ADVANCES IN THE STUDIES OF INFECTIOUS FISH DISEASES

S. F. SNIESZKO, Microbiological Laboratory, U. S. Fish and Wildlife Service, Leetown, West Virginia

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While attending meetings of various scientific societies during the past quarter century, I have noticed that presentation of papers in which some phase of science was reviewed comprehensively were received with greater interest than those in which the speakers were giving accounts exclusively of their own researches in a highly specialized field.

This was one of the reasons why last year I organized a symposium on fish diseases (1954). It should be in your hands any day, as part of the 83rd volume of the Transactions of the American Fisheries Society.

Since this symposium was prepared for publication more than a year ago, additional progress has been made in the research on infectious fish diseases. Today I should like to review briefly some of the progress in this field made in the United States during the past year, as well as summarize the results of the recent investigations carried out at the Microbiological Laboratory at Leetown. I should also like to stress the value of this recently acquired information for the practical fish culturists.

Virus Diseases

The virus diseases of fishes were known for a long time. However the best known fish diseases of viral origin, the fish pox and lymphocystis, are either of insignificant economic importance in America, or occur in large bodies of water as the Great Lakes, and therefore little can be done in regard to their control.

During the past several years heavy mortalities occurred at the Federal and State salmon hatcheries in the northwest. Millions of salmon fingerlings were lost. Rucker et al. (1953) and Watson et al. (1954) have made considerable progress in the study on the nature and control of this disease. They have found that it is caused by an agent which has the properties of a virus. It has neither been seen under the electron microscope nor cultivated in tissue culture as yet. However, the careful studies carried out on the etiology of this disease have shown that in all probability the young salmons get it from adults by the way of food.

In the search for an inexpensive and nutritious food, biologists have found that salmon viscera admirably fulfilled the requirements. However, soon after the introduction of this component of the salmon diet, the losses due to infectious diseases reached the all time high levels. Investigations carried out by Watson et al. (1954) have shown that in a number of adult salmon the virus was present, and that the outbreaks of this disease occurred only in the hatcheries in which young salmon received food containing unsterilized viscera of the adult fish. Since it is a well-known fact that adult animals frequently serve as a reservoir of the germs causing acute diseases of the young, one could logically suspect that research will show that use of unsterilized tissues of adult fishes as food very likely would serve as a vehicle transmitting the virus to fingerling salmon (Snieszko 1953).

Inherited Resistance to Diseases

In human and animal medicine it is a well-known fact that some individuals, or populations, are more resistant than the other, and that such resistance is inherited in accordance with the Mendelian laws.

The problems of the inheritance in relation to fish diseases were throughly discussed in the Symposium on Fish Diseases (1954) by Gordon and Wolf. In the experiments carried out in 1952 - 53, Wolf found that in 9 out of 11 strains of brook trout tested, furunculosis and ulcer disease killed 74 to 100 percent of the fishes. In one strain the losses amounted only to 24 percent and in the most resistant strain were a low as 5 percent. I wish to add here that all experimental trout were maintained for the eleven months of observation period under identical conditions.

At the Leetown station brook trout suffered from such heavy losses due to furunculosis and ulcer disease that production of this species of trout became unpractical, even if the best known treatments were employed. Therefore we decided to repeat Wolf's experiments. We compared the susceptibility of the strain used for years at Leetown (NH) with one found to be most resistant as by Wolf (PA) and another one from a nearby hatchery in Maryland where losses due to furunculosis and ulcer disease were negligible during the recent years (MD).

Our observations are still in progress but as of October 1 the results are as presented in Table 1. The figures show that, so far, there are considerable differences in the susceptibility of the three strains of brook trout, to a mixed infection with ulcer disease and furunculosis.

Table 1. Percent mortality as of October 1, 1954, in three strains of fingerling brook infected with ulcer disease and furunculosis.

Trout strain	Mortality, percent
NH	64
PA	36
MD	19

The early observations of Embody, Hayford and Davis as well as the most recent by Wolf and ourselves suggest that in addition to sanitation and therapy, breeding of disease resistant fishes should be employed as a very important factor in the efficient and economic production of trout (or other fishes) in the hatcheries. It also seems logical to expect that in the survival of the stocked trout in the natural waters, the resistance to diseases should be of great importance. Let us hope that Dr. Wolf will be in a position to utilize fully and for a long time the newly constructed facilities at the Rome, NY, station for the research on breeding of the disease resistant fish. As Gordon (Symposium 1954) said: "It is logical to believe that, given comparable adequate funds for similar research, the fish geneticist could match the success made by the plant and the non-ichthyological animal geneticist. Fishes have an enormously greater reproductive capacity than other domestic animals, an advantage of immense potential value to the breeder, since it enables the fish geneticist to utilize some of the techniques heretofore found applicable only to plant breeders. Once a pair of fish with desirable characters have been developed, the strain may be multiplied on a large scale."

Treatment of the Kidney Disease

Kidney disease has so far been reported from the trout and salmon hatcheries located in the coastal states in the east and west. Fact, that so far it is apparently unknown in the central states, may mean either that it was not recognized there as yet, or that it may be transmitted by animals like birds, or eels, which move about freely and frequently within the coastal areas. This disease has been described in detail by Earp, Ellis and Ordal (1953) and in the Symposium on Fish Diseases (1954). In the research on the therapy of this disease, the western investigators found that some sulfonamides gave promising results while others were toxic to the treated fish.

Further studies on the therapy of this disease in brook trout were carried out at the Berlin, NH, and the Leetown stations. Two groups of drugs were tried. One consisted of sulfonamides as sulfamerazine, sulfadiazine, sulfamerazine mixed with sulfathiazole and sulfisoxazole.[1] In the other group were antibiotics as chloramphenicol, oxytetracycline (terramycin) and chlortetracycline (aureomycin). As it is evident from Table 2, sulfonamides were found to be of superior therapeutic value. The best control of the disease was achieved with sulfamerazine and sulfisoxazole. The problem of the control of the kidney disease can so far be considered as only partially solved, because the effect of treatments is temporary. Within 30 - 40 days following treatments, the disease recurred. In practice however the treatments are of considerable value because the kidney disease is a seasonal ailment. Therapy therefore has to be used only in spring and early summer when this disease is in its most acute stage.

Table 2. Percent mortalities and weight gain among fingerling brook trout treated for the kidney disease with sulfonamides and antibiotics.

Treatment	Mortalities (%)	Weight gain (%)
Controls	93	105
Sulfamerazine	1	48
Sulfisoxazole	1	72
Sulfadiazine	6	18
Sulfamerazine with sulfathiazole	4	20
Chloramphenicol	13	82
Terramycin	63	103
Aureomycin	79	95

This is just a very brief summary of our work on the therapy of kidney disease. A detailed report is ready for publication (Snieszko and Griffin 1955).

Effect of Sulfonamides on the Growth Rate of Normal Trout

Experiments carried out at the Leetown Station several years ago (Gutsell and Snieszko 1949) have shown that sulfamerazine had no retarding effect on the growth of rainbow trout, the higher dosages slowed down somewhat the growth of

[1] Gantrisin R

brook trout, but all dosages completely arrested growth of brown trout. This was an important observation showing that any therapeutic benefit which could be obtained by the treatment of brown trout with sulfamerazine would be reduced by the arrest of their growth. Since the arrest of growth is due to the fact that brown trout gradually take less and less of the medicated diet, the uptake of the drug is diminished and its therapeutic effect minimized.

The just presented results of our studies on the therapy of kidney disease have shown that other sulfonamides restricted the growth of brook trout even more than sulfamerazine. Sulfisoxazole however appeared to have no such undesirable affect. Therefore further experiments were carried out recently. At this time I wish to give you just a brief summary of this work before a more detailed report will be published (Snieszko and Wood 1954; Wood, Yasutake and Snieszko 1954).

As it is evident from Table 3, our previous findings on the effect of sulfamerazine on brook, brown and rainbow trouts were confirmed. A mixture of sulfamerazine with sulfaguanidine has somewhat less drastic effect than that of sulfamerazine alone on the growth rate of brown trout. This may explain why in Flakas' (1950) experiments this drug mixture was superior to sulfamerazine in the treatment of furunculosis in this species of trout. The most striking finding however is that sulfisoxazole has no significant growth retarding effect on brown trout. The next experiment which we hope to make soon will be to determine the therapeutic value of sulfisoxazole in the treatment of furunculosis, ulcer diseases and possibly other infections, in various species of trout, but particularly in brown trout.

Table 3. Response of normal fingerling brook, brown and rainbow trout to a diet containing sulfonamides administered at a rate of 200 milligrams per kilogram per day.

	% Gain		
Treatment	Brook	Brown	Rainbow
Controls	159	140	133
Sulfisoxazole	172	131	137
Sulfamerazine	113	29	130
Sulfamerazine with sulfaguanidine	128	49	115

Infectious Pancreatic Necrosis and Mycotic Granuloma in Brook Trout

Last but not least I should like to give you a bird's eye preview of the experimental work in progress on the infectious pancreatic necrosis and a mycotic granuloma in brook trout. The chief credit for the progress in research on these two diseases is due to Dr. E. M. Wood, the first full time histopathologist employed by the U. S. Fish and Wildlife Service.

During the past year the Leetown station and other hatcheries in the Central Atlantic States suffered from an acute mortality among fingerling brook trout 1.5 to 2 inches long. The symptoms of this disease were typical for the acute catarrhal enteritis (M'Gonigle 1940; Davis 1953). The microscopic examination of the tissues from the diseased specimens indicated however that histopathologically this disease should be classified as an infectious pancreatic necrosis (Wood, Snieszko and Yasultake 1954).

So far neither pathogenic bacteria were isolated nor parasites seen in the diseased fishes. Since the outbreaks of this disease have the characteristics of an epizootic, and cell inclusions are present, one may suspect that it may be of viral origin. Treatment for this disease has not been attempted as yet. It seems unlikely that it is a nutritional disease as suspected by M'Gonigle.

The mycotic granuloma is another recently recognized member in the family of microbial fish diseases. Its chief characteristic is production of large granulomas in the intestinal tract and disseminated lesions in other internal organs of brook trout (Snieszko and Griffin 1955). In tissue sections a microorganism has been found which most likely is a fungus. It has not been isolated as yet. In 1952 and 1953 this disease was common in brook trout at the Leetown hatchery and another in New Hampshire. This year it has not been noticed as yet (October).

Nothing is known about the spread of this disease and the source of the microorganism which causes it. In our future work we are going to investigate however the possibility of its transmission with the meal prepared from marine fishes. Fungal diseases are common in the Atlantic herring and other salt water fishes. Theoretically at least fishmeal, if not heated adequately during processing, may be a source of fish pathogens, just as the salmon viscera are in the transmission of a virus disease of the sockeye salmon mentioned at the beginning of this talk.

General Comments

After informing you about some recent achievements in the research on fish diseases, I should like to make a general comment before finishing this talk.

The revived interest in the research in developing strains of trout having increased resistance against some of the most important bacterial diseases is of great practical importance. All of you interested in the production of the hatchery trout know that many of our strains of trout are highly inbred. Unfortunately this inbreeding rarely was carried on as a well-planned project or a rational breeding program.

One of the standards for the measurement of the performance of trout hatchery superintendents and personnel is the most economical production of fish. In other words premium is given for the production of not necessarily the best, but the cheapest trout. All of you know that in judging livestock, not the low cost of its production but its appearance and performance is of prime importance. I do hope to see in the not too distant future a similar approach to the production of the hatchery trout. Some day we may witness awarding of blue ribbons to hatchery superintendents who will produce trout having a high degree of resistance to diseases, which will do well in the streams or lakes into which they will be released, and will be well adapted for survival under the local or regional ecological conditions. The cost of production based on the food conversion may become a no more important criterion that similar factor would be in the judging of the prize winning cattle or horses.

Another, and the last item which I should like to mention, is the need for closer cooperation between the field and the laboratories. There are so few of us who do research on the nature, treatment and prevention of fish diseases, that without help from the administrators, field biologists, and hatchery personnel, the progress of our work must be very slow. I wish to appeal to you to let us know how

effective are the treatment methods which we find satisfactory under the quite specific laboratory conditions. We are more interested in obtaining information about cases in which our methods fail to produce satisfactory results. Such information will give us the opportunity to do additional studies which may result in improved methods of treatment.

We also shall greatly appreciate if you will send us specimens of diseased fish for examination. If you are going to send specimens to Leetown, please select fishes which show the most typical symptoms of the disease which they may have. If they are no longer than one inch put them, when still alive, in formalin diluted with 3 to 4 parts of water. If they are larger make an incision in the abdominal wall, but do not injure the internal organs.

You will help us even more if you will fix another specimen, or specimens, in the Bouin's solution and after 24 hours transfer it to 65 percent ethyl alcohol and ship so preserved material to Dr. E. M. Wood, Salmon Nutrition Laboratory, Cook, Washington. Dr. Wood will make histopathological examination. Do not forget to include detailed description of the symptoms and the conditions under which the disease appeared. Send one copy of this description with fish preserved in formalin to Leetown, W. Va., and the other together with specimens preserved in alcohol to Dr. Wood.

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