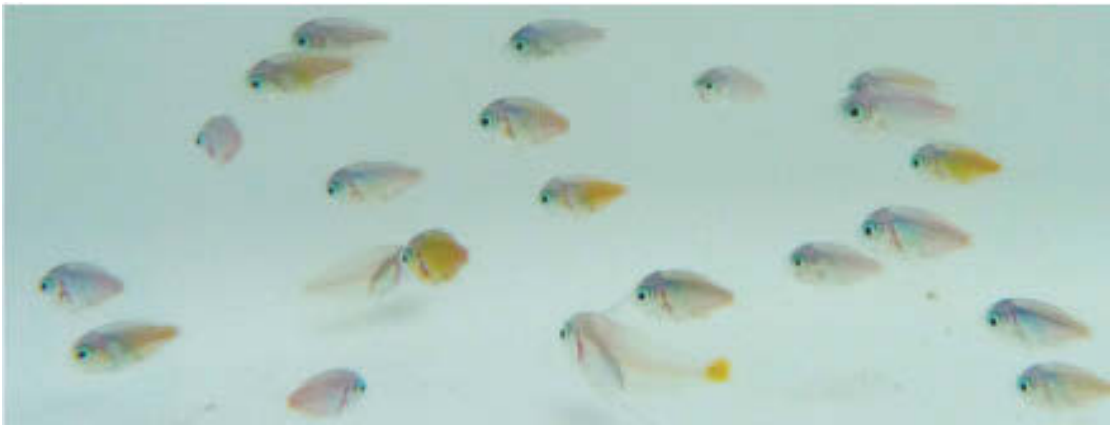
A long way home: orientation behaviour of fishes during the pelagic larval phase



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Abstract

Determining the processes influencing how marine organisms disperse during the larval stage is a major challenge of marine ecology, yet is a task critical to understanding the scale and connectivity of marine populations. Sampling such tiny organisms in the expansive pelagic environment presents complex problems, making the pre-settlement stage a "black box" in our knowledge of the life history of marine organisms. In this thesis I aimed to address some of the main themes characterising this black box, namely when during the larval stage sensory responses to habitat cues develop, which sensory cues may be used for orientation in the pelagic environment and how the condition of the local environment affects settlement behaviour. The results of these experiments increase our understanding of behaviour and sensory abilities of larval fishes and provide new insights for predictive models of larval dispersal, integral tools for effective management of marine populations.

The ontogenetic development of olfactory responses in larvae of two fish species, which recruit to temperate estuaries, shows that chemotactic behaviour relevant to movement towards habitat develops shortly after tail flexion (Chapter 2). This point in ontogenetic growth when choice behaviour between estuarine and coastal water develops which is consistent over multiple cohorts, and correlates with existing data on ontogenetic increases in swimming endurance. The presence of seagrass cues was more important than changes in pH or salinity to this behaviour. This is the first evidence of a consistent size-based ontogeny of sensory response to natural water bodies across cohorts of temperate fish larvae.

In order to orient swimming when in the pelagic zone it is hypothesised that large-scale cue use, namely a celestial compass and/or a magnetic compass, would be required. Behavioural experiments to test the ability of coral reef fish larvae to use the sun's azimuth as a compass to orient swimming found significant differences in the mean orientation direction of larvae as individuals and among-individuals when exposed to different sun azimuths (Chapter 3). Cue-conflict experiments indicate that polarised light patterns also have an effect on orientation behaviour. This experimental data compliments field orientation data of other studies indicating the use of a sun compass as part of an orientation mechanism in larval fishes.

Orientation trials using magnets and a Helmholtz magnetic coil also indicate that coral reef fish larvae have the ability to detect changes in the local magnetic field, i.e. magnetoreception (Chapter 4). Individual larva responded predictably between control and treatment conditions, with a significant angular difference in mean bearings similar to the size of the shift in local magnetic field polarity within the magnetic coil. Larval orientation behaviour was affected differently by the presence of magnets of different strength and, as in Chapter 3, the presence of a polarised light pattern. This is first time magnetoreception has been shown in fish during the larval stage.

Choice experiments on coral reef fish larvae showed habitat cues with increased sediment concentrations changed behavioural response to habitat cues in both before and after settlement (Chapter 5). Pre-settlement stage larvae avoided olfactory cues of water infused with sediment at different concentrations. Settled larvae exposed to sediment at different concentrations for a period of five days changed their preference

in comparison to larvae kept in “clean” water, choosing olfactory cues from dead coral over live coral. These results indicate that larvae may actively attempt to avoid settlement on degraded habitat, while those forced to settle on degraded habitat will have reduced fitness, linking increased sediment pollution to reduced recruitment success in fish larvae.

Certificate of original authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature:

Date: 05/02/16

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