DISEASE IN THE LIVES OF FISH

The Role of Pollution Is Now Being Assessed

Richard Wolke

Ichthyopathology, or the study of fish diseases, is a discipline that bears out the prophetic words of Rudolf Virchow, who said in the late 1800's, "Between animal and human medicine there is no dividing line. . ." Although still in its infancy, the discipline is rapidly awakening the interest of such diverse investigators as the comparative pathologist, the cancer researcher and the ecologist. This interest was reflected in the establishment last year of a small diagnostic and research histopathology laboratory at the University of Rhode Island where fish tissues are examined microscopically for evidence of disease.

The sudden popularity of the field can certainly be attributed in part to the world's rapid increase in population, which has called upon all scientists to find new means of resource conservation and to feed this growing mass of humanity. But the primary stimulus for its new popularity can be attributed to two groups until recently rather widely separated in their interests--the aquaculturists and the comparative pathologists.

Aquaculturists Concerned

Aquaculture has been an important and integral part of agriculture for many centuries, especially in such countries as China and Japan, where fish make up a good proportion of the daily diet. As in any intensive livestock operation, be it with birds or mammals, the bringing together of large numbers of animals in a confined area lends itself to the rapid spread of disease processes. Aquaculture is not immune to this phenomenon. So it was the aquaculturist who first began to ask pertinent questions about fish mortality, and it was the aquaculturist who first began the study of fish diseases.

As the field of human medicine became more sophisticated, it became apparent that diseases of lower vertebrates, long studied by veterinarians, could add much to the body of knowledge collected by the physician. The words of Virchow, who is considered the father of modern pathology, were indeed prophetic. The veterinary pathologist was in a position to supply the physician with animal models of human diseases. It was only a question of time before these veterinarians began to see the importance of fish diseases and to study these diseases in an attempt to help both the physician and the aquaculturist.

Do Fish Suffer Disease?

For the uninitiated, the field of ichthyopathology may raise a number of questions. For instance, do any fish diseases of consequence in fact exist? Are diseases responsible for some of the mass mortalities--fish kills--we occasionally read about in our newspapers? Do they have an effect upon population dynamics or fluctuations of fish in the wild? Are they involved in mortalities connected with aquaculture projects? The answer to all of the questions is yes. Disease plays an important role in the life of all species of fish.

In fact, our investigations indicate that fish suffer from much the same kinds of diseases as man and the other higher vertebrates. Fish contract viral, bacterial and fungal diseases. They, like man, are neither immune to diabetes nor leukemia. Some of their diseases reach epidemic proportions and are responsible for mass mortalities of natural populations. One of the most important killers of fresh-water fish is the bacteria Aeromonas liquifaciens, an ubiquitous organism which, under the right environmental conditions, may increase rapidly in numbers and virulence. Marine fish, too, are no exception to epidemic disease processes. A case in point is the 1933 mass mortality of herring in New Brunswick due to the fungus Icthyophonus hoferii.

At present we are unable to state positively what proportion of fish kills are due solely to disease. We are unable to do so because so few kills are examined by competent pathologists. Qualified investigators are not often called to the scene of the kill and, if

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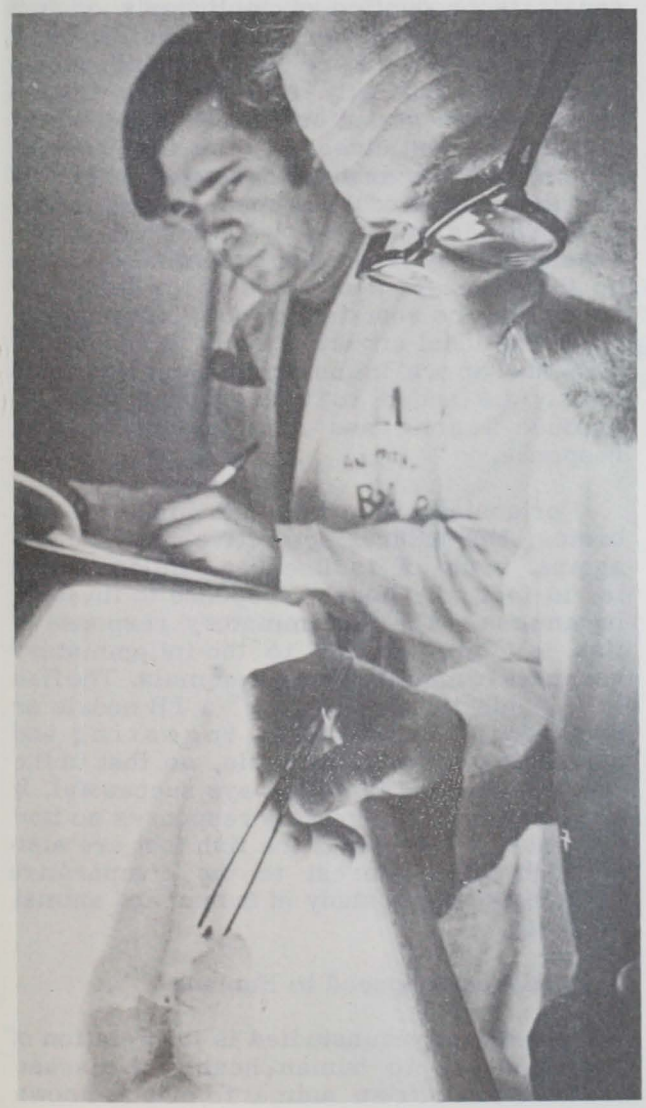
objective investigations are made, they are usually concerned only with water quality. If the water meets approved standards, the cause of mortality usually goes undetermined.

Pollution Kills Many Fish

There can be little question that present day pollution of our streams and rivers is responsible for many mass kills of freshwater fish. Pollutants that affect acidity, alkalinity or dissolved oxygen, or which increase the heavy metal content of the water may be responsible for sudden kills of massive numbers of fish and other aquatic fauna.



Dr. Wolke examining a lesion, or abnormal change within tissue, in a filet of an ocean pout. About 25 years ago these lesions caused the disappearance of ocean pout from the fresh fish market for esthetic reasons. There is no reason to believe the disease is communicable to man.

Of interest to the pathologist, however, is the relationship between low levels of pollution and disease processes. There is much evidence in the literature that this relationship is synergistic, meaning that the combined effect of these factors may be more devastating than any of them acting alone. For instance, the added stress of lowered oxygen tension may increase the risk of fish contracting various infectious bacterial diseases. Other controlled experiments have shown a higher incidence of disease in fish exposed to low levels of insecticides.

Poor Year-Class

In some instances, heavy infestations with intermediate (developing) stages of tapeworm parasites, while not responsible for mass mortality, may be responsible for sterility, leading to poor year class production and definite effects on population dynamics. The best example of this disease type is the freshwater bass tapeworm, Proteocephalus ambloplitus. The bass normally harbors the adult worm in its intestines with no ill effects. However, in areas of dense tapeworm populations, the bass may serve as its own intermediate host and be infected by the larval or plerocercoid stage of the worm. Under these circumstances, the plerocercoid may take up residence in the ovary, resulting in destruction to potential and actual ova.

Diseases of Wild Populations

If the diseases of wild populations of fish were surveyed by randomly sampling them throughout the year, a broad spectrum of diseases would be found, caused by a number of agents. Most commonly, the lesions observed may be classified histopathologically, but will be of unknown origin. This is a reflection on the serious lack of knowledge in the field of ichthyopathology and can be overcome only by patient observations and descriptions. The comparative pathologist must collect base data in order to become aware of the many diseases that certainly exist in the fish, but are presently unknown.

In such a survey, the majority of known lesions will probably be due to the larval stages of migrating worms of the helminth parasite group. This is not to say that parasites are responsible for killing large numbers of fish, for it is indeed a poor parasite that kills its host. There can be little question, however, that such larval migrations are

responsible for decreasing the efficiency of organs infected. In those isolated instances where overwhelming infections do occur, they are responsible for fatalities.

Probably the second most important causative agent recorded would be protozoa (one-celled animals). Fish suffer from a wide number of protozoa, which are both internal and external parasites. This is not surprising, because their aquatic environment is ideal for the reproduction and passage of such organisms. The survey would also include bacterial and fungal diseases, instances of disturbed metabolism, congenital anomalies and, on rare occasions, tumorous processes. It is an unfortunate fact that such a survey would miss many of the older, diseased and weakened fish because of the nature of this environment, where predators and scavengers are quick to dispatch the slow and unhealthy specimens.

Fish Diseases in Aquaculture

It is, however, under aquaculture conditions that we see the most striking examples of fish diseases. In warm, fresh water culture, protozoan external parasites such as Ichthyophthrius multifilis, Chilodenella sp. and Trichodina sp. are responsible for large losses of fish. Bacteria, especially Aeromonas sp. are also serious pathogens. In cold, fresh water husbandry of salmon and trout, a number of viral diseases have been described such as infectious pancreatic necrosis, Egvedt disease and infectious hematopoietic necrosis. Bacterial agents responsible for heavy mortalities have also been incriminated in salmon and trout production. These include the causative agents of furunculosis, Aeromonas salmoncida and Cytophaga psycrophilia, the probable cause of 'cold water disease.' In addition, aquaculture projects are not free of nutritional imbalances or of toxins introduced with the feed, such as aflatoxin, which proved responsible for hepatomas in trout.

Methods for the farming of marine fish (maraculture) are now being seriously explored. Here, too, agents responsible for disease are being regularly recovered. They are the same kinds of etiologic agents we face in fresh water environments, but are adapted to higher salinities.

It is not enough, however, for the aquaculturist simply to know what kind of disease his fish have contracted. If he is to be a successful producer, he must be able to prevent and cure these diseases. Much research is presently being done in the field of therapeusis. We know that many fish pathogens are susceptible to antibiotics commonly used in human and veterinary medicine. Nonetheless, problems arise in dosage rates, means of efficient administration and in treatment of viral and parasitic diseases that are resistant to antibiotics.

Immunizing Agents

One of the most exciting areas of therapeusis is production of biologicals or immunizing agents. It has been known for some time that higher fish are capable of producing antibodies. But only recently has it been shown that these antibodies are able to protect fish against diseases. One major problem is the temperature-dependent nature of the antibody-producing mechanisms of the fish. That is to say, below 50 degrees Fahrenheit antibody production essentially ceases, so that diseases contracted at low temperatures may be resistant to active immunization. The ideal situation would be the development of an oral immunizing agent that could simply be added to tank or pond water to produce a solid and long lasting immune response.

Fortunately the fish, like higher vertebrates, has natural protective mechanisms against many of its diseases. Inflammation is, in fact, the body's response to invading organisms. The inflammatory response of fish is quite similar to the inflammatory response of man and other mammals. The fish is capable of "walling off" a TB nodule or producing cells capable of ingesting and destroying invading bacteria, so that in the wild the disease is not always successful. It is these very inflammatory responses so important to the health of the fish that are also of such vital interest to the comparative pathologist in his study of human and animal diseases.

Fish Diseases Spread to Humans?

An area as yet unstudied is the relation of fish diseases to human health. A disease transmissible from animal to man is known as a zoonose. We are aware of a few zoonoses of fish origin such as the broad tapeworm of man Dibothociphalus, and the bacteria Erysipelas sp. Work in 1968 by investigators

studying fish in Chesapeake Bay indicated that fish close to densely populated areas of human habitation had antibodies against a number of human pathogens. The exact significance of this work has not been determined, but it is indicative that fish may serve as monitors of human disease organisms and therefore may be of public health significance. Recent work by this author (1970) indicates that striped bass, white perch and mummichogs carry a psittacoid agent, which is a microscopic organism similar in some respects to both virus and bacteria. It is similar in appearance to the agent responsible for parrot fever in man. However, interest in the public health aspects of fish diseases has been limited and they must be more intensively investigated.

Diagnostic & Research Lab

The diagnostic and research histopathology laboratory for the study of fish diseases was set up at the University of Rhode Island through the cooperation of the College of Resource Development and the Graduate School of Oceanography, with financial assistance from the Sea Grant program of the National Oceanic and Atmospheric Administration. This laboratory offers diagnostic services to aquaculturists throughout New England. Diseases under investigation include, 'cold water disease' of salmon, Plistophora infections of ocean pout and psittacoid infections of marine fish. By means of a continuing survey of marine fish, both normal and abnormal tissue sections are being collected, classified and stored to serve as base data for teaching and future research projects. The laboratory is also working in conjunction with the International Congress Against Cancer in an attempt to recover and classify neoplastic processes of bottom feeding fish.