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SWIMMING OF YOLK-SAC LARVAL ANCHOVY (*ENGRAULIS MORDAX*) AS A RESPIRATORY MECHANISM

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Larval anchovy exhibit regular bouts of continuous swimming interspersed with periods of resting during the first 3 days after hatching. At this stage larvae have yolk-sacs and jaws have not developed, so that this behaviour is not related to feeding. Hunter (1972) suggested that this behavior might have a respiratory function. Another explanation is that swimming is required to counter the tendency to sink due to the negative buoyancy of larval anchovy. Possible functions of the swimming bouts are investigated theoretically and experimentally in this study.

Respiration must be by cutaneous diffusion, as the gill system is not developed in yolk-sac larvae. Thus, mathematical models for diffusion to both resting and moving larvae are developed, and predictions by the models are compared to published values of oxygen requirements of anchovy larvae. The models predict that when the oxygen level in sea water is above 60% of saturation, the amount of oxygen diffused to a motionless larva is enough to sustain it. However, at lower oxygen levels, swimming induces convective diffusion and requires an accompanying large increase in the oxygen transport.

Experiments were carried out with newly hatched and 24 h old larvae by placing them in closed containers with a controlled level of oxygen. The behaviour of the larvae placed in water was monitored with oxygen concentrations ranging from saturated to 20% saturation. The number, frequency, duration, and direction of swimming bouts was recorded in each of five oxygen concentrations. The experiments were spread out over a number of weeks to reduce the possibility of bias due to a defective cohort group.

The frequency and duration of swimming periods did not change when the oxygen concentration was reduced from saturation to 80 or 60%. However, as predicted by the diffusion models, increases in the amount of time spent swimming were observed at lower (40 and 20%) concentrations. Time spent swimming increased linearly with the decrease in available oxygen.

Because behaviour of yolk-sac larvae did not change at high oxygen concentrations, swimming activity at or near saturation is not primarily a respiratory act. The second hypothesis, swimming to control depth, was tested by measuring the swimming direction taken by the larvae. For newly hatched larvae, which are approximately neutrally buoyant, no preferred direction was found. However, for 24 h old larvae, an average direction of 39° (measured upwards from the horizontal direction) was found. Day old larvae have used up part of the available yolk and are negatively buoyant. The average distance this larvae sank (>5 cm) was in good agreement with the average distance (<7 cm) moved vertically upwards during one swimming bout. Therefore, it is concluded that swimming activity of yolk-sac anchovy larvae is also related to depth control.

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