

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

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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 ($2^{\circ} 1'$ and $1^{\circ} 8'$ 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° 30') and 1 day old *F.varium* (29°) was very much lower than histological estimates. Behavioural acuity improved to 8° 8' in 16 day old *P.auratus* and 4° 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 accommodative 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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Table of Contents

Abstract	ii
Acknowledgements	iv
Table of Contents	v
List of Figures	viii
List of Tables	x
General Introduction	1
Chapter One: Growth, Development and Behaviour of Larval <i>Pagrus auratus</i> and <i>Forsterygion varium</i>.	4
Introduction	4
1.1 Materials and Methods	8
1.1.1 Brood stock husbandry and egg production	8
Snapper	8
Triplefins	9
1.1.2 Larval rearing techniques	9
Rotifer culture	9
Larval culture	10
1.1.3 Larval growth and morphology	10
1.2 Results	11
1.2.1 Snapper	11
Morphological development and behaviour	11
Growth	12
1.2.2 Triplefins	13
Morphological development and behaviour	13
Growth	14
1.3 Discussion	14
1.3.1 Growth	14
1.3.2 Morphological development and behaviour	16
Chapter Two: Retinal Growth and Morphology.	19
Introduction	19
2.1 Materials and Methods	26
2.1.1 Fish capture and husbandry	26

2.1.2 Histology	26
2.1.3 Electron microscopy	27
2.1.4 Morphometry and cell counts	27
2.1.5 Theoretical scotopic sensitivity	28
2.1.6 Theoretical visual acuity	28
2.2 Results	29
2.2.1 Snapper	29
Retinal morphology	29
Morphometry and cell counts	30
Acuity and sensitivity	31
2.2.2 Triplefins	31
Retinal morphology	31
Morphometry and cell counts	32
Acuity and sensitivity	33
2.3 Discussion	33
2.3.1 Retinal morphology	33
2.3.2 Acuity	37
2.3.3 Sensitivity	39
Chapter Three: Visual Function of Larval Fishes	41
Introduction	41
3.1 Materials and methods	48
3.1.1 Histology	48
Accommodative mechanism	48
Matthiessen's ratio	48
Maximum jaw width	48
3.1.2 Behavioural acuity	49
3.1.3 Reactive distance	51
3.1.4 Larval feeding	52
3.2 Results	53
3.2.1 Snapper	53
Accommodative mechanism	53
Matthiessen's ratio	53
Jaw width	53
Behavioural acuity	54
Reactive distance	54
Incidence of feeding	54

3.2.2 Triplefins	54
Accommodative mechanism	54
Matthiessen's ratio	55
Jaw width	55
Behavioural acuity	55
Reactive distance	55
3.3 Discussion	56
References	63
Appendices	75

List of Figures

Chapter One

- Fig. 1-1 Flow Diagram of the Rotifer Culture System.
- Fig. 1-2 Photograph of Algal-Rotifer Cultures.
- Fig. 1-3 Photomicrograph of *P. auratus* Eggs.
- Fig. 1-4 Diagram of Behaviour in Early Larval Stages of *P. auratus*.
- Fig. 1-5 Photomicrographs of Larval *P. auratus* at Hatching, and at 1 and 2 Days of Age.
- Fig. 1-6 Photomicrographs of 3 and 4 Day Old Larval *P. auratus*.
- Fig. 1-7 Photomicrographs of a Fed and Starved Larval *P. auratus*, Seven Days After Hatching.
- Fig. 1-8 Photomicrographs of 14 and 24 Day Old *P. auratus*.
- Fig. 1-9 Growth Curve for *P. auratus* Rearing Trial 1.
- Fig. 1-10 Growth Curve for *P. auratus* Rearing Trial 2.
- Fig. 1-11 Growth Curve for *P. auratus* Rearing Trial 3.
- Fig. 1-12 Growth Curve for *P. auratus* Rearing Trial 4.
- Fig. 1-13 Photomicrographs of Larval *F. varium* Eggs.
- Fig. 1-14 Photomicrographs of Larval *F. varium* at Hatching and 6 days of Age.
- Fig. 1-15 Growth Curve for *F. varium* Rearing Trials 1-3.

Chapter Two

- Fig. 2-1 Schematic Diagram of the Photoreceptors in the Teleost Retina.
- Fig. 2-2 Transverse Sections of *P. auratus* Eyes at Hatching, 2 and 4 Days after Hatching.
- Fig. 2-3 Electron-Micrographs of a *P. auratus* Retina 2 and 3 Days after Hatching.
- Fig. 2-4 Electron-Micrographs of a *P. auratus* Retina 4 Days after Hatching.
- Fig. 2-5 Photomicrographs of Presumptive Rods in the Retina of 18 day old *P. auratus*.
- Fig. 2-6 Photomicrographs of the Adult *P. auratus* Retina.
- Fig. 2-7 Changes in Retinal Cell Densities and Eye Size in *P. auratus*.

- Fig. 2-8 Angular Density of Cones and Rods in *P. auratus*.
- Fig. 2-9 Theoretical Acuity of *P. auratus*.
- Fig. 2-10 Transverse Section of the Eye of a Newly Hatched *F. varium*.
- Fig. 2-11 Photomicrographs of Larval and Juvenile *F. varium* Retinae.
- Fig. 2-12 Photomicrographs of the Adult *F. varium* Retina.
- Fig. 2-13 Changes in Retinal Cell Densities and Eye size in *F. varium*.
- Fig. 2-14 Angular density of Cone and Rods in *F. varium*.
- Fig. 2-15 Theoretical Acuity of *F. varium*.

Chapter Three

- Fig. 3-1 Diagram of the Developing Cranium and Jaw Bones of Red Sea Bream.
- Fig. 3-2 The Optomotor Apparatus.
- Fig. 3-3 Photomicrographs of the Lens Retractor Muscle in *P. auratus*.
- Fig. 3-4 Changes in the Relative Focal Length in Larval *P. auratus*.
- Fig. 3-5 Camera Lucida Drawing of the Cranium and Jaws of 7 and 22 day old *P. auratus*.
- Fig. 3-6 Changes in Jaw Width of Larval *P. auratus*.
- Fig. 3-7 Changes in Behavioural and Theoretical Acuity in *P. auratus*.
- Fig. 3-8 Photomicrographs of the Lens Retractor Muscle in *F. varium*.
- Fig. 3-9 Changes in the Relative Focal Length in Larval *F. varium*.
- Fig. 3-10 Camera Lucida Drawing of the Cranium and Jaws of a 10 day old *F. varium*.
- Fig. 3-11 Changes in Jaw Width of Larval *F. varium*.
- Fig. 3-12 Changes in Behavioural and Theoretical Acuity in *F. varium*.

List of Tables

Chapter One

- 1-1 Rearing Conditions, Larval *P. auratus* Trials 1 to 4.
- 1-2 Rearing Conditions, Larval *F. varium* Trials 1 to 3.
- 1-3 Numbers of *P. auratus* Sampled from Rearing Trials.
- 1-4 Numbers of *F. varium* Sampled from Rearing Trials.
- 1-5 Daily Growth Rates and Linear Regression Coefficients during the Phase of Exogenous Feeding in Larval *P. auratus*.
- 1-6 Growth Rates of Cultured and Wild Teleost Fish Larvae.

Chapter Two

- 2-1 Mean Cone Cell Ellipsoid Diameters in *P. auratus*.
- 2-2 Convergence Ratios, Rod Density and Photoreceptor Length in *P. auratus*.
- 2-3 Mean Cone Cell Ellipsoid Diameters in *F. varium*.
- 2-4 Convergence Ratios, Rod Density and Photoreceptor Length in *F. varium*.

Chapter Three

- 3-1 Values for Matthiessen's Ratio For Various Teleosts.
- 3-2 Rearing Conditions of *P. auratus* used in Optokinetic Experiments.
- 3-3 Optokinetic Stimulus Stripe Widths.
- 3-4 Reactive Distances for Larval *P. auratus*.
- 3-5 Incidence of Feeding in Larval *P. auratus*.
- 3-6 Reactive Distances for Larval *F. varium*.