portion of the fish, the fish should be cooked until it loses its translucency and flakes easily with a fork.

If a parasite is present in a fish, you have several options:

- Remove the parasite, examine the fish for others and cook the fish. Thorough cooking kills all parasites
- Notify the store where you bought the fish so that the store can carefully inspect remaining fish.
- Depending on the return policy of the particular store, you may wish to return or exchange the unused portion.

TYPES OF PARASITES

Parasites are typically divided into two groups: ectoparasites, which live on the outside of a tropical fish host (including the gills, mouth, skin and fin surfaces); and endoparasites, which live in the tissues, blood and/or organs (including the gastrointestinal tract).

Types of hosts

A definitive host is one that harbors the sexual adult stage of the parasite, while an intermediate host harbors an asexual or larval stage. A parasite vector is an arthropod or other invertebrate that transmits the parasite from one vertebrate host to another. Infection and infestation. Infection is parasitism by an internal parasite, while infestation is parasitism by an external one.

Life cycles

Parasites with a direct life cycle are transmitted directly from one fish to another, and may also include a free-living phase when they may inhabit the water or substrate. On the other hand, an indirect life cycle refers to a complex life cycle involving two or more hosts, including a tropical fish (e.g., a fish and a shrimp), and is often characteristic of larger parasites. We've already taken a close look at ich, the white spot disease caused by Ichthyophthirius multifiliis. As noted, ich has both free-living and parasitic stages, and even though there are many different treatments available, the specific treatment must be chosen on the basis of the type of tropical fish infected and the environment in which they are maintained. When it comes

to treating fish parasites, there are some medications commercially available that work well, but others can only be prescribed by a veterinarian.

Drugs or chemicals placed in the water are commonly referred to as "bath" treatments. Drugs delivered orally are generally mixed in the food and are meant to deliver systemic effects. Bath treatments are the most variable, in that a specific concentration of a chemical is placed in the water for a specific length of time. As a rule, lower concentrations are used for longer periods of time or vice versa.

Ich Treatments

I've described the parasite that causes ich. Now let's examine in more detail how to get rid of it.

Salt (plain old sodium chloride), which is often overlooked in favor of other drugs and chemicals often thought to be better and more powerful, is one safe and very effective method of treating ich, as well as many other external parasites. For most purposes, uniodized table salt is adequate, though there is nothing wrong with using aquarium salt specifically sold for that purpose, such as sea salt, or solar salt, salt sold for consumption by livestock and kosher salt.

As an aid to osmoregulation, salt may be added at a concentration of 2 to 3 parts per thousand (1 ppt = 1 tsp/gallon, 3 ppt = 1 tbsp/gallon; for ponds, use 1 pound per 100 gallons). This concentration is safe for most tropical fish, and protozoa cannot live in this level of salinity. As a treatment for ich and some other protozoa, infested fish should be dipped in saltwater at 30 ppt (which is the salinity of seawater) for 30 seconds up to several minutes – or until the fish rolls on its side. The tropical fish should then be placed back in normal-salinity water.

To mix this solution, use aquarium water and dissolve 30 teaspoons of salt per gallon. Place the fish into this water, monitoring it the entire time. Repeat this process once daily for three days, with a 30- to 70-percent aquarium water change between treatments. This treatment is different from most others, in that it is used to treat organisms in the skin of the fish and not the free-living stages found in the aquarium.

Lower doses may be used as a continuous bath in the aquarium fish. At 5 to 10 ppt, tropical fish can survive for several hours to several days, and this will effectively kill the ich organisms. A bath of 4 to 5 ppt will break the ich life cycle and will kill anchorworms and lice, as well. Freshwater fish can live in this salinity for up to four weeks. A salinity of 5 ppt or greater will usually kill live plants.

Formaldehyde (formalin) at 37 percent may be used as a medicated bath as a treatment for ich and some other protozoa. Use a bath for 12 to 24 hours dosed at 1.0 milliliter (ml) per 10 gallons of water. This is repeated for three treatments, every three days. Partial water changes (30 to 70 percent) should be performed between treatments. Formalin may be added to the display aquarium, but because it is so toxic, it's preferable to restrict its use to a treatment aquarium. Formalin removes oxygen from water, so the treated water must be well aerated. It is a carcinogen (capable of causing cancer), too, so anyone using this chemical must be educated about safe handling. Formalin supplied for use by veterinary clinics to preserve tissues is too diluted and is not approved by the Food and Drug Administration. Formalin should only be used after consulting with a veterinarian about its use. Malachite green is another treatment for ich. Dosed at 0.1 to 0.15 ppm, it may be used as a bath for 12 to 24 hours. This is usually repeated daily for three days, with a 30- to 70-percent water change between treatments.

Another ich treatment is Victoria green and acriflavin. These chemicals are available commercially as tablets that fizz as they dissolve. This formulation is also designed to prevent secondary bacterial infections. One dose may be all that is necessary. However, you should change 25 percent of the water every 24 hours if additional doses are needed. Remove activated carbon from the filter during treatment.

For some, copper is the treatment of choice for ich. The safe use of copper depends on the total alkalinity of the water. If total alkalinity is less than 100 milligrams per liter (mg/L), the use of copper sulfate is not recommended. Copper must be carefully dosed. It will also kill invertebrates and live plants.

Increase the fish aquarium temperature during any treatment. This is to speed up the life cycle of the organisms, because treatment is aimed at killing them in their free-living phase.

TRICHODINA AND RELATED PROTOZOA

Other protozoal parasites found externally are Ichthyobodo/Costia, Trichodina and Chilodonella, along with monogenetic flukes (such as Gyrodactylus). The most obvious symptom of this is a gray-white film of excess mucus that develops over the body, and is especially noticeable over the eyes or areas containing dark pigment on the skin. Along the flanks, reddened areas may occur, and sometimes the gills swell up. Tropical fish may move rapidly and flash (swim erratically), and they may have respiratory problems. However, as the infestation progresses, the fish become listless and lie on the bottom of the fish aquarium, occasionally scratching against rocks or aquarium ornaments. Usually, excessive mucus is caused by more than one organism.

Trichodina and the related protozoa usually cause problems in tropical fish that are overcrowded, stressed or suffering from poor husbandry. Trichodina attaches temporarily by an adhesive disc to the skin. In large numbers, they damage the skin, becoming parasitic and feeding on it. Ichthyobodo attaches to the gills or fins, and feeds on cytoplasm, causing hyperplasia (an abnormal increase in volume of a tissue or organ caused by the formation and growth of new normal cells) of the epidermis and destruction of goblet cells (solitary, mucus-secreting cells).

Initially, these should be treated with the same therapy as for ich—these are protozoal parasites (except for the flukes). If the fish have not improved within five to seven days, do a 50-percent water change, and treat with formalin or an organophosphate insecticide used for removing monogenetic flukes (more on these later).

HEXAMITA AND SPIRONUCLEUS

Hexamita and Spironucleus are two other protozoal parasites commonly found in the intestinal tract of some freshwater fish, although systemic infections can occur. Hexamita is also known as “hole in the head disease.” Small holes appear in the body, especially the head region, and often strings of mucus trail from the lesions. Lesions may also develop at the base of the fins and near the lateral line. They have a direct life cycle, and are principally acquired by oral ingestion of trophozoites (the active, motile feeding stage of a sporozoan parasite) or cyst stages.

In addition to skin lesions, fish often go off their food and develop a hollow-bellied appearance. They also typically have stringy, off-color feces. Hexamita often exist at low levels in the intestines of tropical fish, especially cichlid fish (including discus, angelfish and oscars) and gouramis. If conditions in the fish aquarium include stress, overcrowding, low oxygen levels, improper water parameters, changes in temperature or poor diet, the parasites can multiply, and the fish may then develop signs of systemic disease.

The best way to treat Hexamita infections is with medicated food – if the fish are still eating. For both Hexamita and Spironucleus, metronidazole can be used and is available commercially in fish food flakes. However, because infected fish often do not feed, they usually won’t ingest an effective dose. In such cases, a bath of metronidazole can be used instead, immersing the fish for six to 12 hours, with 250 mg of metronidazole per 10 gallons of water. Metronidazole tablets, capsules or liquid can be used to prepare the bath.

Several courses of treatment may be necessary to successfully control these parasites. Of course, as with all infectious organisms, it is always best to prevent introduction to the fish aquarium in the first place by quarantining and prophylactically treating all new stock, as well as maintaining your fish in the most healthful manner possible.

VELVET DISEASE

A parasitic single-celled organism known as a dinoflagellate (Piscinoodinium, commonly called Oodinium) is responsible for velvet disease. This parasite has a direct life cycle, and has free-living and parasitic stages. The obvious symptoms are a yellow-gray coating to the scales, skin and fins. Fish may flash and show increased gill movements. In advanced cases, the fish will become anorexic and float motionless in the water, and the skin may peel away in strips.

A novice may confuse this disease with ich, but fish with velvet appear as if they are sprinkled with gold dust, hence the common name of "gold dust disease." This parasite moves from fish to fish with a flagellated spore, and can live off the fish for at least 24 hours, and probably longer (up to several days).

Velvet is usually introduced with new fish and may develop into a serious problem. Heavy infestation on the gills may kill fish without causing other obvious signs of the disease. It is most often found among some anabantids, killifish and goldfish. The parasite may establish itself in the intestinal tract of fish, making treatment more difficult, and long-term control of the parasite can be quite frustrating.

Treatment with ich or velvet remedies may be used. If the fish are salt tolerant, a prolonged (see the "Ich Treatment" section for suggested durations) salt treatment using 1 teaspoon of salt per 5 gallons of water can be used to eradicate the parasite. Interestingly, because the parasites use photosynthesis, keeping the aquarium relatively dark can help during a serious outbreak.

NEON TETRA DISEASE

Another protozoal parasite, Pleistophora, is responsible for neon tetra disease. A range of fish species are susceptible, but this parasite seems to affect many tetras in particular. Zebra danios and some barbs are also commonly affected by a similar disease.

Heavily infected tropicalfish will exhibit a loss of coloration (especially the red stripe on neons), unusual swimming behavior, spinal curvature, emaciation and frayed fins. Treatment has been attempted with a number of drugs, but none have been completely effective. Some medications, such as combination products on the market that contain an antiprotozoal and antibiotic, will help control secondary bacterial infections.

MONOGENETIC FLUKES

Monogenetic flukes are flatworms that are usually found as ectoparasites of fish. They often have a hooked attachment organ and a simple life cycle, and are just barely visible to the naked eye. They often feed on skin and gill tissue, but usually only cause problems if found in large numbers. Clinical signs are flashing and skin problems.

Treatment with formalin, praziquantel, Trichlorofon (dimethyl phosphate) or salt baths are effective. Formaldehyde can be used as a bath for 12 to 24 hours at 20 to 25 ppm (mg/L), repeated every three days for three treatments, with 30- to 70-percent water changes between treatments (same regimen as for ich).

Praziquantel is dosed as a bath for three to six hours at 5 to 10 mg/L repeated three times. In between each dosage, change 30 to 70 percent of the water. Praziquantel is now available in several commercially prepared tablets.

Trichlorofon is used as a bath for one hour at 0.25 to 1.0 ppm repeated daily for three days, with 30- to 70-percent water changes between treatments. A salt bath can be a four to five-minute dip, dosed at 30 to 35 grams/L repeated daily for three treatments, with 30- to 70-percent water changes between treatments.

DIGENEANS

Digeneans are endoparasitic flukes that have two suckers, one at each end. They have an indirect life cycle, with tropical fish acting as both intermediate hosts (carrying metacercaria larvae) and final hosts. Adult digeneans are usually found in the gastrointestinal tract, while the larvae (which may be encysted) can be found throughout the body and cause problems if they invade such organs as the eyes or heart in high numbers. The larval stages of digenetic fluke parasites cause black spots in aquarium fish.

Praziquantel is the treatment of choice as a bath for three to six hours, dosed at 5 to 10 mg/L, repeated for three doses, with 30- to 70-percent water changes between dosing. This drug may also be dosed in fish food at 5 mg/kilogram of fish.

TAPEWORMS AND ROUNDWORMS

Tapeworms are endoparasites, with adult tapeworms living in the digestive tract. Tapeworms are most common in newly imported or wild-caught fish. They have an indirect life cycle, with fish serving as both intermediate and final hosts. There is a public health concern because some tapeworms can infect humans. Signs of tapeworms may be a swollen abdomen and a fish that appears to be wasting away. Affected fish may have difficulty swimming, as well.

Praziquantel can be used to remove tapeworms from the intestinal tract (same treatment regimen as described in previous digeneans section) but will not eliminate those residing within the body cavity. Repeating treatment with praziquantel may be necessary to completely eradicate tapeworms.

Be aware that some live fish foods, such as cyclops and water fleas, can be the intermediate hosts of many of these parasites, unless you are certain the fish food items come from a fish-free water source. Roundworms (also called nematodes) may also be found inside aquarium fish. They have complex indirect life cycles, and fish can serve as both intermediate and final hosts. Nematodes can cause problems to tropical fish (and also to humans who become infected by eating raw or poorly prepared fish). Roundworms are reddish-brown in color and vary in size. In severe infections, they may be seen protruding from the vent. Nematodes can be found in the digestive system, swim bladder and body cavity.

Treatment involves breaking the life cycle and using appropriate drugs such as fenbendazole, which is dosed in fish food for three days at 200 mg/100 grams of fish food. It may require several rounds of treatment, in addition to eliminating any intermediate hosts and improving general hygiene to remove infective stages. Piperazine can be used to treat livebearers with Camallanus nematodes. Mix 25 mg piperazine citrate with 10 grams of flake food, and feed to fish for five to 10 days. A repeat course of treatment is recommended 10 to 14 days later (dosed at 50 to 100 mg/kilograms of body weight).

FISH LICE, GILL MAGGOTS AND ANCHOR WORMS

Some crustaceans are parasitic to fish, including the fish louse Argulus and the gill maggot Ergasilus. Both of these parasites are usually found on newly imported fish. Because they suck blood, they can transmit certain infections between fish.

The fish louse attaches itself to the skin and fins by means of twin suckers, and feeds on the blood of the host. The intense irritation may cause fish to flash, and heavily infested tropical fish may even jump out of the water. Red lesions occur where the lice have attached, and this opens the skin up to secondary bacterial and fungal infections.

Gill maggots are usually found attached to the gills, gill covers and inside the mouth. They are several millimeters long, and the common name refers to the adult females, with their prominent, whitish, “maggotlike” egg sacs. The male does not become a parasite. Heavy infestation can result in severe gill damage, emaciation, anemia and death.

Treatment requires an organophosphate insecticide such as dimethyl phosphate (also called phosphonate), Trichlorfon and Dimilin. The drug can be applied to a backyard pond or aquarium to eradicate both adult and juvenile crustacean parasites. Baths of Trichlorfon and Dimilin are both effective. Dimilin may be used as a bath for 48 hours, at 0.01 mg/L, repeated up to three times, and Trichlorfon can be used as a bath for one hour at 0.25 to 1.0 ppm, repeated up to three times.

Anchor worms are another crustacean parasite, elongated with two egg sacs at the rear end. They usually embed in the muscle of the body wall and often penetrate as far as the internal organs. A raised ulcer usually develops at the point of attachment, and secondary infections often occur at that site. Heavy infestations may cause weight loss and death.

Anchor worms don’t typically occur in aquariums. They are most often a problem with newly imported tropical fish and in garden ponds during the summer. Male anchor worms have a short life span and die after mating; females are usually seen attached to the fish host. Eggs hatch to produce free-living juvenile parasites, which eventually molt to produce adult stages. The juvenile stages can live without a host for at least five days.

As with other crustacean parasites, organophosphate insecticides are used to eliminate the free-living juvenile stages. Remove adult worms with a forceps and treat the site with a suitable antiseptic. Remove parasites weekly until no more adult worms are found.

CONCLUSION

It's impossible to discuss every type of parasite that can attack freshwater fish, but those discussed in these two articles are the most commonly encountered. Please remember that prevention is always better than trying to treat and cure problems, and quarantining is your best way to protect your established fish.

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