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Parasites and Fishery Problems[1]

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Introduction

ACCORDING TO THE LATEST CONCEPTS, diseases caused by living organisms are parasitic diseases. Thus a multitude of protistans, plants and animals, may be classified as parasites. Parasites inhabiting various fishery organisms have long been of great medical and veterinary interest, *e.g.*, the Asiatic lung fluke (*Paragonimus westermanni*) which is contracted by eating raw crabs and crayfish, the Asiatic liver fluke [*Opistorchis sinensis* (=*Clonorchis sinensis*)] and the European liver fluke (*Opistorchis felineus*) which are ingested with raw fish, and the broad fish tapeworm (*Dibothriocephalus latus*) which is often contracted by cooks preparing "gefüllte" fish from imported walleyes and pikes. Interest in parasites of fishes and other aquatic animals has been largely academic. Recently, however, these parasitic organisms have begun to attract the attention of scientists in applied disciplines, like fishery science.

Parasites and Fishery Populations

We have long been aware that parasites may seriously affect confined aquatic populations. Hatchery operations and food-fish ponds, to say nothing of aquarium displays, are often disrupted by outbreaks of parasitic diseases. Probably not infrequently natural populations have also been adversely affected. We have become increasingly aware that to manage natural fishery populations we must understand the dynamics of these populations. Thus, *all* of the important factors affecting the populations must be known. Walford (1958) points out that enough epidemics among fishery populations have already been reported to suggest that disease might be a more potent factor in marine ecology than is usually suspected, and suggests that past failure to include the study of diseases in marine research programs possibly explains why some of the causes of fluctuating abundance continue to be mysterious. This failure also probably partially accounts for our lack of understanding of certain periodic fish mortalities. Scarcely a year passes without late winter or early spring mortalities of the bay anchovy (*Anchoa mitchilli*), young menhaden (*Brevoortia tyrannus*) and other fishes in lower Chesapeake Bay, the causes of which are unknown. Similar unexplained mortalities occur more or less regularly all along the Atlantic Coast of North America and elsewhere (Sindermann and Rosenfield, 1954; Westman and Nigrelli, 1955; Sindermann, 1956). Little is known of the effects of "non-pathogenic levels" of infection upon the host, but undoubtedly there are some. Almost nothing is known of the comparative longevity of non-parasitized and parasitized populations.

[1]Contribution from the Virginia Laboratory, No. 83.

The list of parasites which produce diseases in fishery animals or their associates ranges from the virus which causes lymphocystis disease of fresh-water fishes, to bacteria, *e.g.*, some vibrios and chromobacters; to fungi, *e.g.*, *Icthyosporidium hoferi*, which causes "pepper-pot disease" in herring and other fishes of the Western North Atlantic; *Lagenidium callinectes*, which parasitizes the egg masses of the blue crab *(Callinectes sapidus)*, and *Labyrinthula* sp. which probably causes the wasting disease of eelgrass, and which probably adversely affected several valuable fishery populations in the pandemic of 1931 and 1932; to protozoans, *e.g.*, the many microsporidians and myxosporidians which attack fishes, decapods and molluscs; and to the helminths and crustaceans which, though usually relatively innocuous, may also produce debilities in their hosts. There are undoubtedly many other virus, fungus, bacterial, protozoan, and metazoan parasites of fishery animals which are as yet unknown. Knowledge of these parasites is increasing, however, because parasitological investigations are now included in several fishery research programs. A significant case in point is the attention recently given the fungus, *Dermocystidium marinum*, which causes oyster mortalities in many Atlantic and Gulf Coast regions. Before the importance of this fungus disease was demonstrated by Mackin *et al.* (1950), Ray (1953), and Andrews and Hewatt (1957), certain regularly occurring losses of many oysters were not understood. As a result of the efforts of these workers the pathogenic fungus has been identified and characterized and it is now possible to advise oystermen how to reduce losses from this pest.

Parasitological Data as Research Tools

Fishery scientists also are becoming more interested in using parasitological data as tools or clues in their efforts to resolve fishery problems. Parasites often exhibit marked geographic restriction and host specificity. These characteristics make possible their use as living indicators or tags.

Parasites as Indicators of Geographical Subpopulations

Studies of U. S. Fish and Wildlife Service personnel (Uzmann *et al.*, 1957) on natural populations of the sockeye or blue-back salmon (*Oncorhynchus nerka*) in the Columbia River system have revealed pronounced differences in the parasite faunas of migrants from the three major spawning tributaries. These workers now believe that it will be possible to derive estimates of the relative abundance of each geographical subpopulation in samples taken from downstream mixing areas by analyzing their parasite complements.

International fishery problems concerning the rational exploitation of high-seas populations of sockeye (*O. nerka*) and pink (*O. gorbuschka*) salmon stimulated formation of the International North Pacific Fisheries Commission in 1953. Early sessions of this body established an artificial boundary line, sometimes called the temporary line of abstention, at the line of meridian 175° West Longitude, to separate the Asiatic (Japan) high-seas salmon fishery from the North American (Canada and the United States) for management and research. At the same time the participants undertook joint research to gather biological data on which a more realistic boundary line might be based. Subsequent researches strongly suggest that it will be possible to utilize differences between the species composition of the parasite faunas and the numerical incidence of various parasites occurring in high-seas populations of sockeye and pink salmon to distinguish their continental origins. According to the parasitological data gathered to date the 1953 boundary line may not effect a biologically realistic separation of the two salmon stocks. For example, Margolis and other Canadian scientists (Jackson, 1957, 1958) who examined large numbers of sockeye and pink salmon from various high-seas and inshore stations from 1955 to 1957, reported that more than 50 species of parasites were encountered. Although the distribution of most of these parasites was not restricted, at least five of those found in sockeye salmon (four acquired in the sea, *Hemiurus levinseni,* a trematode, *Tubulovesicula lindbergi,* a trematode, *Echinorhynchus gadi,* an acanthocephalan, and *Anisakis* sp., a nematode; and one acquired in fresh-water—*Triaenophorus crassus,* a cestode) show promise of usefulness in separating high-seas salmon populations. There were also certain marked discontinuities in the distribution or abundance of three different marine parasites of pink salmon (*Hemiurus,* a trematode, *Bolbosoma,* an acanthocephalan and *Contracaecum,* a nematode) which seemed to indicate several main groups in the high-seas samples that could be related to coastal samples from Asiatic or North American inshore regions.

But helminths are not the only parasites useful as natural tags. After an intensive three year study of various parasites of sea herring (*Clupea harengus*) Sindermann (1957a and 1957b) concluded that the myxosporidian parasite (*Kudoa clupeidae*) should serve as a reliable "natural tag" during the first few years of the life of the host. His laboratory experiments and field observations indicated that the parasite apparently caused little mortality, a necessary attribute of a tag. In addition, the distribution pattern indicated by the relative incidence of this parasite in the different geographical host populations showed an, "absence of large-scale movements of sardine herring along the Maine coast, and a separation of such immature fish from eastern and western Maine, at least during the latter part of the first and much of the second year of life," (Sindermann, 1957b). The incidence of the other parasites encountered (the fungus, *Ichthyosporidium hoferi,* larval cestodes of the order Trypanorhyncha and the larval nematodes of the subfamily Anisakinae) confirmed these findings.

Parasites as Taxonomic Clues

Host specificity makes it possible to use parasitological data as auxiliary clues to the phylogenetic relationships of their hosts (Hargis, 1957). Recently Fish and Wildlife Service biologists in conjunction wth the Virginia Fisheries Laboratory have begun limited investigations into the possibility that certain parasitological data may be used to separate populations of Atlantic menhaden.

Parasites as Physiological Indicators

Often the life cycle of a parasite is so geared to that of its host that it serves as an indicator of the host's physiological condition. For example, juvenile nemerteans (*Carcinonemertes carcinophila*) encysted on the gills of the blue crab (*Callinectes sapidus*) are small and inconspicuous. After the female host has spawned the nemerteans excyst, migrate to her egg mass, grow and mature, lay eggs and return to the gills. It is possible to tell whether a host has spawned by the increased size and more noticeable color of the re-encysted gill parasites (Hopkins, 1947).

Parasites in Predator Control

Parasites and predators have been used to control certain undesirable terrestrial populations. Similar applications have been considered for marine predators like the green crab (*Carcinides maenas*) and oyster drills (*Urosalpinx cinerea* and *Eupleura caudata*), so far without success. However, this possibility deserves further study.

Parasites and the Commercial Fishery

Parasites may have noteworthy adverse effects upon commercial fishery products. The presence of some of the diseases mentioned above, *e.g.*, "pepper-pot disease" of herring, etc., often necessitates culling of infected individuals. As Sindermann and Rosenfield (1954) pointed out, "several examples of decrease in desirability can be found in marine fishes . . . That certain diseases render the infected fish unacceptable as food is seen in fungus disease of herring. Canneries will not accept catches of herring with a high percentage of fungus infection, and excessive numbers of fungus spores in fish packed as sardines may be the cause for rejection of that particular pack by Food and Drug Inspection." Thus economic losses are suffered by the producer or the packer.

Most helminth parasites are eliminated in cleaning or immobilized in cooking and do not affect the marketability or edibility of the product. But some do adversely affect the preparation, marketing and consumption of fishery products. Certain infected fishes are often rejected by wholesalers or consumers because of the unsavory appearance of their wormy flesh.

The encysted flesh tapeworm (*Triaenophorus crassus*) is so unsightly that the Canadian Government regularly inspects whitefish (*Coregonus clupeaformis*) destined for commerce. As a result some Canadian producers have been forced to stop fishing for whitefish in heavily infested lakes. Others have begun to fillet, candle and trim their catches (Miller, 1952). Even so the U. S. Food and Drug Administration refused entry of 85 shipments totaling approximately 43,200 lbs. of infested whitefish during the period from June 1 to September 16, 1958. An additional 6,475 lbs. were seized at various places in this country (B. V. McFarland, personal communication).

For over twenty years northern seafood processors have been forced to candle certain fish, *e.g.*, redfish (*Sebastes marinus*), cod (*Gadus callarius*) and various flounders for flesh and skin parasites. According to personal communications from representatives of two such companies, unsightliness of parasitized fishes and U. S. Food and Drug Administration regulations demand that parasites be picked out or trimmed away before packaging. Their records indicate that candling and trimming cause an increase of up to 80 per cent in the cost of packaging. One company candles approximately 4,500,000 pounds of all commonly parasitized species per year. The parasites involved are: (1) "Buttons" in redfish (*Sphyrion lumpi,* a copepod); codworms (*Porocaecum decipiens,* a nematode); and (3) metacercarial cysts in flounder (*Stephanostomum hysterix,* a trematode). It is of interest to note that most parasitized fishes are caught in inshore areas. Fishes from deeper water seldom have parasites.

According to sport fishermen, Florida grouper fillets are often dewormed before cooking. The Virginia Fisheries Laboratory often receives inquiries from sport fishermen and other consumers concerning the edibility of parasitized fishes. Last summer we received several large preserved specimens of the clam nemertean, *Malacobdella grossa,* from the Virginia Department of Health with an inquiry concerning the edibility of parasitized *Mercenaria.*

Parasites are not always entirely detrimental, however, for the pea crab (*Pinnotheres ostreum*) which probably adversely effects oysters, is considered a delicacy by some and was once commonly packaged for market but the practice is declining. Nowadays shuckers seldom go to the trouble of recovering crabs and the appetites of some seafood gourmets go unsatisfied.

Parasites definitely affect all phases of fishery operations, production, preparation, marketing and research. Many of their effects remain to be assessed. Undoubtedly, fishery science must pay increased attention to them, not only because they are commercially important but also because they have potential value as research tools.

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A New Fishery For Scallops in Western Florida

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THE GULF SCALLOP, *Pecten (Aequipecten) gibbus,* has at last entered the commercial picture. For decades, shell collectors roaming the west coast of Florida have commented on the vast heaps of this species washed ashore by stormy seas, particularly in the Marco and Sanibel Island areas, and it has become a cliché to comment about "commercial possibilities of harvesting" this species. Even with periodic knee-deep windrows of fresh shell lined up on the beaches, no serious consideration was given to commercial investigation.

With the consumer acceptance of grooved shrimp, which occurred in the late 1940's, and the discovery and opening of the Dry Tortugas shrimp grounds in late 1949 and early 1950, an effective scallop catching gear, the shrimp trawl, was introduced to this general area for the first time. Several species of scallops were found within the relatively narrow confines of the early Tortugas fishery and these momentarily excited some interest; however, as the shrimp fishing areas were more closely delineated, and shallower water exploratory probing with try-nets lessened, scallop reports decreased and the fleet limited itself to catching shrimp.

The first active exploration for commercial concentrations of the Gulf scallop was carried out in April, 1954, in conjunction with some "bad bottom" exploratory shrimp trawling conducted by the Fish and Wildlife Service exploratory fishing vessel, *Oregon,* off the southwestern coast of Florida. An examination of earlier *Oregon* shrimp trawling records (January, 1951) in this area revealed that *P. gibbus* was extensively distributed out to depths of twenty-five fathoms and that catches as high as two bushels of two inch scallops were made between five and ten fathoms off Naples. During *Oregon* Cruise No. 22, some