Differences in otolith and somatic growth between spring and autumn spawned herring (*Clupea harengus* L.) larvae

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Background

Autumn and spring spawned herring may have common nursery and feeding areas (Moksness & Fossum 1991, Fossum & Moksness 1993). Larger egg size in spring than in autumn and between stocks (Sinclair & Tremblay 1984) has generated much speculation about growth and survival capabilities of herring progeny originating from different seasons (Gamble et al. 1985). Irrespective of spawning season herring metamorphose from late spring to early autumn. Autumn spawned larvae experience decreasing temperatures, day length and thus deteriorating feeding and growth conditions after hatching, whereas environmental and growth conditions are more favourable for spring spawned larvae at similar age. The aim of this study was to investigate responses of otolith and somatic growth parameters in larvae of an autumn and a spring spawning herring stock at similar environmental conditions but at respective light regimes for the season.

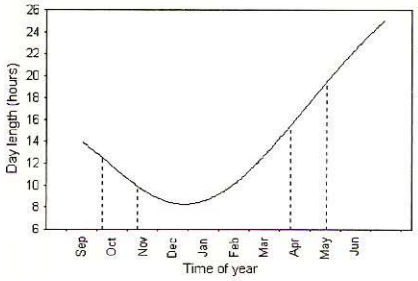

Figure 1. Simulated natural light conditions in Bergen (60°23'N, 5°20'E) applied in experiments with herring larvae in autumn 1995 (5 October - 9 November) and spring 1996 (11 April - 27 May).

Material and methods

Spawning products from running adults of one autumn and one spring spawning herring stock were fertilized in the laboratory and incubated at 10° and 8° C, respectively. The experiments were performed in 500 l tanks and started at hatching (Day 0) on 5 October, 1995 and 11 April, 1996. Monitoring of temperature, prey density and mortality was conducted every day, and larval sampling was performed at least once a week. The duration of the experiments was 35 days. Temperature was kept constant at 8° C, and prey were offered at three different concentrations: 0 l^{-1} (starvation controls), low (20 - 40 l^{-1}) and high (1200 - 2000 l-1) prey densities. Stocking densities of herring larvae were 0.7 l^{-1} and 1.3 l^{-1}, respectively. The tanks were subjected to simulated natural photoperiods similar to the natural light conditions in Bergen, 60°23'N, 5°20'E (Figure 1).

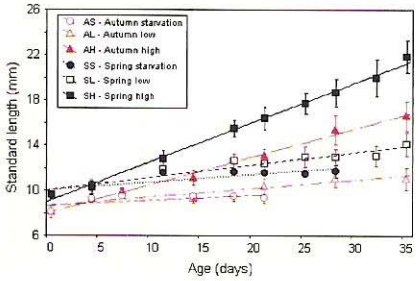

Figure 2. Mean growth in length (± 2 SD) of herring larvae at 8° C and different prey regimes (starvation (0 l^{-1}), low (20 - 40 l^{-1}) and high (1200 - 2000 l^{-1}) prey densities). Linear regressions were fitted for autumn (A) and spring spawned (S) larvae at high prey (AH, SH), low (AL, SL) and unfed (AS, SS) prey regimes.

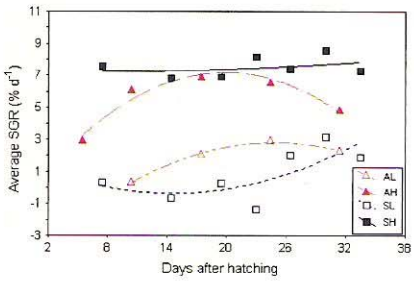

Figure 3. Mean specific growth rates (SGR) of herring larvae in autumn and spring at 8° C and low and high prey densities. SGR (% day^{-1}) = 100 (e^{g} - 1), where g is the instantaneous growth rate. Symbols as in Figure 2.

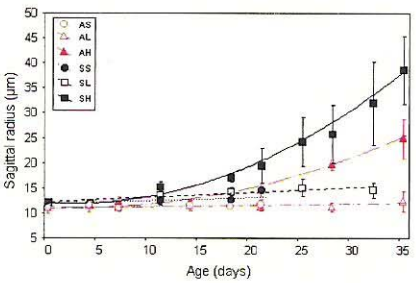

Figure 4. Age-specific growth of larval herring otoliths (sagittal radius, OR) (Mean ± 2 SD) in autumn and spring at 8° C and 3 different prey regimes (starvation, low and high). Symbols as in Figure 2.

Results and Discussion

Growth rates in length were higher in spring than in autumn at similar prey densities, and increased with increasing prey densities (Figure 2). Standard length increased at mean rates of 0.12 and 0.08 mm·d^{-1} in spring and autumn spawned larvae at low prey densities and 0.34 and 0.24 mm·d^{-1} in corresponding high density groups, respectively. Mean rates in unfed groups were 0.09 and 0.06 mm·d^{-1}, respectively.

Somatic growth strategies differed between autumn and spring spawned herring larvae (Figure 3). In autumn the relationship between average specific growth rates (SGR) *vs.* age was dome-shaped, indicating that autumn spawned larvae initially tended to increase body weight within the first month post-hatching. SGR increased from about zero to about 3 %·d^{-1} and to about 7 %·d^{-1} at low and high prey densities, respectively. In spring spawned larvae average growth rates were relatively constant at similar ages. At low prey levels feeding was only sufficient to maintain minimum metabolic requirements and very low growth, whereas at high food levels the larvae grew at approximately 7 %·d^{-1}.

Daily otolith growth rates were also higher in spring than in autumn at similar prey densities, and increased with increasing prey densities (Figure 4). Otolith size increased exponentially with increasing larval length in the length range 8 - 24 mm (Figure 5). Within the first 3 weeks after hatching daily otolith growth rates were below the resolution threshold (<0.4 µm·d^{-1}) for reading distinguishable increments, even at high prey densities.

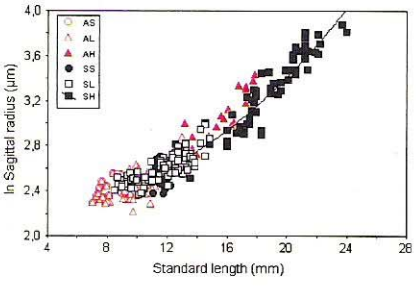

Figure 5. Length-specific growth in larval herring otoliths (ln Sagittal radius, ln OR) in autumn and spring at 8° C and 3 different prey regimes (starvation, low and high). Symbols as in Figure 2.

Conclusions

- Spring spawned herring larvae grew more rapidly in length and otolith radius compared with autumn spawned larvae at similar temperature and prey densities
- Specific growth rates in autumn spawned herring larvae increased initially and then declined whereas they were relatively constant in spring spawned larvae.
- Seasonal light regimes are suggested to generate different growth strategies in autumn and spring spawned larvae.
- Daily otolith increments were initially (first 3 weeks) below 0.4 µm·d^{-1} at 8° C even at high prey densities.

References

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Acknowledgements

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