NOTES ON THE FLESH PARASITES OF MARINE FOOD FISHES

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By Edwin Linton, Ph. D.

Professor of Biology, Washington and Jefferson College, Washington, Pa.

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INTRODUCTION.

In beginning the study of fish parasites it was soon realized that by far the most likely place to find entozoa is within the body cavity of the host. Often, therefore, on account of the abundance of material and the limited time at my disposal, I confined my collecting almost wholly to what could be secured from the alimentary tract and the body cavity. An occasional search for parasites in the flesh of marine fishes met with so few finds that it came to be in large measure neglected. In 1904, however, I discovered that the parasitism which I had already noted in the case of the butterfish (*Poronotus triacanthus*), instead of being of occasional and accidental occurrence, is really of almost universal prevalence in all localities where I have studied this fish.

The results of my investigations on the butterfish parasite naturally suggested inquiry as to the condition in this particular of other food fishes, and it is the purpose of this paper to set forth some of the results of my investigations of this subject. In the summer which has just passed (1908) I spent three weeks at the laboratory of the Carnegie Institution at the Dry Tortugas, and the remainder of the time at the laboratory of the Bureau of Fisheries, Woods Hole, Mass. Most of the fishes that I examined were examined for flesh parasites, and, with one or two exceptions, this paper is confined to results obtained in the present season. This applies more especially to the tabulated results.

The results of this study are as yet very uneven; at the same time they afford certain conclusions which are of importance, as will appear in the progress of the paper. It may be stated properly in this connection that while very few, or even in some cases only one, example of a species of fish was examined, the general results of this past summer's investigation are in agreement with those of previous years—namely, that the marine food fishes, with the exception of the butterfish, are singularly free from parasites in the flesh. Indeed, with the exception of the butterfish, I have not yet found any one of our food fishes which is more than an accidental intermediate host for any parasite. At least, if there are any such they are confined to those cases in which the walls of the alimentary tract furnish a lodgment for various cestode cysts.

The method employed in the examination of the flesh for parasites was the same I have used in examining butterfish in previous years. The fish were split open longitudinally and the flesh separated from the backbone and vertebral spines. Occasionally the flesh was further divided. This method exposes the usual location of flesh parasites.

PRINCIPLES OF DISTRIBUTION OF ENTOZOA.

In order that the subject-matter of this paper be perfectly clear, it is necessary to give a brief résumé of the principles which determine the distribution of the entozoa. The term "entozoan" is a convenient general designation for any animal which lives within another animal. The adult egg-producing animal lives in the alimentary tract, or some part in direct connection with the alimentary tract, as the bile duct, or, in the case of air-breathing animals, also in the air passages. As a rule the eggs, or in the case of the cestode or tapeworm the ripe joints, which separate from the parent chain, are thrown off with the natural discharges of the animal in which they are living. The animal which harbors the adult tapeworm is called the final host. In order to develop, the eggs, as a rule, must enter the alimentary tract of another animal. In this animal the eggshell is digested off and the minute embryo thus liberated penetrates the mucous membrane of this second or intermediate host and sooner or later comes to rest. A cyst of connective tissue is formed around it by the tissues of its host. In this cyst the parasite remains quiescent, and ordinarily this is the end of the individual unless it is swallowed by the animal in whose alimentary canal it can become sexually mature. In this case another generation of eggs is produced and the round of life from egg to egg again is completed.

In the majority of instances a cestode egg gives rise to but one adult chain. In a few instances a large number may develop from one egg, on account of the multiplication of larvæ by a kind of budding in the encysted stage. So far as I have observed, there are no examples of this latter method of reproduction among the cestodes that infest fishes.

ZOOLOGICAL ORDERS REPRESENTED BY FLESH PARASITES OF FISHES.

The following groups are represented in the parasites which I have found in the flesh of our marine food fish:

SPOROZOA.

These protozoan parasites occur in small white cysts, usually along the backbone of small fishes. They seem to be of rather common occurrence in young alewives and herring.[a] I have not examined many full-grown herring

[a] Linton, E.: Parasites of fishes of the Woods Hole region. Bulletin U. S. Fish Commission, vol. XIX, 1899, p. 438, 439.

and alewives, but, so far as my researches have gone, the flesh parasites appear to be confined to the young fish. It seems probable that the badly infected young do not reach maturity. Our knowledge of the life cycle of the sporozoa is very fragmentary, and it is perhaps better to expend our energies in the accumulation of knowledge, even if it must consist largely of apparently unconnected facts, than to attempt to explain what further investigation may show in a clear light.

NEMATODA.

While immature roundworms are very common on the viscera of fish, they are, fortunately from our point of view, of exceedingly rare occurrence in the flesh of marine fish. I have not found them in the flesh of any of the fishes which are strictly food fish at Woods Hole, Beaufort, or Tortugas. In Bermuda I found numerous roundworms (*Ichthyonema globiceps*) in the flesh of a gar (*Tylosurus acus*). These were colored blood-red and lay in tangled clusters in the flesh, most abundant near the backbone. They bore a close resemblance to blood vessels. I have occasionally found this species, or a species near it, in the ovaries of some of our food fishes. If these were of common occurrence the fact would be somewhat disturbing. The worms are long and thread-like, often growing to the length of several inches. They are, moreover, crowded either with ova or, in most cases, with the young. The latter are very minute, but very active, and are in vast numbers. What would be the result if eaten in insufficiently cooked food is not known. If, like the dread *Trichina*, they can resist the digestive juices of the human stomach, they might easily penetrate the mucous membrane and, carried by the blood, finally lodge in congenial tissues of the body, to become encysted, provided the body is able to stand the inflammation produced by the invasion.

Nematodes are very resistant to digestive fluids and are much more to be feared than either trematodes or cestodes. In addition, they are nearer the popular conception of the word worm than representatives of other orders of the helminths. It is, therefore, a satisfaction to state that the probability of consuming nematodes along with our fish food is very slight, indeed, and in no way to be compared with the like probability in the eating of pork.

TREMATODA.

While this order of flat worms has a very large representation among the species of entozoa inhabiting fish, their occurrence in the flesh of marine fish is extremely rare, so much so that the few cases which I have recorded must be regarded as accidental. The only cases where members of this order are at all likely to enter our alimentary canals along with our fish food will be as skin parasites. Many fish, especially tautog, cunner, and, to a lesser degree, flounders,

tomcod, and fish of similar habits, have small distomes encysted in the skin and in the fins. As these are almost always all removed in preparing the fish for cooking, they need cause no more thought, even to the ultra fastidious, than other accidental débris that may be caught by the slimy epidermis of the fish. On fishes inhabiting small fresh-water lakes this form of parasitism is common. The bearer of the adult stage of these skin parasites is commonly some fish-eating bird.

CESTODA.

This order is represented by many genera and species among the entozoa of marine fishes. The sharks and skates harbor a long list of adult cestodes in their alimentary canals, especially in the intestine or spiral valve. The mature joints of these cestodes, each filled with hundreds, even thousands of eggs, are cast into the water in vast numbers along with the fæces of the host. It is a peculiarity of these free segments that they may continue living for some time, even many hours, in sea water. In the water they are likely to be eaten by such fish as feed on small worms, crustacea, and the like. The adult stage of any of these cestodes of the sharks and skates is limited to a few closely related species, or, in some cases, apparently to a single species. They are, on the other hand, capable of living on a large number of intermediate hosts. A little reflection on the contrasted conditions to which the adult and the larval stages, respectively, of a cestode are subjected will serve to explain this difference.

In the adult stage the cestode passes its whole existence in the alimentary canal of its host. It has become adapted to a highly specialized set of conditions. Hosts differ specifically not only in respect to their morphological characteristics but in their physiological characters as well. Thus a given cestode may find the juices of the alimentary canal of a tiger shark kindly while it finds the juices of the alimentary canal of any other shark fatal to its development. There is also some difference in the character of the food. The latter might seem to account for the difference between the parasites of a shark whose diet consists mainly of crustaceans, and one which has a strictly fish diet. On the other hand, sharks which feed on practically the same food, if they are not closely related morphologically, may be found to harbor a different set of cestode parasites. For example, the entozoa of the dusky shark (*Carcharhinus obscurus*) and those of the blue shark (*C. milberti*) comprise practically the same species. When the list from either of these sharks is compared with the list from the sand shark (*Carcharias littoralis*), some constant differences at once appear. There is one species of cestode (*Crossobothrium laciniatum*) which is almost invariably present in the sand shark and usually in considerable numbers. It has not been found in any other species of shark or skate. Furthermore, very few of the long list of cestodes from the dusky shark have been found in the sand shark.

When we turn to the intermediate hosts of these cestodes we find no such limitations. For example, there is a cestode (*Tetrarhynchus bisulcatus*) which is of common occurrence in the dusky shark in the Woods Hole region. I found the same or a closely related species in a shark, which was rather doubtfully identified as a blue shark, at Beaufort, and two specimens, not yet mature, in a sharp-nosed shark (*Scoliodon terræ-novæ*) at that place. This cestode may be said to be practically limited to the dusky shark as its final host. I have found it encysted in at least 18 species of fish at Woods Hole, in 22 at Beaufort, and in 2 in Bermuda. The intermediate hosts of this parasite include a great range of species. They are not even confined to the teleosts, but include some of the sharks and skates as well. The occurrence of encysted cestodes in sharks and skates is not as rare as it was thought to be by Beneden, who coined the word xenosite, or stranger, for such cases.

It does not come within the plan of this paper to give details of distribution. The following typical examples, therefore, will probably be sufficient to illustrate this matter of the limitation in the number of final hosts and the wide range of intermediate hosts.

DISTRIBUTION OF TYPICAL CESTODES IN FINAL AND INTERMEDIATE HOSTS.

Cestode.	Usual or only known final host.	Intermediate host.
Tetrarhynchus bisulcatus	Carcharhinus obscurus	18 species of Woods Hole fishes. 22 species of Beaufort fishes. 2 species of Bermuda fishes.
Rhynchobothrium bulbifer	Mustelus canis	22 species of Woods Hole fishes.
Rhynchobothrium speciosum	Carcharhinus obscurus	12 species of Woods Hole fishes. 3 species of Beaufort fishes. 5 species of Bermuda fishes. 4 species of Tortugas fishes.
Rhynchobothrium imparispine	Raja ocellata	28 species of Woods Hole fishes.
Otobothrium crenacolle	Sphyrna zygæna	In a large number of Woods Hole and Beaufort fishes, and in 3 Bermuda fishes; especially abundant in flesh of butterfish.

In view of the frequency of occurrence of cestode parasites in body cavities of marine fishes their comparative rarity as flesh parasites is striking. While larval cestodes have been found in the great majority of the species of fish I have examined, in those cases where a considerable number of individuals were examined the number of species of fish in which I have found parasites in the flesh is surprisingly small. A glance at the appended tables will show the small number of fishes found to harbor parasites in the flesh among those examined in the summer of 1908. When it is remembered that with no more than three exceptions entozoan parasites have been collected from all the species of fish named in the tables, that flesh parasites are recorded from only 12 species out of a total of 76, and that in only 2 of the 12 species were flesh parasites found in many individual fish or in large numbers in any, the comparative scarcity of flesh parasites in the marine fishes becomes a still more noteworthy fact.

Aside from the butterfishes, which will be considered later, the only instances in which I have found cestodes in the flesh of marine fishes under conditions which led me to regard their occurrence as other than accidental are the following:

1. Two species of gars, *Tylosurus acus* in Bermuda and *T. rapidoma* at Beaufort. Two fish of the former species and one of the latter were examined. In each of them there were many cestodes in the flesh. This cestode was described[a] under the name *Otobothrium* sp. The examples from the Bermuda gars proved to be the same species and have been given a specific name, *O. penetrans*.[b]

2. The sand launce (*Ammodytes americanus*). I have found a species of cestode (*Rhynchobothrium bulbifer*) in the flesh of a considerable number of these fishes in previous years, although none were found in the lot which was examined this season.

3. Two sticklebacks (*Gasterosteus bispinosus*) which were examined this season had each many cestodes encysted in the flesh.

Two of the three cases cited above are based on too small a number of individuals to be of much value, at the same time the manner of infection in each case was such as to lead me to more than suspect that they are common carriers of cestode parasites in the flesh.

THE CASE OF THE BUTTERFISH.

A reference to the appended table III, wherein details of the examination of the butterfish are given, and to tables I and II, where a summary is given in which the parasitism of the butterfish may be compared with that of other food fishes examined during the summer of 1908, will show that in respect to the matter of flesh parasites the butterfish occupies a unique position. All the other food fish, as a rule, show either none or only an occasional individual with parasites in the flesh, and even in cases where any were found in the flesh, there were at most few, often but one. The butterfish, on the other hand, proves to be so generally infected that the infected condition really seems to be the normal. An examination in the season of 1908 of 720 butterfish, ranging in length from 6 to 23 centimeters, resulted in finding cestode cysts in the flesh of all but 21.

As this case of parasitism has already been reported it is not necessary to devote much time to it here.[c] Inasmuch as the case is a most remarkable and exceptional one, however, there are certain phases of the subject which should be considered.

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[a] Linton, E.: Parasites of fishes of Beaufort, N. C. Bulletin, Bureau of Fisheries, vol. XXIV, 1904, p. 357.

[b] Linton, E.: Notes on parasites of Bermuda fishes. Proceedings U. S. National Museum, vol. XXXIII, 1908, p. 100

[c] Linton E.: A cestode parasite in the flesh of the butterfish. Bulletin Bureau of Fisheries, vol. XXVI, p. 1–48, pl. 1 and 2.

This parasite is a cestode, described first from adult forms found in the spiral valve of the hammerhead shark (*Sphyrna zygæna*).[a] In the butterfish it is found, sometimes in enormous numbers, in the flesh. The favorite resting place of these cysts is between the vertebral spines on the ventral side of the backbone, but they are often almost equally abundant between the vertebral spines on the dorsal side of the backbone, and scattered generally through the muscles of the body, for the most part in a dorsoventral median plane. The cysts are small, usually 1 millimeter or less in greatest diameter, oval in shape, and present the appearance of small fish-roe. In the young fish they are translucent white, which becomes tinged with yellow in the larger fish. Each cyst, when crushed, liberates a characteristic cestode nurse (plerocercus or blastocyst) in which is the scolex or head of the tapeworm. In all the cysts that I have studied this season, even those from the smallest fish, I have not failed to find a well-formed scolex bearing the characteristic marks by which the species may be recognized. In former years the smaller fish were found to be much less infected than the older fish and many were found in which no cysts were seen. Also in former years cysts were found in some of the smaller fish which contained scoleces in which the characteristic hooks on the proboscides and the pits on the bothria were not yet developed. In the season of 1908 even the smaller fishes were found to be largely infected. As they are recorded in the tables, the grouping into "cysts in enormous numbers," "very numerous," "numerous," etc., is more or less arbitrary. It is to be hoped, however, that it will convey a fairly correct picture of the actual condition. Of course the terms are to be understood as of only relative significance. A small fish, for example, recorded as having numerous cysts would contain a smaller actual number than would a large fish similarly characterized.

This case of parasitism of the individuals of a species which inhabits the open sea is most exceptional. In a confined area, as in a small lake, or in exceptional conditions, such as obtain in as large a body of water as Yellowstone Lake, a general prevalence of parasites can be accounted for.[b] But why should the butterfish and its near relative, the harvestfish, be so excessively and universally parasitized while other species of fish, though they inhabit the same waters and feed on practically the same food, escape? That an occasional butterfish should be found with these cysts in the flesh would not of itself be a thing remarkable. That these cysts should even be present in very large numbers, even thousands, as is often the case, is not inexplicable. That such an enormous percentage should be affected, as is proved by the facts exhibited in the tabular statements in this paper, is the really difficult matter to explain.

[a] Linton, E.: Notes on entozoa of marine fishes of New England, with descriptions of several new species. Report U. S. Fish Commission, 1887, p. 850–853, pl. XIII, fig. 9–15; pl. XIV, fig. 1–4. 1891.

[b] Linton, E.: On two species of larval Dibothria from the Yellowstone National Park. Bulletin U. S. Fish Commission, vol. IX, p. 65–79, pl. XXIII–XXV; p. 337–358, pl. CXVII–CXIX. 1891.

1. As to the fact that these parasites have the habit of gaining lodgment in the flesh of the butterfish, it may be said that evidently here is a case of mutually favoring conditions. A careful study of the anatomy of the butterfish, especially of the vascular system, may throw some light on the problem. At any rate the fact that the larvæ of *Otobothrium crenacolle* penetrate to the muscles of the butterfish and harvestfish, instead of lodging in the submucous coat of the stomach and intestine, as is their habit in other fishes in which this cestode has been found, is probably a purely physiological question. The other species of *Otobothrium* mentioned above presents a somewhat similar case. In the case of the gars, however, a large number of small gars have been examined for flesh parasites without any being found. Either the infected gars were exceptional cases, or it is only in certain regions that the conditions favor the ingestion of cestode eggs.

It would appear that certain species of the Tetrarhynchidæ, and notably of the genus *Otobothrium*, are enabled to penetrate to the muscles of certain intermediate hosts, possibly on account of being of suitable size and structure so that they are carried by the blood away from the immediate vicinity of the viscera. Or, more probably, there is here a case of accidentally mutual adjustment on the part of the anatomical structure, and possibly the physiological habit of the butterfish on the one part, to the structural features, and possibly the physiological requirements of the parasite on the other.

2. That these cysts should be present in very large numbers in a single fish is not difficult to understand once given the possibility of their being in the flesh at all. A free, ripe segment of the cestode *Otobothrium crenacolle* will remain living for hours after it has been placed in sea water. Moreover, it may contain an enormous number of eggs. There is no necessity, therefore, in postulating some method of reproduction of cysts by budding, for which there is not the slightest evidence, to account for the presence of a large number of cysts in a single butterfish. The ingestion of a single joint, in which there is a large number of eggs, will be sufficient to give rise to several hundred, possibly a few thousands of cysts, each with its living scolex. Indeed it is rather easier to explain the cases in which there are hundreds of cysts than it is to explain those in which there are less than a dozen. Cases of slight infection are probably due to the accidental swallowing of a few eggs instead of an entire joint. This might happen if a fish swallowed a bit of fecal matter which might well have one or more eggs intermingled with it.

3. How is the apparently almost universal parasitism of the butterfish to be explained? Before attempting to answer this question it may be well to consider whether the case, aside from the fact that the cysts are in the muscles, is unique. Unfortunately, I have not my notes arranged in such a way as

will enable me to tabulate readily or completely the data which it is desirable to marshal for this particular purpose. The following statements, however, are abundantly warranted from many observations made during previous years, and have some bearing on the immediate question.

The stomach wall of most squeteagues (*Cynoscion regalis*) contains a greater or less number of cysts of a definite species of cestode (*Tetrarhynchus bisulcatus*) which is found in the adult stage in the stomach and intestine of the dusky shark. Furthermore there is found in the cystic duct of the same fish a larval cestode (*Scolex polymorphus*), almost always in considerable number. The same parasite is also quite common in the cystic duct of the summer flounder (*Paralichthys dentatus*). For example, during the past summer I examined a flounder from Menemsha Bight which appeared to be suffering from a case of jaundice. The whole surface was yellow, the unpigmented under side being a decidedly bright lemon yellow. The flesh and the viscera were also yellow. The cystic duct was occluded by a mass which looked something like a soft tumor. When this mass was cut open it was found to consist of a cluster of these cestodes. Their heads were buried in the mucous membrane while their bodies effectually stopped the lumen of the duct. Other cases of prevalent parasitism in intermediate hosts could be cited.

In like manner cases of prevalent parasitism of final hosts are not lacking. Thus every specimen of tiger shark (*Galeocerdo tigrinus*) which I have examined, about 15 in all, at intervals during many years, has been found to harbor large numbers of a singular cestode (*Thysanocephalum crispum*), a species which has not been found as yet in any other host. Again, nearly every sand shark in the Woods Hole region harbors a species of cestode (*Crossobothrium laciniatum*), often in large numbers.

Plainly, then, all that is necessary to make parasitism, by means of a given species of parasite, affect the majority of the individuals of the host, is to have the source of infection sufficiently widespread, abundant, and pervading in the natural habitat of the infected species. Not only must the final and the intermediate hosts, in the case of the cestodes, be related to each other as eater and eaten, but their association together must be otherwise close, else the intermediate host will not become largely infected. At present I can see no other explanation of the almost universal prevalence of this parasite in the flesh of the butterfish than that which I gave in the paper cited above. The butterfish must have formed the habit of following sharks, attracted by the bits of food which float off in the water while the shark is feeding. The voracious, fish-eating sharks tear and shake their prey as they eat it, so that there must often be in the vicinity of a shark a cloud of bits and shreds of meat which are greedily sought by smaller fish. This zone of sure, even if it be intermittent, food supply

can not fail to be attractive to small fish. These small fish, especially when traveling in schools, must themselves often pay tribute to the shark. There is thus established by the common bond of mutual advantage an association which must be extremely favorable to the parasite which can thrive well in both the intermediate and the final host which are the principals in this association. From time to time the ripe joints of the cestode will be discharged into the water along with the fæces from the intestine of the shark. These joints look, behave, and doubtless feel to a small fish much as other small swimming forms, entomostracans, annelids, and the like do, and consequently are picked up by them. In some such manner do the eggs of the cestode gain lodgment in the intermediate host. What is difficult to picture is the actual situation which not only makes possible but actually brings to pass the infection of practically all the butterfish. A study of the appended tables will make it quite clear that among the half grown and fully grown butterfish an individual which is free from these cysts in the flesh is exceptional.

Butterfish are not fish of rare occurrence traveling singly or even in very small schools. They are taken in considerable numbers in the fish pounds, and evidently move in fairly large schools. How far they migrate along the coast is not known. I have found the adult cestode, though not abundant, in the sharp-nosed shark at Beaufort. This shark is abundant. The other known final host is the hammerhead shark, which is not an abundant species, though it is one which has a wide distribution. I hope to be able to gather more data on this interesting problem of distribution.

GENERAL CONSIDERATIONS AS TO FLESH PARASITES OF FISHES.

To what extent is the food value of fishes impaired by the presence of parasites in the flesh?

With the exception of the common butterfish (*Poronotus triacanthus*), and its rarer relative the harvestfish (*Peprilus alepidotus*), I find that the marine food fish I have thus far examined are so free from parasites in the flesh that the question has, at present, little more than an academic or rather a purely zoological interest. To take the case of the butterfish, it may be remarked:

1. Since the cysts might be easily mistaken for ova by one whose knowledge of the natural position of the ovary is indefinite, and since the nutritive value of the cysts is doubtless little different from that of so much fish-roe, it is likely that the food value of the parasitized fish is not much different from that of the nonparasitized or but slightly parasitized fish of the same weight. There is no evidence of any inflammatory or pathological condition of the tissues of the fish brought about by the presence of the cysts. From another point of view the cysts are a decided detriment. A number of badly parasitized fish was selected

and an equal number, corresponding in length and depth, of nonparasitized, or but slightly parasitized fish. The two sets were weighed and the weights compared. This was repeated a number of times. In each instance the parasitized fish weighed less than the others.

2. It can be quite confidently asserted, although no feeding experiments have been attempted, that these cysts, even if they were to be swallowed uncooked, would fail to develop in man, or indeed in any warm-blooded animal. Even among fishes they are restricted to a few closely related sharks for their final hosts.

3. The greatest impairment which is wrought on the value of the butterfish as food by this parasite is the subjective effect which the knowledge of its presence in the flesh of the fish has on the mind or imagination of the consumer. This is probably in large part due to the fact that the parasite is a parasite, and especially a worm parasite. The conjunction of such appetite-destroying ideas as are embraced in the mere words worm and parasite is bad enough, but when one substitutes the word cestode for worm, and then is obliged to confess that the word cestode means tapeworm the situation is not made better in the least.

Touching the matter of the discovery of this parasite in the flesh of the butterfish, I may be permitted to say that I am very sorry to be the bearer of this painful news. Possibly some compensation will be afforded by the further intelligence which I feel warranted in bringing that the plight of the butterfish is a most exceptional one, and that so far as my investigations have gone, it can be stated with entire confidence that the flesh of the marine food fishes is, to a very high degree, free from parasites. Certainly the examination of such excellent food fishes as the scup, bonito, squeteague, flounders, etc., as shown in the appended tables, is sufficient to warrant the conclusion that so far at least as the investigation has progressed, the presence of parasites in the flesh of our marine food fish, excepting always from this guaranty the butterfish, is very exceptional.

TABLE I.—SHOWING SUMMARY OF RESULTS OF THE EXAMINATION OF FOOD FISHES FOR PARASITES IN THE FLESH, WOODS HOLE, MASS., JULY TO SEPTEMBER, 1908.

Name of fish.	Number of fish examined.	Parasites found in the flesh.	Name of fish.	Number of fish examined.	Parasites found in the flesh.
Eel (Anguilla chrysipa)	4	None.	Butterfish (Poronotus triacanthus).	720	Cysts in 699; large numbers in most cases.
Round herring (Etrumeus sadina).	243	None.	White perch (Morone americana).	2	None.
Herring (Clupea harengus).	1	Sporozoa.	Scup (Stenotomus chrysops).	73	None.
Alewife (Pomolobus pseudoharengus).	73	Sporozoa in 21.	Squeteague (Cynoscion regalis).	39	Four cysts in 3 fish.
Glut herring (Pomolobus aestivalis).	1	None.	Kingfish (Menticirrhus saxatilis).	19	None.
Smelt (Osmerus mordax)	21	None.	Cunner (Tautogolabrus adspersus).	59	None.
Silverside (Menidia notata).	28	One cyst.	Tautog (Tautoga onitis)	37	None.
Mullet (Mugil cephalus)	23	None.	Triggerfish (Balistes carolinensis).	2	None.
Barracuda (Sphyræna borealis).	5	None.	Whiting (Merluccius bilinearis).	24	None.
Mackerel (Scomber scombrus).	2	None.	Pollock (Pollachius virens).	3	None.
Chub mackerel (Scomber colias).	10	One cyst.	Tomcod (Microgadus tomcod).	5	None.
Bonito (Sarda sarda)	57	None.	Hake (Phycis tenuis)	4	None.
Pilotfish (Seriola zonata).	4	None.	Hake (Phycis chuss)	5	None.
Mackerel scad (Decapterus macarellus).	9	None.	Summer flounder (Paralichthys dentatus).	9	None.
Yellow crevalle (Caranx chrysos).	1	None.	Sand dab (Lophopsetta maculata).	16	None.
Round pompano (Trachinotus falcatus).	5	None.	Winter flounder (Pseudopleuronectes americanus).	40	One cyst.
Bluefish (Pomatomus saltatrix).	58	None.			
Harvestfish (Peprilus alepidotus).	12	Numerous cysts in all.			

TABLE II.—SHOWING SUMMARIZED RESULTS OF EXAMINATION OF FISHES FOR PARASITES IN THE FLESH, DRY TORTUGAS, FLA., JUNE TO JULY, 1908.

Name of fish.	Number of fish examined.	Parasites found in the flesh.	Name of fish.	Number of fish examined.	Parasites found in the flesh.
Green moray (Lycodontis funebris).	1	None.	Bermuda chub (Kyphosus sectatrix).	2	None.
Great barracuda (Sphyræna barracuda).	3	None.	Cock-eye pilot (Eupomacentrus leucostictus).	3	None.
Blue runner (Caranx ruber).	4	None.	Cow pilot (Abudefduf saxatilis).	6	None.
Red grouper (Epinephelus morio).	5	None.	Chlorichthys bifasciatus	1	None.
Rockfish (Mycteroperca venenosa).	4	A few degenerate cysts in flesh of one and under the peritoneum of another.	Blue parrotfish (Scarus cœruleus).	6	None.
			Parrotfish (Scarus croicensis).	5	None.
			Scarus sp	2	None.
Big eye (Priacanthus cruentatus).	1	None.	Black angelfish (Pomacanthus arcuatus).	10	None.
Gray snapper (Neomænis griseus).	14	None.	Angelfish (Angelichthys isabelita).	2	None.
Schoolmaster (Neomænis apodus).	1	None.	Blue tang (Teuthis cœruleus).	8	None.
Muttonfish (Neomænis analis).	1	None.	Surgeonfish (Teuthis hepatus).	12	None.
Yellowtail (Ocyurus chrysurus).	11	None.	Shellfish (Lactophrys triqueter).	1	None.
Yellow grunt (Hæmulon sciurus).	3	None.	Shellfish (Lactophrys trigonus).	4	None.
White grunt (Hæmulon plumieri).	54	None.	Cowfish (Lactophrys tricornis).	2	None.
Porgy (Calamus calamus)	12	Two cysts in one, one cyst in another.	Shark sucker (Echeneis naucrates).	2	None.

TABLE III.—SHOWING OCCURRENCE OF CESTODE CYSTS IN FLESH OF BUTTERFISH, AND RELATION TO SIZE OF HOST.

Length in centimeters.	Number of fish examined.	Number of fish with—				
		Very numerous cysts in flesh.	Numerous cysts in flesh.	Many cysts in flesh.	Few cysts in flesh.	No cysts in flesh.
1904.						
20 centimeters and over	100	21	63	5	11	0
15 to 20 centimeters	42	8	7	13	13	1
10 to 15 centimeters	56	4	4	19	25	4
Less than 10 centimeters	4	0	0	0	1	3
Total for 1904	202	33	74	37	50	8
1905.						
20 centimeters and over	242	69	54	32	80	7
15 to 20 centimeters	75	21	5	11	26	12
10 to 15 centimeters	26	2	1	1	8	14
Less than 10 centimeters	4	0	0	0	0	4
Total for 1905	347	92	60	44	114	37
1906.						
20 centimeters and over	32	17	6	3	5	1
15 to 20 centimeters	24	7	1	4	7	5
10 to 15 centimeters	7	0	0	0	0	7
Total for 1906	63	24	7	7	12	13
1907.						
20 centimeters and over	12	1	2	4	4	1
1908.						
20 centimeters and over	180	75	38	38	26	3
15 to 20 centimeters	129	61	32	22	14	0
10 to 15 centimeters	207	63	67	42	29	6
Less than 10 centimeters	204	3	30	75	84	12
Total for 1908	720	202	167	177	153	21
Total for 1904–1908	1,344	352	310	269	333	80