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CERATOMYXOSIS

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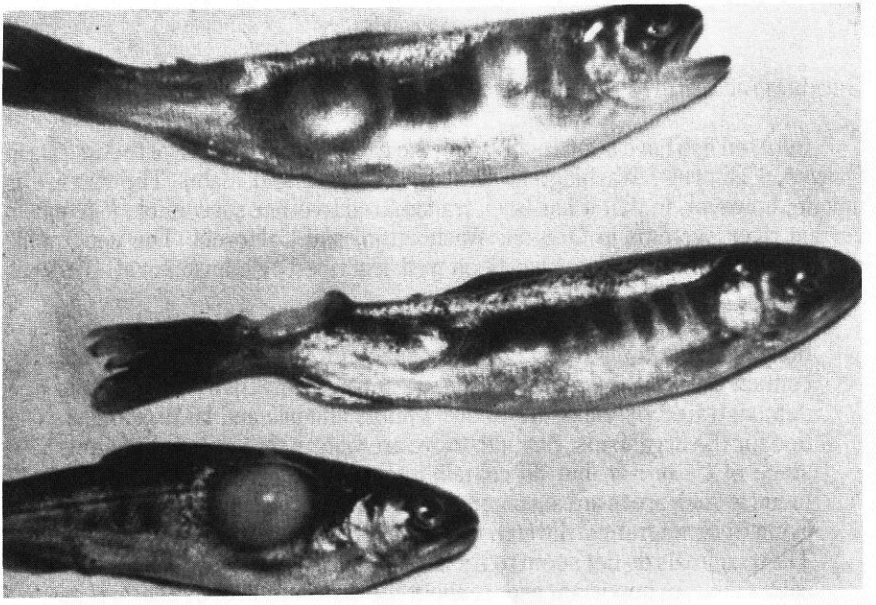
Ceratomyxosis is caused by Ceratomyxa ***shasta,*** a tissue-invading pm-tozoan parasite. It is an infectious disease capable of causing serious losses of



The protozoan parasite, *Ceratomyxa shasta,* causes large, spore-filled cysts in young salmonids. (J. Conrad, Oregon Fishery Commission)

both prespawning adults and in hatchery and wild juvenile salmonids (Johnson et al. 1979). C. *Shasta* is unique in that it has never been reported outside of the Pacific Northwest in North America (Johnson et al. 1979). In fact, the only known method of initiating an infection with C. Shasta is by exposure of fish to water containing the infectious stage (Schafer 1968). Since the disease has never been detected outside the Pacific Northwest, every effort should be made to contain it within its present range.

SIGNS OF INFECTION

Signs of *Ceratomyxa* infections vary in different species of salmonids. Clinical signs include loss of appetite, a distended abdomen, popeye, dropsy, emaciation, swelling in the area of the vent, and hemorrhages and swelling along the digestive tract. Other signs include nodules in the gut of adult chinook salmon, large abscesses in the musculature, and gross lesions in the kidney, liver, and spleen. Juvenile steelhead may also show infectious material in the entire digestive tract, liver, spleen, gonads, kidney, heart, gills, and skin (Johnson et al. 1979).

DIAGNOSIS

The disease is confirmed by the microscopic demonstration of typical spores in scrapings from the lower intestinal wall, gall bladder, or lesions. Spores are bicapsulate with broadly rounded ends and shell valves that are strongly arched posteriorly (in other words, somewhat kidney-bean shaped). The spores measure 14-23 nm long and 6-8 run wide at the middle (johnson et al. 1979).

EPIZOOTIOLOGY

GEOGRAPHIC AND HOST RANGES

Infected fish have been found along the northwest coast of North America in Oregon, California, Washington, British Columbia, and Idaho. The disease is unique, however, in that it has been transmitted to other susceptible fish only in certain river systems in Oregon, Washington, and California. The geographic distribution of the organisms has been well described by Johnson et al. (1979) as follows:

> "There are two principal features concerning the geographic distribution of C. *shasta* that must be emphasized. First, there are waters that contain the infective stage of the organisms. Infectivity is generally demonstrated by exposure of susceptible animals and later examination for the organisms. Second, there are waters that lack the infective stage of C. *shasta*, but do contain infected salmonids. Diseased fish found in such areas are assumed to have contracted the organism while living in or migrating through waters containing the infectious stage. These animals do not seem to transmit the disease to other susceptible salmonids. An important aspect about the distribution of C. shasta is its confinement to salmonids along the Pacific Coast. The parasite has not been reported elsewhere during the period of almost 30 years since the

disease was first described. This restricted distribution is in marked contrast to that of many other fish pathogens, which have a wider distribution, often as a result of the shipment of eggs or fish to new locations. Such ecological specificity is compatible with the idea that some, as yet unknown, specific factor is required for infection of salmonids by C. ***shasta".***

The overwhelming evidence suggests that the parasite cannot establish itself outside of the waters presently known to contain infective stages -hence it is assumed that the parasite cannot be spread through transfer of infected fish or eggs. However, until this hypothesis is established beyond doubt, the importation of fish or eggs from enzootic areas is not recommended unless the fish have been inspected and certified to be free of C. ***shasta.***

The following species have been infected with C. ***shasta*** (either naturally or experimentally): coho, chinook, sockeye, chum, and Atlantic salmon; and rainbow, cutthroat, brown and brook trout. Of these, rainbow trout, cutthroat trout, chum salmon, and coho salmon are the most susceptible; brown trout, brook trout, and Atlantic salmon are much less susceptible (Johnson et al. 1979).

SOURCES AND RESERVOIRS OF Infection

The only known sources and reservoirs of the infectious agent are waters that contain the infective stage. The mechanism of transmission is unknown since diseased fish do not transmit the disease directly to other susceptible salmonids. As long as the mode of transmission remains an unknown, there is the chance that the disease might occur elsewhere. Thus, the movement of fish from enzootic to non-enzootic areas is not recommended.

Schafer (1968) reports that standing (lake or pond) water is required in a system for C. ***shasta*** to become infective. This observation has been substantiated by the work of others (Harlan Johnson, former USFWS hatchery biologist at Little White Salmon Hatchery, Washington) and by epizootiological studies on the Deschutes River system in Oregon which has headwaters in infected lakes. It is apparent from hatcheries operated by the Oregon Department of Fish and Wildlife that C. ***Shasta*** is no problem at hatcheries fed by fast flowing streams with no lakes or reservoirs in the headwaters.

SUSCEPTIBLITY AND RESISTANCE FACTORS

All species of salmonids tested were found to be susceptible (Zinn et al. 1977), although only rainbow trout, cutthroat trout, and chum salmon are highly susceptible (Johnson et al. 1979). Coho and chinook salmon are somewhat less susceptible, brook trout and brown trout are much less so (Johnson et al. 1979).

There is considerable variation in susceptibility among different strains of rainbow trout and chinook salmon. Those strains originating from areas with a long history of exposure to the parasite are generally more resistant than newly-exposed strains 'Johnson et al. 1979).

Temperature also plays a role in susceptibility. In a report by Udey et al. (1975), juvenile rainbow trout mortalities averaged 80% and were independent of water temperature between 6.3 and 23.3°C. However, in coho salmon, mor-

talities increased progressively from ‘2% at 9.4°C to 22% at 15.0°C to 84% at 20.5°C No deaths occurred in either rainbow or cobo at 3.9°C nor in coho at 6.7°C.

MODES OF Transmission

Natural transmission occurs only when susceptible salmonids come in contact with water containing the infective stage. A 30 minor longer exposure to such water is necessary to initiate the disease. Fish to fish infection does not occur. According to Johnson et al. (1979): “Transmission has not occurred as a result of feeding of infected tissues, cohabitation of infected fish with susceptible fish, or holding susceptible salmonids in water containing a mixture of mud and infected tissues”.

Incubation PERIOD

The incubation period, defined as the length of time from infection to death varies with fish species and water temperature. The infection will develop only at water temperatures above 3.9°C. Deaths occur in coho at 12.5 d at 23.3°C and losses do not occur until 146 d at 9.4°C. Deaths in rainbows occur in 14 d at 23.3°C to 15 d at 6.7°C or colder (Udey et al. 1975).

SEASONAL INCIDENCE

Infections first appear in the spring when waters reach lO°C, and fish continue to become infected until water temperatures cool in late fall or early winter (Schafer 1968).

METHODS OF CONTROL

PREVENTION

The disease may be prevented in areas where it is endemic by avoiding the use of infected water supplies or by treatment of infected water with a combination of filtration followed by chlorine or UV irradiation (Sanders et al. 1972).

The disease can be prevented from reaching geographic regions where it does not presently occur by not transferring fish or water into these areas from locations where the disease occurs.

Resistant stocks should be used to reduce the incidence of C. Shasta. Use of resistant stock in known infected waters should reduce the number of infective units being returned to the “mud” (Zinn et al. 1977)

THERAPY

There is no known treatment.

KEY STEPS TO REMOVE THE DISEASE AND/OR AGENT FROM FISH POPULATIONS

IMMEDIATE

There is no known way to rid infected fish of the parasite.

LONG TERM

In three areas where C. Shasta occurs, the use of non-infected water sources in hatcheries has proven effective. Treatment of infected water by a combination of filtration followed with chlorine or UV irradiation has prevented outbreaks of the disease (Sanders et al. 1972).

REFERENCES

Johnson, K.A. 1975. Host susceptibility, histopathologic, and transmission studies on Ceratomyza *shasta,* a myxosporidan parasite of sahnonid fish. Ph.D. Thesis, Oregon State Univ., Corvallis. 145 p.

Johnson, K.A., J.E. Sanders and J.L. Fryer. 1979. *Ceratomym shad* in s&nonids. U.S. Fishand Wildi. Serv., FishDis. Leafl. No. 58. Washington, DC. 11 P.

Ratliff, D. E. 1981. *Ceratomyxa* shasta Epizootiology in chinook salmon of central Oregon. Trans. Am. Fish. Sot. 110: 507-513.

Sanders, J.E., J.L. Fryer, and R.W. Gould. 1970. Occurrence of the myxosporidan parasite, *Cemtomyza shad, in* salmonid fish from the Columbia River basin and Oregon coastal streams, p. 133-141. In S. E Snieszko (ed.) A svmoosium on diseases of fishes and shellfishes. Am. Fish. Sot. Spec. Publ. *5:* Bkthesda, MD.

Sanders, J.E., J.L. Fryer, D.A. Leith, and K.D. Moore. 1972. Control of the infectious protozoan *Ceratomyxa shasta* by treating hatchery water supplies. Prog. Fish-Cult. 34: 13-17.

Schafer, W.E. 1968. Studies on the epizootiology of the myxosporidan *Ceratomym Shasta* Noble. Calif. Fish and Game. 54: 90-99.

Udey, L.R., J. L. Fryer, and K. S. Pilcher. 1975. Relation of water temperature to ceratomyxosis in rainbow trout (Salvo gairdneri) and coho salmon *(Oncorkynchlcs kisutck).* J. Fish. Res. Board Can. 32: 1545.1551.

Zinn, J.L., K.A. Johnson, J.E. Sanders, and J.L. Fryer. 1977. Susceptibility of salmonid species and hatchery strains of chinook salmon *(Oncovhynchw* tshau@.wluz) to infections by *Ceratomyza shasta.* J. Fish. Res. Board Can. *34: 933-936.*