NOTES

Growth of Larval Herring (*Clupea harengus*) in the Bay of Fundy and Gulf of Maine area[1]

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DAS, N. 1972. Growth of larval herring (*Clupea harengus*) in the Bay of Fundy and Gulf of Maine area. J. Fish. Res. Bd. Canada 29: 573–575.

Initial growth rate for autumn-hatched herring larvae in the Bay of Fundy–Gulf of Maine area is about 2 mm per week. It gradually declines to less than 1 mm per week during the late autumn and winter months, and then increases geometrically in the spring and early summer to an average of 2.5 mm per week.

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Les larves de hareng écloses à l'automne dans la région baie de Fundy–golfe du Maine croissent initialement au rythme d'environ 2 mm par semaine. La croissance diminue graduellement à moins de 1 mm par semaine à la fin de l'automne et en hiver, pour ensuite augmenter géométriquement jusqu'à 2.5 mm par semaine en moyenne au printemps et au début de l'été.

Received October 14, 1971

DURING the past 50 years much research effort has been devoted to the study of Atlantic herring, yet our knowledge of the growth and survival of larvae is limited. Of the few significant studies, all except one preliminary report by Tibbo et al. (1958) were made in the northeast Atlantic, mainly in European waters (Bowers 1952; Jensen 1950; Marshall et al. 1937; Masterman 1896). The aim of the present study (see also, Das 1968) was to determine the growth rate of the autumn-hatched larvae in the Bay of Fundy–Gulf of Maine area by following changes in size from month to month.

Materials and methods — Larval herring were collected in St. Marys Bay, the Bay of Fundy, and in the northern region of the Gulf of Maine (Fig. 1) from September 1960 to June 1963. Collections were usually made at monthly intervals with two types of plankton nets: a 1-m (#0 mesh size) nylon net of conventional conical shape, and an Isaacs-Kidd midwater trawl modified to 2-m size. The nets were towed first at 20 m, then raised to 10 m, and finally to the surface. The 1-m net was towed for 5 min at each level at a speed of approximately 2 knots. The Isaacs-Kidd trawl was towed at a speed of 4 knots in the same depth sequence as the 1-m net, but for 10 min at each depth. Larval collections were preserved in 5% formalin.

Before setting tow nets, surface water temperatures were taken at each station.

When large numbers of herring larvae were caught in a tow, a subsample of 100 specimens was examined to estimate the size distribution of the whole sample. Subsamples were obtained either by spreading the larvae evenly over a squared grid and then taking all specimens in squares picked at random, or by taking a grab sample from the total lot stirred in a large beaker of water. When larvae were less abundant, all specimens from the tow were measured. Larvae were measured from the tip of the snout to the distal end of caudal fin, to the nearest half-millimeter.

The autumn spawning in the Bay of Fundy–Gulf of Maine area usually starts in late August, and continues for a period of 8–10 weeks. Herring seem to come in batches to the spawning grounds, and both spawning and hatching occur more or less in "waves." However, there is some overlapping of spawning activity in the area within this period. Because of the length of the spawning season, individual collections usually contain a mixture of individuals at different stages of development; newly hatched and older larvae are often found together. The mean lengths of individual samples, therefore, may not provide a satisfactory method for estimating rate of growth since they are not those of homogeneous groups of larval fish. Length frequencies

[1]Based upon portions of a thesis presented to McGill University, in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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Printed in Canada (J2328)

of larvae in pooled samples showed unimodal distribution early in the spawning season but, as the season advanced, the distributions were often bimodal and sometimes multimodal. The general pattern of larval growth could be seen in the shift of histograms to the right, and modal lengths of pooled samples which were easily distinguished in histograms appeared to be the best available means of defining growth curves rather than the mean or median lengths.

Results and discussion — Larval collections for all areas of capture were pooled, and the results plotted as an annual time series (Fig. 2). Collections were usually small between January and March, and the samples did not always show a pronounced mode as in autumn and spring samples. However, the length ranges of those samples were included for uniformity in the treatment of results.

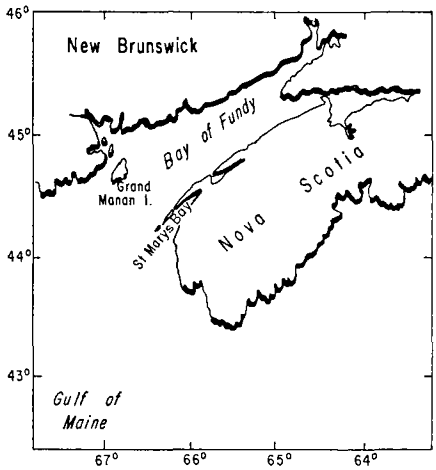

FIG. 1. Map showing the principal localities referred to in this study.

The fall-spawned larvae in the Fundy area usually hatch at a length of 5–9 mm. Most of the specimens caught in September were newly hatched (6–7 mm long) with full yolk sacs. No larvae smaller than 5 mm were captured. During that month surface water temperatures varied between 11.2 and 15.0 C, and larval growth was rapid, averaging 2 mm per week. The modal lengths of the samples collected in the middle of October indicated that the average rate of linear growth of newly hatched larvae was still close to 2 mm per week. The mean surface temperature for October was 11.2 C. From the modes of the samples taken in early November and December it was evident that growth was slower during late October and November, averaging less than 1.5 mm per week. Surface water temperatures were between 6.4–8.7 C in early November of 1960 and 1961, and in 1962 somewhat higher, from 8.2 to 9.0 C. Several other workers have found similar pattern of growth amongst the fall-hatched young in various Atlantic waters (Jensen 1950; Bowers 1952; Tibbo et al. 1958).

The apparent similarities between the size ranges of larvae captured in January and early April (Fig. 2) suggest that perhaps the larval growth was minimal during winter, less than 1 mm per week, or may have stopped. Surface water temperatures varied from 0.9 to 3.8 C in January 1961 and to -0.3-1.3 C at the end of February 1963. The general decline in growth rate in winter also seems to be characteristic of the fall-hatched larvae elsewhere in the Atlantic: Jutland Reef and southern Kattegat, Jensen (1950); Manx waters, Bowers (1952); Scottish waters, Masterman (1896).

The size ranges and modal lengths of the samples taken in April and May indicate that linear growth rate increased in spring, being higher than that of late fall and winter, averaging about 1.5 mm per

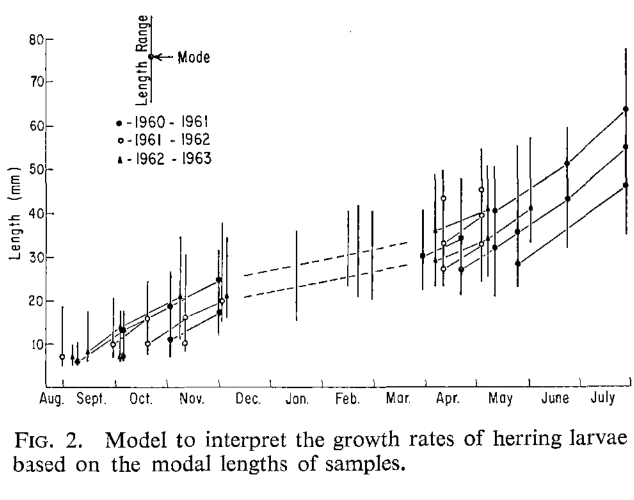

FIG. 2. Model to interpret the growth rates of herring larvae based on the modal lengths of samples.

week in April, and nearly 2 mm per week in May. The mean surface water temperature at the end of March 1961 was 1.7 C, and in early April 1962 and 1963 it was 3.6 and 3.0 C, respectively; it varied from 5.3 C at the end of April to 7.9 C in late May.

Interestingly enough, the present data on growth rate of the fall-hatched larvae during spring in the Fundy area seem to agree with the data on the growth rate of the spring-spawned larvae (over 2 mm per week) from other parts of the Atlantic (Marshall et al. 1937; Jensen 1950; Jean 1956).

Data on the growth rate of larvae in June and July are available for the year 1961 only. However, there is no reason to suppose that the rate of growth in June and July 1961 is not valid for the corresponding periods in 1962 and 1963. Figure 2 indicates that during a period of 9 weeks (May 24–July 27, 1961) growth was close to 22 mm, i.e. about 2.5 mm per week.

In Figure 3 growth curves for herring larvae from the Bay of Fundy–Gulf of Maine area, and from other areas in the Atlantic, for which data are available (Jensen 1950; Bowers 1952; Tibbo et al. 1958), have been plotted together for comparison.

A marked similarity between the growth curves for the early fall-spawned larvae in the Fundy area (A) and Manx waters (a) is evident, but in late autumn, the growth rate in the Fundy area appears to be slightly faster than in Manx waters. However, based on the data available for late autumn and winter in the Fundy area, the differences seem to be of doubtful significance. Tibbo et al. (1958) reported similar instances of faster growth amongst the fall-hatched young in the Bay of Fundy and the Gulf of Maine area. However, their data did not provide adequate information on the rate of growth beyond the month of January, and most of their collections were made on the northern edge of Georges Bank where surface water temperatures during winter were considerably higher than that in the Fundy area. The growth curve (B) for late-hatched fall larvae in the Fundy area shows good agreement with the growth of late-hatched fall larvae in Manx waters (b).

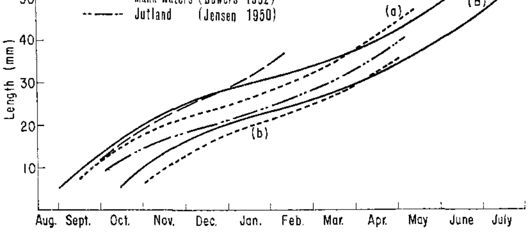

FIG. 3. Comparison of growth rates of autumn-hatched herring larvae from different areas. Aa and Bb represent early and late hatched autumn larvae, respectively.

Figure 3 also shows similarities between the growth curves for fall-hatched larvae in the Fundy area and the Jutland Reef region (Jensen 1950), in that the Jutland curve falls between the two Fundy curves. However, it appears that the growth in Danish waters is somewhat slower during early autumn than that in Fundy region. Jensen (1950), however, did not give any information on sea temperatures in the Jutland Reef region.

The growth curves, for the fall-hatched larvae from the Fundy area and other parts of the Atlantic, thus indicate that growth is rapid during autumn, and in general slows down considerably as winter sets in, as might be expected since conditions of temperature and feeding would be less favourable to growth in winter. It would appear that growth is rapid during autumn spawning while the larvae still bear yolk sacs. Rapid growth in spring is presumably due to the increase in water temperature and to more favorable feeding conditions. Since no detailed temperature data are available with the samples from other areas of the Atlantic referred to in Figure 3, it is impossible at the present time to show any simple relation between temperatures and growth in these areas.

Acknowledgments — I am indebted to Mr S. N. Tibbo for his support and helpful advice during this study, and for his critical review of the manuscript.

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