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Growth, Development and Visual Ontogeny of Two Temperate Reef Teleosts *Pagrus auratus*, (Sparidae) and *Forsterygion varium*, (Tripterygiidae).

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Arohanui

Abstract

Growth, development and behaviour were examined in artificially reared larval *Pagrus auratus* and *Forsterygion varium*, from the time of hatching. Yolk-sac larval *P.auratus* hatched at a small size (2.00mm SL), without functional eyes, mouth or digestive tract, and for three days spent long periods at rest. Growth was initially rapid but slowed by 3 days as yolk reserves neared depletion. By days 4-5, the mouth had opened, eyes were functional, yolk was depleted, and a rudimentary gut had formed. Larvae were now able to maintain a horizontal swimming mode and were actively searching for and attacking prey. First feeding was observed in some larvae. Growth was retarded during the transition from endogenous to exogenous nutrition and then increased as feeding proficiency improved. Yolk-sac *F.varium* hatched at a larger size (4.78mm SL), with functional eyes and jaws. Larvae were able to maintain a horizontal swimming mode from hatching. First feeding was observed from the first day after hatching. *F.varium* larvae grew steadily from the time of hatching.

Ocular morphology was examined in larval, juvenile and adult *P.auratus* and *F.varium*. There was a 96 fold increase in eye size, from 0.23mm diameter in a 4 day old larval *P.auratus* (3.4mm SL) to a maximum diameter of 22mm in an adult of 333mm body length. *F.varium* displayed a 26 fold increase in eye size, from 0.28mm diameter in the smallest larva (5.00mm SL) to a maximum eye diameter of 7.2mm in a 110mm long adult. Larval fish had pure cone retinae, however putative rod precursor cells were present from hatching in *F.varium* and from 18 days in *P.auratus.* Juvenile and adult fish had duplex retinae with cones arranged in a square mosaic in which 4 twin cones surround a central single cone. Hypertrophy of cone ellipsoids with increasing eye size, resulted in maintenance of a closely packed array in fishes of all sizes. The appearance of retinomotor movements was coincident with the development of a duplex retina in both species.

Theoretical spatial acuity (calculated as a function of cone spacing and focal length of the lens) was poor in the smallest larval fish (2^{o} 1' and 1^{o} 8' minimum separable angle

in 4 and 1 day old *P.auratus* and *F.varium* respectively) but improved to asymptotic values in adults (3'- 4', and 9' in *P.auratus* and *F.varium* respectively). Behavioural acuity (determined using the optokinetic response) of 4 day old larval *P.auratus* (37^{o} 30') and 1 day old *F.varium* (29^{o}) was very much lower than histological estimates. Behavioural acuity improved to 8^{o} 8' in 16 day old *P.auratus* and 4^{o} 18' in 14 day old *F.varium*, but did not attain theoretical estimates for fish of that size (55' and 54').

A rudimentary retractor lentis muscle was first apparent in larval fish 1 week after hatching, and was coincident with the formation of a posterior lental space. Presumably larval fish eyes were incapable of accomodative lens movements until this time. A relative measure of Matthiessen's ratio (distance from lens centre to boundary of the pigmented retinal epithelium/lens radius) measured histologically, decreased from 4.2 and 2.7 in 3 day old *P.auratus* and newly hatched *F.varium*, to 2.2 and 2.3 in larvae 22 and 16 days of age respectively. This suggests that growth of the retina and lens were not symmetrical in the eyes of very small larval fish. If Matthiessen's ratio holds for little eyes, then they will initially be strongly myopic. This may account in part for the mismatch between behavioural and theoretical acuity.

Perceptive distances of first feeding larval *P.auratus* and *F.varium*, estimated for prey items equal in dimensions to maximum jaw widths, were very small (0.2mm and 0.4mm for prey 0.15mm and 0.2mm in size respectively), but increased with increasing body size to 2.1mm and 4.0mm for prey 0.3mm in size, at 16 and 14 days of age respectively. These data have implications for larval feeding in the wild.

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