Vertical distribution of cod at early life stages: positioning according to thermoclines in experimental columns

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INTRODUCTION

Life in the pelagic is typically characterized by smaller-scale horizontal gradients in environmental variables. Vertically however, physical and biological parameters will change with depth in distances within reach of larval fish by directional swimming (Olla and Davis 1996). Changes in vertical distribution may be one way to mediate drift, growth and predation risk over ontogeny (Fiksen et al. 2007). Furthermore, positioning according to temperature in the water column allow larvae to behaviourally regulate its own metabolism and thus utilization of energy and growth (Batty 1994).

We set up a controlled lab experiment with vertical temperature gradients (8-4 ˚C) to investigate change in vertical distribution and temperature exposure of cod through early life stages.

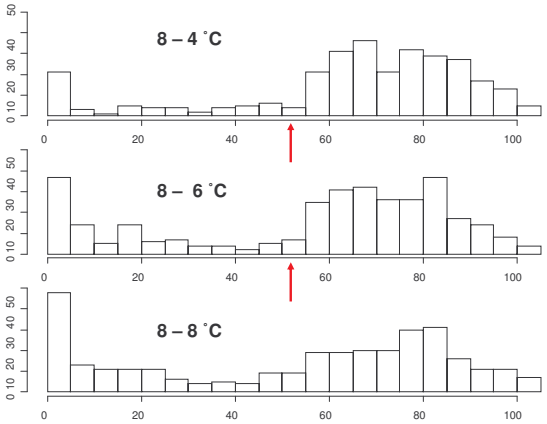

Figure 1 Distribution of cod larvae in experimental columns at 46-47 dph from 0 cm (bottom) to 100 cm (top). The red arrow indicates the thermoclines.

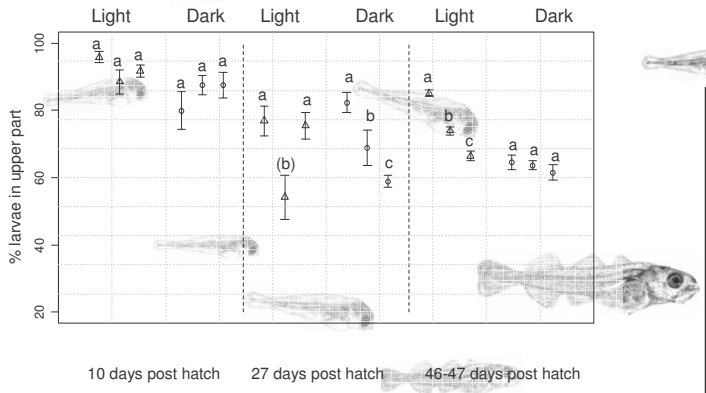

Figure 2 Percent larvae in upper part of the column in the subsequent order 8-4, 8-6 ˚C and no thermocline. Data is presented for each of the sampling day and both light (triangles) and darkness (circles) treatment. Letters indicate significant difference within sampling date and treatment. Parenthesis indicate significant level above 0.01.

Material and Methods

Vertical distribution observations were done at 10, 27 and 45-47 days post hatch in transparent plastic bags with a diameter of 20 cm and a water level of 1 meter. Half of the water column (50 cm) was submerged in three large aquariums to create a thermocline of 8- 4 and 8- 6 ˚C and a control with no thermocline (8 ˚C). The columns where illuminated from above. Light levels were relatively uniform in the water column (Top: 6.4 $\mu Em^{-2}s^{-1}$ Bottom: 2.6 $\mu Em^{-2}s^{-1}$).

Twenty-four fish was inserted into the water column from above. Vertical distribution of the larvae in the column was measured manually after 10, 20 and 120 minutes. Then the light was turned off and after two hours the upper and lower part of the water column was filtrated and the fish larvae counted and weighed. The following day the lower part of the water column was illuminated from the side while the upper part was covered. After two hours the larvae were sampled as in darkness. Each treatment was replicated 6-20 times.

RESULTS

- The larvae is positively buoyant and actively seeks upwards (pers. obs.) at 10 dph (days post hatch). Almost all the larvae are found near the water surface (fig. 2).
- At 26 dph the larvae seek further down, but do not seem to actively avoid the thermocline, but do so in darkness.
- At 47 dph the larvae avoid the thermocline (fig. 2) , but this patterns disappears in darkness
- Change in light settings (light in lower part) does not affect the response of the larvae to the thermoclines.
- There was a downwards movement (10-20 min) followed by an upwards movement after two hours.
- Greatest variability in behavioral response was observed at 27 dph.
- Larger larvae were in general observed in the upper part of the column (fig. 3)

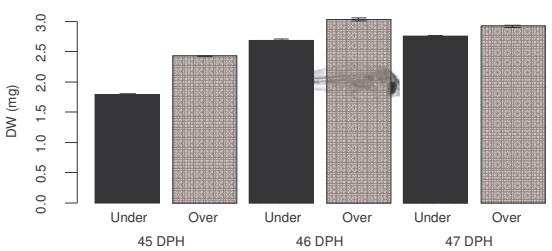

Figure 3 Larval size (dry weight) at the three last sampling days (45-47 dph). Black and grey columns indicate fish from lower and upper part of the column, respectively.

DISCUSSION

Upwards movement at early stages is probably a behavioural mechanism to seek increasing light level and encounter with suitable prey.

The ontogenetic change in vertical position correlates with increase in size, pigmentation and thus vulnerability to visual predators.

Positioning relative to the thermocline at later stages (45-47 dph) indicates that temperature does become an important physical gradient that post larval fish respond to.

Positioning according to the thermocline in darkness at 27 dph might be a consequence of buoyancy differences since larval fish become less active in darkness.

The response to the thermocline cannot be explained by size alone since there was no threshold size where the larvae would respond to the cline. There were however a general size trend, indicating that faster growing, and thus probably better conditioned larvae, would position themselves in the warmer waters.

References

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