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Abstract:
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In seven experiments herring larvae were fed to herring. After a digestion period of 15, 30, 60, and 120 minutes respectively, the stomach contents were examined.

The results show that the larvae are digested almost completely within an hour. The digestion rate is decreased by the presence of other prey in the stomach.

Introduction

When trying to estimate the predation on herring larvae (Clupea harengus) by examining the stomach contents of different fish species caught near herring spawning grounds, the results are obviously affected by the digestion rates of the food in the stomachs.

Christensen (1) found that in the stomachs of sand eel (Ammodytes marinus) identifiable remains of herring larvae could not be found more then 30 minutes after the larvae had been captured.

Even on a research vessel it seldom takes less than 15 minutes between the end of a haul and the moment the fish is in the ship's laboratory. If Christensen's findings are also representative for other predators, there would be little chance to find remains of herring larvae in the stomachs of captured fish. Also, if there is a great difference in digestion rates between fish of different species, it would have consequences when trying to find a main predator of herring larvae by examining stomach contents.

Much research has been done to determine differences in digestion rates in different species, using weight ratio as the important factor. However, very little is known about how long prey can be detected morphologically in the stomach contents of different species.

During a stomach research project in September 1983, herring was found to be a predator on herring larvae. When larvae as well as herring happened to be available in the laboratory it was decided to carry out some digestion experiments, using morphological criteria.

Materials and methods:

Herring:

In September 1983 herring was caught in the harbour of Aberdeen and taken to the aquarium in IJmuiden. They were kept in a cylinder shaped tank with a diameter of 3.1 m and a depth of 1.0 m. Temperature was 11.5 C. Deep frozen mysids were used as food. The size of the herring used in the experiments varied from 10 to 15 cm.

Larvae:

In December 1983 fertilized eggs were obtained from herring, spawning in the English Channel. The methods used were roughly the same as descibed by Munk and Rosenthal (2). After hatching, the larvae were transferred to a 750 l rectangular, black plastic, tank. The larvae were fed with Artemia nauplii. At the time of the experiments in February, the larvae were 6 to 8 weeks old. Their length was 13 to 18 mm.

Observation tank:

The experiments were carried out in a half circular shaped tank with a diameter of 1 m and a depth of 0.3 m. It had one straight wall made of glass. The round wall was made of black plastic, to create a dark background.

The tank was placed in a dark room where only diffuse light entered. A 60 W lamp placed over the tank was lit approximately 10 hours a day.

The herrings' behaviour could be observed from outside the room on a TV screen connected to a camera installed in front of the tank.

The experiments:

In each experiment, two herrings were transferred from the large tank to the observation tank. After a few hours when the herring behaved normally, 4 to 6 larvae were added. The larvae could not escape from the tank so if they had dissappaered after some time, it was assumed that they had been captured by the herrings. This could take 48 hours. Then again 4 to 6 larvae were added and now the tank was continuously observed until feeding behaviour started again. This procedure had to be repeated three to four times, until only a few hours elapsed between the moment the larvae were added and the moment the herrings started feeding. In all experiments only one herring was feeding while the other one did not seem to notice the larvae.

After a fasting period of four hours, it was assumed the herrings' stomach was empty again and 4 to 6 larvae were transfered into the observation tank. All larvae had to be caught within less then 10 minutes from the moment the first larva was captured. If it took more time for the larvae to be caught, the experiment was terminated and only started again after another fasting period.

After 15, 30, 60 or 120 minutes the herring was removed from the tank. The gut was removed immediately and was put into a 4% formaline solution. After 30 minutes the contents of the gut were examined.

In one experiment the herring was fed 0.5 cc chopped mysids, before the larvae were added. When all larvae had been captured, another 0.5 cc was added. The whole procedure took no longer than 10 minutes. After 60 minutes the herring was removed from the tank.

Results:

The pictures in figure 1 show that 15 minutes after the larvae had been captured, they were hardly digested (1a). After half an hour the larvae can still easily be distinguished (1b). The figures 1c,1d and 1e show larvae after a digestion period of one hour. In one of those experiments there were hardly any remains to be found (1d). After two hours there were no traces left.

When mysids as well as larvae have been fed, the larvae are digested at a much lower rate (1f).

Discussion:

Estimating predation by analysing stomach contents morphologically is possible only if the duration of the haul is short (15 minutes) and if the catch is sorted out quickly. Field observations have shown that stomachs always contain other prey besides larvae. This will decrease the digestion rate. It is estimated that the presence of larvae in stomach contents can be proved morphologically within one hour from the moment of ingestion. This only refers to relatively old (large) larvae. Christensen made use of larvae, less then 18 days old. When comparing these results with Christensen's, the difference shows that younger larvae are digested at a higher rate.

It is not certain whether the digestion rates found in these experiments is completely comparable to those occuring under field conditions. In the experiments, the observation tank had to be small in order to be able to check the number of larvae and watch the behaviour of the herrings on TV. It took a considerable time for the herrings to get used to their new surroundings and they were easily disturbed by movement or sound. This may have affected the digestion rate.

These experiments only give a preliminary indication on the digestion rate of herring larvae. The main purpose was to test whether this kind of experiments was feasible. Future research should be concentrated on the relationship between digestion rate and:

- the age of the larvae
- the size of the predator
- the other contents of the stomach
- the predator species.

References:

Christensen,V.: Predation by sand eel on herring larvae. ICES C.M.1983/L:27

Munk,P. and Rosenthal,H.:Variability of size in herring larvae at hatching - Influence of egg deposition patterns and parental fish. ICES C.M.1983/L:33

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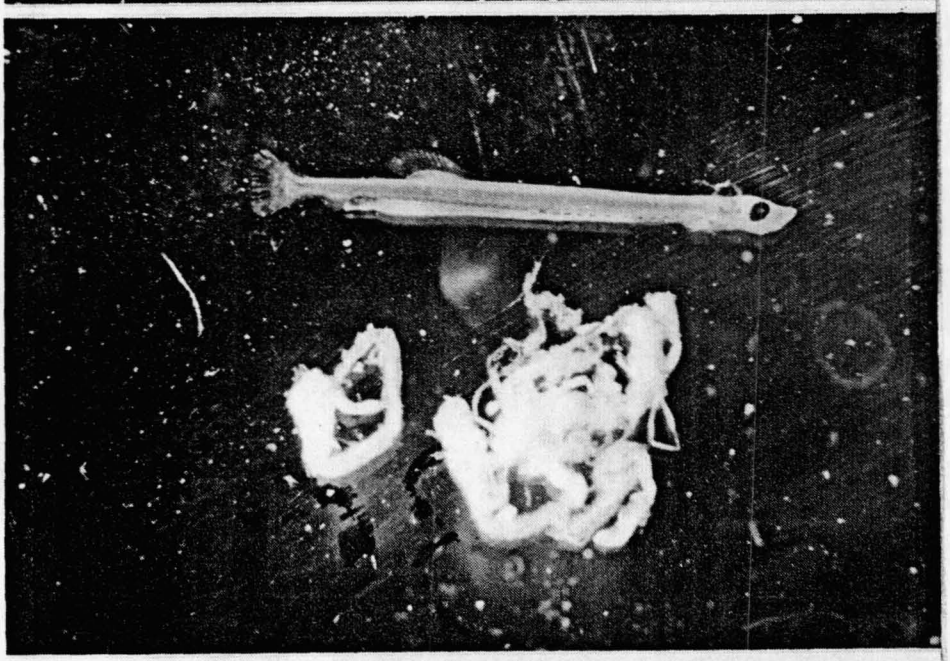
Figure 1: Herringlarvae from herrings' stomachs after a digestion period of 15 min (1a), 30 min (1b), and 60 min (1c,1d,1e). Figure 1f shows larvae after a digestion period of 60 min, when the stomach contained mysids as well.

The larva on top of each picture is an undigested larva, used as reference. All larvae were preserved in a 4% formalin solution.

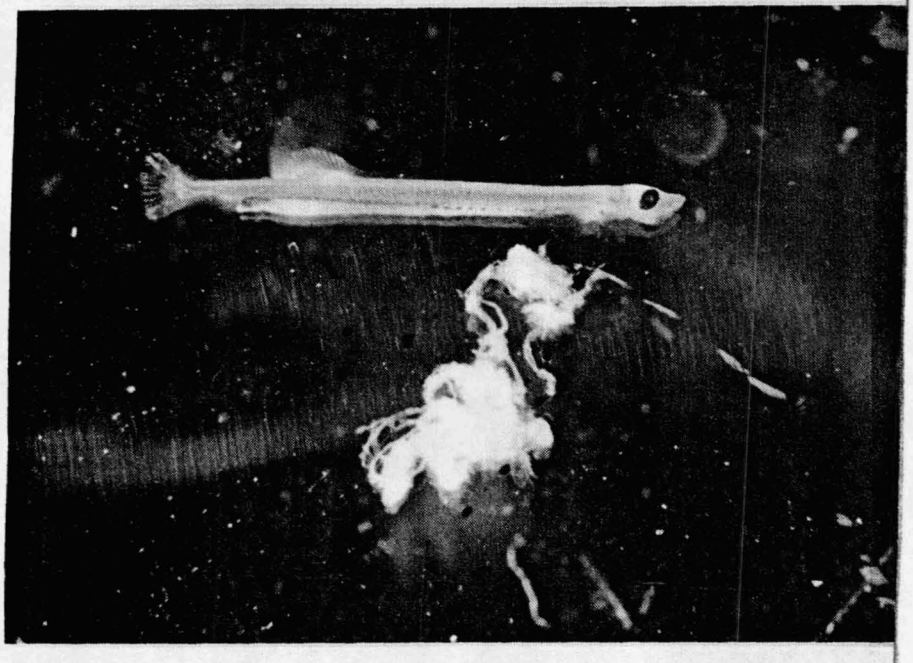
1a: after 15 min.



1b: after 30 min.

1c: after 60 min.

1d: after 60 min.



1e: after 60 min.

1f: after 60 min. in a stomach, also containing mysids.