MICHIGAN DEPARTMENT OF NATURAL RESOURCES

Research and Development Report No. 246*

August 13, 1971

SYMPTOMATIC KEY TO DISEASES OF SALMONID FISH IN MICHIGAN HATCHERIES, 1971**

By Leonard N. Allison

Fish Pathologist

This report contains a 2-page dichotomous and diagnostic key to 23 kinds of fish diseases which occur in Michigan hatcheries, mostly among salmonids, and a 4-page list of treatments recommended for individual diseases. The recommended treatment is specified in the 2-page key for each disease. This guide has proved to be useful to Michigan's fish-culturists, and therefore has been duplicated in this formal report series. Incidentally, August 13, 1971 was the date of Dr. Allison's retirement from State service.

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*Institute for Fisheries Research Report No. 1782

**A contribution under Federal Aid Project AFC-7, Michigan.

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1. a. Many fish at surface of water gulping air, or crowded at inlets (sudden or rapid depletion of oxygen); or fish moribund, dashing sporadically about (gradual depletion of oxygen over a period of weeks). .LACK OF OXYGEN - (T-1)**
   b. Fish not at surface gulping air, and not crowded at inlet. 2

2. a. Fish dart about erratically; may die with body bent into"C"-shape; usually gas bubbles visible in blood vessels in fins and in tissue surrounding eye balls, causing popeye. . .GAS BUBBLE DISEASE - (T-2)
   b. Fish not as in "a" 3

3. a. Loss of appetite***. 4
   b. Usually no loss of appetite. 5

4. a. Fish weakened; may lie on bottom of pond; cloudiness or bluish-gray film on skin . . . . . .CHILODON, COSTIASIS - (T-3)
   b. Whirling, corkscrew motion; may become spasmodic while lying on bottom; pin-heads common; affects fish up to about 2" long; larger fish seldom affected. . . . . .HEXAMITUS (OCTOMITUS) - (T-4)
   c. Fish lie listless near surface of water. .GILL TROUBLE - (T-5)

5. a. Fins affected; no other symptoms 6
   b. Fins may or may not be affected; other symptoms present. 7

6. a. Fins gradually eroded to base, leaving projecting stubs of fin rays and bloody margin; may invade flesh at base of fin; usually no fungus present; mortality may be high . . . . . .FIN ROT - (T-6)
   b. Among rainbow trout, dorsal fin with thickened, white margin; fin becomes gradually shorter, but never with bloody margin or projecting fin rays; no associated mortality. . . . .NIPPING - (T-7)
   c. Fins frayed, may have open sores; fungus may be present; fish "flash" or rub sides on bottom of pond . . . . . .GYRODACTYLUS - (T-3)

7. a. Gills pale; anemia indicated 8
   b. Gills normal in color. 9

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*More detailed information regarding disease and treatment can be found by contacting the Hatchery Biology Service Center, P.O. Box 507, Grayling, Michigan 49738 or in the following publications:

Davis, H. S. 1967. Culture and Diseases of Game Fishes. Univ. California Press, Berkeley and Los Angeles, California. $6.50.

Leitritz, Earl. 1960. Trout and Salmon Culture. California Dept. Fish and Game, Fish Bull. No. 107, Printing Division, Documents Section., N. Seventh St. at Richards Blvd., Sacramento 14, California. $2.00.

Wood, James W. 1968. Diseases of Pacific Salmon, their Prevention and Treatment. Dept. Fish., 115 General Adm. Bldg., Olympia, Washington.

**Refer to Treatment Section.

***Loss of appetite is associated with many diseases, especially vitamin deficiencies, so associated symptoms are important.

8. a. Fish weakened; whitish parasites on fins and gills; brook trout only . . . . . .GILL LICE - (T-8)
   b. Fish weakened; no whitish parasites. . . .DIET INDUCED ANEMIA - (T-9)

9. a. Gray, hair-like patches on body and/or fins. . .FUNGUS - (T-10)
   b. No gray, hair-like patches 10

10. a. Grayish-white spots or areas on head, gills, fins or body. 11
    b. No white spots or areas. 12

11. a. Grayish-white areas gradually expand and margin may have reddish tinge; appears like fungus but is not fuzzy; in fingerling trout, usually appears as a gray saddle over back, including dorsal fin . . .COLUMNARIS - (T-11)
    b. White, round spots of small diameter; in heavily infested fish, spots may merge forming irregular whitish areas; fish "flash", or scrape sides on bottom of pond. . . . . .ICHTHYOPHTHIRIUS - (T-12)

12. a. Crystalline lens of eye cloudy or white and opaque 13
    b. Crystalline lens of eye clear. 14

13. a. Small parasites in lens. . . . . .CATARACT WORM - (T-13)
    b. No parasites in lens . . . . . .DIET DEFICIENCY - (T-14)
    or. . . . . .DIRECT RAYS OF SUN - (T-15)

14. a. Blisters or ulcers on skin; or bloody mucus may be squeezed from gills and vent; sudden rise in mortality when water temperature increases rapidly, or following handling; or small spot-hemorrhages (petechiae) on belly of fish and kidney with swelling and pus pockets. 15
    b. No blisters or ulcers present; no bloody mucus at gills or vent. 16

15. a. Blisters containing bloody pus in skin, extend deep into flesh; tiny hemorrhages internally, especially on swim bladder; body cavity appears generally inflamed; bloody mucus may be squeezed from gills and vent . . . . . .FURUNCULOSIS - (T-16)
    b. Open sores or ulcers in skin, at first a small whitish pimple, later with destruction of skin, flesh exposed in shallow crater not extending deep into flesh. . . . . .ULCER DISEASE - (T-16)
    c. Dropsy frequently present; granuloma of stomach surface frequently present; internal organs may be hemorrhagic; nodules containing pus in kidneys . . . . . .KIDNEY DISEASE - (T-16c)

16. a. Skin on top of head of yearling lake trout eroded during June, July and August; lesions heal thereafter; loss above normal; growth retarded; or, among brood stock fish, rough denuded patches of skin, sometimes hemorrhagic, on dorsal areas where body presents nearly flat, horizontal surface. . . . . .SUNBURN - (T-17)
    b. Skin not eroded. 17

17. a. Eyes protruding; body cavity filled with fluid . . .DROPSY - (T-18)
    b. Eyes not protruding. 18

18. a. Spiral, side-swimming; mortality high, larger fingerlings of lot affected. . . . .INFECTIOUS PANCREATIC NECROSIS (IPN) - (T-19)
    b. Erratic swimming behavior (tail chasing is characteristic) when disturbed by feeding, or quick motions near holding pond; misshapen head and/or spinal deformities; black tail . . .WHIRLING DISEASE - (T-20)

TREATMENTS - General

Stagnation treatment: Water in pond or trough should be lowered at least 1/3 normal depth, and inflow and outflow stopped during treatment. Treated water should be flushed out at the lower depth before returning level to normal.

Flow-through treatment: Depth of water need not be changed nor inlet or outlet stopped. Chemical is introduced at the inlet continuously at the precalulated rate during the entire recommended time. No post-treatment flushing is necessary.

Medicants: (Sulfamerazine, Terramycin, etc.) When mixed with ground meat may be lost when the food is put into water at feeding time. This loss can be minimized by mixing with the meat enough meal (pellet meal) to bind the mixture. Medicants can be added to pellets by first coating the pellets with cod liver oil, so the medicant will stick to them, then thoroughly mixing the material. Pellets containing medicants can be purchased from manufacturers and are the preferred method of treatment.

NOTE: Due to restrictions by the Federal Drug Administration that apply to food for human consumption, certain chemicals and drugs recommended in the 1967 Key have been banned for treatment of fish disease, unless the fish are for such purposes as brood stock, display, etc., and are not to be used for human food.

TREATMENTS

T-1. Oxygenate water by:
a. Install device at inlet to increase splashing of water.
b. Pump water from pond and return it by spray.
c. Increase flow of water.
d. Reduce number of fish in pond or trough.

A combination of these methods may be necessary under certain conditions.

T-2. Bubbles beneath the skin and in blood vessels are caused by an excess of gas in the supply water. This can be released by breaking up the water into small drops or spray as in T-1 a. or 1 b.

T-3. FORMALIN, 1:4,000 for one hour. Stagnation treatment. Dilute quantity of formalin needed at least 10 times before spraying evenly into trough or pond. A small amount of Oxalate Crystals of Malachite Green, zinc-free, (just enough to color the solution) should be added to the stock solution. This will act as a tracer to assure complete and even mixing of the colorless formalin with water in troughs and ponds.

T-4. CARBASONE, one (1) gram per each pound of food. Dissolve amount of carbasone required in small quantity of one (1) percent bicarbonate of soda solution, mix thoroughly with food and let stand at least two hours. It can stand overnight if refrigerated. Feed in all food for four (4) days.

When adding medicants to ground meat, as liver, also add enough pellet or other meal to bind the meat to prevent loss of medicant when food is put into water when fed to the fish.

T-5. Gill disease is usually caused by environmental stresses, either single or multiple. Excessive silt erodes the delicate surface membranes of the gills, providing ideal habitat for bacteria. Overcrowding is a stress of its own, and can result in excess ammonia from waste products, which also predisposes gill damage. Diets low or lacking the vitamin pantothenic acid, also cause gill abnormalities. Insufficient flow of water may result in build-up of ammonia as in overcrowding. Adverse environmental conditions should be corrected, when possible, in addition to chemical treatment.

ORTHO DIQUAT, 1:125,000 for 1 hour has provided control in some cases.

HYAMINE 1622, 1:500,000 for 1 hour may be effective.

PANTOTHENIC ACID. Addition of Brewer's yeast at the 8 percent level will supply enough pantothenic acid, if fish do not respond to chemical therapy.

P-7138. Effective experimentally at 2 p.p.m. active ingredient for 1 hour. This chemical is not yet (1971) on the market, but is mentioned here as it will be available in the future.

T-6. COPPER SULPHATE, dip fish for 1 to 2 minutes in dilution of 1:2,000. If solution changes color from clear blue to milky light blue, add acetic acid until original clear blue is obtained. Flush treatment in troughs 1' wide x 12' long x 4" depth of water with 2 ounces of formalin and 2 ounces of a 1/40 Malachite Green solution is effective.

Fin rot is easily controlled in its early stages, but difficult in late stages. Treat when first symptoms are observed.

T-7. NIPPING is caused by overcrowding. Fewer fish per cubic foot of water should reduce nipping.

T-8. GILL LICE, cannot be killed while attached to fish because they are copepods with a tough leathery skin and they bury their heads in the flesh of fish. The tough skin is not affected by chemicals in strengths not lethal to fish. To control this parasite effectively, all fish must be removed from the ponds, the ponds treated with chlorine, or allowed to dry completely for several days. Ponds must be restocked with fish free of the parasite, and the supply water kept free of infested fish.

T-9. Change diet to fresh meat (preferably beef liver) for two weeks, or until symptoms disappear. Meat diet is 3 percent daily of the weight of the fish, or about 1/3 more than the daily ration of pellets.

T-10. OXALATE CRYSTALS OF MALACHITE GREEN, zinc-free, dip in 1:15,000 dilution for 10 to 30 seconds. Used at some stations as flush treatment, but dilution not known (developed by trial and error method).

For eggs: 1 1/2 ounces of Malachite Green are dissolved in 1 gallon of water for use as a stock solution. To treat eggs in a single trough with a water flow of 6 gallons per minute, add 3 ounces of stock solution at the head of the trough at 8 a.m. and 5 p.m. daily, 7 days per week. For two troughs in series with same water flow as above, add 3 ounces of stock solution at the head of the upper trough and after approximately 75 percent of this solution has left the upper trough, add 1 1/2 ounces of stock solution to the head of the lower trough. If silting conditions exist, the dose may be doubled with no danger to the eggs.

T-11. SULFAMERAZINE, 12 grams per 100 pounds of fish for 7 days, followed by 1/2 dose for the next 7 days.

TERRAMYCIN, (TM-50) 2.5 grams per 100 pounds of fish per day for 10 days. To be effective treatment must begin before the disease has become well established.

T-12. ICHTHYOPHTHIRIUS MULTIFILLIS, (ICH or White Spot), is a protozoan parasite that partially imbeds itself in the skin of fish where it cannot be reached by treatments. The individuals in the skin reproduce by dividing into small individuals which are liberated into the water and are infective to fish. These small forms are delicate and can be killed by chemical treatment. They are also carried by water currents, so if affected fish are held in fast-running water, the small infective individuals are carried away from the fish. Since

the parasites on the fish mature more slowly in cold water than in warm water, it is necessary to hold infested fish in fast water for five weeks at 52°F., but only two weeks at 62°F. (Mature forms on the fish disintegrate after reproducing). This is the one method employed for control. Another method is to kill all young by daily chemical treatment of the water with 3 percent salt solution, or formalin, 1:4,000 for one hour. Daily treatments must be continued for the same period of time as with the treatment with swift water. Another effective, and more easily applied, method of control is a modified treatment developed by D. W. Galvin, Hatchery Biologist for the Sturgeon River Trout Rearing Station. It is a 1-hour flow-through application of Malachite Green at a dilution of 0.2 p.p.m. applied with a constant-flow siphon. To get this dilution of 0.2 p.p.m., add Malachite Green constantly at the rate of 1 gram of chemical for each 20 gallons of flow. If the initial treatment does not give relief in a few days, the dilution can safely be increased to 0.4 p.p.m.

T-13. View dissected crystalline lens with microscope. Diplostomum flexicaudum is small (1/2 mm), flat, oval-shaped, whitish larva. Parasite is a trematode with the following life cycle: Adult in sea gull; eggs fall into water, hatch and burrow into snail; multiply 1,000-fold and leave snail to burrow into fish, concentrating in the crystalline lens; fish or fish eyes eaten by sea gull where larvae develop into egg-laying adults. Since snails carry the infestation which is transmitted to the fish, further infestations can be prevented by killing all snails in the ponds. This can be accomplished by introducing solutions of chlorine or copper sulphate ($CuSO_4$) to water. HTH or Perchloron are powders that contain chlorine and are more easily handled and stored than liquid sources of chlorine. The treatment is applied by removing all fish from the pond and draining it. As the pond refills, add enough powder to make 10 p.p.m. solution when the pond is full.

Directions as to amount of powder needed will be found on the containers. This solution should be applied in the afternoon and allowed to stand in the pond all night. Treatment with copper sulphate is made the same way, employing a concentration of 20 p.p.m.

CAUTION: Both chlorine and copper sulphate are deadly to fish and great care should be exercised to prevent water from treated ponds from flowing into enclosures containing fish.

Because organic matter rapidly removes chlorine from the water, copper sulphate should be used in large ponds with muddy bottoms. Also, in large ponds snails may crawl out of the treated water, returning after treatment is over, or burrow into the mud and escape death. Therefore, two treatments per year may be required.

T-14. DIETARY BLINDNESS is reported to be due to a lack of the vitamin Riboflavin in the diet. The daily requirement of riboflavin varies with the species of fish. Since cloudiness of the lens and blindness develop only after about two months of faulty diet, a quick cure cannot be expected. Addition of brewer's yeast to the diet at the 8 percent level will supply necessary vitamins and prevent further blindness. Also, blindness may develop among brook trout if fed a diet containing 25 percent, or more, horse meat (liver, etc.). Brown and rainbow trout are not affected.

T-15. Lake trout held for more than several months in water less than 20 inches deep, and exposed to direct rays of the sun develop cataract (opaque lens). Protect fish from sun by shade devices or hold in water more than 20 inches deep.

T-16. SULFAMERAZINE:

a. For stations having infected fish present in water supply, the fish should receive 12 grams sulfamerazine per 100 pounds of fish, daily for 4 consecutive days. Treatment is directed towards reduction of mortality only and not eradication of the disease because the fish will become reinfected very soon after treatment ceases.

b. For stations having a water supply free of infected fish, the fish should receive 12 grams sulfamerazine per 100 pounds of fish daily for 3 consecutive days, then 1/2 dose for the next 7 days.

c. No successful therapy has been found for kidney disease. Some suppression of losses may be provided by sulfamerazine therapy, as outlined in "a.", if treatment is ititiated when the disease is in a very early stage.

TERRAMYCIN: Best results are obtained when the sulfa treatment is followed immediately by a 3-day treatment with terramycin at the rate of 2.5 grams (1/11 ounce) per 100 pounds of fish daily. Terramycin is given to kill any bacteria that may have become sulfa-resistant.

T-17. Treat as in T-10 and provide shade as in T-15.

T-18. Several conditions may result in accumulation of fluid in the body cavity and protrusion of the eyeballs. In certain waters this condition will develop among trout that are overfed when water temperature is low. This condition can be anticipated in the fall of the year among rainbow trout and avoided by gradually reducing the food ration as water temperatures become lower. Kidney malfunction may be cause. For other causes, refer to "Culture and Diseases of Game Fishes" by H. S. Davis.

T-19. INFECTIOUS PANCREATIC NECROSIS (IPN) is a virus disease that can be definitely identified only by tissue culture methods. No therapy is known. Infected brood stock are thought to be responsible for transmission.

T-20. WHIRLING DISEASE (Myxosoma cerebralis) is a protozoan parasite transmitted among salmonid fishes by spores. The parasites develop in the cartilage of the head and spine of very small fish. Destruction of the cartilage causes spinal deformities, misshapen heads and erratic swimming. No treatment has been found to cure affected fish. Some spores may live for years in soil in dirt ponds, or natural streams and are extremely resistant to chemical treatment. If fish are suspected of having whirling disease, the Hatchery Biology Service Center, Grayling, Michigan should be contacted immediately. Biologists will go to the location to examine the fish. Under no circumstances should the fish be removed from the location until examinations have been completed. Do not bring specimens to the Hatchery Service Center unless advised to do so.

Report approved by G. P. Cooper