The Development, Ultrastructure and Biomechanics of the Swimbladder of the New Zealand Snapper, *Pagrus auratus.*

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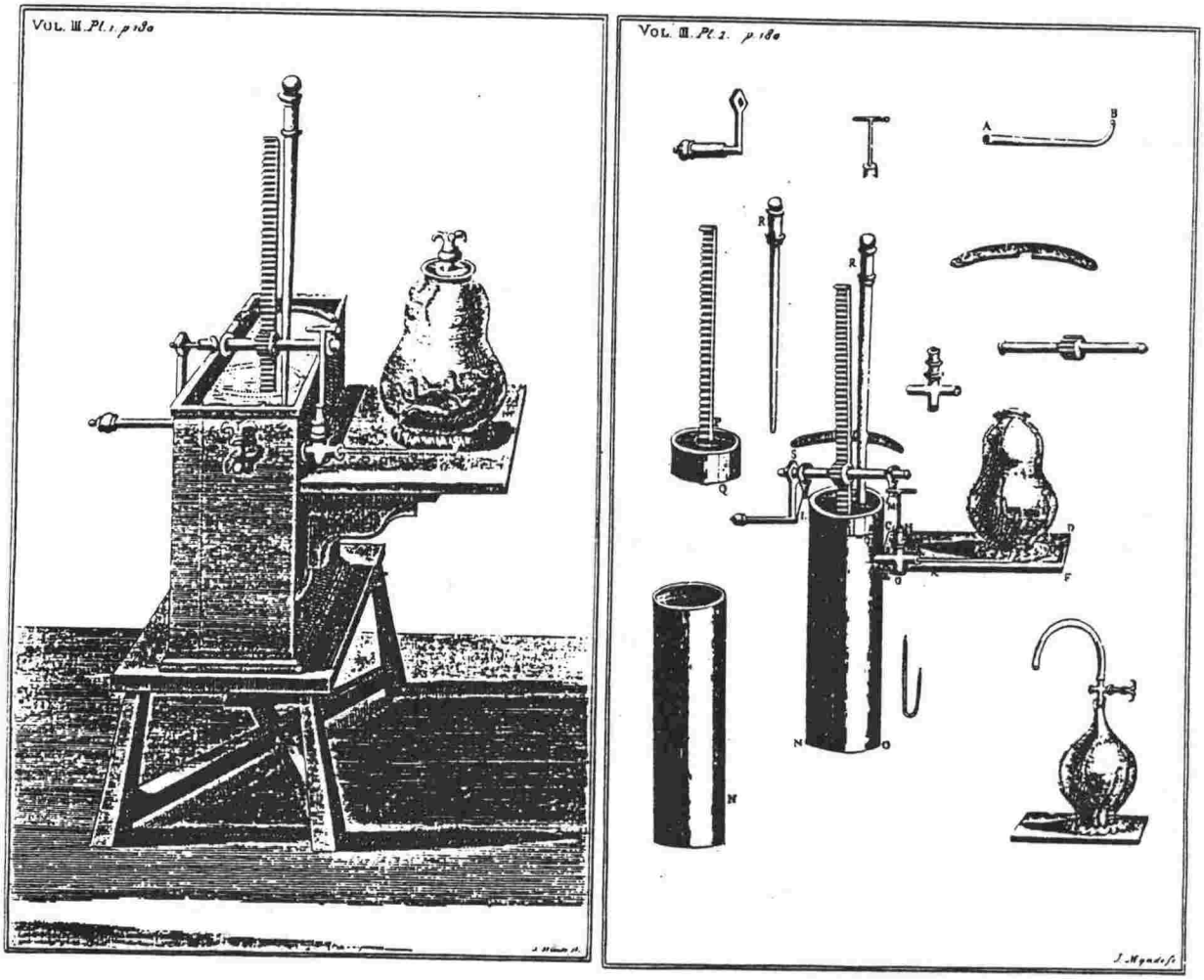
A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy.
February 1990.

'When it was propounded to the Honourable Robert Boyle, he, reflecting upon the manner how a Fish comes to rise or sink in water, soon bethought himself of an Experiment probably to determine, Whether a Fish makes those motions by constricting or expanding himself? The Experiment by him suggested was; To take a Bolthead with a wide neck, and having fill'd it almost full with water, to put into it some live fish of a convenient size, that is, the biggest that can be got in, as a Roch, Perch, or the like; and then to draw out the neck of the Bolthead as slender as you can; and to fill that also almost with water: Whereupon the fish lying at a certain depth in the water of the Glass, if upon his sinking you perceive the water at the slender top does subside, you may inferr, he contracts himself, and if, upon his rising, the water be also raised, you may conclude, he dilates himself.'

A.I. (1675)



Robert Boyle's Pneumatical Engine

Abstract

The eggs and larvae of the New Zealand snapper *Pagrus auratus* are pelagic with early buoyancy provided by dilute body fluids. The swimbladder begins to develop on the third day after hatch from a dorsal evagination of the gut tube. Communication with the gut is lost on about the tenth day following pneumatic inflation at around day eight. At this age the gas gland system appears fully functional and capable of secreting gas. By the age of settlement at around 30 days the swimbladder is a fully functional replica of the adult form except for the lack of a resorbent capillary system which does not develop until later in juvenile life.

The swimbladder of the adult is of the euphysoclist form with a dorsally located resorbent oval area and sits high in the pleural cavity. The ventral tunica externa is firmly attached to the connective tissue lining the pleural space. The adult swimbladder displaces 5.6% of the volume of the body and its volume is regulated to provide near neutral buoyancy. The connective tissue integument provides almost no restriction to volume changes brought about by vertical movements of the fish and the swimbladder obeys Boyle's Law for physiological pressure changes. The ability of the connective tissue of the tunica externa to accomodate large tissue strains is due to massive regular crimping of otherwise straight collagen fibrils allowing reversible extensions up to 130%. In all other respects however the tissue structure of the tunica externa is consistent with a tissue providing an active mechanical role. The fibrillar morphology and physicochemical properties of swimbladder collagen is consistent with the vertebrate type I form however there are interesting variations in collagen form distributed throughout the swimbladder. Fibrillar morphology of the highly extensible tunica interna is significantly different to that of the tunica externa and appears to play very little mechanical role. The extensibilty of the tunica externa appears to be regulated by physiological stress and related to the past history of tissue strain.

Acknowledgements

I would firstly like to thank the encouragement and support of my supervisor Associate Professor John C. Montgomery in this prolonged and divaricating series of investigative avenues. I am also indebted to the support and friendship of Associate Professor Rufus Wells in providing continued academic encouragement. I am especially grateful to Rufus for the opportunity to visit the Ice-hole Marine Laboratory. Professor P. R. Bergquist has also provided valuable assistance especially in terms of financial support.

The following members of the technical staff have rendered invaluable and expert assistance:

Heiko Weix for friendship and electronic confusion.

Brent Beaumont for first class instruction in electron-microscopy and for an enthusiastic introduction to the world of the collagen fibril and the jig rod.

To John White and Raewyn Eagar for unrestricted access to their labs. and the materials therein and for photographic assistance.

To Bronwyn Trevenen and Mein Low for unrestricted access to their labs. and materials and especially to Bronwyn for expert and patient assistance with electrophoresis.

To Tom Wustenberg at Leigh and Trevor Belsten at Auckland for bravely providing unrestricted access to their beloved workshops and tools.

Special thanks to the following:

Dr Neil Broom at the Biological Engineering Laboratory has provided invaluable help with tissue testing and provided apparatus and materials. Ken Grange at the New Zealand Oceanographic Institute has provided expert radiographic assistance and facilities.

Tish Pankhurst for a valuable critical appraisal of parts of the manuscript and Malcolm Francis for information from the Hauraki Gulf Snapper Tagging Program.

Many thanks to Carol Parrish for providing an environment condusive to economic survival.

I would also like to pay special mention to the enthusiatic assistance provided by Heiko Weix, Brent Beaumont and Andrew Collins in the capture of specimens for this study and their ungrudging help in the disposal of experimental waste.

I shall be eternally grateful for the support and patience of Kate Willis during the final stages of this study and above all for providing that most essential ingredient necessary for successful completion of such endevours - motivation.

And finally I must acknowledge the continued and unquestioning support of my parents (both moral and financial) throughout the academic endevours of the past decade.

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