The Food of Young Herring.

By

Marie V. Lebour, D.Sc.,

Naturalist at the Plymouth Laboratory.

THE Herring season of 1923–24 was a peculiarly good one, the fishery continuing from the end of October into the beginning of February.

Newly hatched Herring were first observed on December 17th, 1923, and post-larvæ were abundant up to March, 1924, in the neighbourhood of Plymouth.

Investigations were made into the food of these young Herring, and the probable depth at which they were feeding. Hauls with Young Fish Trawl were made near the surface, midwater, and near the bottom, and tow-nettings were also taken. It has, however, now been found by Mr. Russell that the samples assumed to be near the bottom were possibly in reality some distance above it.

The results of these investigations show that there are more young Herring near the surface and that they feed more there than lower down, and this is quite in accordance with Cossar Ewart's remarks (1886), who showed that newly hatched Herring ascend to the surface layers almost immediately after hatching.

Many large hauls of newly hatched Herring were taken towards the end of December and early in January at all depths, samples of 100 of each haul being examined for food, but none being found. The first seen were from the region of Bigbury Bay, by the end of December being farther west in a straight line from Plymouth Sound, and in January they were scattered in many directions, occurring inside the Sound and outwards towards the Eddystone and beyond as far as Station E1, which is the farthest station usually worked.

It was not until January 14th that any food was found inside the Herrings this year, and those measured 10 mm. with the yolk sac gone, although in previous years those still bearing a yolk sac contained small metazoa (Lebour, 1921). The contents of the alimentary canal were various, larval mollusks, small copepods, and unicellular matter being present in about equal proportions. In the larger specimens copepods are nearly always taken.

When possible 100 Herring from each sample were examined for food, and it was found that more empty specimens occurred in the lower layers than near the surface. After March very few young Herring were to be found.

The following is a list of all food taken by the Herrings up to 12 mm. long :—

Mollusks	Larval bivalve. ,, gastropod.
Copepods	*Pseudocalanus elongatus.* *Acartia Clausi.* *Corycæus anglicus.* *Oncæa* sp. Harpacticid indet. Copepod nauplius. ,, juv. ,, egg.
Infusoria	Egg indet. *Tintinnopsis beroidea.* *T. ventricosa.*
Flagellate	*Halosphæra viridis.*
Diatoms	*Hyalodiscus stelliger.* *Coscinodiscus excentricus.* *C. concinnus* *C.* sp. *Paralia sulcata.* Green remains.

In the following list the food of all the young Herring examined is given, with the size, locality, and date. For the sake of brevity the contents of the alimentary canal have been divided into copepods, mollusks, eggs, and unicellular food, the last including green remains, diatoms, Halosphæra, and tintinnids, copepods including adults, young and nauplii, mollusks including larval gastropods and larval bivalves. The numbers after the specified food indicate the individual food organisms present. In the case of unicellular matter if food organisms could be identified the numbers are given, the sign + after the number indicating indistinguishable green remains ; a query (?), indicating green remains alone ; S.=Surface ; M.=Midwater ; B.=near bottom ; Y.F.T.= Young Fish Trawl ; T.N.=tow-nets.

1924, January 14th, L6, S., Y.F.T., 6 in sample, all examined, 10 mm. long ; 2 contained mollusks alone (4–6), 2 contained mollusks + copepods (3–6), 1 contained copepods alone (1), 1 empty. L6, B., Y.F.T., between

10 and 30 in sample, 10 examined, 7 contained mollusks alone (1–2), 1 contained mollusks + unicellular matter (5), 2 empty.

January 21st, Rame N.E., 4 miles, Y.F.T., S., between 100 and 1000 in sample, 100 examined, ca 10 mm. long, 5 contained mollusks alone (1), 2 contained mollusks + copepods (2), 1 contained mollusks + unicellular matter (3), 11 contained copepods alone (1–3), 1 contained copepods + eggs (2), 5 contained copepods + unicellular matter (2–3), 1 contained copepods + eggs + unicellular matter (3 +), 3 contained eggs (1–3), 21 contained unicellular matter (1–2 +), 53 empty; B., Y.F.T., 100 in sample, all examined, ca 10 mm. long, 6 contained mollusks alone (1–2), 2 contained copepods alone (1), 6 contained unicellular matter (1–2 +), 1 contained a dark indistinguishable mass, 85 empty.

January 23rd, T.N., near S., 20 in sample, all examined, ca 9 mm., Downderry N.E., Looe N., 2 contained copepods alone (2), 11 contained unicellular matter (?), 7 empty.

January 24th, Breakwater Light N., Mewstone N.E. by N., Y.F.T., S., over 1000 in sample, 100 examined, ca. 10 mm., 2 contained mollusks alone (2), 5 contained mollusks + unicellular matter (1 + to 3 +), 1 contained mollusks + copepods + unicellular matter (2 +), 2 contained copepods (1–2), 8 contained copepods + unicellular (1+), 47 contained unicellular matter (?); Breakwater Light N.N.E., Mewstone N.E., B., Y.F.T., over 1000 in sample, 100 examined, ca 10 mm., 1 contained mollusks (1), 2 contained copepods (1), 2 contained unicellular matter (1), 95 empty; T.N., under Penlee, near S., over 100 in sample, 100 examined, ca 10 mm., 40 contained mollusks alone (1–3), 1 contained mollusks + copepods (2), 1 contained mollusks + unicellular matter (1 +), 10 contained copepods alone (1–4), 48 empty.

January 28th, 13 in sample, all examined, T.N., Whitsand Bay, near S., ca 11 mm., 1 contained mollusks (1), 7 contained copepods (1), 5 empty.

January 28th, Y.F.T., Eddystone, S.S.E., 4 miles, S., over 100 in sample, 100 examined, ca 10–11 mm., 9 contained mollusks (1–2), 1 contained mollusks + eggs + unicellular (3 +), 1 contained mollusks + unicellular (3 +), 19 contained copepods (1–2), 2 contained copepods + unicellular (1–2 +), 5 contained unicellular matter (?), 47 empty. M., 50 in sample, all examined, ca 10–11 mm., 2 contained copepods (1), 1 contained eggs (1), 2 contained unicellular matter (?), 45 empty. B., over 1000 in sample, 100 examined, ca 10–11 mm., all empty.

February 1st, Y.F.T., Eddystone S. by W. 2 miles, S., over 1000 in sample, 50 examined, ca 10–11 mm., 1 contained mollusks + copepods (2), 1 contained copepods (1), 15 contained eggs (1–4), 3 contained eggs + unicellular matter (1–2 +), 6 contained unicellular matter (3 +),

24 empty. M., over 50 in sample, 50 examined, ca 10–11 mm., 4 contained copepods (1), 6 contained eggs (1–2), 2 contained eggs + unicellular matter (1–2 +), 4 contained unicellular matter (?), 34 empty.

February 4th, Y.F.T., Eddystone S.E., 1 mile, S., between 50 and 100 in sample, 50 examined, ca 11 mm., 6 contained copepods alone (1), 1 contained copepods + eggs (3), 2 contained copepods + unicellular matter (2–3), 1 contained eggs (2), 5 contained unicellular matter (?), 37 empty.

February 7th, Y.F.T., Bolt N.E., Prawle E.N.E., S., 100 in sample, all examined, ca 11 mm., 17 contained mollusks alone (1–6), 8 contained mollusks + copepods (2–5), 10 contained mollusks + unicellular matter (1–3 +), 20 contained copepods alone (1–3), 3 contained copepods + unicellular matter (2–3 +), 6 contained unicellular matter (2 +), 36 empty. (N.B.—Several sand grains and larval trematodes in these.) M., between 100 and 1000 in sample, 100 examined, ca 11 mm. long, 22 contained mollusks alone (1–2), 9 contained mollusks + copepods (2–4), 10 contained mollusks + unicellular matter (3–7), 1 contained mollusks + eggs + unicellular matter (2 +), 8 contained copepods alone (1–2), 1 contained copepods + unicellular matter (2), 2 contained unicellular matter (1–3 +), 29 empty. Many sand grains in these. B., between 100 and 1000 in sample, 100 examined, ca 11 mm., 8 contained mollusks alone (1–2), 5 contained mollusks + copepods (2–3), 1 contained mollusks + unicellular matter (2), 22 contained copepods alone (2–4), 1 contained copepods + unicellular matter (2), 1 contained eggs (1), 1 contained eggs + unicellular matter (2), 5 contained unicellular matter (?), 52 empty.

February 14th, Y.F.T., Rame N.W., Breakwater Light N.N.E., S., between 100 and 1000 in sample, 100 examined, 10–14 mm., 8 contained mollusks alone (2), 3 contained mollusks + copepods (3), 1 contained mollusks + unicellular matter (3), 19 contained copepods alone (1–3), 1 contained copepods + unicellular matter (1 +), 1 contained eggs (1), 3 contained unicellular matter (?), 64 empty. M., between 100 and 1000 in sample, 100 examined, ca 11 mm., 1 containing mollusks alone (1), 9 containing copepods alone (1), 2 containing eggs (1), 1 containing unicellular matter (?), 87 empty. B., between 100 and 1000 in sample, 100 examined, ca 10–11 mm., 1 containing mollusks alone (1), 13 containing copepods alone (1–2), 1 containing copepods + eggs (2), 1 containing eggs (1), 2 containing unicellular matter (2 +), 80 empty.

February 16th, Y.F.T., off the Lizards, S., 12 in sample, all examined, 3 contained mollusks alone (1–2), 1 contained mollusks + copepods (3), 4 contained copepods alone (1), 1 contained eggs (1), 3 empty. M., 12 in sample, all examined, 10–12 mm., 4 contained mollusks alone (1–3), 1 contained mollusks + copepods (2), 1 contained mollusks + eggs (3),

2 contained copepods alone (1), 1 contained eggs (2), 3 empty. B., 3 in sample, all examined, 11 mm., 1 contained a copepod, 2 empty.

February 22nd, Y.F.T., Knap, S., 17 in sample, all examined, ca 12 mm., 7 contained copepods alone (1–4), 1 contained eggs (1), 9 empty. B., 2 in sample, 12 mm., both contained copepods (2).

March 3rd, Y.F.T., L4, B., 9 in sample, all empty.

March 8th, Y.F.T., L4, midnight, B., 20 in sample, 12–23 mm., all empty.

March 20th, Y.F.T., Mewstone N.N.E., Yealm Point E.S.E., B., 12 in sample, all examined, 12–26 mm., 4 contained copepods alone (1–5), 1 contained copepods + eggs (4), 7 empty. Y.F.T., Shagstone N.E., Mewstone S.E., M., 6 in sample, 8–24 mm., 2 contained copepods alone (1–3), 4 empty.

March 31st, 1 in sample, 24 mm., L4, Y.F.T., empty.

We find from these records that out of 1593 Herring examined, 768 came from surface hauls, 269 from midwater and 556 from near the bottom; 978 were empty, 265 from the surface, 169 from midwater and 341 from near the bottom. Thus more than half those from near the bottom and from midwater were empty, and only a little more than a third were empty from the surface. Further, those which had food inside usually contained more when from the surface than from the lower layers. The food of the small Herring is varied, unicellular matter, larval mollusks and small copepods (including nauplii) occurring in about equal proportions. In a former paper on the food of young clupeoids (Lebour, 1921) the writer has shown that larval gastropods are of special importance. It now seems that unicellular matter may be taken just as freely, possibly the mollusks (both gastropods and bivalves) being taken in preference if present. Many of the little Herring contain green material, which is probably the remains of diatoms or flagellates. *Halosphæra viridis* is present as food frequently in one or two hauls. Indeed, it seems that in certain hauls certain food has been taken. At a length of 10 mm. such copepods as *Pseudocalanus elongatus*, *Acartia Clausi* and *Corycæus anglicus* are often taken, usually, however, not more than one to four at a time. These are the common copepods of the plankton at this time, and the larval mollusks are also plentiful. Few diatoms were recognised, amongst these being *Hyalodiscus stelliger*, *Paralia sulcata* and *Coscinodiscus excentricus*, again the common forms in the winter plankton. It was noticed in one surface haul (Rame N.E., 4 m., 21.1.24) that Acartia was very abundant in the plankton, and the little Herring were eating it. Inside the Acartia taken from the Herring were many diatoms—*Paralia sulcata*, *Coscinodiscus* sp., *Thalassiosira* sp., *Thalassiothrix nitzschioides* and small naviculoid diatoms. These are also the essential food of

Pseudocalanus, which is breeding in the early winter months. At this time of year the surface is swarming with small plankton, diatoms, larval mollusks, larval and small adult crustacea. Herrings hatch at the bottom and make their way to the surface where food is most abundant, begin to feed before the yolk has entirely disappeared, at first on unicellular matter, larval mollusks and small copepods, and as they grow live chiefly on copepods. *Paralia sulcata* is a diatom having profound significance from the point of view of food. It may be eaten directly by the baby Herring or indirectly by the small organism serving for its food, larval mollusks, copepod nauplii, adult copepods, which are all common food of the baby Herring, or the adult Herring may eat it indirectly, as it is also a common food of many other copepods (Calanus, etc.) and schizopods, much eaten by the Herring.

Besides the food for the Herring there are many enemies eating the tiny fishes. Even the adult Herring itself, Mackerel and Pilchard were sometimes found full of the newly hatched Herring. Medusæ of many kinds, Pleurobrachia and Sagitta all abound and eat the Herring (Lebour, 1922–23). Taking Paralia as a base we can thus see many food chains reaching to the fishes. Paralia is eaten by Acartia, other copepods, larval mollusks and other crustacea which are eaten by the young Herring, which, in their turn, may be eaten by various cœlenterates, worms and older fishes.

LITERATURE.

1886. Cossar Ewart, J. Appendix to 4th Ann. Rep. Fishery Board for Scotland, p. 43.

1921. Lebour, M. V. The Food of Young Clupeoids. Jour. Mar. Biol. Assoc., N.S., Vol. XII, No. 3.

1922. Lebour, M. V. The Food of Plankton Organism. *Ibid.* Vol. XII, No. 4.

1923. Lebour, M. V. The Food of Plankton Organism, II. *Ibid.* Vol. XIII, No. 1.