Fish Health News You Can Use

Brought to you by the Pacific Region Fish Health Program

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This Issue

Contact Us

Pacific Region Fish Health Program Manager
Andrew Goodwin
US Fish and Wildlife Service, Pacific Region
911 N.E. 11th Avenue
Portland, OR 97232
Phone: (503) 231-6784
Email: andrew_goodwin@fws.gov
Website
www.fws.gov/pacific/Fisheries/fishhealth/

In the Next Issue

- Flagellated Parasites – Inside and Out
    - Cryptobia
    - Ichthyobodo
    - Hexamita/spironucleus
- Carbon Dioxide and fish
- Ammonia and Fish
- Fun factoids
- PRFHP updates
- Mystery parasite of the day

Highlights of the New FWS Fish Health Policy

I had hoped that by now the new draft National Fish Health Policy would be finalized, but it is still waiting on high level review and revision.

Diseases Caused by Yellow Filamentous Bacteria

The yellow filamentous bacteria are common in freshwater environments. Most of them can get along just fine without infecting animals, but when conditions are right they are willing and able to kill fish. Yellow filamentous bacteria cause three common diseases in trout and salmon; bacterial coldwater disease, bacterial gill disease, and columnaris disease. We'll look at all three.

Figure 1: Columnaris bacteria growing on an agar plate. It is obvious here why they are called "yellow filamentous bacteria.

Bacterial Coldwater Disease

Bacterial Coldwater Disease (BCWD) is a significant problem on trout and salmon hatcheries worldwide. It is caused by a bacterium called *Flavobacterium psychrophilum*. It affects many species of fish but the most serious outbreaks occur in coho salmon, rainbow trout, and steelhead.

Figure 2: Coho salmon after a bacterial coldwater disease outbreak. Survivors are often deformed.

Flavobacterium psychrophilum bacteria are found in cool freshwater systems throughout the world. These bacteria can live for months (and probably years) in water and as biofilm communities growing on surfaces. Like the "fungi" that we talked about in the last edition of the Fish Health News, it is best to think of *Flavobacterium psychrophilum* as always present and waiting for an opportunity to produce disease when conditions are right.

There are a number of conditions that seem to trigger outbreaks of BCWD in susceptible fish species. The disease occurs in a wide temperature range of 40-60° F with the most serious outbreaks occurring as temperatures warm toward 60° F. It got its "Coldwater Disease" name because it is able to produce disease at very cold temperatures and not because it is unable to cause disease when water is warmer. BCWD is most likely to occur when fish are young, when conditions are stressful, and especially when fish have skin damage.

The role of skin damage in coldwater disease appears to be very important. Both science and practical experience clearly show that the disease is far more likely to occur following handling (nets, graders, marking, tagging) when even microscopic damage to the skin allows the bacteria to enter. More surprisingly, it appears that very minor damage to eggs or sac fry that occur during incubation can allow the bacteria to enter eggs and fry and produce BCWD. It even appears that low loading or high flows in Heath trays can allow eggs and fry to bounce around and suffer damage that promotes BCWD. Leaving fry in vertical trays for too long can also cause fish to be damaged by the screens allowing bacteria to enter.

One of the most frustrating things about *Flavobacterium psychrophilum* is that not only is it nearly ubiquitous in freshwater environments where trout and salmon live, but it also appears to be vertically transmitted from adult female fish to their progeny. In a more perfect world our egg treatments with iodine would prevent this from happening, but it turns out that these bacteria 1) are quite resistant to iodine, and 2) may be hiding within eggs where the iodine can't get to them. Some evidence for within-the-egg vertical transmission is controversial, but the bacteria clearly target eggs in female fish before they are expelled and, while iodine is certainly helpful, even the most careful iodine treatments don't seem to prevent transmission through eggs. Thus, *Flavobacterium psychrophilum* may be present even in stacks loaded with disinfected eggs and using water from protected sources.

Given the association between BCWD, stress, and skin injuries, some steps for the prevention of BCWD are obvious:

1) Disinfect eggs with iodine
2) Disinfect egg spawning and incubation equipment between batches
3) Use protected water supplies
4) Match egg loading and water flows in trays to minimize eggs tumbling
5) Remove fry from trays before they start bumping up against the screens
6) Don't pond or feed fish too early
7) Maintain clean tanks & adequate flows
8) Minimize handling and handle as gently as possible when handling is necessary
9) Monitor fish closely, especially in the first 2-3 weeks after handling
10) Remove morts as often as possible (sick and dead fish with BCWD shed millions of *Flavobacterium psychrophilum*/hr)
11) Call the your fish health folks whenever you suspect that BCWD is developing

So how do you recognize BCWD? The classic signs of BCWD are fin erosion and then sores on the tail of the fish.

Figure 3: Typical tail erosion associated with bacterial coldwater disease.

However, the disease can have a different appearance with sores on the lower jaw, pale gills, or dark pigmentation (especially of the tail).

Figure 4: Nose erosion on a fish with bacterial coldwater disease.

Sick fish might be slow and lethargic, but spiral swimming also sometimes occurs. In very small fish, lethal damage to internal organs may happen before outward signs are obvious. The only way to be sure is to have the fish health experts look for bacteria in wet mounts under a microscope and to also set up cultures so that the bacteria can be definitively identified.

Figure 5: Skull deformities in a bacterial coldwater disease survivor.

Once a BCWD outbreak has been confirmed, the next step is to ponder treatment options.

Making sure that everything is right with the husbandry and that morts are being regularly removed is step one. If losses are severe, the next step may be the use of antibiotic-medicated feed. Unfortunately BCWD bacteria are masters at developing antibiotic resistance. Any antibiotic used repeatedly at the same hatchery will likely promote the development of resistant bacterial strains. This is especially common with oxytetracycline, but other antibiotics (including amoxycillin and oxolinic acid in Europe) quickly become useless. The current drug of choice in our region is florfenicol, but in other settings *Flavobacterium psychrophilum* has shown no difficulties in developing resistance to this antibiotic. Cultures and antibiotic sensitivity testing are a critical part of BCWD treatment. Antibiotics should only be used when 1) losses are likely to be severe, and 2) the bacteria are known to be susceptible. It is important to note that antibiotic use must be reserved for severe cases and that relying on regular antibiotic use will quickly lead to antibiotic resistance and major fish losses. As with all bacterial diseases, hatchery programs that regularly rely on antibiotics will not succeed. BCWD outbreaks must be managed by husbandry methods with antibiotics only used rarely and as a last resort. **Bacterial culture and sensitivity testing is a critical part of any plan to treat BCWD with antibiotics.**

Bacterial Gill Disease

Bacterial gills disease is caused by *Flavobacterium branchiophilum*, another yellow filamentous bacterium. Like the coldwater disease bacteria, bacterial gill disease bacteria are present in freshwater environments. They don't need fish, but they will take advantage of the right situation and attack the gills when conditions allow it. The disease occurs mostly in trout and salmon, but it has been reported in other species like carp and minnows.

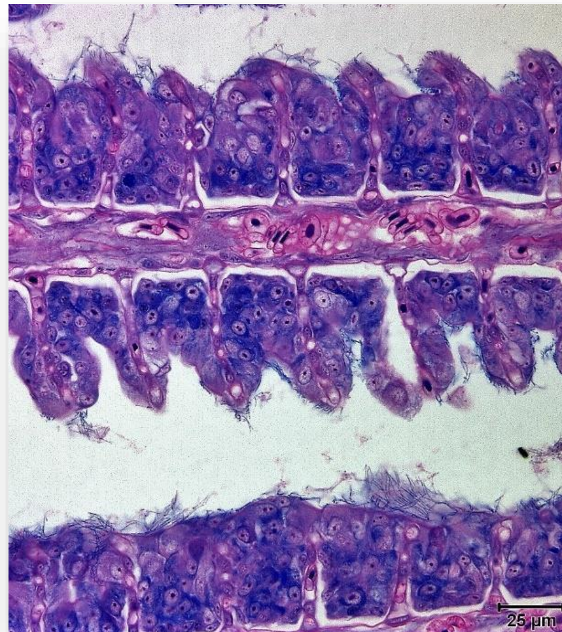


Figure 6: Histology of a stained slice of gill tissue. Bacterial gill disease bacteria are obvious as blue "fuzz" along the edges of the gills.

The relationship between husbandry and outbreaks of bacterial gill disease is very clear. When small fish are crowded and water quality is poor (ammonia, low oxygen, turbidity, excessive particulates, RAS) the disease is more likely to occur. That said, there are examples where it looks like even good husbandry is overcome by very high numbers of the bacteria in a water supply.

Afflicted fish will hang out near incoming water. The gills of affected fish will look swollen and fish may even be unable to completely close their opercular flaps. Once an outbreak begins, it spreads rapidly and mortality can be quite high.

Figure 7: Bacterial gill disease often leads to swollen gills. In these pictures, the disease is so severe that the fish are unable to close their gill covers.

As with all fish diseases, prevention is the best approach. Problems occur at a wide temperature range, but are often associated with spring when surface water supplies are affected by spring melt and rain. On facilities with a history of bacterial gill disease, or that are experiencing an active outbreak, it is important to look closely at fish densities, water flows, and water quality to see if future outbreaks and losses can be prevented. It is worthwhile to note that bacterial gill disease is never seen in wild fish. Outbreaks usually occur because of bad environmental conditions.

When outbreaks do occur, improving water quality and reducing fish density can have beneficial effects. Your fish health expert can diagnose the disease by examining gill filaments under a microscope. If the outbreak is severe enough, the fish health person may recommend treatments with surface-acting disinfectants (chloramine-T or hydrogen peroxide). Medicated feeds (antibiotics) are not used for bacterial gill disease because the bacteria are on the surface of the fish and not within the fish where the antibiotics would be effective.

Columnaris Disease

Columnaris bacteria (*Flavobacterium columnare*) are famous for causing fish diseases at warm temperatures, so columnaris disease has not historically been a major concern in hatchery fish in the Pacific Northwest. However, recent high summer water temperatures have triggered major outbreaks and climate change is likely to increase the prevalence and severity of columnaris disease in Pacific salmon.

Figure 8: Columnaris in a sockeye exposed to warm temperatures during migration.

Columnaris disease is seldom seen at water temperatures below 55° F, but outbreaks can be devastating at 65° F and above. In unusually warm summers, columnaris has caused major losses of adult salmon migrating through the Columbia River system. It was a major contributor to the big losses of adults, especially sockeye, in 2015. In warmer parts of the US, columnaris produces devastating disease outbreaks in catfish, sunfish, carp, minnows, and other species of fish in the wild and on hatcheries. The bacteria are widespread in the environment, and outbreaks (especially after fish are handled at warm temperatures) develop very rapidly and often produce high mortality.

Figure 9: Columnaris damage and yellow bacteria on the gill cover of a sockeye.

Columnaris bacteria usually start out by infecting the skin and gills.

Figure 10: Columnaris infection on salmon gills. Destruction of gill filaments is obvious. The yellow color is from dense growths of columnaris bacteria.

Under some conditions (immunosuppression is probably key), the bacteria then invade the fish and may begin to destroy internal organs. Afflicted fish usually have eroded patches of skin and gills, or fin damage.

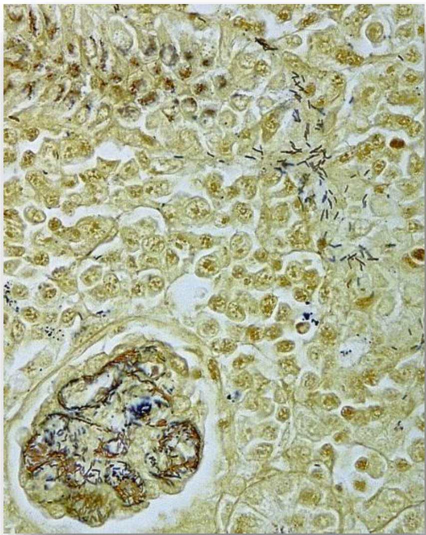


Figure 11: Histology of a salmon kidney infected by columnaris bacteria (blue rods).

Like the other yellow filamentous bacteria, columnaris are common in aquatic habitats and happy to take advantage of fish when conditions allow. The conditions that favor columnaris disease include skin or gill damage, high numbers of bacteria in the water, warm temperatures, and immunosuppressed fish. The combination of handling (skin damage) and warm water temperatures (fast bacterial growth and fish immunosuppression) is the perfect mix. Prevention is key because treatment can be very frustrating.

Treating columnaris disease is challenging because the bacteria are able to proliferate both on the fish's surface and internally. Infections that are predominantly external can be treated like bacterial gill disease with hydrogen peroxide (Chloramine-T is not labelled for columnaris in salmonids). Oxytetracycline or Aquaflor medicated feeds can be used for internal infections. Fish health experts can diagnose columnaris by the lesions that it causes and by its unique appearance under a microscope. If antibiotic use is contemplated, the bacteria must be cultured and tested for antibiotic sensitivity. Unfortunately, the relationship between lab tests for sensitivity and drug effectiveness in the field is not nearly as strong as we'd like.

Fun Filamentous Factoids

Columnaris bacteria are one of the very few bacteria that are fascinating under a light microscope. On this piece of gill tissue, you can see the tall columns of bacteria that give "**Columnaris**" its name

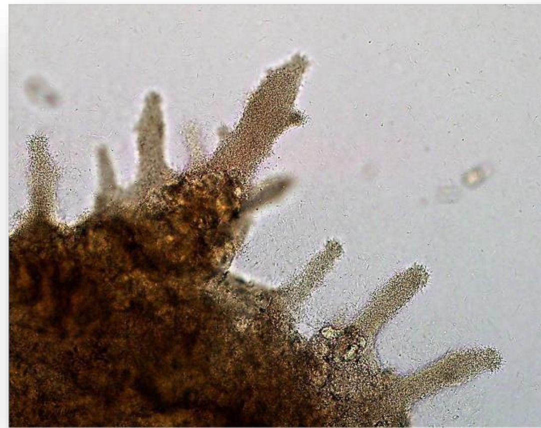


Figure 12: "Columns" of columnaris.

In this next picture, you can see evenly spaced columnaris "haystacks" on a fish gill. The stacks are all the same size. If one starts to get larger than the others, the bacteria will migrate to a new stack.

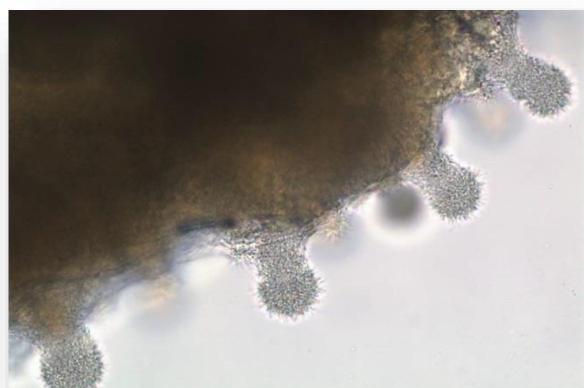


Figure 13: "Haystacks" of columnaris bacteria. Note the even size and spacing of the stacks.

Below, it appears that the bacteria have built a bridge to help them migrate to the next stack.

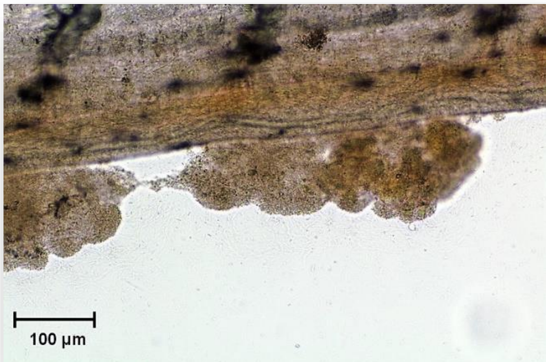
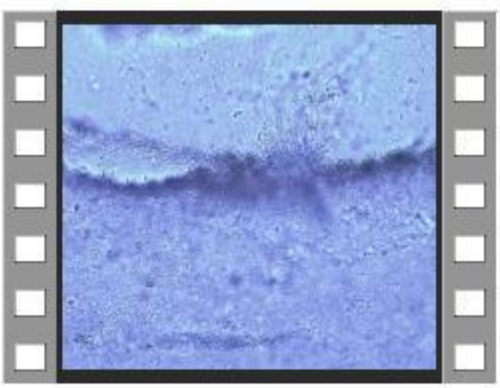


Figure 14: Columnaris colonies on a fish fin. The colonies are connected by a bridge.

So how do they move around? This has been a major mystery for 50 years! In this linked video, you can see the bacteria in the haystacks waving around (I am aware of no other group of bacteria with this behavior). What is a bit harder to see is bacteria not in the stacks that are migrating by "gliding".



Click here to see a video clip of Columnaris

(Use your web browser's back button when finished to return to the newsletter)

The actual mechanism for gliding in unknown. Most motile bacteria have flagella that move them forward like a propeller, but columnaris have no flagella. Ten years ago the best theory was that they had a rocket nozzle and excreted a special protein into the nozzle. The protein rapidly absorbed water, expanded, and worked like rocket fuel.

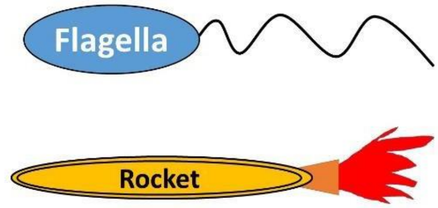


Figure 15: Flagella compared to the rocket theory of filamentous bacteria propulsion.

More recent theories are even stranger. In one (below), motors (red) use energy from the bacteria to grab, push, and then let go of protein plates (green) that are on the surface of the bacteria and stick to the substrate beneath. All of the motors push the same way so the bacterium moves along.

Figure 16: Motor and plate flavobacterium propulsion.

In another theory (below), the motors (red) move belt-like proteins with treads (black) that catch onto the surface plates (green) and push them along moving the bacterium forward.

Figure 17: The belt drive or "snowmobile" theory of flavobacterium propulsion.

There is more columnaris weirdness. On the agar plates that we use to grow the bacteria, the columnaris make yellow colonies with spreading root-like structures (migrating bacteria). The strange part is that rather than being loose on the surface, the bacteria grip the jelly-like agar so tightly that it is very hard to scrape them off.

Figure 18: Bright yellow columnaris colonies in culture on an agar plate.

In this article I mention 3 species of filamentous bacteria. It is now becoming obvious that there are dozens, or even hundreds of bacteria species in this group and that a good number of them can infect fish and cause disease.

Marine forms: There are filamentous yellow bacteria relatives that cause very similar fish diseases in marine environments.

Some close relatives of these fish disease bacteria can produce diseases in humans.

In warmwater fish, columnaris often produce characteristic “saddleback” lesions. This chub has a triple saddle.

Figure 19: Triple saddle lesions typical of columnaris infections in warmwater fish.

Herbicides: Columnaris and some other yellow filamentous bacteria are sensitive to the herbicide Diquat. There is even currently an active Diquat INAD. These bacteria must share a metabolic pathway with plants!

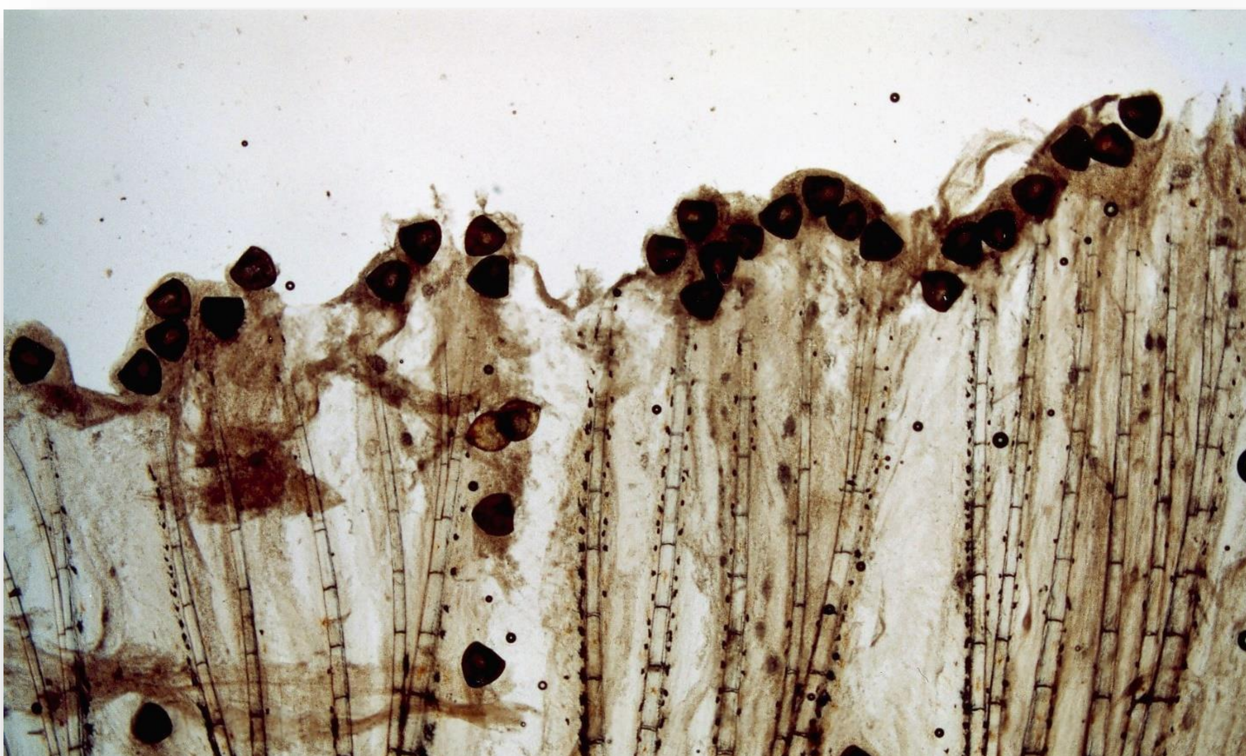
PRFHP Update

The Washington State Animal Disease Diagnostic Laboratory (WADDL) in Pullman, WA has been doing all of the lab tests supporting our work for the Leavenworth Complex and Puget Sound/Olympic Peninsula Complex hatcheries since last summer. We switched the testing from the Gorge Complex hatcheries to WADDL in January 2019 and plan to move the Dworshak Complex work near the end of this calendar year.

The testing that is being done at WADDL is under the highest level of veterinary diagnostic laboratory accreditation. It allows the FWS to take advantage of the economies of scale at WADDL that enable them to have certified clinical specialists and sophisticated instrumentation while still conducting tests at a lower cost. The WADDL partnership allows our PRFHP staff to spend more time on disease prevention, management, and treatment and less time on repetitive laboratory tests.

We are currently advertising for two new veterinarians to support the work that we do out of Lacey and for the Gorge Complex.

Mystery Parasite of the Day



For the answer, click HERE.