THE FEEDING HABITS OF THE TOADFISH (OPSANUS TAU) BASED ON AN ANALYSIS OF THE CONTENTS OF THE STOMACH AND INTESTINE

by

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INTRODUCTION

Opsanus tau, (Linneaus)-the toadfish, inhabits a vast area along the Eastern Sea Coast of North America. It is found from the coast of Maine to the regions of the West Indies. North of Cape Cod, its occurrence is rather rare. As for the Chesapeake localities, according to previous records the toadfish lives in the muddy bottoms of the cyster regions of the Chesapeake Bay, around the mouth of the Potomac River, and elsewhere in the salt water regions. Many specimens were collected from many localities around Annapolis, Maryland to the entrance of the Bay by Hildebrand and Schroeder (1927).

The toadfish was first classified as Gadus tau by Linneaus, but in 1818 Rafinesque, when describing a toadfish from the south shore of Long Island, used the scientific name Opsanus cerapalus. In 1824 LeSeur termed his fish by the name of Batrachoides vermullas while in 1842 DeKay used Batrachus tau for his identification purposes. Before 1900 Jordan and Evermann listed the name of Opsanus tau, and following them in 1899 Bean and Smith also employed that as the scientific name for the toadfish (Gudger, 1908).

The toadfish is very distinctive in its appearance. Cornelia Clapp (1899) gave a very picturesque description of Opsanus tau stating that there is something singularly grotesque in the appearance of the toadfish, and as its name would imply, there is to some extent a superficial resemblance to the familiar batrachian. The disposition is sluggish, and the wrinkled scaleless skin is of a molten brown and gray color. The eyes of the toadfish along with its depressed head are not suggestive of the typical teleost. The young fish are very tadpole like in their appearance. Gill (1907) in his description was more scientific and expressed the toadfish as

having an oblong form, a broad flattened head, with restricted lateral gill openings, two dorsal fins, the anterior being very small and possessing two or three spines. The second fin is very long, and the anal is also moderately long while the pectorals are broad with the ventral fins being singular and imperfect.

In comparison to many of our commercial fish, the average size of the toadfish is very small. In speaking of the northern variety of Opsanus tau, Goode (1884) stated that they rarely exceed ten, twelve, or at the most fifteen inches. Hildebrand and Schroeder (1927) in reference to those found in the Chesapeake Bay area gave the maximum size of the fish as fifteen inches, but stated that such a size must be regarded as exceptional. The largest specimen that they saw during their investigation measured twelve and five-eights inches in length (they did not specify what type of length was used in measuring the fish) and weighed one pound two ounces.

The method of food-capturing in the toadfish is by means of strategy and stealth rather than by swiftness and motion. The toadfish usually hides under or behind stones, rocks, or weeds or steals from one cover to another. From these places it watches its victims until they are nearby, when it darts forth with a quickness which is quite astonishing considering its usual sluggishness (Goode, 1884). Their food usually consists of crustaceans, molluscan remains, and the bones and scales of fishes. Linton (1901) described the toadfish as having a mouth eminently fitted for the catching and reception of the kind of food they secure. The gape of their mouth is very large and the powerful jaws are filled with bluntly conical teeth with which the fish can inflict a rather severe and painful bite.

Opsanus tau is an omnivorous fish. The peice de resistance of his daily fare is crab, young molting crabs are preferred, any crustacean will do how-

ever, or fish, or almost any kind of offal (Gudger, 1908). Gill (1907) spoke of the toadfish as being voracious and almost omnivorous. He also stated that the assumption of Gunther, that all of the Batrachoids with obtuse teeth in the palate and in the lower jaw feed on mollusca and crustacea, is only half true. Gill noted that besides crustaceans, molluscans, and worms the toadfish also preys on such small fish as it may be able to catch, especially the Anchovies. Linton at Woods Hole (1901) and Beaufort (1905) dissected several Opsanus tau and found that various shells and crustaceans were the principal contents. The crustaceans present besides the hermit crabs were shrimps which he identified as the species Paleomenetes vulgaris and true crabs of other species. Linton also found the remains and fragments of other fishes, and also among these remains was noted a partly digested toadfish. A still more decided case of cannibalism fell under his observations when he noticed a toadfish in the aquarium in the act of swallowing another of its own species that was a little smaller than the fish itself.

On the approach of cold weather it was noticed that the toadfish retreats from the shallow water to deeper water. Here they bury themselves in the mud and remain torpid. In the summer toadfishes come closer to the shore, this movement is to a large extent at least, thought to be induced by procreative instincts (Ayres, 1842). In the Chesapeake Bay aboard the Fish Hawk, Hildebrand and Schroeder (1927) by means of a beam trawl, during the winter months, gathered toadfish present in waters ranging from five to twenty-seven fathoms in depth.

The diseases that occur in the toadfish are due chiefly to the parasitic worms that are present in their alimentary tract. The most important of these from an economic standpoint are the threadworms. These worms are

slender, cylindrical animals, ranging from microscopic size to half an inch or more in length (Pratt, 1919). Of the forty-eight fish that Professor Binford (1908) examined, he found that forty per cent of all these fish were infected with Ascaris. While Linton (1905) in reference to his Parasites of the Fishes of Beaufort examined one hundred thirty five fish. From these examinations he obtained the following figures: one hundred ninety nematodes, the same number of cestodes and more than one hundred trematodes. The nematodes were identified as the species Ascaris habena while the cestodes that were present comprised five genera and equally as many species. The trematodes belong to three genera and three species as far as they were identified at the time.

Economically, the toadfish are of little value as food. This fish is much disliked by the fishermen because of its fighting habits, ugliness, and lack of commercial value. The flesh is said to be of good appearance and fine flavor, but the toadfish is not utilized due to its repulsiveness in appearance (Hildebrand and Schroeder, 1927). In writing on the same subject, Storer (1855) stated it was uncommonly employed as an article of food because of its repulsive aspect, the small size which it attains, and the fact that it is never taken in any large quantities. He did state though that its flesh is delicate and good. Rafinesque (1818) also claimed it as good to eat as the different species of Phycis or Cusk. The only way a demand could be created for the toadfish to be utilized as food would be to dress it up as is done now with a few other repulsive fish such as the catfish and the rosefish.

Studies on the feeding habits of the toadfish have not been very extensive over the past years as reviewed in the literature. Little attention has been given to very detailed analyses of this type because of their lack

of economic importance. (Hildebrand and Schroeder, 1927) in their mention of the toadfish state that its principal food appears to consist of crustaceans, with a combination of molluscs, or other fish. Small crabs among the crustaceans appeared most frequently in the food, although shrimp (and in the smaller individuals Amphipods) and Isopods also were present. Almost any kind of offal is eaten, and in places where garbage is thrown overboard, toadfish are almost always present in comparatively large numbers. (Linton, 1901) noted that the alimentary canal is cheifly filled with crustacean and molluscan remains and the bones and scales of fishes. He also noted finding a partly digested toadfish in the stomach of another. (Gudger, 1908) stated that their favorite food is young molting blue crab; any crustacean will do, however, or fish or almost any kind of offal.

This investigation was concerned with the feeding habits of Opsanus tau in the Chesapeake Bay in the vicinity of Crisfield, Maryland. A somewhat detailed analysis was made in the determination of the specific type of food that was present in comparison to what has previously been noted. In correlation with previous accounts of notations made on the feeding habits of the toadfish, a definite relation occurred between the analyses presented here with the earlier findings.

MATERIALS AND METHODS

The data on feeding habits presented in this paper are based on specimens of Opsanus tau, that were collected from the inshore area at Crisfield, Maryland during the months of May to September inclusive. The collection extended over a period of three years from 1948 to 1950.

The fish were collected by use of a seventy-five foot minnow seine measuring four feet in depth and having a quarter inch mesh. The specimens were preserved immediately in ten per cent formalin solution and measured upon return to the laboratory. All length data are reported as total length measured as the distance from the tip of the snout to the tip of the tail.

The specimens examined were slit along the ventral surface so as to avoid injury to the stomach and intestine. A total of one hundred twenty seven individuals were examined to determine the feeding habits. The stomach and intestine were opened separately, and the contents of each were placed in small shell vials containing a five per cent formalin solution. The contents were then examined by the use of a dissecting microscope for proper identification.

The books used in the identification of the material were Manual of the Common Invertebrate Animals by Henry S. Pratt (1948), Invertebrate Zoology by Robert W. Hegner (1937), Selected Invertebrate Types edited by Frank A. Brown, Jr. (1950), and The Cancroid Crabs of America by Mary J. Rathbun (1930).

Observations

The toadfish examined in this study ranged in size from 32.0 mm. to 252.0 mm. A general summary of the material observed in the alimentary canal of these fish is presented in Table I. By reference to this table, it may be observed that the fish included under 100 mm. in length feed on the mud crab, Eurypanopeus depressus, the grass shrimp, Paleomentes vulgaris, Amphipoda and miscellaneous Arthropoda. The occurrence of fish scales or vertebrae is comparatively rare in this group of fishes. The shrimp are more numerous in this group than they are in the other size groups examined. As was true of all size groups, the crabs make up the highest percentage of the diet in this size range. Of some interest is the fact that the snail, Littorina irrorata was found in one specimen examined. Grass is present in 11% of the stomachs and 18% of the intestines examined, and organic matter and detritus is present in all fish.

In the next size range, 101 to 150 mm., an increase in the number of teleost fishes may be observed. The number of fish scales and vertebrae present have increased. This is correlated with a decrease in the percentage of miscellaneous Arthropoda and the number of specimens containing Paleomontes vulgaris. Similarly, we observe a decline in the use of Amphipoda as a constituent of the diet. The extent of the utilization of crabs has increased considerably over the previous group and associated with this there is an increase in the amount of grass present in the alimentary canal. This suggests that the area over which the toadfish is foraging is somewhat different or more extensive for this size range.

In the 151 to 200 mm. group the stomach contents were less in total amount than the previous groups. This was compensated for, however, by an increase in the contents of the intestinal portion of the tract. In this

group we have an increase in the teleost fish and their component parts as well as an increase in the crabs forming part of the diet. The number of shrimp present in the analysis has also increased. The Amphipoda, on the other hand, have decreased in importance.

The largest fish examined, those between 201 to 250 mm., show no significant differences in feeding habits. Apparently, their diet is approximately the same as smaller members of the species. They do not show any increase in total quantity of food associated with their larger size. As would be expected, many of the forms utilized by the smaller fish are not found in the contents of the stomach and intestine of these larger fish.

By way of general summary of the feeding habits of the toadfish, as presented in Table I, it may be noted that the mud crab, Eurypanopeus depressus appears to be the most important single constituent of the diet. A few specimens of the blue crab, Callinectes sapidus, were also found in the contents examined but they were not of sufficient importance to be enumerated. The teleost fishes likewise formed an important part of the diet of the toadfish. No effort was made to keep a numerical score by species as much of the material was too fragmentary for specific identification. However, it was observed that those species that were identified were all typical inshore fish, resident of the area. The more common species identified are as follows: Lucania parva, Fundulus majalis, Menidia menidia, Menidia beryllina, Apeltes quadracus, Gobiosoma boscii, and a single specimen of Opsanus tau.

Of particular importance in the diet of the smaller fish were such forms as miscellaneous Arthropoda, Amphipoda, and the grass shrimp, Palaemontes vulgaris. About 98% of all fish feed to some extent on Amphipoda, and detritus and organic matter was found in 100% of the fish examined.

A more detailed analysis of the feeding habits of Opsanus Tau may be obtained by analysis of the collections separately. This also gives some indication of the seasonal variation in feeding habits since the collections were made over the period from May through September. The data on which this study is based begins with the collection of May 5, 1948. The analysis of the material observed in the stomach and intestine of two fish collected on this date appears in Table II.

It will be noted that there are only four types of material present in the stomach, while the intestine showed five types present. The source of food for this period was some fish material and grass with some undetermined organic matter. As we observed in Table I, there were a certain number of nematode worms present, but these are a case of parasitism and will not be considered in the analysis of the feeding habits of the fish.

The second collection was made on August 10 and 11, 1948, and the data is presented in Table III. The stomach contained ten types of material present while in the intestine we note the presence of sixteen types of material present. Crabs of the species Eurypanopeus depressus made up the major portion of the diet along with some Arthropoda, Amphipoda, shrimp and fish components. At this time we note the first occurrence of Littorrina irrorata, a mollusc not too frequently present in the food of this fish.

The third seining, took place on August 24, 1948 with the observation that the toadfish at this time had only three forms of food in their stomach with seven present in the intestine. Their diet was composed almost entirely of Arthropoda with the occasional appearance of shrimp, grass, or a few parts of a crab or fish, as can be noted in Table IV.

Table V covers a two day period of September 15 and 16, 1948. The fish at this time are limited to the presence of two materials in the stomach,

crabs with crab components and shrimp. The intestine has an equal distribution as to the types of food material present, exactly the same as those in the stomach, but with a large number of each. It is quite evident that the diet at this time is composed mainly of crabs and shrimp.

The second year's data begin with the collection of May 19, 1949 (See Table VI). Once again the stomach contents are composed of four types of food fish including scales and vertebrae, a few shrimp, and Arthropoda. The intestine has one additional type of food present, that is a few fragments of crab. The diet in this case is rather well distributed among all of the forms present, with no form playing a major role.

July 12, 13, and 14, 1949 is the first collection made in this month and the summary of the observations appears in Table VII. Here all species used as food are present. The stomach as well as the intestine contains an equal variety of nine types of food; crabs, fish, shrimp, Amphipoda and Arthropoda, as well as grass. The stomach shows a high percentage of crab material along with a similar occurrence in the intestine. The crab, thus constitutes the major portion of the diet, with fish components next in importance. The other forms do not constitute a major portion of the diet at this time.

The second collection of this month was made on July 26, 1949. The data are presented in Table VIII. This table shows the same number of forms present as in Table VII namely a variety of nine types of food both in the stomach and intestine. The stomach shows a high percentage of fish material with a smaller amount of crab and other material. The intestine on the other hand still has crabs and fish as its major percentage of the diet. There are some Arthropoda, Amphipoda and shrimp present.

Table IX presents the analysis of the collections of August 10 and 11,

1949. The variety of items in the diet begins to decrease at this time both in the stomach and intestine. The stomach contents are composed mainly of fish and components while crabs are present to a notable extent. In the intestine the contents are still equally divided between the crab and fish with their component parts, while all other forms are on the decline. It is at this time that the second period of collection comes to a close.

On July 6, 1950 the third and final year of collection was started. In the stomach contents we note that there are only two types of food material present other than the organic matter. The crab makes up the major percentage of the diet. The intestine has five items present, but the crab is still of major importance with fish being of secondary importance. Shrimp, Amphipoda and Arthropoda and grass are notable to some extent.

On the following day, July 7, 1950, another collection was made. At this time there was no change in the type of diet as can be noted in Table XI. In both the intestine and stomach contents, the crab is still the major item with some fish present. The other forms mentioned above also appear at about the same extent.

On the second of August, 1950, as noted in Table XII, another collection was made. In the stomach there was little food, only two forms being noted, Paleomenetes vulgaris and Arthropoda. It is difficult to say what is the major part of the diet until the food contents of the intestine are observed. In the intestine, the crab is slightly more abundant than the fish, while some Arthropoda and grass are present.

August 3, 1950 completes the collections for this investigation. The data is presented in Table XIII. The stomach shows the presence of one form, the Arthropoda, while the intestine reveals the presence mainly of some fish scales and vertebrae as well as some Amphipoda and their fragments. These

are the only food materials that were present at that time.

In making a comparison of the three summer periods, the collections of July were only made in 1949 and 1950, while none were made during that month in 1948. The Tables VI, VII, IX, and X show the collections for this month. The food of the larger toadfish is chiefly a combination of crabs with its parts as well as undigested fish matter. The July collections reveal a consistency throughout of the presence of a high per cent of crabs with its parts as well as fish with some variations being related to independent fish themselves. The fish were comprised of Apeltes quadracus and Menidia menidia. There was a large number of complete crabs and among them was noted a completely undigested molting form of Callinectes sapidus of 46.5 mm., which was located in the stomach of one of the specimens. The smaller toadfish change their diet to one that comprises shrimp and Arthropoda. The shrimp are present in notable quantity along with several Amphipoda which have also been distinguished. It is readily observed at this time of the year that grass was not present in as many fish as might have been expected.

In 1948 and 1949, collections were made on the same dates of August. Although the dates were the same, the stomach and intestinal contents found in the toadfish of 1949 showed a much greater variety than those of 1948. In 1949 there appeared a much higher degree of fish material, and in one toadfish a large number of several complete fish were observed. These fish were of a different species from those found in the July collection. They consisted of Lucania parva, Gobioscoma boscii, Menidia beryllina, and Opsanus tau (which can be assumed as a rather rare occurrence). The collection for this month in 1950 shows a much higher percentage of crabs and crab components than fish components although some are present. These indications can be noted by looking at Tables II, III, VIII, IX, and XII.

The only collection made during September took place in 1948 and can be noted in Table V. Here towards the end of the summer season the diet is limited to the crabs and components with just a few irrelevant forms present.

The nematode parasites are definitely not a part of the food material of the toadfish. There is a very high degree of parasitism in Opsanus tau due to the presence of the form Contrecaecum habena. The highest point of parasitism is definitely associated with the group of fish ranging in size from 151 mm. to those of 251 mm. In this group we can also note that the presence of the nematode worm is greater in the intestine than it is in the stomach. The smaller group ranging from 20 mm. to 150 mm. also indicates the presence of this parasite, but not to the same extent as the larger fish. The nematode is present in both portions of the alimentary canal, as was noted in the larger Opsanus tau.

The presence of a few trematodes is also noted, but their sparseness in comparison to the nematode leaves actually little to be said about their presence except that they were observed and that they do cause some degree of parasitism in the toadfish.

DISCUSSION

Gudger (1908), in speaking about the feeding habits of Opsanus tau, indicated that the daily diet of the toadfish was young molting crabs. Any crustacean however will do, and fish or practically any type of offal will be utilized by them as food. Evidence is readily obtainable among the large toadfish to enhance the validity of this statement. This investigation concludes that the feeding habits of the toadfish are essentially those mentioned earlier, and furnishes a complete picture of the feeding habits of both the young and adult forms.

Most toadfish are ravaneous or voracious in their feeding Gill (1907), and therefore it would be assumed that their diet would include any type of animal matter or vegetation that would be easily obtainable. Upon examination of their alimentary tract, we can observe the fact that the length of their stomach and intestine is definitely associated with omnivorous type foods, and that some of the food is of a plant nature and would be digested for utilization by the fish itself. In comparing all of the fish this was evaluated by direct observation of the intestinal contents. The examination of the entire digestive tract showed that it was filled chiefly with both crustaceans, a few mollusc remains, and a large number of bones and scales of fishes. Similar observations were made previously by Linton (1901). With the remains or undigested particles of fish matter it was also observed in several specimens that there were large, partially digested portions of fish, which were beyond the stage of identification as to the species. At the same time it was observed that numerous complete fish that were determined to genus and species without difficulty.

The variety of such fish present did determine the fact that the size

of the fish utilized by the toadfish were in most cases much smaller than the toadfish itself. Among the smaller fish observed were Apeltes quadracus, Lucania parva, and Gobiosoma boscii. There were present a few fish of a much larger size about 50 mm. in length. These belong to two families of fish: the Atherinidae which included Menidia menidia and Menidia beryllina; the other family Cyprinodontidae included Fundulus majalis.

Opsanus tau is not considered cannibalistic in habits. In the analysis of the intestinal tract of one toadfish a smaller toadfish was noted among the other partially digested fish. Linton (1901) made reference to a controlled feeding experiment under laboratory conditions where he had observed a toadfish in the process of swallowing another of its own species, but a little smaller than itself. He also noted the fact that upon examination of the stomach, there was present a partly digested toadfish in the stomach of another of its own kind.

Most food analyses of the toadfish were made mainly on the average sized fish giving little or no attention to those of the smaller size group. Therefore references to the feeding habits of the toadfish are usually associated with this larger group. In analysis of the younger group, the diet does not contain a large portion of crabs or fish, but is limited to a great extent to the smaller members of the Arthropoda. There was present a large number of Arthropod sections. Also present was a large number of shrimp which were important in the diet of this sized group of fish. The shrimp were also found to some extent in the larger sized group. Hildebrand and Schroeder (1927) in speaking of the feeding habits of the toadfish of the Chesapeake Bay stated that their food included shrimp, and noted in the smaller individuals the presence of Amphipoda and Isopoda.

A seasonal difference in the type of material that is observed in the toadfish of all sized groups starts in the early spring around May with a high number of Arthropoda, Amphipoda, Paleomenetes vulgaris, and to some extent Eurypanopeus depressus, a small crab. As the summer season progresses there is a change to fish, fish vertebrae and scales, and an increase in the number of crabs and component parts. The fish and crab with their parts are almost of equal distribution in quantity in both the stomach and intestine. There is a decrease during this period in the Arthropoda and Amphipoda. As we approach the months of August and September the amount of fish material begins to decline and the crab and its parts begin to play the major role of food material present in the diet. During September, the diet is almost completely comprised of the crab.

No collections were made at any time during the fall, winter, or early spring of the three-year period, because of the fact that the toadfish, Opsanus tau, goes into deeper waters where it is not very active at any time. Therefore a comparison could not be made as to the seasonal variations of the food that might be present at this time of the year in the stomach of the toadfish.

The intestine and stomach of Opsanus tau are not exceptionally large organs when not distended with food. It seems apparent though that when the toadfish engulfs its food the stomach can be distended with little difficulty. In one specimen a molting blue crab of 46.5 mm. was observed. In a number of other fish it was noted that at many times the entire intestine was distended to several times the original size, while the stomach showed no distension whatever. When distension of the intestine was present it was not necessarily found in the same condition throughout the intestine, but many portions bulged while immediately following or preceding this distension the intestine was once again normal in size.

The amount of food that was present within the fish of course depended on several factors. With the realization that this investigation was not an actual laboratory controlled experiment, the examination of the toadfish gave a variety of conditions in which the alimentary canal was present. In a laboratory experiment one can control the type of food to determine what would be utilized and then would be able to examine the fish immediately or at any time after feeding. Nevertheless, the obtaining of fish in the manner used in this investigation enabled one to view the variety of forms that could be present as well as noting that a somewhat restricted type of diet was followed even though the region where the fish were caught is characterized by a rather varied fauna.

Detritus and organic matter were always present in all sized fishes. The detritus comprised mostly silica or mud particles, which were obtained off the bottom of the feeding area of the toadfish. Hildebrand and Schroeder (1927) state that Opsanus tau lives in the Chesapeake Bay area in the mud of the oyster bar region, but is often found in regions of garbage disposal. Therefore a large amount of detritus along with organic matter can be expected. The origin of the organic matter is difficult to determine. Much of the organic matter, we assume, comes from the material that is taken in as food, namely the flesh of fish as well as crab meat. This probably does not account for all of the organic matter. Since in many locations large amounts of organic matter will be found in the water as a result of garbage disposal, as well as the decaying matter of other forms that inhabit the aquatic enviroment of the toadfish, it would be expected that much of this material would be present with the other defined organic substances.

In examining the stomach and intestine, as far as the process of digestion was concerned, the larger percentage of this occurred within the

intestine itself. There was noted at times a beginning of digestion in the stomach, but much of the material that was usually present did not show many changes as far as being affected by the digestive process. The stomach of the toadfish seems to be more of a storage organ of the fish with little or no participation in the digestive process. Most of the fish that were present in the stomach showed no indications of digestion at all, but when other fish of the same species were viewed in the intestine, different stages of the digestive process were noted. Some fish appeared to show no signs of digestion, while other sections of fish that were almost completely digested were present. The effect of the process of digestion could be observed more accurately by examining the fish that were present as food rather than that of the crab or Arthropod forms, because digestive juices do not effect the exoskeleton of these forms. Many times the crabs are broken up in the stomach, causing their fleshy part to appear in the stomach but since it is not of a compact nature it is difficult to state directly whether it is being digested or not. This process is easily determined with the fish that are present because their flesh is more compact and digestion on such types of tissue is more readily noticeable. Since digestion occurs for the most part in the intestine, absorption of the food would also occur from this same region of the digestive tract of the toadfish.

The appearance of nematodes and trematodes demonstrates the fact of internal parasitism of the toadfish, because none of these parasites were present in the digested form. Binford (1908) in an analysis of the toadfish noted that out of forty-eight specimens that he examined, forty per cent of these were infected with Ascaris. The greater number of worm parasites that were found included the nematode forms while occasionally some trematodes forms were found. The occurrence of trematodes seems to be associated with

only a few fish, while the nematodes were found in most of the fishes. The smaller toadfish did not show a high infection of nematodes (these parasites rarely occurring in these small individuals).

In cases of infection by nematodes, the largest number of individuals were observed in the intestine. In many cases, the parasite was absent from the stomach. The incidence of parasitism appears to be greater in the 151 to 200 mm. group. Only a single small fish was observed that harbored the parasite, and the incidence of infection was less in the larger fish than in the size range indicated.

SUMMARY AND CONCLUSIONS

During the summers of 1948 through 1950 inclusive, as part of an investigation of the inshore fishes of the Chesapeake Bay, collections of the toadfish (Opsanus tau) were made on the sand flats of the Annemessex River at Crisfield, Maryland. In order to ascertain, at least in part, the feeding habits of this ubiquitous inshore species, one hundred twenty seven individuals ranging in size from 32.0 mm. to 252.5 mm. were examined.

The contents of the stomach and intestine of these specimens were carefully removed and examined separately. On the basis of the observations, the following conclusions may be drawn:

1. The food of the toadfish consists of Teleost fishes, crabs, Arthropoda, Amphipoda, shrimp, grass, and organic matter.

2. Toadfish under 101 mm. in length feed principally on crabs, Arthropoda, Amphipoda, and shrimp.

3. The intermediate sized toadfish, ranging from 101 mm. to 200 mm., feed principally on a combination of Teleost fishes, and crabs.

4. Those specimens over 201 mm. in length feed on crabs mainly and secondly Teleost fishes.

5. The brief seasonal aspects of the investigation indicate that there is a difference in feeding habits based on the availability of material, in that during May most of the food material was comprised of Teleost fishes with a small percentage of crabs; during July and August there was an abundance of both Teleost fishes and crabs with the presence of numerous Arthropoda, Amphipoda, and shrimp; in September the crab is the only abundant food item.

6. The principal inshore forms used as food are as follows: Arthropoda, crabs, Eurypanopeus depressus and Callinectes sapidus, shrimp, Paleomenetes vulgaris and Amphipoda. The Teleost fishes are, in order of their abundance, Apeltes quadracus, Menidia menidia, Menidia beryllina, Fundulus majalis, Lucania parva, Gobioscoma boscii, and Opsanus tau.

7. Incidental to the investigation on food habits, it was observed that 58 per cent of the specimens were infected by the round worm, Contrecaecum habena, parasitic in the digestive tract.

8. In general the infestation was not observed in specimens below 76.5 mm. in length.

TABLE I

General Summary of the Contents of the Intestinal Tract Observed in 127 specimens of the Toadfish, Opsanus Tau.

Size Range of Fish in mm.	20-100	101-150	151-200	201-251
Number of Fish Examined	56	24	34	13
Stomach Contents				
Nematode Contrecaecum habena	5	24	28	41
Nematode Fragments	1	11	26	1
Crabs Eurypanopeus depressus	17	11	26	-
Cephlathorax	7	7	6	-
Chelipeds	5	14	6	1
Walking Legs	17	22	20	7
Teleost Fishes (sev. spp.)	-	2	1	1
Fish Sections	-	1	1	-
Fish Scales	33	172	93	1
Fish Vertebrae	12	7	18	3
Arthropod Sections	45%	40%	6%	-
Amphipods (sev. spp.)	12	-	-	-
Amphipod Fragments	3	-	-	-
Shrimp Paleomentes vulgaris	14	8	1	1
Grass	11%	21%	51%	33%
Detritus	100%	100%	100%	100%
Organic Matter	100%	100%	100%	100%
Intestinal Contents				
Nematode Contrecaecum habena	26	66	128	72
Nematode Fragments	10	8	58	22
Trematode	4	12	3	-
Teleost Fishes (sev. spp.)	-	-	6	1
Fish Sections	-	-	2	2
Fish Scales	5	85	1120	156
Fish Vertebrae	33	87	265	65
Tunicates	-	-	3	3
Amphipods (sev. spp.)	9	2	3	-
Amphipod Fragments	21	15	-	-
Arthropod Sections	61%	8%	6%	8%
Crabs Eurypanopeus depressus	8	13	4	2
Cephlathorax	74	105	110	29
Chelipeds	53	146	142	53
Walking Legs	184	205	149	41
Gills	87	117	127	47
Eyes	30	75	52	7
Maxilla	49	63	32	-
Maxillipeds	38	43	20	-
Littorina irrorata	1	-	2	-
Shrimp Paleomenetes vulgaris	15	-	9	-
Grass	18%	54%	58%	83%
Detritus	100%	100%	100%	100%
Organic Matter	100%	100%	100%	100%

- indicates form absent
% indicates number of fish having form present.

TABLE II

Analysis of the Stomach and Intestinal Contents of the Fish Collected on May 5, 1948.

Fish Number	1	2
Length in mm.	205.0	168.0
Stomach Contents		
Nematode Contrecaecum habena	1	1
Nematode Fragments	-	-
Crabs Eurypanopeus depressus	-	-
Cephlathorax	-	-
Chelipeds	-	-
Walking Legs	-	-
Teleost Fishes (sev. spp.)	-	-
Fish Sections	-	-
Fish Scales	-	-
Fish Vertebrae	-	-
Arthropod Sections	-	-
Amphipods (sev. spp.)	-	-
Amphipod Fragments	-	-
Shrimp Paleomenetes vulgaris	-	-
Grass	*	-
Detritus	*	*
Organic Matter	*	*
Intestinal Contents		
Nematode Contrecaecum habena	10	3
Nematode Fragments	-	7
Trematode	-	-
Teleost Fishes (sev. spp.)	-	-
Fish Sections	-	-
Fish Scales	49	65
Fish Vertebrae	-	-
Tunicates	-	-
Amphipods (sev. spp.)	-	-
Amphipod Fragments	-	-
Arthropod Sections	-	-
Crabs Eurypanopeus depressus	-	-
Cephlathorax	-	-
Chelipeds	-	-
Walking Legs	-	-
Gills	-	-
Eyes	-	-
Maxilla	-	-
Maxillipeds	-	-
Littorina irrorata	-	-
Shrimp Paleomenetes vulgaris	-	-
Grass	*	-
Detritus	*	*
Organic Matter	*	*

* indicates form present
\- indicates form absent

TABLE II

Analysis of the Stomach and Intestinal Contents of the Fish Collected on August 10, 11, 1948.

Fish Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Length in mm.	89.5	100.5	157.0	174.0	202.0	192.0	173.5	2.0	176.0	235.0	198.5	237.0	155.0	144.0	91.5	88.0	76.5	94.5	50.5	40.5
Stomach Contents																				
Nematode Contrecaecum habena	-	-	1	1	3	3	-	1	1	5	1	3	-	-	-	1	-	1	1	-
Nematode Fragments	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	1	-	-
Crab Eurypanopeus depressus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cephlathorax	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chelipeds	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-
Walking Legs	-	-	-	-	-	1	-	2	-	-	-	3	-	-	-	-	-	-	-	-
Teleost Fishes (sev. spp.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish Sections	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish Scales	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-
Fish Vertebrae	-	-	1	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	*	-
Arthropod Sections	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	1	-	-	-	-
Amphipods (sev. spp.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amphipod Fragments	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Shrimp Paleomenetes vulgaris	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	*	*	*	*
Grass	-	-	*	-	-	*	*	*	*	*	*	*	*	-	*	*	*	*	*	*
Detritus	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Organic Matter	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Intestinal Contents																				
Nematode Contrecaecum habena	1	4	10	14	1	4	16	36	3	6	10	-	5	6	3	1	-	1	-	-
Nematode Fragments	-	-	4	-	-	-	-	-	12	2	2	-	-	5	-	-	-	3	-	-
Trematode	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Teleost Fishes (sev. spp.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish Sections	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish Scales	-	-	-	9	-	-	-	4	-	10	2	1	-	-	-	-	-	-	-	-
Fish Vertebrae	-	-	-	3	-	-	-	14	-	25	-	-	-	-	-	-	-	-	-	-
Tunicates	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Amphipods (sev. spp.)	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	1	-	-	-	-
Amphipod Fragments	2	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	5	2	-
Arthropod Sections	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	-	*
Crabs Eurypanopeus depressus	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Cephlathorax	-	3	3	1	-	2	2	20	-	-	17	-	3	6	1	3	2	1	-	-
Chelipeds	-	4	3	1	-	-	3	16	-	-	12	4	4	13	4	2	-	-	-	-
Walking Legs	1	8	3	-	-	-	7	32	-	-	16	5	4	19	7	3	1	-	-	-
Gills	-	8	-	-	-	-	-	24	1	-	46	1	5	10	2	-	7	-	-	-
Eyes	1	2	4	-	-	-	2	5	-	-	2	-	3	9	-	-	-	-	-	-
Maxilla	-	3	4	-	-	-	-	-	-	-	-	-	-	5	2	-	-	-	-	-
Maxillipeds	-	4	2	-	-	-	-	-	-	-	-	4	-	3	1	-	-	-	-	-
Littorina irrorata	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Shrimp Paleomenetes vulgaris	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Grass	-	*	*	*	-	*	*	*	*	*	*	*	*	-	*	-	*	*	-	-
Detritus	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Organic Matter	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

* indicates present
\- indicates absent

TABLE IV

Analysis of the Stomach and Intestinal Contents of the Fish Collected on August 24, 1948.

Fish Number	1	2	3	4	5	6
Length in mm.	252.5	42.0	33.0	38.5	38.0	37.0
Stomach Contents						
Nematode *Contrecaecum habena*	25	-	-	-	-	-
Nematode Fragments	8	-	-	-	-	-
Crabs *Eurypanopeus depressus*	-	-	-	-	-	-
Cephlathorax	-	-	-	-	-	-
Chelipeds	-	-	-	-	-	-
Walking Legs	2	-	-	-	-	-
Teleost Fishes (sev. spp.)	-	-	-	-	-	-
Fish Sections	-	-	-	-	-	-
Fish Scales	-	-	-	-	-	-
Fish Vertebrae	-	-	-	-	-	-
Arthropod Sections	-	-	*	*	*	-
Amphipods (sev. spp.)	-	-	-	-	-	-
Amphipod Fragments	-	-	-	-	-	-
Shrimp *Paleomentes vulgaris*	-	-	-	-	-	1
Grass	-	-	-	-	-	-
Detritus	*	*	*	*	*	*
Organic Matter	*	*	*	*	*	*
Intestinal Contents						
Nematode *Contrecaecum habena*	20	-	-	-	1	-
Nematode Fragments	10	-	-	-	-	-
Trematode	-	-	-	-	-	-
Teleost Fishes (sev. spp.)	-	-	-	-	-	-
Fish Sections	-	-	-	-	-	-
Fish Scales	1	-	-	-	1	1
Fish Vertebrae	-	-	-	-	-	-
Tunicates	-	-	-	-	-	-
Amphipods (sev. spp.)	-	-	-	-	1	-
Amphipod Fragments	-	-	-	-	-	-
Arthropod Sections	-	*	*	*	*	-
Crabs *Eurypanopeus depressus*	-	-	-	-	-	-
Cephlathorax	-	-	-	-	-	-
Chelipeds	1	-	-	-	-	-
Walking Legs	-	-	-	-	-	-
Gills	-	-	-	-	-	-
Eyes	-	-	-	-	-	-
Maxilla	-	-	-	-	-	-
Maxillipeds	-	-	-	-	-	-
Littorina irrorata	-	-	-	-	-	-
Shrimp *Paleomenetes vulgaris*	*	-	-	-	-	1
Grass	*	*	*	*	*	-
Detritus	*	*	*	*	*	*
Organic Matter						*

* indicates present
\- indicates absent

TABLE V

Analysis of the Stomach and Intestinal Contents of the Fish Collected on September 15, 16, 1948

Fish Number	1	2	3	4
Length in mm.	94.5	109.0	133.0	158.0
Stomach Contents				
Nematode Contrecaecum habena	-	-	-	-
Nematode Fragments	-	2	1	-
Crabs Eurypanopeus depressus	-	-	-	-
Cephlathorax	1	1	-	-
Chelipeds	1	1	-	-
Walking Legs	-	2	-	-
Teleost Fishes (sev. spp.)	-	-	-	-
Fish Sections	-	-	-	-
Fish Scales	-	-	-	-
Fish Vertebrae	-	-	-	-
Arthropod Sections	-	*	-	-
Amphipods (sev. spp.)	-	-	-	-
Amphipod Fragments	-	-	-	-
Shrimp Paleomenetes vulgaris	-	2	4	-
Grass	-	*	-	-
Detritus	*	*	*	*
Organic Matter	*	*	*	*
Intestinal Contents				
Nematode Contrecaecum habena	5	2	-	-
Nematode Fragments	2	-	-	-
Trematode	-	-	8	-
Teleost Fishes (sev. spp.)	-	-	-	-
Fish Sections	-	-	-	-
Fish Scales	-	-	-	-
Fish Vertebrae	-	-	-	-
Tunicates	-	-	-	-
Amphipods (sev. spp.)	-	-	-	-
Amphipod Fragments	-	-	-	-
Arthropod Sections	*	-	-	-
Crabs Eurypanopeus depressus	1	-	-	1
Cephlathorax	2	4	3	10
Chelipeds	4	6	2	14
Walking Legs	14	12	7	17
Gills	9	17	6	14
Eyes	-	3	6	6
Maxilla	5	8	6	6
Maxillipeds	6	12	4	4
Littorina irrorata	-	-	-	-
Shrimp Paleomenetes vulgaris	1	-	-	-
Grass	-	*	-	*
Detritus	*	*	*	*
Organic Matter	*	*	*	*

* indicates present
- indicates absent

TABLE VI

Analysis of the Stomach and Intestinal Contents
of the Fish Collected on May 19, 1949

Fish Number	1	2	3	4	5
Length in mm.	236.5	65.0	60.0	195.5	157.5
Stomach Contents					
Nematode Contrecaecum habena	2	-	-	2	1
Nematode Fragments	-	-	-	-	-
Crabs Eurypanopeus depressus	-	-	-	-	-
Cephlathorax	-	-	-	-	-
Chelipeds	-	-	-	-	-
Walking Legs	-	-	-	-	-
Teleost Fishes (sev. spp.)	-	-	-	-	-
Fish Sections	-	-	-	1	-
Fish Scales	-	-	30	-	-
Fish Vertebrae	-	-	12	-	-
Arthropod Sections	-	*	-	-	-
Amphipods (sev. Spp.)	-	-	-	-	-
Amphipod Fragments	-	-	-	-	-
Shrimp Paleomenetes vulgaris	1	1	-	-	-
Grass	*	-	-	-	-
Detritus	*	*	*	*	*
Organic Matter	*	*	*	*	*
Intestinal Contents					
Nematode Contrecaecum habena	28	-	-	2	3
Nematode Fragments	3	-	-	-	4
Trematode	-	-	-	-	-
Teleost Fishes (sev. spp.)	-	-	-	-	-
Fish Sections	-	-	-	-	-
Fish Scales	2	-	-	-	-
Fish Vertebrae	-	-	-	-	-
Tunicates	-	-	-	-	-
Amphipods (sev. spp.)	-	-	-	-	-
Amphipod Fragments	-	-	-	-	-
Arthropod Sections	-	*	*	-	-
Crabs Eurypanopeus depressus	-	-	-	-	-
Cephlathorax	-	-	-	-	1
Chelipeds	-	-	-	1	-
Walking Legs	1	-	-	1	2
Gills	-	-	-	-	-
Eyes	-	-	-	-	-
Maxilla	-	-	-	-	-
Maxillipeds	-	-	-	-	-
Littorina irrorata	-	-	-	-	-
Shrimp Paleomenetes vulgaris	-	1	-	-	-
Grass	*	-	-	-	*
Detritus	*	*	*	*	*
Organic Matter	*	*	*	*	*

* indicates present
\- indicates absent

TABLE VII

Analysis of the Stomach and Intestinal Contents of the Fish Collected on July 12, 13, 14, 1949.

Fish Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Length in mm.	180.5	175.5	136.0	98.0	35.0	38.5	34.0	33.0	43.0	132.5	119.0	139.5	89.0	143.0	196.5	155.3	135.5	127.5	41.0	32.0	32.0	26.0	169.
Stomach Contents																							
Nematode Contrecaecum habena	5	3	4	1	–	–	–	–	–	–	–	18	–	1	–	6	1	1	–	–	–	–	–
Nematode Fragments	9	2	1	–	–	–	–	–	–	–	–	4	–	1	–	–	–	–	–	–	–	–	–
Crabs Eurypanopeus depressus	–	–	1	4	–	–	–	–	–	2	1	2	10	1	1	–	–	–	–	–	–	–	–
Cephlathorax	–	–	–	4	–	–	1	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	1
Chelipeds	–	1	1	–	–	–	–	–	–	1	7	1	1	–	–	–	–	–	2	–	–	–	–
Walking Legs	–	–	–	5	–	–	–	–	–	5	5	–	4	–	–	–	–	–	3	–	–	–	–
Teleost fishes (sev. spp.)	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–
Fish Sections	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Fish Scales	–	–	–	–	–	–	–	–	–	–	–	25	–	–	–	–	–	–	–	–	–	–	–
Fish Vertebrae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Arthropod Sections	*	*	*	–	–	*	–	–	–	–	–	–	*	–	–	–	–	–	–	*	*	*	*
Amphipods (sev. spp.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Amphipod Fragments	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shrimp Paleomenetes vulgaris	–	–	–	–	2	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Grass	–	–	*	–	–	–	–	–	–	–	–	*	–	*	–	*	*	*	–	–	–	–	*
Detritus	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Organic Matter	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Intestinal Contents																							
Nematode Contrecaecum habena	1	5	1	–	–	–	–	–	–	1	2	21	1	5	4	4	2	3	–	–	–	–	6
Nematode Fragments	–	1	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	5
Trematode	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Teleost Fishes (sev. spp.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fish Sections	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
Fish Scales	28	–	7	–	–	–	–	–	–	–	–	–	–	–	–	14	10	–	–	–	–	–	–
Fish Vertebrae	19	6	21	–	–	–	–	–	–	–	–	–	7	–	–	4	–	–	–	–	–	–	–
Tunicates	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Amphipods (sev. spp.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Amphipods Fragments	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	6	5	–	–	–	–	–
Arthropod Sections	–	–	–	*	*	*	*	*	*	–	–	–	–	–	–	–	–	–	*	*	*	*	–
Crabs Eurypanopeus depressus	–	–	–	–	–	–	–	–	–	3	2	–	2	–	–	–	–	–	–	–	–	–	–
Cephlathorax	2	–	4	14	–	–	–	–	–	12	–	3	1	4	6	10	14	7	–	–	–	–	–
Chelipeds	7	–	5	11	–	–	–	–	–	7	9	2	–	4	1	12	19	11	–	–	–	–	–
Walking Legs	8	2	8	36	–	–	–	–	–	39	17	5	3	7	5	10	28	15	–	–	–	–	–
Gills	–	6	10	16	–	–	–	–	–	11	8	8	–	3	3	8	12	11	–	–	–	–	–
Eyes	2	–	5	3	–	–	–	–	–	7	1	3	–	–	–	4	9	6	–	–	–	–	–
Maxilla	–	4	3	6	–	–	–	–	–	10	–	–	–	–	–	7	12	7	–	–	–	–	–
Maxillipeds	–	3	2	10	–	–	–	–	–	4	–	–	–	3	–	4	10	8	–	–	–	–	–
Littorina irrorata	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–
Shrimp Paleomenetes vulgaris	–	–	–	–	1	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Grass	*	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	*
Detritus	*	*	*	*	*	*	*	*	*	*	*	*	*	*	–	–	*	*	*	*	*	*	*
Organic Matter	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

* indicates present
– indicates absent

TABLE VIII

Analysis of the Stomach and Intestinal Contents of the Fish Collected on July 28, 1949

Fish Number	1	2	3	4	5	6	7	8	9	10	11	12
Length in mm.	176.5	161.5	134.0	161.5	149.0	91.0	76.0	92.0	90.5	39.0	35.0	34.0
Stomach Contents												
Nematode Contrecaecum habena	4	-	-	3	-	-	-	-	-	-	-	-
Nematode Fragments	3	4	-	-	1	-	-	-	-	-	-	-
Crabs Eurypanopeus depressus	-	-	-	-	-	-	-	-	-	-	-	-
Cephlathorax	-	-	-	-	-	-	-	-	-	-	-	-
Chelipeds	-	-	-	1	1	-	-	-	-	-	-	-
Walking Legs	-	-	-	-	-	-	-	-	-	-	-	-
Teleost Fishes (sev. spp.)	-	-	-	-	-	-	-	-	-	-	-	-
Fish Sections	-	-	-	-	142	3	-	-	-	-	-	-
Fish Scales	-	41	-	9	-	-	-	-	-	-	-	-
Fish Vertebrae	-	-	-	-	-	-	-	-	-	-	-	-
Arthropod Sections	-	-	-	-	-	-	*	-	-	*	*	*
Amphipods (sev. spp.)	-	-	-	-	-	-	-	2	-	-	-	-
Amphipod Fragments	-	-	-	-	-	-	-	-	1	-	-	-
Shrimp Paleomenetes vulgaris	-	-	-	-	-	-	-	-	-	-	-	-
Grass	-	-	-	-	-	*	-	-	-	-	-	-
Detritus	*	*	*	*	*	*	*	*	*	*	*	*
Organic Matter	*	*	*	*			*	*	*	*	*	*
Intestinal Contents												
Nematode Contrecaecum habena	9	15	1	5	3	-	1	2	-	-	-	-
Nematode Fragments	3	-	-	2	2	-	-	-	-	-	-	-
Trematode	-	-	-	-	-	-	-	-	-	-	-	-
Teleost Sections (sev. spp.)	-	-	-	-	-	-	-	-	-	-	-	-
Fish Sections	-	168	-	345	2	-	-	-	-	-	-	-
Fish Scales	-	28	-	17	-	-	-	-	-	-	-	-
Fish Vertebrae	-	-	-	-	-	-	-	-	-	-	-	-
Tunicates	-	1	1	-	-	-	-	-	1	-	-	-
Amphipods (sev. spp.)	-	-	-	-	-	-	-	-	-	-	-	-
Amphipods Fragments	-	-	-	-	-	-	-	-	-	*	*	*
Arthropod Sections	-	-	-	1	4	2	-	-	-	-	-	-
Crabs Eurypanopeus depressus	1	2	4	-	6	1	4	-	3	-	-	-
Cephlathorax	15	3	3	2	7	2	5	4	3	-	-	-
Chelipeds	8	-	2	2	6	1	18	12	9	-	-	-
Walking Legs	17	-	-	-	10	3	5	4	2	-	-	-
Gills	6	-	-	6	5	5	7	3	-	-	-	-
Eyes	6	-	-	-	3	1	6	4	-	-	-	-
Maxilla	5	-	-	-	4	6	3	2	-	-	-	-
Maxillipeds	7	-	-	-	1	2	-	-	-	-	-	-
Littorina irrorata	-	-	-	1	-	-	-	-	-	-	-	-
Shrimp Paleomenetes vulgaris	-	*	*	*	*	*	*	*	*	*	*	*
Grass	*	*	*	*	*	*	*	*	*	*	*	*
Detritus	*	*	*				*	*	*	*	*	*
Organic Matter												

* indicates present
\- indicates absent

TABLE IX

Analysis of the Stomach and Intestinal Contents of the Fish Collected on August 10, 11, 1949.

Fish Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Length in mm.	177.5	128.5	194.5	131.5	131.0	136.5	123.0	120.0	169.5	177.0	173.0	160.5	196.5	224.5	164.0	140.5	84.5	78.0
Stomach Contents																		
Nematode Contrecaecum habena	–	–	1	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–
Nematode Fragments	–	1	1	–	–	–	1	–	2	–	–	–	–	–	–	–	–	–
Crabs Eurypanopeus depressus	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	–
Cephlathorax	–	2	–	–	–	–	1	–	–	–	–	2	1	–	–	1	–	–
Chelipeds	–	–	–	–	–	–	1	–	–	–	–	1	2	–	–	–	–	–
Walking Legs	–	–	–	–	–	–	1	–	–	–	–	7	8	–	–	4	–	–
Teleost Fishes (sev. spp.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fish Sections	–	–	–	–	–	–	–	–	–	20	24	3	–	–	–	–	–	–
Fish Scales	4	–	–	2	–	–	5	–	–	–	7	–	1	–	–	–	–	–
Fish Vertebrae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	*	–	*	–
Arthropod Sections	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Amphipods (sev. spp.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Amphipod Fragments	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	2
Shrimp Paleomenetes vulgaris	–	–	–	–	–	–	–	–	*	*	–	–	–	–	–	1	–	–
Grass	*	*	–	*	*	*	*	*	*	*	*	*	*	*	*	*	*	–
Detritus	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Organic Matter	*	*	*															
Intestinal Contents																		
Nematode Contrecaecum habena	–	3	–	1	–	–	3	–	1	3	4	1	–	–	1	–	–	1
Nematode Fragments	1	–	1	2	–	–	1	–	2	4	1	–	–	1	–	–	1	–
Trematode	–	–	–	–	–	–	–	–	–	–	–	5	–	–	1	1	–	–
Teleost Sections (sev. spp.)	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
Fish Sections	–	–	–	–	–	78	–	–	1	3	24	92	–	1	1	–	–	–
Fish Scales	3	–	151	–	–	–	–	–	31	–	10	–	2	–	–	25	–	–
Fish Vertebrae	–	11	22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tunicates	–	–	–	–	–	–	–	1	–	–	–	–	–	*	–	–	3	–
Amphipods (sev. spp.)	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
Amphipod Fragments	–	–	–	–	–	2	6	–	7	3	–	–	4	–	–	–	–	–
Arthropod Sections	–	–	–	–	–	34	10	–	9	7	1	–	4	2	–	–	1	3
Crabs Eurypanopeus depressus	–	4	–	–	–	46	18	–	3	8	–	–	9	3	–	2	–	1
Cephlathorax	–	5	1	–	–	55	5	–	–	3	–	–	8	–	1	3	1	3
Chelipeds	–	5	–	–	–	53	7	–	5	4	–	–	–	–	–	3	–	6
Walking Legs	–	–	–	–	–	34	1	–	–	2	–	–	4	–	–	–	–	–
Gills	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	2	–	–
Eyes	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	2
Maxilla	–	–	–	–	–	–	–	–	–	–	–	6	–	–	–	–	–	1
Maxillipeds	–	–	–	–	–	–	*	–	–	–	*	–	*	*	–	–	–	–
Littorina irrorata	–	–	–	–	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Shrimp Paleomenetes vulgaris	–	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Grass	–	*	*	*	*													
Detritus	*	*																
Organic Matter	*																	

* indicates present
– indicates absent

TABLE X

Analysis of the Stomach and Intestinal Contents of the Fish Collected on July 6, 1950

Fish Number	1	2	3	4
Length in mm.	214.5	165.5	142.5	93.5
Stomach Contents				
Nematode Contrecaecum habena	-	-	-	-
Nematode Fragments	-	-	-	-
Crabs Eurypanopeus depressus	-	-	-	-
Cephlathorax	-	-	2	-
Chelipeds	-	-	2	-
Walking Legs	-	-	4	-
Teleost Fishes (sev. spp.)	-	-	-	-
Fish Sections	-	-	-	-
Fish Scales	-	-	-	-
Fish Vertebrae	-	-	-	-
Arthropod Sections	-	-	-	-
Amphipods (sev. spp.)	-	-	-	-
Amphipod Fragments	-	-	-	-
Shrimp Paleomenetes vulgaris	-	-	-	-
Grass	-	-	-	-
Detritus	*	*	*	*
Organic Matter	*	*	*	*
Intestinal Contents				
Nematode Contrecaecum habena	4	6	2	-
Nematode Fragments	4	4	-	-
Trematode	-	-	-	-
Teleost Sections (sev. spp.)	1	-	-	-
Fish Sections	-	-	-	-
Fish Scales	-	7	-	3
Fish Vertebrae	-	13	-	-
Tunicates	-	-	-	-
Amphipods (sev. spp.)	-	-	-	1
Amphipod Fragments	-	-	3	-
Arthropod Sections	-	-	-	*
Crabs Eurypanopeus depressus	-	-	-	-
Cephlathorax	8	2	17	1
Chelipeds	4	4	14	2
Walking Legs	3	3	14	5
Gills	-	5	-	-
Eyes	-	3	10	-
Maxilla	-	-	-	-
Maxillipeds	-	-	-	-
Littorina irrorata	-	-	-	-
Shrimp Paleomenetes vulgaris	-	-	-	1
Grass	*	-	*	-
Detritus	*	*	*	*
Organic Matter	*	*	*	*

* indicates present
- indicates absent

TABLE XI

Analysis of the Stomach and Intestinal Contents of the Fish Collected on July 7, 1950

Fish Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Length in mm.	53.2	196.0	178.5	128.0	82.5	86.0	170.0	73.5	153.0	76.5	86.0	206.0	209.5	265.0	27.0	29.0	23.5	29.0	29.0	120.5	87.0	76.0	77.0
Stomach Contents																							
Nematode Contrecaecum habena	-	1	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1	-
Nematode Fragments	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Crabs Eurypanopeus depressus	1	-	-	-	-	-	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cephlathorax	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chelipeds	-	-	-	-	-	-	2	1	-	-	1	-	1	-	-	-	-	-	-	-	-	1	-
Walking Legs	1	-	-	-	-	-	4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Teleost Fishes (sev. spp.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish Sections	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish Scales	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	*	-	-	-	*	*	-	*
Fish Vertebrae	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Arthropod Sections	*	-	-	-	*	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	-
Amphipods (sev. spp.)	-	-	-	-	-	-	-	-	-	-	1	-	*	-	-	-	-	-	1	-	-	-	-
Amphipod Fragments	-	-	-	-	-	-	*	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*
Shrimp Paleomenetes vulgaris	-	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
Grass	-	-	*	-	*	*	*	*	*	*	*												
Detritus	*	*	*	*	*																		
Organic Matter	*	*	*	*																			
Intestinal Contents																							
Nematode Contrecaecum habena	-	5	-	1	-	-	1	-	1	2	-	3	-	-	-	-	-	-	-	2	1	-	1
Nematode Fragments	-	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-	-	-	-	-	-	1	-
Trematode	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Teleost Sections (sev. spp.)	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fish Sections	-	-	-	-	-	-	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	-
Fish Scales	-	-	-	-	9	-	-	-	-	8	-	89	-	-	-	-	-	-	-	1	-	-	-
Fish Vertebrae	-	-	15	-	-	1	-	-	-	-	-	6	-	-	-	-	-	-	-	-	2	-	4
Tunicates	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	-
Amphipods (sev. spp.)	-	-	-	-	-	-	*	-	*	*	*	-	2	-	-	-	-	-	-	-	-	1	-
Amphipod Fragments	-	-	-	-	-	*	-	*	-	-	*	1	2	-	-	-	-	-	-	1	3	2	4
Arthropod Sections	*	-	-	*	-	-	3	1	12	7	1	1	4	-	-	*	-	*	-	2	5	8	8
Crabs Eurypanopeus depressus	2	-	-	-	4	-	7	1	13	2	-	3	7	-	-	-	-	-	-	-	-	-	8
Cephlathorax	1	-	5	2	5	-	8	2	12	8	-	1	2	-	-	-	-	-	-	-	2	3	1
Chelipeds	2	3	5	1	7	-	4	6	10	5	-	5	8	-	-	-	-	-	-	-	-	-	4
Walking Legs	5	3	6	-	9	-	-	5	8	1	-	2	5	-	-	-	-	-	-	-	-	-	3
Gills	-	-	10	-	2	-	-	3	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-
Eyes	-	-	3	-	4	-	-	2	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-
Maxilla	-	-	-	-	2	-	-	-	-	-	1	-	-	-	2	-	-	1	-	-	*	*	*
Maxillipeds	-	-	-	-	-	-	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*
Littorina irrorata	-	-	-	-	-	-	-	-	-	-	*	*	*	*	*	*	*	*	*	*			
Shrimp Paleomenetes vulgaris	-	-	-	-	-	-	*	*	*	*	*	*	*	*	*	*	*	*	*	*			
Grass	-	*	*	*	*	*	*	*	*	*	*												
Detritus	*	*	*	*	*																		
Organic Matter	*	*	*																				

* indicates present
\- indicates absent

TABLE XII

Analysis of the Stomach and Intestinal Contents of the Fish Collected on August 2, 1950.

Fish Number	1	2	3	4	5
Length in mm.	166.5	132.0	90.5	205.0	56.0
Stomach Contents					
Nematode Contrecaecum habena	-	1	-	-	-
Nematode Fragments	-	-	-	-	-
Crabs Eurypanopeus depressus	-	-	-	-	-
Cephlathorax	-	-	-	-	-
Chelipeds	-	-	-	-	-
Walking Legs	-	-	-	-	-
Teleost Fishes (sev. spp.)	-	-	-	-	-
Fish Sections	-	-	-	-	-
Fish Scales	-	-	-	-	-
Fish Vertebrae	-	-	-	-	-
Arthropod Sections	-	-	-	-	*
Amphipods (sev. spp.)	-	-	-	-	-
Amphipod Fragments	-	-	-	-	-
Shrimp Paleomenetes vulgaris	-	-	-	-	1
Grass	*	-	-	*	-
Detritus	*	*	*	*	*
Organic Matter	*	*	*	*	*
Intestinal Contents					
Nematode Contrecaecum habena	-	3	6	-	-
Nematode Fragments	-	-	-	-	-
Trematode	-	-	2	-	-
Teleost Sections (sev. spp.)	-	-	-	-	-
Fish Sections	-	-	-	2	-
Fish Scales	-	-	-	3	-
Fish Vertebrae	8	18	-	10	-
Tunicates	-	-	-	-	-
Amphipods (sev. spp.)	-	-	-	-	-
Amphipod Fragments	-	-	-	-	-
Arthropod Sections	-	-	-	-	*
Crabs Eurypanopeus depressus	-	-	-	-	-
Cephlathorax	-	-	3	-	-
Chelipeds	4	-	7	-	-
Walking Legs	-	-	18	-	-
Gills	2	-	6	-	-
Eyes	1	-	2	-	-
Maxilla	-	-	8	-	-
Maxillipeds	-	-	4	-	-
Littorina irrorata	-	-	-	-	-
Shrimp Paleomenetes vulgaris	-	-	-	-	-
Grass	*	-	-	-	-
Detritus	*	*	*	*	*
Organic Matter	*	*	*	*	*

* indicates present
\- indicates absent

TABLE XIII

Analysis of the Stomach and Intestinal Contents
of the Fish Collected on August 3, 1950

Fish Number	1	2	3	4	5
Length in mm.	194.0	39.5	34.5	40.0	38.0
Stomach Contents					
Nematode *Contrecaecum habena*	-	-	-	-	-
Nematode Fragments	-	-	-	-	-
Crabs *Eurypanopeus depressus*	-	-	-	-	-
Cephlathorax	-	-	-	-	-
Chelipeds	-	-	-	-	-
Walking Legs	-	-	-	-	-
Teleost Fishes (sev. spp.)	-	-	-	-	-
Fish Sections	-	-	-	-	-
Fish Scales	-	-	-	-	-
Fish Vertebrae	-	-	-	-	-
Arthropod Sections	-	-	-	-	*
Amphipods (sev. spp.)	-	-	-	-	-
Amphipod Fragments	-	-	-	-	-
Shrimp *Paleomenetes vulgaris*	-	-	-	-	-
Grass	-	-	-	-	-
Detritus	*	*	*	*	*
Organic Matter	*	*	*	*	*
Intestinal Contents					
Nematode *Contrecaecum habena*	-	-	-	-	-
Nematode Fragments	2	-	-	-	-
Trematode	-	-	-	-	-
Teleost Sections (sev. spp.)	-	-	-	-	-
Fish Sections	-	-	-	-	-
Fish Scales	213	-	-	-	-
Fish Vertebrae	54	-	-	-	-
Tunicates	-	-	-	-	-
Amphipods (sev. spp.)	-	-	1	1	-
Amphipod Fragments	-	-	-	-	1
Arthropod Sections	-	-	-	-	-
Crabs *Eurypanopeus depressus*	-	-	-	-	-
Cephlathorax	-	-	-	-	-
Chelipeds	-	-	-	-	-
Walking Legs	-	-	-	-	-
Gills	-	-	-	-	-
Eyes	-	-	-	-	-
Maxilla	-	-	-	-	-
Maxillipeds	-	-	-	-	-
Littorina irrorata	-	-	-	-	-
Shrimp *Paleomenetes vulgaris*	-	-	-	-	-
Grass	*	-	-	-	-
Detritus	*	*	*	*	*
Organic Matter	*	*	*	*	*

* indicates present
\- indicates absent

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