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THE DURATION OF THE FIRST TWO YOLK SAC STAGES IN HERRING (*CLUPEA HARENGUS* L.) LARVAE

By

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ABSTRACT

FOSSUM, P. 1986. The duration of the first two yolk sac stages in herring (*Clupea harengus* L.) larvae. *FiskDir. Skr. Ser. HavUnders.*, *18*: 77–82.

Artifically fertilized and naturally spawned herring eggs from the local herring stock in Lindåspollene, north of Bergen, Norway, were hatched at 9°C in 1978 and at 6°C in 1979. The purpose was to calculate the duration of the first two yolk sac substages. All the larvae hatched in 1978 were in substage 1a (DOYLE 1977). In 1979, however, 73% and 27% of the hatched larvae were in substages 1a and 1b, respectively.

The duration of substage 1a is affected both by the amount of yolk present at hatching and by the temperature. The duration of substage 1a was 1 day in 1978 and 1.2 days in 1979. The duration of substage 1b is only affected by the temperature and was 1.2 days in 1978 and 3.3 days in 1979. Genetic differences between the Lindås herring and the Clyde herring may account for the different durations of the first two yolk sac substages. This experiment demonstrates the importance of hatching experiments in connection with spawning stock abundance investigations.

INTRODUCTION

A reliable estimation of the abundance of a spawning stock is essential for its optimal exploitation. Important methods in stock abundance estimation are the use of fisheries statistics, acoustic surveys and tagging experiments. A fourth method is based on the count of spawning products. This method has of late been increasing in importance because of its particular applicability to spawning stocks when low.

In species with demersal eggs the newly hatched larvae can be used to estimate the abundance of the spawning stock if the egg mortality is negligible or can be accounted for (GJØSÆTER and SÆTRE 1973). The

present investigation was carried out to get additional information about the duration of the first two yolk sac substages in herring larvae, for the accurate ageing of newly hatched larvae is essential for reliable estimation of the spawning stock.

The investigation was carried out with larvae from the local herring stock in Lindåspollene, north of Bergen, Norway (Fig. 1). The staging system based on the morphology of the yolk sac as described by DOYLE (1977) is used in this investigation. Doyle used the staging system to study the development of artificially reared Clyde herring larvae.

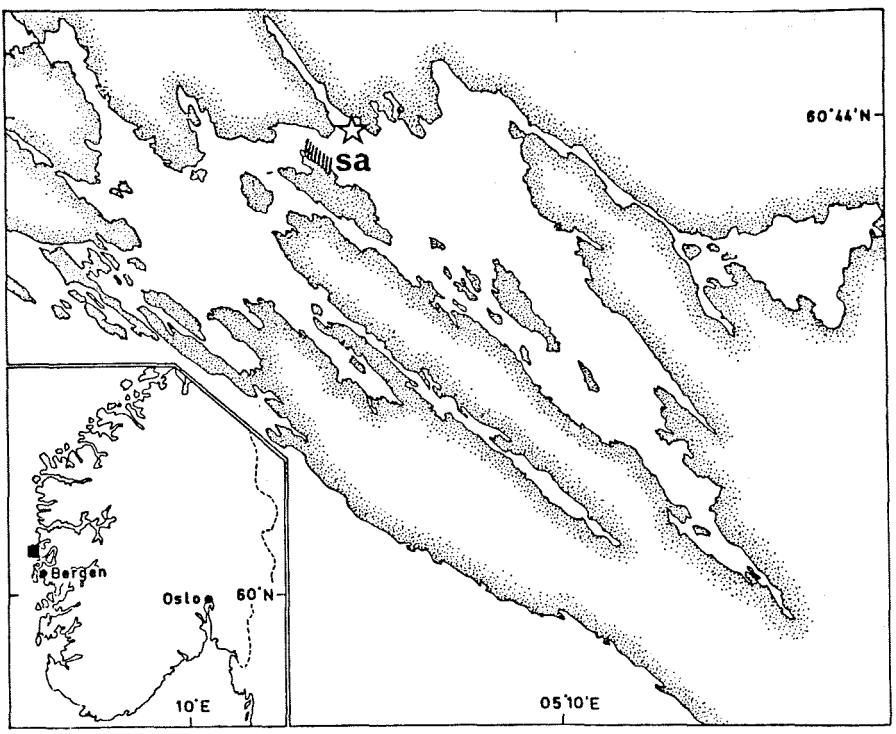

Fig. 1. Map of Lindåspollene, with laboratory raft and spawning area (sa) of the local herring stock.

MATERIALS AND METHODS

In 1978, the larvae were obtained both from artifically fertilized eggs from herring caught with gill nets at the spawning grounds and from naturally spawned eggs collected at the same spawning grounds. In 1979, all the larvae were obtained from naturally spawned eggs, also collected at the same spawning grounds. The eggs were transferred to 8.8 l glass aquaria with plankton net bottoms, mesh size 90 µm, and

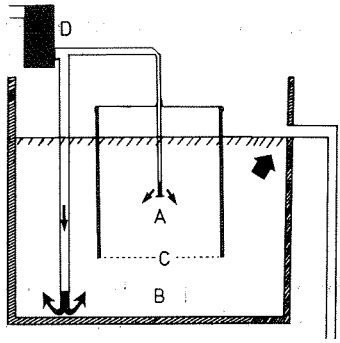

Fig. 2. Experimental equipment. A) Rearing aquarium, B) Water bath, C) Plankton net bottom, D) Fulflo filter, 7 µm.

placed in a water bath in an open circulating system (Fig. 2). The hatching conditions were identical except for the temperature, which was kept constant at 9°C in 1978 and at 6°C in 1979. The sea water, filtered through a 7 µm Fulflo filter, was let into the aquaria in the center and out through the bottom. The light fluctuated between 10 and 100 lux. The developmental substages (Table 1 and Fig. 3) were identified after DOYLE (1977).

Table 1. The substages of the first main stage after hatching (after DOYLE (1977)).

Main stage	Substage	Characterization of the substages
1	1a	Depth of yolk sac equal to or exceeding 2.5 times the depth of the myotomal musculature which lies immediately adjacent and dorsal to the sac.
	1b	Depth of yolk sac about twice the depth of the myotomal musculature which lies immediately adjacent and dorsal to the sac.
	1c	Depth of yolk sac equal to or less than depth of the myotomal musculature which lies immediately adjacent and dorsal to the sac.

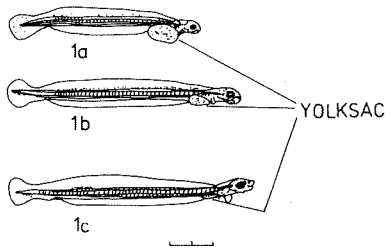

Fig. 3. Stage 1 herring larvae: substages 1a, 1b and 1c. Scale bar represents 2 mm.

The duration of the substages were calculated from daily samples of yolk sac larvae by means of the formula (DOYLE 1977):

$$t_n/T = \frac{\sum_i (S_n/S)_i}{\sum_n \sum_i (S_n/S)_i}$$

where t_n is the time interval occupied by a given substage, T is the total time of development, $(S_n/S)_i$ is the fraction of the total larvae number in the i-th sample lying between substages n and n+1.

RESULTS AND DISCUSSION

In 1978, all the larvae were in substage 1a at hatching. In 1979, however, 73% of the larvae were in substage 1a at hatching, while 27% had less yolk and were determined to be in substage 1b at hatching (Table 2 and 3). The mean duration of substage 1a was 1 day at 9°C in 1978 and 1.2 days at 6°C in 1979 (Table 4). In 1978, the larvae in the substage 1b dominated the larval population on the second day after hatching, while the substage 1b was most abundant in the period from one to four days after hatching in 1979. The duration of this substage was 1.2 days in 1978 and 3.3 days in 1979. DOYLE (1977) found that the 1a-substage lasted 3.2 days while the 1b-substage lasted 3.7 days at 8.9°C.

Table 2. Percentage of the larval population in the different yolk sac substages at daily intervals from hatching (t=9°C) 1978.

Age (days)	Substage 1a %	Substage 1b %	Substage 1c %	Number of larvae
0	100	0	0	14
1	8	64	28	39
2	7	36	57	30
3	7	28	65	29
4	0	0	100	19
5	0	0	100	12
6	0	3	97	31
7	0	2	98	40
8	0	1	99	142
9	0	0	100	29

Table 3. Percentage of the larval population in different yolk sac substages at daily intervals from hatching (t=6°C) in 1979.

Age (days)	Substage 1a %	Substage 1b %	Substage 1c %	Number of larvae
0	73	27	0	22
1	36	64	0	25
2	9	83	8	35
3	8	79	13	38
4	0	46	54	37
5	5	42	53	19
6	0	12	88	16
7	0	17	83	6
8	0	0	100	18

Table 4. Duration of the first two yolk sac substages (days) in 1978 and 1979, together with the results of DOYLE (1977).

	Substage 1a	Substage 1b
1978 (9°C)	1.0	1.2
1979 (6°C)	1.2	3.3
DOYLE (8.5–9°C)	3.2	3.7

Differences in the duration of developmental substages may to some degree be explained by different rates of yolk turnover, being genetic or temperature dependent. The different durations of substages in the present experiment are most likely due to different temperature regimes. The same amount of yolk (the substage 1b) is absorbed three times faster at 9°C than at 6°C. Differences in substage durations between our experiments and Doyle's may be explained by genetic differences between the two stocks. The Clyde herring used by Doyle was adapted to a slightly higher temperature, 7–7.5°C (DOYLE 1977), compared to 5.5–6.0°C in Lindåspollene (AURE pers.comm.). The consequence will be that the substage 1b lasts three times longer in Clyde herring than in Lindås herring at the same temperature.

The duration of the substage 1a depends upon both the amount of yolk present at hatching and the rate of yolk absorption. Clyde herring larvae generally hatched with a dry weight of 190 µg (BLAXTER and EHRLICH 1974) which is considerably larger than the 110 µg of newly hatched Lindås herring larvae (FOSSUM 1980). The explanation of the difference in dry weight may be that the Clyde herring are hatched with more yolk and therefore stay longer in substage 1a. Different rates of yolk turnover may also account for the different durations of the substages.

The Lindås herring larvae hatched with less yolk in the 1979 experiment than in 1978, and the dry weight of the herring larvae was 20 µg lower at hatching. But the yolk mass was absorved at a faster rate at 9°C in 1978 than at 6°C in 1979, and the result was that substage 1a lasted about one day both years. The reason for less yolk being present at hatching in 1979 may be due to the lower incubation temperature, as more yolk will be absorbed during a prolonged incubation period at a lower temperature. More recruit spawners in the spawning stock in 1979 could be an explanation of less yolk being present at hatching, as older fish seems to have larger eggs than recruit spawners (HEMPEL and BLAXTER 1967). However, no change of the age composition of the spawning stock in the two years has been observed (JOHANNESSEN, in press).

Feeding was not observed before the larvae reached substage 1c in field investigations in Lindåspollene (FOSSUM and JOHANNESSEN 1979), and no energy surplus should therefore interfere with the duration of the yolk sac substages 1a and 1b.

The abundance of larvae in yolk sac substage 1a has been used to estimate the daily production of larvae from a spawning bed (JOHANNESSEN, in press). Compensation must be made for variations in substage duration, otherwise these will strongly influence the estimates. The duration of the actual substage at prevailing temperatures and the genetic conditions of the particular stock are important to know for the purpose of abundance estimation. *In situ* hatching experiments in connection with the investigation of fish stock abundance can therefore be of great importance in the future.

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