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GENERAL AQUARIUM MAINTENANCE, MAINTENANCE OF WATER QUALITY, CONTROLLING AMMONIA, FEEDING REGIMES

An aquarium is a vivarium of any size having at least one transparent side in which aquatic plants or animals are kept and displayed. Fishkeepers use aquaria to keep fish, invertebrates, amphibians, aquatic reptiles such as turtles, and aquatic plants. The term "aquarium", coined by English naturalist Philip Henry Gosse, combines the Latin root *aqua*, meaning water, with the suffix *-arium*, meaning "a place for relating to".

The aquarium principle was fully developed in 1850 by the chemist Robert Warington, who explained that plants added to water in a container would give off enough oxygen to support animals, so long as the numbers of animals did not grow too large.

The aquarium craze was launched in early Victorian England by Gosse, who created and stocked the first public aquarium at the London Zoo in 1853, and published the first manual, *The Aquarium: An Unveiling of the Wonders of the Deep Sea* in 1854. An aquarium is a water-filled tank in which fish swim about. Small aquariums are kept in the home by hobbyists. There are larger public aquariums in many cities. This kind of aquarium is a building with fish and other aquatic animals in large tanks. A large aquarium may have otters, turtles, dolphins, sharks and whales. Most aquarium tanks also have plants.

An aquarist owns fish or maintains an aquarium, typically constructed of glass or high-strength acrylic. Cuboid aquaria are also known as fish tanks or simply tanks, while bowl-shaped aquaria are also known as fish bowls. Size can range from a small glass bowl, under a gallon in volume, to immense public aquaria of several thousand gallons. Specialized equipment maintains appropriate water quality and other characteristics suitable for the aquarium's residents.

Aquarium maintenance

Large volumes of water enable more stability in a tank by diluting effects from death or contamination events that push an aquarium away from equilibrium. The bigger the tank, the easier such a systemic shock is to absorb, because the effects of that event are diluted. For example, the death of the only fish in an 11-litre (3 US gal; 2 imp gal) tank causes dramatic changes in the system, while the death of that same fish in a 400-litre tank with many other fish in it represents only a minor change. For this reason, hobbyists often favor larger tanks, as they require less attention.

Several nutrient cycles are important in the aquarium. Dissolved oxygen enters the system at the surface water-air interface. Similarly, carbon dioxide escapes the system into the air. The phosphate cycle is an important, although often overlooked, nutrient cycle. Sulfur, iron, and micronutrients also cycle through the system, entering as food and exiting as waste. Appropriate handling of the nitrogen cycle, along with supplying an adequately balanced food supply and considered biological loading, is enough to keep these other nutrient cycles in approximate equilibrium.

An aquarium must be maintained regularly to ensure that the fish are kept healthy. Daily maintenance consists of checking the fish for signs of stress and disease. Also, aquarists must make sure that the water has a good quality and it is not cloudy or foamy and the temperature of the water is appropriate for the particular species of fish that live in the aquarium.

Typical weekly maintenance includes changing around 10–30% or more of the water while cleaning the gravel, or other substrate if the aquarium has one; however some manage to avoid this entirely by keeping it somewhat self-sufficient. A good habit is to remove the water being replaced by "vacuuming" the gravel with suitable implements, as this will eliminate uneaten foods and other residues that settle on the substrate.[61] In many areas tap water is not considered to be safe for fish to live in because it contains chemicals that harm the fish. Tap water from those areas must be treated with a suitable water conditioner, such as a product which removes chlorine and chloramine and neutralizes any heavy metals present. The water conditions must be checked both in the tank and in the replacement water, to make sure they are suitable for the species.

Water conditions

The solute content of water is perhaps the most important aspect of water conditions, as total dissolved solids and other constituents dramatically impact basic water chemistry, and therefore how organisms interact with their environment. Salt content, or salinity, is the most basic measure of water conditions. An aquarium may have freshwater (salinity below 500 parts per million), simulating a lake or river environment; brackish water (a salt level of 500 to 30,000 PPM), simulating environments lying between fresh and salt, such as estuaries; and salt water or seawater, simulating an ocean environment. Rarely, higher salt concentrations are maintained in specialized tanks for raising brine organisms.

Saltwater is usually alkaline, while the pH of fresh water varies more. Hardness measures overall dissolved mineral content; hard or soft water may be preferred. Hard water is usually alkaline, while soft water is usually neutral to acidic. Dissolved organic content and dissolved gases content are also important factors.

Home aquarists typically use tap water supplied through their local water supply network to fill their tanks. Straight tap water cannot be used in localities that pipe chlorinated water. In the past, it was possible to "condition" the water by simply letting the water stand for a day or two, which allows the chlorine time to dissipate. However, chloramine is now used more often and does not leave the water as readily. Water conditioners formulated to remove chlorine or chloramine are often all that is needed to make the water ready for aquarium use. Brackish or saltwater aquaria require the addition of a commercially available mixture of salts and other minerals.

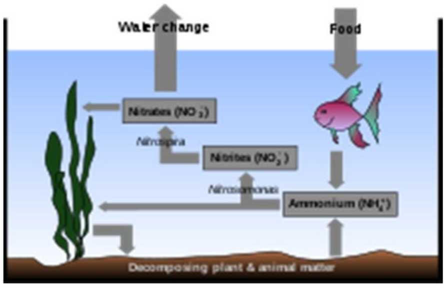
This aquarium features a heated tank and a glass-enclosed top for warmth during winter

Some aquarists modify water's alkalinity, hardness, or dissolved content of organics and gases, before adding it to their aquaria. This can be accomplished by additives, such as sodium bicarbonate, to raise pH. Some aquarists filter or purify their water through deionization or reverse osmosis prior to using it. In contrast, public aquaria with large water needs often locate themselves near a natural water source to reduce the level of treatment. Some hobbyists use an algae scrubber to filter the water naturally.

Water temperature determines the two most basic aquarium classifications: tropical versus cold water. Most fish and plant species tolerate only a limited temperature range; tropical aquaria, with an average temperature of about 25 °C (77 °F), are much more common. Cold water aquaria are for fish that are better suited to a cooler environment. More important than the range is consistency; most organisms are not accustomed to sudden changes in temperatures, which can cause shock and lead to disease. Water temperature can be regulated with a thermostat and heater.

Water movement can also be important in simulating a natural ecosystem. Aquarists may prefer anything from still water up to swift currents, depending on the aquarium's inhabitants. Water movement can be controlled via aeration from air pumps, powerheads, and careful design of internal water flow (such as location of filtration system points of inflow and outflow).

Nitrogen cycle



The nitrogen cycle in an aquarium

Of primary concern to the aquarist is management of the waste produced by an aquarium's inhabitants. Fish, invertebrates, fungi, and some bacteria excrete nitrogen waste in the form of ammonia and must then either pass through the nitrogen cycle or be removed by passing through zeolite. Ammonia is also produced through the decomposition of plant and animal matter, including fecal matter and other detritus. Nitrogen waste products become toxic to fish and other aquarium inhabitants at high concentrations. In the wild, the vast amount of water surrounding the fish dilutes ammonia and other waste materials. When fish are put into an aquarium, waste can quickly reach toxic concentrations in the enclosed environment unless the tank is cycled to remove waste.

The process

A well-balanced tank contains organisms that are able to metabolize the waste products of other aquarium residents. This process is known in the aquarium hobby as the nitrogen cycle. Bacteria known as nitrifiers (genus *Nitrosomonas*) metabolize nitrogen waste. Nitrifying bacteria capture ammonia from the water and metabolize it to produce nitrite.

Nitrite is toxic to fish in high concentrations. Another type of bacteria (genus *Nitrospira*) converts nitrite into nitrate, a less toxic substance. (*Nitrobacter* bacteria were previously believed to fill this role. While biologically they could theoretically fill the same niche as *Nitrospira*, it has recently been found that *Nitrobacter* are not present in detectable levels in established aquaria, while *Nitrospira* are plentiful. However, commercial products sold as kits to "jump start" the nitrogen cycle often still contain *Nitrobacter*

In addition to bacteria, aquatic plants also eliminate nitrogen waste by metabolizing ammonia and nitrate. When plants metabolize nitrogen compounds, they remove nitrogen from the water by using it to build biomass that decays more slowly than ammonia-driven plankton already dissolved in the water.

Maintaining the nitrogen cycle

Live plants in an aquarium help to complete the nitrogen cycle, by utilizing nitrate as fertilizer. This 60-litre aquarium contains *Anubias barteri* and *Echinodorus bleheri*. A heater and small filter are in the background.

What hobbyists call the nitrogen cycle is only a portion of the complete cycle: nitrogen must be added to the system (usually through food provided to the tank inhabitants), and nitrates accumulate in the water at the end of the process, or become bound in the biomass of plants. The aquarium keeper must remove water once nitrate concentrations grow, or remove plants which have grown from the nitrates.

Hobbyist aquaria often do not have sufficient bacteria populations to adequately denitrify waste. This problem is most often addressed through two filtration solutions: Activated carbon filters absorb nitrogen compounds and other toxins, while biological filters provide a medium designed to enhance bacterial colonization. Activated carbon and other substances, such as ammonia absorbing resins, stop working when their pores fill, so these components have to be replaced regularly.

New aquaria often have problems associated with the nitrogen cycle due to insufficient beneficial bacteria.[65] Therefore, fresh water has to be matured before stocking them with fish. There are three basic approaches to this: the "fishless cycle", the "silent cycle" and "slow growth".

In a fishless cycle, small amounts of ammonia are added to an unpopulated tank to feed the bacteria. During this process, ammonia, nitrite, and nitrate levels are tested to monitor progress. The "silent" cycle is basically nothing more than densely stocking the aquarium with fast-growing aquatic plants and relying on them to consume the nitrogen, allowing the necessary bacterial populations time to develop. According to anecdotal reports, the plants can consume nitrogenous waste so efficiently that ammonia and nitrite level spikes seen in more traditional cycling methods are greatly reduced or disappear. "Slow growth" entails slowly increasing the population of fish over a period of 6 to 8 weeks, giving bacteria colonies time to grow and stabilize with the increase in fish waste. This method is usually done with a small starter population of hardier fish which can survive the ammonia and nitrite spikes, whether they are intended to be permanent residents or to be traded out later for the desired occupants.

The largest bacterial populations are found in the filter, where is high water flow and plentiful surface available for their growth, so effective and efficient filtration is vital. Sometimes, a vigorous cleaning of the filter is enough to seriously disturb the biological balance of an aquarium. Therefore, it is recommended to rinse mechanical filters in an outside bucket of aquarium water to dislodge organic materials that contribute to nitrate problems, while preserving bacteria populations. Another safe practice consists of cleaning only half of the filter media during each service, or using two filters, only one of which is cleaned at a time.

Biological load

A very heavily stocked 19-liter aquarium containing *Paracheirodon innesi*, *Trigonostigma heteromorpha*, and *Hemigrammus erythrozonus*

The biological load, or bioload, is a measure of the burden placed on the aquarium ecosystem by its inhabitants. High biological loading presents a more complicated tank ecology, which in turn means that equilibrium is easier to upset. Several fundamental constraints on biological loading depend on aquarium size. The water's surface area limits oxygen intake. The bacteria population depends on the physical space they have available to colonize.

Physically, only a limited size and number of plants and animals can fit into an aquarium while still providing room for movement. Biologically, biological loading refers to the rate of biological decay in proportion to tank volume. Adding plants to an aquarium will sometimes help greatly with taking up fish waste as plant nutrients. Although an aquarium can be overloaded with fish, an excess of plants is unlikely to cause harm. Decaying plant material, such as decaying plant leaves, can add these nutrients back into the aquarium if not promptly removed. The bioload is processed by the aquarium's biofilter filtration system.

Experienced aquarists warn against applying these rules too strictly because they do not consider other important issues such as growth rate, activity level, social behaviour, filtration capacity, total biomass of plant life, and so on.[68] It is better to apply the overall mass and size of a fish per gallon of water, than simply the length. This is because fish of different sizes produce quite differing amounts of waste. Establishing maximum capacity is often a matter of slowly adding fish and monitoring water quality over time, following a trial and error approach.

Feeding regimes

Fish were fed to apparent satiation by adopting the following procedures. All tank rations were gradually increased from 1.5 to 5.0% of tank biomass in the 3 days following stocking (i.e. acclimation). During this period the allocated ration for each tank was split equally between a morning and afternoon feeding. Information on feeding strategies, feed conversion ratios, etc. is limited, mostly referring to Australian farming practices. Here the fattening period is short, varying from 3 to 10 months. Fat levels show a decline over winter months, supporting the fact that the summer growth produces better quality fish. The farmed southern bluefin tuna are fed baitfish six days a week, twice a day. The feed is generally presented by placing the frozen blocks of baitfish (pilchards, herrings, mackerel, squid) in a mesh within each cage. Supplementary feeding is generally done by hand. In 2001 some 20 species and about 45 000 tonnes of baitfish were used, sourced locally and overseas. typically, over a farming season, food conversion ratios are about 10-15:1 using baitfish.

BACTERIAL, VIRAL, FUNGAL, PROTOZOAN, CRUSTACEAN FISH DISEASES

Bacterial Diseases

Bacterial disease is the most common infectious problem of ornamental fishes. Collectively, only water quality problems exceed bacterial diseases in the area of pet fish morbidity and mortality. The majority of bacterial infections are caused by Gram-negative organisms including the following pathogenic genera: *Aeromonas, Citrobacter, Edwardsiella, Flavobacterium (Flexibacter), Mycobacterium, Pseudomonas, and Vibrio. Streptococcus,* a Gram-positive genus, has been shown to cause disease in ornamental fishes. Bacterial organisms may be the primary cause of disease, or they may be secondary invaders, taking advantage of a breach in the fish's integument or compromise of its immune system. The majority of bacterial fish pathogens are natural inhabitants of the aquatic environment, whether it be freshwater or marine. Nearly every bacterial pathogen of fish is capable of living independently away from the fish host. Virtually any extrinsic stress, including shipping, crowding, poor water quality, and inadequate nutrition, may predispose an ornamental fish to bacterial disease.

Bacteria are simply everywhere. One study sampled water from pet store aquariums and found a wide vareity of Gram-positive, Gram-negative, aerobic, and anaerobic organisms. In fact, every one of the eighteen samples of tropical fish water in this study contained *Pseudomonas* and *Citrobacter* while over 80% of the goldfish water samples contained *Pseudomonas*, *Citrobacter*, and *Escherichia* .

For a complete review of bacterial diseases of fish (primarily food fish species), the reader is encouraged to examine Bacterial Diseases of Fish, edited by Inglis, Roberts, and Bromage.

Viral Diseases

Several viral diseases have been thoroughly described in ornamental tropical fishes. The most commonly observed viral disease of tropical fish is called lymphocystis disease. This disease is caused by an iridovirus which infects connective tissue cells of the fish. The virus induces these cells to undergo extensive hypertrophy until the cells may actually be visible to the naked eye. Affected cells can increase a thousandfold in size. The disease appears to be more common in marine and brackish water fishes. Certain species of freshwater tropical fish like the green terror (*Aequidens rivulatus*) are prone to the disease. Members of the genera *Scatophagus*, *Monodactylus*, and *Changa* are all brackish water fishes that seem predisposed to lymphocystis disease. Stress is almost certainly a factor in this disease since outbreaks are frequently observed following capture and shipping of fishes. Gross lesions appear white and granular and usually are seen on the skin and fins. Occasionally, lesions will be seen in the mouth and on the gills. There is no proven chemotherapeutic treatment. Most cases are self limiting if the fish is provided with proper water quality and nutrition. Surgery can be performed on affected fish by carefully scraping the hyperplastic fibroblasts clear of the fish with a sterile scalpel or scissors. This procedure should be performed quickly and the patient(s) should receive 5-10 days of topical antibiotic therapy following the surgery. A definitive diagnosis can be made by microscopically examining a scraping of the affected area. The enlarged connective tissue cells will appear circular and in clusters. These cells frequently emit a light orange hue under the microscope.

Fungal Diseases

It is common for hobbyists and pet store owners alike to refer to any grossly visible skin disease of tropical fish as "fungus." one frequently sees diseases such as lymphocystis and protozoal ectoparasitic diseases lumped into the fungus category. Fortunately, fungal disease is very easy to identify under the microscope and other disease problems can be quickly ruled out following a simple skin scraping. Fungi belonging to the genus Saprolegnia are the most commonly observed species affecting tropical fishes. Such fungi are opportunistic pathogens which typically colonize exposed damaged tissue. A typical presentation of Saprolegnia would be on the fin rays of a catfish which had been recklessly handled with a net. Under most conditions, if the fish is well supported with clean water and good food, the fungal tufts will slough off in time without the necessity of treatment. In severe cases, treatment may be warranted. These fungi are susceptible to several compounds including formaldehyde, malachite green and salt. Microscopically, the clinician will see typical fungal hyphae wound in a tight mat with the possibility of reproductive bodies being present.

Protozoal Diseases

The following list provides the correct spellings and a brief description of some important protozoal disease agents of tropical fish.

Brooklynella- The marine "cousin" of *Chilodonella*. Found on saltwater tropicals. Looks very similar to *Chilodonella*. This parasite is also easily treated with protozoicides.

Chilodonella- A ciliated protozoan which can cause high morbidity and mortality among freshwater tropical fishes at the wholesale and fish farming levels of the industry. Attacks skin and gills. Easily identified microscopically by its heart-shaped structure and slow circular motion when not crawling on the surface of the fish. Once diagnosed, this problem is easily treated with formaldehyde, malachite green or salt.

Cryptocaryon- The marine form of "Ich." Frequently referred to as "white spot disease." This large ciliate possesses both free-swimming and encysted stages. Many aquarists control its spread with the prophylactic use of copper sulfate in the water. A quarantine protocol for new fishes can greatly help reduce the spread of this disease.

Epistylis (Heteropolaria)- A stalked ciliate which is commonly found in freshwater containing a high organic load. Tends to colonize bottom dwelling fish such as the plecostomus catfish. Lesions appear pale and white in color and resemble a fungal disease. Microscopically, one sees a ciliated crown atop a long stalk which is prone to frequent contractions. Easily treated with formaldehyde however a clean well filtered tank is the best solution to the problem. This disease is usually not fatal in itself but may open the fish up to secondary bacterial disease.

Henneguya- A sporozoan which presents in the form of small white cysts on the fins and gills of some fish. The cysts contain infective spores. Commonly seen on the dorsal fins of imported *Leporinus* species. Not harmful to the fish. Careful removal by scraping with a scalpel is the best treatment since the parasite is aesthetically undesirable.

***Hexamita (Spironucleus)*-** These flagellated protozoa may cause severe gastrointestinal disease if present in large numbers. Normal inhabitant of fish digestive tract. As an ectoparasite it is believed to be involved with "Hole in the Head Disease" (Head and Lateral Line Erosion) common to oscars and other cichlids. Treated effectively with metronidazole.

Ichthyobodo- Formerly (and still commonly) called Costia. A flagellated protozoal ectoparasite. A normal inhabitant of fish skin. Poor water quality and other stresses (especially crowding) may allow this normally mutualistic parasite to reproduce rapidly and overwhelm the host. It is responsive to treatment with formaldehyde and malachite green but tougher than most protozoa. Microscopically the protozoa are very small (5-10 microns), move rapidly, and are shaped like small sickles. They may be attached to host tissue or swimming free. Most common in freshwater species of fishes but has been reported from several marine fishes.

***Ichthyophthirius*-** Known commonly simply as "Ich." The largest protozoal parasite of fish and one of the most commonly encountered. Trophozoites may reach 1.0 mm in diameter. Can affect skin, gills or both. Prevention is the best method of control although the parasite is susceptible to a variety of parasiticides including malachite green and formaldehyde.

Plistophora- A microsporidian sporozoan which is the causative agent for true "Neon Tetra Disease." The parasite is not specific to neon tetras and when present will attack the musculature of the affected fish. Infected muscle will contain numerous sporoblasts containing spores. Grossly infected muscle will appear white or pale. Certain bacterial skin diseases will produce similar gross lesions. Such sporozoan infections are usually unresponsive to treatment and diseased fish should be removed from the tank. High mortality is usually associated with this disease.

Tetrahymena- Commonly called "Guppy Killer Disease." A ciliated protozoan which can be free-living or parasitic. Common in crowded conditions and in water containing excessive organic debris. Unaffected by parasiticides because of its ability to burrow deeply into skin of host which ultimately protects parasites from chemotherapeutics. Best method of control is prevention through sound husbandry practices. These pear-shaped protozoa may be present in very large numbers when the infestation is severe.

Trichodina- A disc-shaped ciliate protozoan found on the skin and gills of many fish. Circular rows of denticles and a ciliary girdle give this parasite a unique radial symmetry. Probably not harmful when present in small numbers.

Uronema- The marine counterpart of *Tetrahymena*. This is also a significant disease causing parasite. Tissue destruction by this protozoan will allow for secondary invasion by pathogenic bacteria.

Trematode Diseases

Both monogenean and digenean trematodes parasitize tropical fishes. Monogenean parasites including *Dactylogyrus* and *Gyrodactylus* are ectoparasitic and can cause considerable damage to the host when present in high numbers. These parasites possess a multiple hooked attachment organ called an opisthaptor which disrupts the integrity of the host's skin and mucus membranes. These monogeneans can complete their entire life cycle on a single host and in some species the cycle may be as short as 60 hours if all environmental conditions are optimal. Crowding and other stress factors predispose tropical fish to monogenean trematode problems. These parasites are generally resistant to low doses of formaldehyde and even some organophosphates. Most freshwater monogeneans can be killed quickly with a 3 to 5 minute saltwater bath (30-35 parts per thousand). Glacial acetic acid or hydrogen peroxide dips will also kill these parasites. Dosage information is given in the provided articles and references. Praziquantel baths have also proved to be effective in killing some monogenean worms. While expensive, this is a relatively safe treatment when used at a concentration of 10 parts per million for 3 to 6 hours.

The majority of digenean fluke problems appear to be primarily aesthetic in nature among tropical fish. Fish commonly serve as an intermediate host for these parasites which frequently have a complex life cycle. Invertebrates may be the first host and a bird or mammal the primary host. Encysted digeneans are commonly observed as metacercaria in the skin and underlying tissues of tropical fish. Occasionally these metacercaria are found in the coelomic cavity of tropical fish. Imported silver dollar fish species from South America are commonly infected with metacercaria belonging to the genus *Neascus*. Some fish may have only one or two metacercaria while others may harbor hundreds. This disease will not harm the fish and will not progress unless the fish is consumed by an appropriate primary host animal. Fish which are affected are sometimes said to have "Salt and Pepper" disease since the cysts become pigmented and the uplifted scales appear especially white or shiny. Another common digenean parasite is *Clinostomum* which is called the "Grub" by fish farmers in Florida. Excysted worms may be more than 5 millimeters long and are easily visible to the naked eye. If the metacercaria are not too numerous, they can be removed safely with a clean scalpel.

Occasionally, larvae belonging to the genus *Diplostomum* have been found associated with the lens in the eyes of tropical fish. In such cases the lens will become opaque and the fish may be blinded. There is no reported treatment for this disease.

Cestode Diseases

Tapeworms are found inhabiting the digestive tract of wild tropical fishes. Diagnosis can be made by fecal examination observing proglottids exiting the vent of a fish, or during necropsy. Recently, work has been published using praziquantel to treat infected fishes and it appears that certain tapeworms are susceptible to a dose as low as 2 parts per million in the water. Infected fish can be bathed in this solution for 3 hours with adequate aeration.

Tropical fish commonly act as an intermediate host in a cestode's life cycle and encysted tapeworm larvae called procercoids can be found in the coelomic cavity of tropical fishes.

Nematode Diseases

Nematodes are common parasites of fish and can be especially abundant in wild species. In some cases the tropical fish is the definitive host and the nematodes will be found in the gastrointestinal tract. In other instances the fish is an intermediate host and the larval nematodes will be seen encysted beneath the skin, in the musculature or in the coelomic cavity. Medical treatment of the larval forms is very difficult because these nematodes are encysted and well protected. Some species of *Eustrongyloides* form large cysts just under the skin of tropical fish and can be removed surgically, especially if the fish is relatively large. As is the case with other encysted larval helminth parasites, the disease will usually not progress unless the fish is eaten by the definitive host.

Gastrointestinal nematodes can be observed on necropsy and ova are readily seen on examination of the feces. While the presence of these parasites may not cause a problem in nature, the stresses of captivity and shipping may exacerbate any parasitic problem. Nematodicides such as fenbendazole and piperazine may be incorporated into food in order to successfully treat these problems. The attached articles contain dosage and treatment information.

Crustacean Diseases

There are several important crustacean parasites of tropical fish. *Laernea*, known commonly as "Anchorworm," is a modified copepod parasite which infects large scaled freshwater tropical and temperate species of fish. This parasite possesses a life cycle that includes microscopic pelagic larval stages that molt and grow several times before attacking the fish host. On the host the female anchorworm matures and produces two large egg sacs containing hundreds of *Laernea* eggs. This parasite is easily visible to the naked eye and may be more than 2 centimeters in length. They get their name from the attachment organ which is a highly modified structure which resembles the anchor on a ship. This structure is buried in the host's musculature and allows for the invasion of pathogenic bacteria. Plucking the parasites from the fish is warranted and usually results in inflamed areas which heal quickly. Organophosphates and glacial acetic acid dips are successful in treating the problem. The disease is especially common in imported and domestic goldfish.

The other major crustacean parasite is *Argulus*. This branchiuran crustacean is commonly called the "Fish Louse." Fish lice are flattened creatures with a very distinctive shape and appearance. They have a pair of eyespots and are about 5-10 millimeters in length. They move about the skin of a fish very effectively and camouflage themselves well on the host. They suck bodily fluids from the fish via a sharp stiletto that actually injects a small amount of toxin into the fish. These parasites are especially harmful to small fish. *Argulus* also possesses a life cycle with pelagic larval stages so the entire aquarium system may have to be treated with organophosphates to control the disease. Depending on temperature, the total life cycle takes between 6 and 20 weeks.

A less commonly seen group of crustacean parasites are the isopods. While most isopods are free living, members of the genus *Livoneca* can be parasitic. Terrestrial pill bugs commonly seen under rocks and logs are isopods and the aquatic parasitic forms resemble their land dwelling relatives. While *Argulus* is dorsoventrally compressed, isopods like *Livoneca* are laterally compressed and appear segmented.