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Flukes and Sick Guppies

By Diana Walstad (April 2018)

Upon a visit to most any aquarium store or pet shop, it is not hard to find sickness in the guppy tanks—clamped fins, shimmying, body sores, etc. Many hobbyists have given up on keeping guppies, because they seem so prone to dying from "who knows what." However, recent fish health surveys [1] show that flukes are *the* most common parasites of both diseased and non-diseased aquarium fish, including guppies. It is time to shine a spotlight on them!

High-Dorsal Blue Grass Guppies. Guppies from this beautiful strain that I shipped in from California were ones that I was unwilling to lose. When they got sick, I took action.

Flukes have been a disease problem for guppies for a long time. Indeed, wild guppies carry them in native habitats in Trinidad. In 1964, one famous guppy breeder's verdict (referring to the *Gyrodactylus* fluke) was that, "this parasite has caused us more trouble than all parasites combined. It causes the fish to shimmy his life away, and until cures were found for it, it made guppy keeping far less fun than it now is." [2] In 1999, another dedicated guppy breeder decided to nuke all of his guppies and start over because of an infestation of *Dactylogyrus* flukes (personal communication).

In 2017 when I started raising Guppies again, I was forced to face a problem that I had previously dismissed—sick guppies that died from unknown causes. Their problem turned out to be flukes, but it took awhile for me to figure that out.

In September 2017, two young females suddenly stopped eating, clamped their fins, and started shimmying. I was perplexed because these fish, which I had raised from birth, had been perfectly healthy a few days before. I did not know what their problem was, much less how to cure it.

However, faded notes from long ago described treating miscellaneous guppy diseases with salt. It would be a last-ditch effort to save some precious fish. But hey, I had an empty tank and I did have salt. I transferred the sick females to a 2-gal tank, now designated as a hospital tank. I fixed it up with an air bubbler and a reptile heating pad.

I started the saltwater treatment in a small container with 1 T. salt per gal (water from an established aquarium). After an hour, I moved the fish into a hospital tank with 2 T. salt/gal, which works out to 8.8 ppt (parts per thousand) or 0.88%. (Seawater is 35 ppt salt.) I was careful not to overfeed and replaced 50% of the water every other day with fresh 8.8 ppt saltwater. The sick females made a home underneath the heating pad and I expected them to die there. On the second day, however, they appeared noticeably better and began eating live brine shrimp. The improvement continued and the fish recovered fully within the next two days. I was astounded!

I still had no idea what disease the fish had come down with. It probably was not Fish TB, a chronic, slow-acting disease. Rather, I was witnessing a disease that progressed almost overnight from normal-appearing fish to sick fish. Treating the tank with the antibiotic Amoxicillin had no effect, so the problem was probably not bacteria.

The only symptom that I initially observed was "flashing," that is, a few fish sometimes scraped against objects in the tank. On the skin of fish that had become noticeably sick, I could discern faint whitish abnormalities; their skin wasn't clean and shiny. This suggested that the problem could be an external pathogen on the fish rather than an internal problem. The fact that salt had worked so well supported my growing suspicion that the pathogen might be an external parasite.

Fish Autopsy I euthanized this juvenile female guppy (2.5 cm long and about 6 weeks old), quickly and without pain, by putting her into about 1 cup of tank water in a glass jar with 2 drops of clove oil. It was essential that I mix the oil with the water beforehand; otherwise, the oil just floats on the water surface and doesn't affect the fish.

But if a parasite was plaguing my guppies, which parasite? As I began digging into the scientific literature, I learned that Monogenean flukes cause guppies—and other freshwater fish—a lot of problems. Moreover, Monogeneans can be easily killed by salt, the "wonder drug" that had cured my sick guppies. So I had a hunch that the pathogen could be a Monogenean.

One day when one young female was flashing vehemently, I decided to take a closer look. I euthanized the fish and put her under an inexpensive student microscope. Much to my surprise, I discovered on her skin at least 6 flukes flapping away. A veterinarian confirmed that they were skin flukes, that is, species of *Gyrodactylus*. (I call them "GYROs".)

The Pathogen Revealed Photo shows a skin fluke on my guppy's skin next to one of her fins. Length of fluke is about 0.3 mm. Most likely, it is either *Gyrodactylus turnbulli* or *G. bullatarudis*, the two GYRO species commonly associated with guppies.

Flukes Don't Like Salt

Putting fish into saltwater kills flukes, because the salt sucks the water out and dries them up like prunes. The smaller an animal/organism's size, the greater will be salt's impact. (Smaller animals have a higher surface area to volume ratio such that they are more affected by the salt.) Thus, the 9 ppt salt that I used to treat my Guppies had killed the ~0.3 mm flukes but not the 2.5 cm (~1 inch) fish being treated.

Determining a salt concentration that kills the fluke without stressing the fish unnecessarily is not always straightforward. Guppies adjust well to higher salinities, but plants and some aquarium fish (e.g., catfish) do not. Salt has multiple effects. Higher salinities strip off the fish's mucus layer or "slime coat," thereby exposing the fluke to salt's drying power. In contrast, low salt stimulates the fish to produce more mucus. Mucus generally protects the fish, but it is also what flukes feed on. Thus, investigators [3] found that 3 ppt salt actually

stimulated the proliferation of GYROs on guppies during the first two weeks; in contrast, 7 ppt hindered fluke population growth dramatically within days.

Quick baths at higher salt concentrations can stress the fish and may not eradicate all flukes. Thus, investigators reported that giving infected guppies "salt baths" (15 minutes at 25 ppt salt) killed 100% of *Gyrodactylus turnbulli* but only 73% of *G. bullatarudis* [3]. The investigators noted that some of the juvenile guppies subjected to these salt baths died 3 days later.

Drug Treatment

The salt treatment I used (3-4 days at 8.8 ppt salinity) miraculously cured sick adult guppies that I had thought were goners. The results had also helped me frame a diagnosis at practically no cost. But for the long run, the salt treatment was unwieldy, because it required isolating fish in a hospital tank. (The salt would kill plants and stress juvenile guppies.) As progeny of the cured adults began to show symptoms, I realized that I needed another option.

Fish can be treated for flukes with a gamut of chemicals—salt, formalin, Praziquantel, etc [4]. I first used a liquid preparation of the drug Praziquantel. I treated all the tanks once and then again 4 days later at a Praziquantel concentration of 2.5 mg/liter. I observed no side effects on plants, fish, or snails.

Praziquantel helped, but the flukes came back a month later. The new infestation was particularly bad in the 50 gal where there was a lot of "coming and going." (The 50 gal was a holding tank for assorted adults that I had used for breeding or was planning to use for breeding.) Within 2 weeks of adding new fish, 3 of the ~15 resident guppies died and several were showing symptoms—dark coloration, whitish growths and patches.

For this major outbreak, I used Levamisole HCl[1], an anthelmintic frequently used by guppy-fluke investigators for short-term (24 hour) treatment [5, 6]. For my stock solution, I dissolved 5 grams of the white powder in 130 ml of distilled water in a glass jar (no plastic). I added 50 ml of this stock solution to the 50 gal tank which yielded a final Levamisole concentration in the tank of 10 mg/ml. No UV or charcoal filtration. I stored the stock solution—for up to 6 weeks—in the refrigerator.

To monitor the treatment and possible drug toxicity, I kept my eye on one big Blue Grass female. She was still eating, but had a tiny white pimple above her eye, rough patches on skin, and her body had darkened. After 24 hours of treatment, the white pimple was gone, but she still had skin patches. All the guppies had stopped eating. So I changed 20% of water and added charcoal to the filter to remove some of the drug. Next day, I transferred all 10 surviving guppies to a new tank (no Levamisole).

Levamisole kills GYRO flukes very quickly (minutes and hours [5]), so I didn't see any point in keeping my guppies exposed to this powerful drug any longer than necessary. Levamisole apparently may cause health problems in guppies with long-term exposure (e.g., 7 days) [6]. One investigator reported that Levamisole treatments caused sterility in brood stocks of Zebrafish [7].

I discarded one small female who did not show improvement, but the 9 remaining fish recovered completely within a few days and adapted well to their new 20 gal tank. (*See* photo on next page.)

It is entirely possible that the flukes may return, because a comprehensive survey of the literature shows that there is no "sure cure" against flukes [8]. And if even one fluke survives, it can start a new infestation. But first a little bit about flukes.

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[1] Levamisole HCl can be purchased from Charles Harrison at: http://www.inkmkr.com/Fish/ItemsForSale.html OR Greg Sage at http://www.selectaquatics.com OR from Amazon.com (as a sheep and cattle dewormer).

Rescued Guppies Seven days after treating 10 sick guppies with Levamisole HCl (10 mg/l for 24 hours), the 9 survivors made a complete recovery from a fluke infestation. These particular fish (both the fancy-bred HD Blue Grass and various pet shop fish) seem to have some innate resistance to the flukes.

The Nature of Flukes

Flukes of the Phylum Platyhelminthes are divided into Monogeneans (MONOs) and Trematodes (TREMs). The TREMs, which are found on wild and pond fish, require an intermediate host like a bird or a specific snail (*Melanoides tuberculata*) to transmit. Because TREM-infected fish are not contagious once in the aquarium, TREMs are not that big a problem for aquarium hobbyists.

In contrast, MONOs readily transmit directly from fish-to-fish. They also reproduce rapidly. The MONOs most relevant to hobbyists are small flukes of the Super families Gyrodactyloidea (GYROs) and Dactylogyroidea (DACTs). According to health surveys [1], GYROs and DACTs are equally prevalent in aquarium fish. Both can be killed by the same chemicals and drugs [4].

DACTs lay eggs and infest the gills. Their total life cycle takes 5-40 days. Each day, an adult fluke lays about 5-60 eggs, which sink to the substrate. The eggs hatch 2-6 days later (at 20- 28°C). The

***Gyrodactylus salaris* on a Salmon [9]**

Photo shows flukes feeding on the fish's skin and mucus layer. Since the mid 1970s, this fluke species has wreaked havoc on the wild salmon in many Norwegian rivers.

[Photo used with permission of the authors.]

swimming larvae must reach a fish host within 4- 6 hours before they run out of energy. Once attached to the fish, the larvae migrate to the gills and develop into adults with their characteristic four eyespots within 4-5 days [10]. Because DACTs lay eggs, they are—according to one knowledgeable guppy breeder—harder to get rid of than GYROs.

GYROs, which mainly infect the fish's skin and fins, are livebearers. Like a Russian Doll, each newly born GYRO is already carrying an embryo—and within it another embryo. When a GYRO is one day old, it produces a first-borne daughter. The first-borne daughter gives birth one day later, and her daughter, in turn, gives birth one day later and so forth for up to 30 generations. (For the guppy fluke *G. bullatarudis*, the released embryo gives birth even sooner—within 18 hours [11].) This rapid asexual reproduction insures rapid colonization of an infected fish.

An individual fluke tends to stay on the same fish upon which it was born. The fish's increasing immunity or its own death may force the fluke to leave home. For flukes, life in the open water is risky. Once detached from guppies, GYRO parasites *G. bullatarudis* and *G. turnbulli* were dead at 30 hours; mean survival time was 18 hours at 25°C [3].

For GYRO transmission, a fluke may grab on to another fish during direct fish-to-fish contact. *G. turnbulli* actually crawls up to the surface water film to hang there waiting to latch onto surface-feeding guppies [9]. Another transmission means is via the fish's "mucus shedding." Fish shed some of their mucus layer every 1-2 days [12]. This normal cleansing mechanism protects the underlying epidermis from colonization by microorganisms and parasites in the water [13]. GYROs embedded in this mucus material are automatically sloughed off [12]. Uninfected fish come in contact with this parasite-infested material while they are foraging or resting on the bottom. Transmission may also take place when guppies give birth, thereby infecting their fry [9].

That said, fluke transmission is generally clumsy. Experimental studies have reported considerable "transmission failure" in trying to transfer GYRO flukes purposely from infected fish to uninfected ones [14].

Disease Resistance and Management

Once a fish colony is infected with GYROs, not all individual fish are doomed. Fish contain a huge assortment of chemical weapons (anti-microbial peptides, lyzozyme, etc) in their mucus layer [13]. Many scientists have noted that the GYRO population on infected fish begins to decline within two weeks following a GYRO epidemic; they attribute this to the surviving fishes' development of increased resistance [3, 12, 14]. This acquired immunity, however, lasts only a few weeks once the flukes are gone.

Wild guppies in Trinidad are generally infected with small numbers of GYROs. A few isolated habitats, however, contain uninfected guppies [15]. One study [16] showed that the fluke population on experimentally infected Guppies died out completely within about 3 months—*provided* that no new fish were introduced into the tanks. Any addition within that time-frame of new—and presumably immunologically susceptible—fish stimulated the parasite population and kept it from dying out.

For keeping aquarium fish, I think prophylatictic treatment of new, incoming fish is warranted. Well-managed fish stores treat their tanks twice a week with formalin and/or keep their fish in salt. These measures automatically keep the fluke population under control while fish are under stress. When I purchase new fish now, I just assume that they carry parasites. I do not wait for them to get sick. I either put them in a quarantine tank with 8.8 ppt salt for a few days or treat them briefly with Levamisole (e.g., 4 hours at 10 mg/l).

Although a guppy carrying GYRO flukes may "flash,"this behavior does not automatically signal an impending epidemic. Indeed, I have witnessed "flashing" fish that later seemed to have gotten rid of their flukes. Flukes are only lightly attached to fish; their 2 big hooks and 16 "hooklets" sink into the mucus but not the fish's skin [9, 12]. Thus, investigators can dislodge flukes from an anesthetized fish—viewed under a dissecting microscope—using either a jet of water [17] or by pulling them off with fine forceps [8] without injuring the fish. I believe flashing is just a protective cleaning mechanism. If the fish is otherwise healthy, it may be able to scrape off its little pests.

Flashing When this pretty male was 2 months old, I noted that he was "flashing." I kept an eye on him, concerned that he might have flukes. But nothing developed on him. The breeding pair (depicted here at 3 months of age) represent a promising cross between a fancy Blue-Grass male and a yellow pet store female.

Genetically susceptible fish create problems. One of my "fancy-bred" guppy strains and its progeny seemed to be particularly vulnerable to flukes. The problem with disease-susceptible fish is not just that they die, but they become a disease foci. Flukes multiply on them without restraint such that the fish becomes the starting point for an epidemic in the tank. Indeed, investigators [14] determined that the more GYROs on an infected guppy and the longer that fish stays in the tank, the greater the probability of its starting a fluke outbreak. In contrast, fish density—whether 3, 6, 12 or 24 guppies in a 10 gal tank—did not affect fluke outbreaks.

Most guppies offered in pet stores and many aquarium stores are imported from Southeast Asia (Singapore, Hong Kong, Sri Lanka). The fish are healthy, but they often carry small numbers of parasites [1]. The parasites are simply part of the pond environments from where the fish originated. Because pet store guppies often die after purchase, hobbyists view them as fragile. But most of that fragility and disease susceptibility comes from the stress associated with the fish's shipping and handling. Bagged up in Southeast Asia, fish are often in transit for up to a week without food or a water change.

Inevitably, broodstocks from Southeast Asian ponds have developed genes for parasite resistance in order to survive. Mass production of inexpensive fish in ponds does not allow for

Disease Resistance Ten days after I moved these 3 males from breeding tanks into this 50 gal holding tank with other guppies, a major fluke outbreak occurred. The two purebred beauties (Metalheads at the bottom of photo) died. Other guppies like the yellow pet store male (top of photo) did much better.

much “chemical coddling.” Disease-susceptible fish die or get culled out. Thus, pet store fish—genetically speaking—are more disease-resistant than the fancy strains, some of which have probably never seen a fluke.

If a single fish in a tank gets sick, ideally one should remove it before it dies, so as not to endanger its tank mates. This policy works well with flukes, because GYRO transmission from an infected guppy to uninfected tank mates is not that straightforward. One sick fish in a tank does not mean that all its tank mates will become sick.

I monitor my fish daily and keep records. Fish that have stopped eating or isolated themselves from other fish get a closer watch. If they get worse, I take them out of the tanks. In selecting breeding stock, I always choose the largest and most vigorous fish from a brood. In my opinion, a guppy’s resistance to flukes and other diseases is just as important as fin size and color.

Guppy fry and juveniles are vulnerable, because their immune systems are not fully developed. They can kick-start a low-level, endemic fluke population. To protect adult fish, I remove fry from breeding tanks in a timely manner.

Good general care of fish helps keep flukes from causing disease. I feed my guppies plenty of food twice a day. Babies and juveniles get live baby brine shrimp daily. All tanks support fast plant growth so that I can feed my fish well without having to do massive water changes or worry about water quality. (In these setups, excess food simply provides nutrients for plants.) I remove debris and change ~20% of the water every two weeks.

Discussion

Most aquarium hobbyists are unaware of the problems that flukes can cause. For a long time, that was also the case with biologists and taxonomists who mainly studied GYROs because of their interesting “Russian Doll” reproduction. But the devastation—beginning in the 1970s—of wild Norwegian salmon by *Gyrodactylus salaris* put a spotlight on GYRO flukes and spurred a flurry of research. The guppy and its two associated fluke species *G. bullatarudis* and *G. turnbulli* have become a popular model for scientists studying the GYRO problem in salmon [9]. Aquarium hobbyists trying to keep guppies healthy can benefit from their research.

Norway’s difficulties over the past several decades attempting to eradicate *G. salaris* from its wild salmon [9]—despite massive expenditure and effort, such as depopulating whole rivers of fish—should serve as a warning to aquarium hobbyists. Total eradication via drugs, botanicals, salt, etc may not be possible [6, 8]. Once a fish colony gets infected, relying solely on drugs to kill the flukes or destroying all potentially infected fish may only generate false hope and frustration.

Granted, it is possible that in a tightly controlled breeding setup, such as those of show-guppy breeders, one can eradicate flukes altogether. However, then one ends up with “bubble fish” that will have trouble holding their own against flukes in the real world.

Over the years, I have gotten very good results by crossing fancy guppies with pet store guppies. The progeny have hybrid vigor and get genes for disease resistance from the pet store guppies.

I gave my guppies a fighting chance with salt and the anthelmintic drugs Praziquantel and Levamisole. Newly purchased fish will always get some initial “chemical coddling.” After that, I plan to rely on good tank management and breeding disease-resistant fish.

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