

FOOD OF YOUNG WINTER FLOUNDERS.¹

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In connection with work on the parasites of fishes it has been the author's practice to keep a record of the food of the fishes which were being examined for Entozoa. Such miscellaneous data, while not without value, are lacking in that definiteness which is afforded by quantitative studies. It was therefore suggested by the Bureau of Fisheries that an intensive study of the food of one or two families or groups of fishes, preferably those of economic importance, be undertaken.

During the summers of 1915 and 1916 the author spent a part of his time in the examination of small winter flounders (*Pseudopleuronectes americanus*) for their food. The fish were seined by Vinal N. Edwards at 36 stations at Woods Hole, Mass., and vicinity, on dates ranging from May 2 to November 2. The total number of fish examined was 398.

Fishes collected in the months of May, June, September, October, and November were preserved in formaldehyde and examined in the summer of 1916. Fish seined in July and August were brought to the laboratory soon after they were taken from the water. If taken at some distance from the laboratory, they were placed in a strong preservative as soon as they were taken from the water. At first the smaller fish were preserved entire in 95 per cent alcohol, after opening the abdominal cavity. The viscera of the larger fish were removed and kept in dishes of formaldehyde. It was soon found that the formaldehyde material was the more satisfactory for study, and, when well washed in water, could be looked over without discomfort. In each case the alimentary canal was opened throughout its entire length and examined in alcohol or water. The material was separated with the aid of a dissecting lens, the compound microscope being used when necessary for the identification of material. Quantitative estimates were then made, using the smallest lot as a unit.

It often happens that much of the contents of the alimentary canal of the fish does not admit of satisfactory separation into distinct lots, even when its general character is more or less identifiable. For example, in cases where annelids, having much sand in their intestines, have been eaten, what at first appeared to be a mass of

¹ Appendix IV to the U. S. Report of the Commissioner of Fisheries for 1921. B. F. Doc. 907.

sand, upon closer examination proved to contain setæ of annelids, with occasional shreds of cuticle. As the body of the annelid is being digested, the intestine, gorged with sand and mud, often remains in a condition that admits of identification as annelid remains. It is doubtless true that much of the material recorded as ostracodes and small univalve shells has been introduced with annelids.

In the beginning of this work the author was often greatly puzzled when attempting to determine the quantitative values to be placed on the different food materials. After some practice, however, one develops a method which takes into account such material as can readily be separated and classified, and often makes it possible to reduce the unidentified débris to small proportions. In view of the nature of the food of many annelids it is to be noted that the percentage of materials counted as annelid does not always indicate similar percentage of food ingested. Doubtless, also, especially in the beginning of these studies, the estimated percentage of débris is sometimes larger than it should be, due to the fact that portions of the mucous membrane, which are detached when the contents of the alimentary canal are removed, become mixed with the food proper.

Plant material was noted in only 20 of the flounders, approximately 5 per cent of the whole number examined for food. In all instances where plant remains were noted in the contents of the alimentary canal, the amount was always both absolutely and relatively small. Usually it consisted of a few fragments of filamentous algæ, the presence of which could be accounted for as material which had accidentally been taken in along with the proper food of the fish. No place, therefore, was given for plant remains in the table of quantitative estimates.

It would seem, however, that the winter flounders may, on occasion, make use of plant food. From unpublished food notes made in connection with the examination of winter flounders for parasites, mostly by Vinal N. Edwards, out of 82 examinations, 23 records note the presence of plant remains in the alimentary canal. In some cases considerable amounts of plant material were present. Thus, on three dates—April 14, November 7, and 12—the record reads, "Stomachs filled with eelgrass;" on August 31, "Stomach and intestine filled with green seaweed;" on September 30, "Stomach full of algæ (*Ulva*)." It is likely that the eelgrass is eaten for the incrustations of the tunicate *Botryllus gouldii*.

A detailed account of the results of the examination of each of the 398 small flatfish would make a very bulky report, and is considered unnecessary. Illustrative details, omitting some of the notes on Entozoa, are here given for one station only.

FOOD AND ENTOZOAN PARASITES OF SMALL WINTER FLOUNDERS.

STATION 19. KATAMA BAY, JULY 27, 1915.

[Fish seined in water 1 to 4 feet in depth. Bottom, sand with red seaweed and other alga. The bay had been closed on the ocean side for the preceding six years; there was, therefore, little current produced by the tide. Winter flounders, few. Figures referring to food represent average per cent of volume; lengths are given in millimeters.]

1. *Length, 28.*—Food: Copepods, 95; débris, 5. Entozoa: 141 appendiculate distomes, 1 ivory-white sporozoan cyst on intestine.
2. *Length, 30.*—Food: Alimentary canal empty. Entozoa: 317 appendiculate distomes in stomach, 6 in intestine.

3. *Length, 31*.—Food: Copepods, 95; débris, 5. Entozoa: 247 appendiculate distomes in stomach.

4. *Length, 31*.—Food: Copepods, 30; débris, mostly sand, 70; alimentary canal nearly empty. Entozoa: 145 appendiculate distomes in stomach.

5. *Length, 37*.—Food: Amphipods, 50; copepods, 10; débris, 40. Entozoa: 3 appendiculate distomes in stomach.

6. *Length, 37*.—Food: Annelids, 40; copepods, 10; zoæ, 10; ostracodes, 10; amphipods, 10; débris, 20; small fragment of Sagartia. Entozoa: 12 appendiculate distomes in stomach, 4 small nematodes.

7. *Length, 40*.—Food: Amphipods, 20; cumacea, 20; copepods, 5; Crepidula, 5; ostracodes, 5; annelids, 30; débris, 15. A small fragment of the body wall of a synapta was noted. Entozoa: 200 appendiculate distomes in stomach.

8. *Length, 43*.—Food: Amphipods, 10; zoæ, 10; copepods, 10; annelids, 60; débris, 10. Entozoa: 24 appendiculate distomes in stomach.

9. *Length, 44*.—Food: Amphipods, 65; copepods, 10; ostracodes, 4; Sagartia, 5; nemerteans, 5; Crepidula, 5; débris, 6. Entozoa: 24 appendiculate distomes in stomach, 3 in intestine; 4 small nematodes, length 5.

10. *Length, 44*.—Food: Amphipods, 25; ostracodes, 25; copepods, 25; Crepidula, 5; débris (fragments of crustacea), 20; 1 zoea noted. Entozoa: 80 appendiculate distomes in stomach, 3 small nematodes.

11. *Length, 48*.—Food: Amphipods, 90; débris, 10; one small insect larva (Chironomus) noted. Contents of alimentary canal almost completely digested, its nature revealed only when the compound microscope was used. Entozoa: 4 distomes.

12. *Length, 49*.—Food: Amphipods, 90; débris, 10; 1 insect larva noted.

13. *Length, 52*.—Food: Amphipods, 80; Crepidula, 20.

14. *Length, 58*.—Food: Amphipods, 100.

15. *Length, 115*.—Food: Amphipods, 50; Crepidula, 10; débris, 40; 1 small annelid noted. Entozoa: A few sporozoan cysts on wall of intestine.

16. *Length, 120*.—Food: Amphipods, 95; crabs, 1; Crepidula, 2; débris, 2. Entozoa: Sporozoan cysts on intestine.

17. *Length, 120*.—Food: Amphipods, 80; crabs, 10; Crepidula, 2; débris, 8. Entozoa: A few sporozoan cysts on intestine.

18. *Length, 120*.—Food: Amphipods, 15; crabs, 15; Limulus, 15; Crepidula, 5; annelids, 45; débris, 5.

19. *Length, 125*.—Food: Annelids, 95; débris, 5.

20. *Length, 130*.—Food: Limulus, 2; clams, 50; Crepidula, 15; annelids, 3; débris, 30; a few strands of algæ. Entozoa: 1 distome.

21. *Length, 135*.—Food: Amphipods, 98; crabs, 2. Entozoa: 2 distomes.

22. *Length, 135*.—Food: Amphipods, 60; crabs, 30; shrimp, 5; gastropods, 5.

23. *Length, 140*.—Food: Amphipods, 5; crabs, 2; Limulus, 1; bivalve mollusks, 2; annelids, 90. The mollusks were a small Crepidula and fragments of a small clam. Entozoa: 3 distomes.

24. *Length, 150*.—Food: Amphipods, 8; spider crabs, 3; clam, 1; annelids, 80; débris, 8.

25. *Length, 170*.—Food: Nothing in alimentary canal that could be identified except a few fragments of algæ and what appeared to be remains of the mantles of clams. Entozoa: 1 distome.

26. *Length, 190*.—Food: Amphipods, 5; mollusks (small clam and small gastropod), 15; annelids, 75; débris, 5. Entozoa: 2 distomes.

SUMMARIZED RECORD OF FOOD AND PARASITES OF 398 SMALL WINTER FLOUNDERS (*PSEUDOPLEURONECTES AMERICANUS*) COLLECTED AT WOODS HOLE, MASS., AND VICINITY, 1915 AND 1916.

[Figures referring to food represent average per cent of volume; figures referring to parasites, where not otherwise indicated, represent numerical average. The lengths are given in millimeters. The stations have been arranged according to dates as if of one year.]

STATION 1. GREAT HARBOR, MAY 2, 1916.

Length, 26 to 50.—Number examined, 1. Food: Amphipods, 85; Cumacea, trace; insect larvæ, 1; débris, 14. Parasites: Distomes, 4.

Length, 51 to 75.—Maximum length, 72; minimum, 64; average, 70.8. Number examined, 4. Food: Amphipods, 48.8; annelids, 17.5; copepods, trace; insect larvæ, 1.5; débris, 32.2. Parasites: Distomes in each, average 16; Sporozoa, 8 small cysts on intestinal walls of one.

Length, 76 to 100.—Maximum length, 97; minimum, 76; average, 87.7. Number examined, 3. Food: Amphipods, 20; annelids, 48.3; shrimp, 30; débris, 1.6. Parasites: Distomes, 2.3; nematodes, 1 young Ascaris in stomach of one fish.

STATION 2. EEL POND, MAY 16, 1916.

Length, 51 to 75.—Maximum length, 68; minimum, 58. Number examined, 2. Food: Amphipods, 67.5; annelids, 12.5; Cumacea, 10; isopods, trace; débris, 10. Parasites: Distome, 1, in one fish.

Length, 101 to 125.—Maximum length, 125; minimum, 102; average, 113.2. Number examined, 5. Food: Amphipods, 79; annelids, 4.6; Cumacea, 0.2; insect larvæ, 2.4; isopods, trace; débris, 13.8. Parasites: Distomes, 1 in one fish; nematodes, 1 in one fish; Sporozoa, masses of cysts on lower half of intestinal wall of three.

STATION 3. GREAT HARBOR, JUNE 27, 1916.

[Bottom, sandy.]

Length, 25 to 50.—Maximum length, 42; minimum, 25; average, 34.9. Number examined, 12. Food: Amphipods, 20.4; annelids, 24; copepods, 4.7; débris, 51. Parasites: Distomes in each fish, average 35.4.

STATION 4. SHEEP-PEN COVE, JUNE 27, 1916.

[Bottom, muddy with some eelgrass.]

Length, under 25.—Length, 24. Number examined, 1. Food: Amphipods, 1; annelids, 22; copepods, 73; débris, 4. Parasites: Distomes, 10.

Length, 26 to 50.—Maximum length, 38; minimum, 28; average, 33.8. Number examined, 13. Food: Amphipods, 59.7; annelids, 11.8; copepods, 6.3; ostracodes, 0.8; Cumacea, trace; débris, 21.4. Parasites: Distomes, 21.4.

STATION 5. WAREHAM RIVER, JUNE 30, 1916.

[Bottom, mud and eelgrass.]

Length, 26 to 50.—Length, 32. Number examined, 1. Food: Amphipods, 10; annelids, 50; débris, 40. Parasites: Distomes, 18.

Length, 100 to 125.—Maximum length, 120; minimum, 113; average, 116.2. Number examined, 5. Food: Amphipods, 4.2; annelids, 54.8; bivalve mollusks, 0.2; insect larvæ, trace; débris, 40.8. Parasites: Distomes, 10.2; Sporozoa, numerous cysts on intestine of one fish, 1 cyst on intestine of another.

STATION 6. HADLEY HARBOR, JULY 1, 1916.

[Bottom, eelgrass and sand.]

Length, under 25.—Length, 23. Number examined, 1. Food: Amphipods, 5; copepods, 90; débris, 5. Parasites: Nematodes, 1.

Length, 25 to 50.—Maximum length, 44; minimum, 25; average, 35.2. Number examined, 13. Food: Amphipods, 63.4; annelids, 0.4; copepods, 25.7; ostracodes, 2.9; shrimp, 0.5; débris, 6.6. Parasites: Distomes, 0.5.

STATION 7. HEAD OF LACKEY'S BAY, JULY 1, 1916.

[Bottom, eelgrass and mud.]

Length, under 25.—Maximum length, 23; minimum, 21. Number examined, 2. Food: Amphipods, 16; annelids, 2.5; copepods, 70; Cumacea, 0.1; insect larvæ, 1.5; ostracodes, 3.5; débris, 6.5.

Length, 25 to 50.—Maximum length, 42; minimum, 27; average, 35.2. Number examined, 12. Food: Amphipods, 32.3; annelids, 15.9; copepods, 13.5; Cumacea, 0.1; insect larvæ, 0.2; ostracodes, 1; débris, 37. Parasites: Distomes, 6.2.

STATION 8. SHEEP-PEN COVE, JULY 11, 1916.

[Bottom, mud and eelgrass.]

Length, under 25.—Length, 22. Number examined, 1. Food: Copepods, 50; débris, 50.

Length, 25 to 50.—Maximum length, 50; minimum, 29; average, 37.7. Number examined, 13. Food: Amphipods, 33.9; annelids, 7; copepods, 22.1; Cumacea, 0.8; insect larvæ, 0.2; ostracodes, 0.8; débris, 36.2. Parasites: Distomes in each fish, maximum, 484; minimum, 17; average, 155.3.

STATION 9. HEAD OF GREAT HARBOR, JULY 11, 1916.

[Bottom, sandy.]

Length, under 25.—Length, 24. Number examined, 1. Food: Amphipods, 10; copepods, 10; débris, 80. Parasites: Distomes, 27.

Length, 25 to 50.—Maximum length, 50; minimum, 26; average, 33.7. Number examined, 10. Food: Amphipods, 18; annelids, 25.6; copepods, 17.2; larval Crustacea, trace; débris, 39.1. Parasites: Distomes in each fish, maximum, 154; minimum, 3; average, 46.9. One fish (50 mm. in length) had nothing in the alimentary canal except distomes, of which there were 154 in the stomach.

Length, 51 to 75.—Maximum length, 57; minimum, 51; average, 54.3. Number examined, 3. Food: Amphipods, 81.6; annelids, 6.7; copepods, 6.7; débris, 5. Parasites: Distomes in each fish, maximum, 125; minimum, 30; average, 92.6.

STATION 10. TARPAULIN COVE, JULY 14, 1916.

[Soft bottom, with eelgrass.]

Length, 25 to 50.—Maximum length, 50; minimum, 44; average, 48.1. Number examined, 7. Food: Amphipods, 82.1; copepods, trace; isopods, 2.5; ostracodes, trace; débris, 15.3.

Length, 51 to 75.—Maximum length, 55; minimum, 54. Number examined, 2. Food: Amphipods, 72.5; isopods, 2.5; débris, 25.

STATION 11. MENEMSHA BIGHT, JULY 14, 1916.

[Bottom, sand and eelgrass.]

Length, 101 to 125.—Maximum length, 120; minimum, 101; average, 109. Number examined, 5. Food: Amphipods, 74.2; annelids, 7.2; bivalve mollusks, 1.6; insect larvæ, 0.4; débris, 16.4. Parasites: Distomes, 0.6; Acanthocephala, 1 in one fish; nematodes, 0.6; Sporozoa, 1 cyst on intestine of one fish and a few scattering cysts on the intestine of another.

STATION 12. LAGOON POND, VINEYARD HAVEN, JULY 17, 1916.

[Sandy bottom.]

Length, 25 to 50.—Maximum length, 50; minimum, 30; average, 43.1. Number examined, 10. Food: Amphipods, 18.8; annelids, 49.2; copepods, 0.1; insect larvæ, 0.1; débris, 31.9. Parasites: Distomes in each fish, maximum, 400 (approximate); minimum, 2; average, 70.7.

Length, 51 to 75.—Maximum length, 56; minimum, 54; average, 55. Number examined, 4. Food: Amphipods, 14.3; annelids, 51.3; insect larvæ, 0.2; ostracodes, trace; débris, 34.2. Parasites: Distomes in each, average, 39.2.

STATION 13. HEAD OF GREAT HARBOR, JULY 20, 1916.

[Bottom, sand and eelgrass.]

Length under 25.—Maximum length, 24; minimum, 22. Number examined, 2. Food: Amphipods, 5; annelids, 40; copepods, 12.5; larval Crustacea, 7.5; ostracodes, trace; débris, 35. Parasites: Distomes, 25.

Length, 25 to 50.—Maximum length, 42; minimum, 26; average, 33.1. Number examined, 9. Food: Amphipods, 45; annelids, 8.3; copepods, 9.6; gastropod mollusks, trace; ostracodes, 0.1; débris, 36.9. Parasites: Distomes in each fish, 38.3.

Length, 51 to 75.—Maximum length, 59; minimum, 58. Number examined, 3. Food: Amphipods, 13.3; annelids, 50; young fish (80 per cent in one fish), 26.6; débris, 10. Parasites: Distomes in each, 93.3.

STATION 14. HEAD OF GREAT HARBOR, JULY 22, 1915.

[Sandy bottom.]

Length, 25 to 50.—Maximum length, 50; minimum, 45; average, 47.6. Number examined, 3. Food: Amphipods, 15; annelids, 61.6; copepods, 0.3; isopods, 1; ostracodes, 0.3; débris, 21.6. Parasites: Distomes, 2.3.

Length, 51 to 75.—Maximum length, 75; minimum, 51; average, 63.5. Number examined, 17. Food: Amphipods, 12; annelids, 72; copepods, 0.1; insect larvæ, trace; isopods, 0.6; ostracodes, 1.3; univalve mollusks, 0.1; débris, 14. Parasites: Distomes, 6.2; nematodes, 1, in one fish.

Length, 101 to 125.—Length, 120. Number examined, 1. Food: Amphipods, 20; annelids, 30; ostracodes, 5; univalve mollusks, 20; débris, 25.

STATION 15. GREAT POND, EAST FALMOUTH, JULY 22, 1915.

[Low tide, 1 to 2 feet of water; bottom, sand and mud with clams; seining done along edge of eelgrass half-way up the pond; water clear, 78° F.; flounders, abundant.]

Length, 51 to 75.—Maximum length, 72; minimum, 52; average, 66. Number examined, 9. Food: Amphipods, 20; annelids, 50; Cumacea, trace; isopods, 6.6; débris, 23.4. Parasites: Distomes in each fish, average, 22.6.

Length, 76 to 100.—Maximum length, 96; minimum, 78; average, 88.2. Number examined, 4. Food: Amphipods, 15; annelids, 51.2; isopods, 20; débris, 13.8. Parasites: Distomes in each fish, average, 16.2.

Length, 101 to 125.—Maximum length, 125; minimum, 105; average, 115. Number examined, 3. Food: Amphipods, 18.3; annelids, 58.3; isopods, 3; ostracodes, 0.3; débris, 20. Parasites: Distomes in each fish, average, 12.6; Sporozoa, cysts in intestinal wall of one fish (length, 125 mm.).

Length, 126 to 150.—Length of each, 135. Number examined, 2. Food: Amphipods, 5; annelids, 87.5; clams, 6.2; débris, 1.2. Parasites: Distomes in each fish, average, 1.5; Sporozoa, numerous cysts in intestinal walls of one fish.

Length, 151 to 175.—Maximum length, 175; minimum, 155; average, 168.3. Number examined, 3. Food: Annelids, 65; clams, 16.6; débris, 18.3. Parasites: Distomes in each fish, average, 15.3; Sporozoa, cysts very numerous in intestinal wall of one fish.

STATION 16. EEL POND, JULY 25, 1916.

[Bottom, eelgrass and mud.]

Length, 51 to 75.—Maximum length, 72; minimum, 58; average, 59.8. Number examined, 5. Food: Amphipods, 51.2; annelids, 1; Cumacea, 13; débris, 34.8. Parasites: Distomes, 2; nematodes, one small *Filaria* in one fish.

STATION 17. CUTTYHUNK, JULY 26, 1916.

[Bottom, sand and eelgrass.]

Length, 26 to 50.—Maximum length, 50; minimum, 36; average, 43.7. Number examined, 7. Food: Amphipods, 38.5; annelids, 22.8; copepods, 5.3; ostracodes, 0.8; débris, 32.4. Parasites: Distomes, 6.5.

Length, 51 to 75.—Maximum length, 75; minimum, 52. Number examined, 2. Food: Amphipods, 56; annelids, 25; insect larvæ, trace; débris, 24. Parasites: Distomes, 23; nematodes, 2.5. The débris consisted of annelid and crustacean fragments, and diatoms; the latter were interpreted as having been introduced with the amphipods.

STATION 18. NAUSHON, BUZZARDS BAY SHORE, JULY 26, 1916.

[Bottom, sand and eelgrass.]

Length, 26 to 50.—Maximum length, 40; minimum, 37. Number examined, 2. Food: Amphipods, 35; annelids, 20; copepods, trace; débris, 45. Parasites: Distomes, 6.5.

Length, 51 to 75.—Maximum length, 65; minimum, 52; average, 55.6. Number examined, 6. Food: Amphipods, 77.1; annelids, 15; copepods, trace; insect larvæ, 0.1; ostracodes, trace; débris, 7.6. Parasites: Distomes, 10.8; nematodes, 0.5; Sporozoa, 1 cyst on serous membrane, between stomach and liver of one fish.

STATION 19. KATAMA BAY, MARTHAS VINEYARD, JULY 27, 1915.

[Bottom, sand, with much algæ. The bay had been closed on the ocean side for the preceding six years. There is, therefore, but little current produced by the tides. Flounders, few.]

Length, 26 to 50.—Maximum length, 49; minimum, 28; average, 38.5. Number examined, 12. Food: Amphipods, 32.7; annelids, 11.8; Cumacea, 1.8; copepods, 26.3; cœlenterates (*Sagartia*), 0.5; univalve mollusk (*Crepidula*), 1.3; larval Crustacea, 1.8; nemertean, 0.5; ostracodes, 4; débris, 19.1. Parasites: Distomes, maximum, 317; minimum, 3; average, 99.7; Sporozoa, 1 cyst on intestine of smallest fish. In one fish (32 mm. in length), the alimentary canal was empty except for the presence of distomes, of which there were 317 in the stomach.

Length, 51 to 75.—Maximum length, 58; minimum, 52. Number examined, 2. Food: Amphipods, 90; mollusks (*Crepidula*), 10.

Length, 101 to 125.—Maximum length, 125; minimum, 115; average, 120. Number examined, 5. Food: Amphipods, 48; annelids, 28; crabs, 5.2; *Limulus*, 3; mollusks (*Crepidula*), 3.6; débris, 12. Parasites: Sporozoa, a few cysts on the intestines of three fish.

Length, 126 to 150.—Maximum length, 150; minimum, 130; average, 138. Number examined, 5. Food: Amphipods, 34.2; annelids, 35.6; bivalve mollusks, 10; crabs, 7.4; *Limulus*, 0.6; ostracodes, trace; shrimp, 0.9; univalve mollusks, 4.6; débris, 7.6. Parasites: Distomes, 1.2.

Length, 176 to 200.—Length, 190. Number examined, 1. Food: Amphipods, 5; annelids, 75; clams, 15; débris, 5. Parasites: Distomes, 2.

STATION 20. KATAMA BAY, JULY 28, 1916.

[Bottom, sand and gravel.]

Length, 26 to 50.—Length, 45. Number examined, 1. Food: Amphipods, 65; annelids, 15; copepods, 5; débris, 15. Parasites: Distomes, 50.

Length, 51 to 75.—Maximum length, 74; minimum, 52; average, 63.2. Number examined, 13. Food: Amphipods 65; annelids, 11.2; bivalve mollusks, 0.1; copepods, 0.1; isopods, 0.1; ostracodes, 0.1; débris, 23.4. Parasites: Distomes in each fish, average 20.1; Sporozoa, 1 cyst, 2 mm. in diameter, on intestine of one fish (61 mm.).

STATION 21. MONUMENT BEACH, AUGUST 1, 1916.

[Bottom, sand and eelgrass.]

Length, 25 to 50.—Maximum length, 50; minimum, 35; average, 41.8. Number examined, 5. Food: Amphipods, 40.6; annelids, 26; copepods, 4.8; *Cumacea*, 1; débris, 27.6. Parasites: Distomes, 3.4.

Length, 51 to 75.—Maximum length, 75; minimum, 52; average, 60.3. Number examined, 6. Food: Amphipods, 14.1; annelids, 48.3; débris, 37.5. Parasites: Distomes, 1.1; Sporozoa, 1 cyst, 2 mm. in diameter, on intestine of one fish (69 mm.).

Length, 76 to 100.—Length, 80. Number examined, 1. Food: Amphipods, 50; crabs, 2; isopods, 12; shrimp, 2; débris, 34. Parasites: Nematodes, 2.

STATION 22. MENEMSHA POND, AUGUST 2, 1916.

[Bottom, sand and eelgrass.]

Length, 26 to 50.—Maximum length, 50; minimum, 43; average, 47.2. Number examined, 5. Food: Amphipods, 32.4; annelids, 38; copepods, trace; débris, 29.6. Parasites: Distomes, 4.6.

Length, 51 to 75.—Maximum length, 74; minimum, 57; average, 65.5. Number examined, 7. Food: Amphipods, 6.7; annelids, 58; débris, 35.2. Parasites: Distomes, 1.8.

STATION 23. MENEMSHA, INSIDE BREAKWATER, AUGUST 2, 1915.

[Bottom, sand and pebbles.]

Length, 25 to 50.—Maximum length, 42; minimum, 35. Number examined, 2. Food: Amphipods, 17.5; ostracodes, 20; débris, 62.5. Parasites: Distomes, 24.5.

Length, 101 to 125.—Length, 110. Number examined, 1. Food: Amphipods, 3; isopods, 2; shrimp, 75; débris, 20.

Length, 126 to 150.—Maximum length, 140; minimum, 127; average, 130.2. Number examined, 4. Food: Amphipods, 27.5; annelids, 10; isopods, trace; mollusks (siphons of clams), 7.5; shrimp, 47.5; débris, 7.5.

STATION 24. MOUTH OF TRURO HARBOR, CAPE COD BAY, AUGUST 8, 1916.

[Bottom, sandy.]

Length, 25 to 50.—Maximum length, 50; minimum, 44; average, 46.7. Number examined, 4. Food: Amphipods, 1; annelids, 80; insect larvae, 0.5; débris, 18.5.

Length, 51 to 75.—Maximum length, 62; minimum, 60. Number examined, 2. Food: Annelids, 82.5; débris, 17.5. The indigestible residue in this lot of fish, as in all cases where annelids form the bulk of the food, is sand, and has doubtless been introduced with the annelids.

STATION 25. MENEMSHA, AUGUST 10, 1915.

[Inside harbor, on grassy and gravelly bottom.]

Length, 51 to 75.—Length, 70. Number examined, 1. Food: Amphipoda, 50; annelids, 25; débris, 25.

Length, 101 to 125.—Maximum length, 125; minimum, 115. Number examined, 2. Food: Amphipoda, 25; annelids, 72.5; débris, 2.5. Parasites: Sporozoa, many cysts on intestine of smaller fish.

Length, 126 to 150.—Maximum length, 150; minimum 130; average, 140. Number examined, 4. Food: Amphipods, 21.5; annelids, 71.2; bivalve mollusks, 0.1; fish, 0.5; isopods, 0.3; débris, 6.6. Parasites: Distomes, 50.

Length, 151 to 175.—Maximum length, 175; minimum, 153; average, 161.2. Number examined, 4. Food: Amphipoda, 1.6; annelids, 95; bivalve mollusks, 0.3; univalve mollusks, 0.1; débris, 3. Parasites: Distomes, 45; Sporozoa, 1 cyst on intestine of fish measuring 153 mm.

STATION 26. LACKEY'S BAY, AUGUST 3, 1915.

[Muddy bottom, fish collected at high tide.]

Length, 51 to 75.—Maximum length, 74; minimum, 55; average, 64.8. Number examined, 6. Food: Amphipods, 13.1; annelids, 27.3; copepods, 0.1; insect larvæ, 2.5; ostracodes, 0.1; débris, 56.6 (consisting of a little vegetable material and sand). Parasites: Distomes, 3.8.

Length, 76 to 100.—Maximum length, 100; minimum, 76; average, 83.5. Number examined, 4. Food: Amphipods, 31.2; annelids, 57.5; insect larvæ, 3.4; ostracodes, 0.9; débris, 6.7. Parasites: Distomes, 3.2; Sporozoa, many cysts on lower part of intestine of fish 100 mm. in length.

Length, 101 to 125.—Maximum length, 122; minimum, 115; average, 119. Number examined, 3. Food: Amphipods, 15; annelids, 5; bivalve mollusks, 0.3; ostracodes, trace; univalve mollusks, 0.3; débris (some vegetable material), 79.3. Parasites: Nematodes, 0.3; large numbers of cysts of Sporozoa on intestine of fish measuring 120 mm.

Length, 126 to 150.—Maximum length, 142; minimum, 126; average, 136. Number examined, 4. Food: Amphipods, 8.5; annelids, 25.2; bivalve mollusks (young *Mya* and *Solenomya*), 5; ostracodes, 0.2; débris (a little vegetable material, with fragments of amphipods, setæ of annelids, and sand), 61. Parasites: Distomes, 1.5; nematodes, 1.

STATION 27. EEL POND, SEPTEMBER 2, 1915.

[Bottom, eelgrass and mud.]

Length, 51 to 75.—Length, 62. Number examined, 1. Food: Amphipods, 95; ostracodes, trace; débris, 5. Parasites: Nematodes, 2 small *Filaria* and 1 immature *Ascaris*.

Length, 126 to 150.—Maximum length, 142; minimum, 130; average, 138. Number examined, 3. Amphipods, 95; bivalve mollusks, 0.3; ostracodes, 0.3; débris (trace of vegetable material), 4.3.

Length, 151 to 175.—Maximum length, 172; minimum, 154; average, 144.6. Number examined, 6. Food: Amphipods, 48.3; annelids, 7; bivalve mollusks (*Venus*, small), 5; *Cumacea*, trace; ostracodes, trace; univalve mollusks (*Bulla*, etc.), 4.1; débris, 35.6. Parasites: Nematodes (*Filaria*), 4.3; many cysts on rectum of one fish (150 mm.), a few cysts on mesentery of another (172 mm.).

Length, 176 to 200.—Maximum length, 192; minimum, 182. Number examined, 2. Food: Amphipods, 27.5; annelids, 25; univalve mollusks (*Bulla*), 5; débris, 42.5.

Length, 201 to 225.—Maximum length, 225; minimum, 212. Number examined, 2. Food: Amphipods, 5; annelids, 5; bivalve mollusks, 1; univalve mollusks (*Bulla*), 42.5; débris (some vegetable material), 46.5. Parasites: Nematodes, 1 (*Filaria*).

STATION 28. SHEEP-PEN COVE, SEPTEMBER 9, 1915.

[Bottom, mud and sand; high tide; depth, 3 feet; temperature of water, 67° F.]

Length, 51 to 75.—Maximum length, 73; minimum, 53; average, 66. Number examined, 4. Food: Amphipods, 50; annelids, 33.7; débris, 16. Parasites: Distomes, 4.7.

Length, 76 to 100.—Maximum length, 90; minimum, 85. Number examined, 2. Food: Amphipods, 75; annelids, 20; débris, 5. Parasites: Distomes, 10.

Length, 101 to 125.—Length, 104. Number examined, 1. Food: Amphipods, 2; annelids, 88; débris, 10. Parasites: Distomes, 2.

Length, 126 to 150.—Length, 132. Number examined, 1. Food: Amphipods, 1; annelids, 95; débris, 4.

STATION 29. MENEMSHA BIGHT, SEPTEMBER 10, 1915.

[Sandy bottom with eelgrass; depth of water, 6 feet; temperature, 68° F.]

Length, 51 to 75.—Length, 70. Number examined, 1. Food: Amphipods, 4; annelids, 48; débris, 48. Parasites: Distomes, 5; nematodes (*Filaria*), 2.

Length, 126 to 150.—Maximum length, 150; minimum, 140. Number examined, 2. Food: Amphipods, trace; annelids, 50; bivalve mollusks, 2.5; débris, 47.5. Parasites: Distomes, 1; *Acanthocephala*, 1 in one fish.

Length, 151 to 175.—Maximum length, 162; minimum, 152; average, 156.3. Number examined, 3. Food: Amphipods, 9; annelids, 26.3; bivalve mollusks (broken shells, probably introduced with annelids), 3.3; shrimp, 10.6; débris, 50.6. Parasites: Distomes, 2; nematodes, 1 small *Filaria* in one fish.

STATION 30. GREAT HARBOR, SEPTEMBER 14, 1915

[Sandy bottom.]

Length, 51 to 75.—Maximum length, 72; minimum, 62; average, 66.5. Number examined, 4. Food: Amphipods, 69.5; annelids, 10; ostracodes, trace; débris (sand, with annelid setæ), 19.5. Parasites: Distomes, 1.5; sporocysts, few, 0.5 mm. in diameter, on intestine of one fish.

Length, 76 to 100.—Maximum length, 96; minimum, 84; average, 88.3. Number examined, 3. Food: Amphipods, 14.3; annelids, 69.6; *Cumacea*, 1.3; débris (some red alga in one fish), 14.6. Parasites: Distomes, 1.

Length, 126 to 150.—Length, 128. Number examined, 1. Food: Amphipods, 15; débris (sand, with annelid setæ, alimentary canal nearly empty), 85. Parasites: Sporozoa, large numbers of cysts, 1 mm. and less in diameter, on intestine.

STATION 31. EEL POND, SEPTEMBER 18, 1915.

[Bottom, mud and eelgrass; temperature of water, 70° F.]

Length, 51 to 75.—Length each, 70. Number examined, 3. Food: Amphipods, 91.7; annelids, 8.3. Parasites: Distomes, 1 in one fish; nematodes, 1 in one fish; Sporozoa, wall of intestine of one fish thickly beset with small cysts, 0.4 mm., more or less, in diameter, and 1 cyst, 2 mm. in diameter, on intestine of another.

Length, 76 to 100.—Maximum length, 90; minimum, 87; average, 98. Number examined, 3. Food: Amphipods, 97.6; bivalve mollusks, 0.3; ostracodes, 2. Parasites: Distomes, 2.

STATION 32. EEL POND, OCTOBER 18, 1915.

[Muddy bottom; temperature of water, 55° F.]

Length, 101 to 125.—Length, 104. Number examined, 1. Food: Amphipods, 80; annelids, trace; bivalve mollusks, trace; ostracodes, trace; débris, 20. Parasites: Nematodes, 1 (*Filaria*).

Length, 126 to 150.—Maximum length, 150; minimum, 130; average, 136.6. Number examined, 3. Food: Amphipods, 53.3; annelids, 3.3; bivalve mollusks, 0.3; ostracodes, 0.3; débris (some vegetable material, scales and bits of muscle tissue of fish, and crustacean fragments), 42.6. Parasites: Nematodes, 1 (*Filaria*) in one fish; Sporozoa, large numbers of cysts on intestine of each fish, 1 mm. and less in diameter. The alimentary canal of one fish, 150 mm. in length, was nearly empty; the tissue of the intestinal wall was almost completely replaced by cysts. In each case the cysts were closely crowded together and the intestine was easily broken.

Length, 151 to 175.—Maximum length, 158; minimum, 155. Number examined, 2. Food: Amphipods, 12.5; annelids, 30; ostracodes, trace; débris, 57.5.

STATION 33. QUISSET HARBOR, OCTOBER 19, 1915.

[Muddy bottom; temperature of water, 55° F.]

Length, 76 to 100.—Maximum length, 96; minimum, 82; average, 88.6. Number examined, 3. Food: Amphipods, 16.6; annelids, 11.6; shrimp, 30; débris (contents of intestines of annelids), 41.6. Parasites: Sporozoa, a few cysts, 2 mm. in diameter and less, on intestine of smallest fish.

Length, 101 to 125.—Maximum length, 124; minimum, 110; average, 116. Number examined, 9. Food: Amphipods, 2.9; annelids, 32.4; bivalve mollusks, 0.8; isopods, 0.1; shrimp, 24; univalve mollusks (Bulla), 12.1; débris (largely from annelids), 27.6. Parasites: Distomes, 0.2; nematodes (Filaria), 1.

STATION 34. QUISSET HARBOR, OCTOBER 22, 1915.

[Sandy bottom; temperature of water, 55° F.]

Length, 51 to 75.—Length, 62. Number examined, 1. Food: Amphipods, 2; débris, 98.

Length, 76 to 100.—Maximum length, 98; minimum, 80; average, 90.2. Number examined, 4. Food: Amphipods, 21.5; annelids, 43.5; bivalve mollusks, 0.5; débris, 34.5. Parasites: Distomes, 2 in one fish (98 mm.); nematodes, 1 (Filaria) in one fish (80 mm.).

Length, 101 to 125.—Length, 110. Number examined, 1. Food: Amphipods, 2; annelids, 68; débris, 30.

STATION 35. BUZZARDS BAY SHORE, NEAR WOODS HOLE, OCTOBER 26, 1915.

[Bottom, white sand; temperature of water, 55° F.]

Length, 51 to 75.—Maximum length, 74; minimum, 54; average, 63.6. Number examined, 5. Food: Amphipods, 10.2; annelids, 60; débris (sand with algæ, and annelid setæ), 29.8. Parasites: Distomes, 1.4.

Length, 76 to 100.—Maximum length, 96; minimum, 78; average, 84. Number examined, 3. Food: Amphipods, 1.6; annelids, 43.3; shrimp, 13.3; débris (sand, algæ, and annelid setæ), 41.6. Parasites: Distomes, 4.6; Sporozoa, numerous cysts, 1.5 mm. and less in diameter, on intestine of one fish.

STATION 36. EEL POND, NOVEMBER 2, 1915.

[Muddy bottom.]

Length, 76 to 100.—Maximum length, 100; minimum, 78; average, 90.2. Number examined, 5. Food: Amphipods, 76; annelids, 9; isopods, 5; ostracodes, 0.4; débris, 9.6. Parasites: Distomes, 0.6; nematodes, 0.4; Sporozoa, 1 cyst, 3.5 mm. in diameter, on intestine of one fish (100 mm.), numerous cysts, 1 mm. or less in diameter, clustered on lower half of intestine of one fish (92 mm.). In a fish measuring 86 mm. the intestine was densely covered and its walls filled with cysts 1 mm. or less in diameter. The intestine was easily broken in the formalin specimen. The alimentary canal was nearly empty. The same condition was noted under station 32.

FOOD AND PARASITES OF 398 SMALL WINTER FLOUNDERS DISTRIBUTED ACCORDING TO SIZE OF FISH, NUMBER OF FISH, AND NUMBER OF STATIONS.

[Figures referring to food represent average per cent of volume; figures referring to parasites represent numerical average except under Sporozoa, where they indicate the number of fish in which cysts were found.]

	Num-ber.	Average length in millimeters.	Fish.	Crabs.	Shrimp.	Larval crustacea.	Amphipods.	Iso-pods.	Cumacea.	Ostracodes.	Cope-pods.	Insect larvæ.
Size of fish, in millimeters:												
Under 25.....	8	22.9				1.8	6.1			0.6	50.9	0.3
25 to 50.....	142	36.4			0.05	.14	38	0.15	0.25	1.1	11	.04
51 to 75.....	113	61.8	0.7				38	.01	.79	.23	.23	.21
76 to 100.....	35	88.4		0.02	6.34		37.2	3.3	.13	.31	(1)	.38
101 to 125.....	45	114.1		.6	6.4		33.0	.66	(1)	.13		.31
126 to 150.....	30	136.6	.07	1.27	6.38		26.6	(1)		.08		
151 to 175.....	19	161.6			1.7		18.3			(1)		
176 to 200.....	4	186					15					
201 to 225.....	2	218.5					5					
Number of fish.....			2	8	16	4	329	30	19	80	99	27
Number of stations.....			2	2	8	3	36	11	11	19	16	10

	Num-ber.	Average length in millimeters.	Litu-lus.	Bi-valve mol-lusks.	Uni-valve mol-lusks.	Anne-lids.	No-mer-teans.	Co-len-ter-ata.	Dés-bris.	Spo-rozoa.	Trom-atodes.	Nema-todes.	Acan-tho-ceph-ala.
Size of fish, in millimeters:													
Under 25.....	8	22.9				10.7			30.1		7.7	0.2	
25 to 50.....	142	36.4			1.0	18.85		0.03	29.1	2	30.9		
51 to 75.....	113	61.8		(1)	.2	34.6			23.37	7	11.4	.21	
76 to 100.....	35	88.4		0.05		34.2			17.4	6	3.8	.2	
101 to 125.....	45	114.1	0.33	.38	3.40	29.9			25.4	12	1.02	.34	0.02
126 to 150.....	30	136.6	.08	4.14	.8	35.4			24.6	7	9.2	.03	.03
151 to 175.....	19	161.6		4.8	1.34	39.7			28.7	3	12.3	1.4	.05
176 to 200.....	4	186			6.25	31.2			47.5	1			
201 to 225.....	2	218.5		1	42.5	5			46.5			1	
Number of fish.....			3	27	34	241	1	1	360	38	246	32	3
Number of stations.....			1	14	9	34	1	1	35	19	19	14	3

¹ Trace.

It will be seen from the table that small winter flounders feed principally upon amphipods and other small Crustacea, and upon annelids. At the same time they are not restricted to Crustacea and annelids but evidently can utilize a variety of alternative material.

The habits of the flounder—as one may observe its behavior in an aquarium which is provided with sufficient sand—while strictly those of a bottom fish (so far, at least, as its position is concerned) are in reality those of an active and predatory fish. The food to which it will most readily react must be in the shape of objects which are in motion. Although it is by no means a swift swimmer it is capable of very quick movements within a limited range. In its favorite position it lies flat on the bottom, often partly covered with sand. When not concealed by a covering of sand, it quickly assumes a color and marking which cause it to blend indistinguishably with its surroundings. From this natural ambush it makes sudden dashes—with surprising quickness—upon objects which move

near it. Thus it is easily explained why it is that the principal food of this bottom fish is not such objects as would be obtained by rooting or grubbing in the sand and mud, but crustaceans and annelids, the capture of which requires considerable agility.

The presence of the siphons of pelecypod mollusks, which are occasionally found in the stomachs of flounders, is accounted for when it is recalled that flounders often bite off the extended siphons of mollusks. The appearance of such siphons as I have found in the stomachs of flounders would indicate this origin rather than that they represent the least digestible parts of the mollusk.

Vinal Edwards's record shows that 628 adult winter flounders were examined on 82 dates. The following data from his unpublished food notes are appended: Annelids are recorded on 9 dates, in 50 fish; Crustacea, on 10 dates, in 67 fish; ascidians, on 26 dates, in 126 fish; and mollusks, on 11 days, in 56 fish. The ascidian which Mr. Edwards records is *Botryllus gouldii*, which occurs abundantly on eel-grass, where it forms translucent, fleshy incrustations. The small flounders which the author has examined did not contain any tunicate material.

An increase in the ratio of annelids to Crustacea with the size of the fish is observable in fishes under 200 mm. in length. Thus the percentages are: In 150 fish, 50 mm. and under, Crustacea 51.45, annelids 18.10; in 148 fish, 51 to 100 mm. in length, Crustacea 41.21, annelids 34.47; in 75 fish, 101 to 150 mm. in length, Crustacea 34.74, annelids 32.10; in 23 fish, 151 to 200 mm. in length, Crustacea 14.17, annelids 36.91.

