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Induced Spawning and Culture of  
Yellowfin Bream, *Acanthopagrus australis* (Günther, 1859)  
and  
Mangrove Jack, *Lutjanus argentimaculatus* (Forsskål, 1775)

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September 1995

for the degree of Doctor of Philosophy  
in the Department of Zoology  
James Cook University of North Queensland



**FRONTISPIECE:** **Top:** A 6 kg male mangrove jack broodfish used in spawning induction trials.

**Bottom:** A pair of yellowfin bream broodfish (male upper, 240 g; female 310 g) used in spawning induction trials.

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September 1995

## **Declaration**

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

Ken Cowden

September 1995

## **Ethics Statement**

This research was conducted within the guidelines of the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes. Ethical clearance was granted by the James Cook University Experimentation Ethics Review Committee, approval number A167.

## **Acknowledgements**

Foremost, I must gratefully acknowledge the help and guidance of my supervisor, Norm Milward, whose support in times of need assisted in taking this project to completion. I wish to thank David Hallam, Stuart Fielder, and Tony Salisbury of Sea Harvest Ltd. (now Bluewater Barramundi), Mourilyan, for their invaluable assistance in the early stages of this project, and also Ian Patch, Michael Mallett, David Borgelt and other staff of Bluewater Barramundi, Mourilyan, who were always enthusiastic and uncompromising in their help toward obtaining mangrove jack spawnings. Similarly I wish to thank Dennis Hart and Andres Perez of Hart Fisheries, Townsville, for their considerable help with the bream growout component, and for the use of cage space. Thanks must also go to Rod Garrett of the D.P.I. Northern Fisheries Research Centre, Cairns, for much helpful discussion relating to the spawning of mangrove jack.

I would like to acknowledge the Townsville Port Authority for granting me permission to fish in areas of the harbour closed to the public, and the Townsville Bureau of Meteorology for supplying annual photoperiod data for Townsville.

At James Cook University I would like to thank Paul Southgate for many helpful suggestions relating to the nutritional component of this project; Garry Russ for his aid with finding published information on my species; Dong Lou for assisting in the preparation of samples for biochemical analysis; Zoli Florian for assistance with the taking and preparation of photographs; Don Booth, David Welch and Steve Edgar for their willingness to help with technical aspects of the project; Natalie Moltschaniwskyj and Janet Estacion for statistical advice, and fellow students Adrian Collins and Peter Appleford for help with the biochemical analysis of samples.

I am indebted to a large group of friends who gave up countless long cold nights to help with the procurement of bream broodstock, and whose angling skills were of great value. In particular Michael Keegan, Anne Lee and Ruth Malo are acknowledged in this regard.

Finally, I must thank my parents, Betty and Ken, and my sister, Christianne, for their inestimable support throughout the duration of this project, and my girlfriend, Selina, for her encouragement and extraordinary patience.

Funding for the project was provided internally by the Zoology Department, and, in its second year, by a University Merit Research Grant. I was supported during my candidature by an Australian Postgraduate Research Award, for which I am most grateful and appreciative.

## Abstract

This study aimed to investigate the biological characteristics of the yellowfin bream, *Acanthopagrus australis*, and mangrove jack, *Lutjanus argentimaculatus*, relevant to their consideration for aquaculture. All stages of the production cycle were considered, except growout of mangrove jack owing to poor larval rearing success. The study was conducted on fish populations from the Townsville region of far north Queensland.

The yellowfin bream spawning season was found to extend for a period of at least 10 weeks, from mid June to early September. Data confirmed this species to be protandrous, maturing as males in the first year and changing to females at approximately 21-27 cm total length. Females are serial spawners with an 'asynchronous' ovary. The synthetic hormone LHRHa (des-gly<sup>10</sup>, D-al<sup>6</sup>, pro<sup>9</sup>-ethylamide) was capable of reliably inducing spawnings in mature females when administered in aqueous or pelletised form, whereas the hormonal preparation 'Ovaprim' was less effective. A minimum aqueous dose of 15-20 µg/kg LHRHa was necessary to reliably induce spawning, and at a dose of 40 µg/kg in an 85% cholesterol/15% cellulose pellet, multiple spawnings on consecutive nights were possible.

Yellowfin bream spawned in the late evening, after a latent period of approximately 45 h at 22°C. Single spawnings of over 100,000 eggs were observed from females of approximately 500 g, and a seasonal fecundity of at least 1.6 million eggs/kg female body weight was estimated. Eggs were spherical, transparent, pelagic and positively buoyant, and were apparently of good quality, generally showing high fertilisation and hatching rates. Mean egg and oil globule diameters were  $786.8 \pm 19.7$  µm, and  $186.2 \pm 7.4$  µm, respectively.



The incubation period ranged from 22.5-44.2 h over the temperature range 19.4-27.7°C. Mean larval total length and yolk volume at hatch were 2.03 mm and 0.116 mm<sup>3</sup>, respectively. Total length at first feeding was 3.15 mm, and mouth width at this stage would indicate an optimum food width of 90-100 µm. The temperature and salinity optima for eggs and yolk sac larvae, at which survival, growth and yolk utilisation efficiency were maximal, and the occurrence of deformities minimal, was 22.6-23.9°C and 35 ppt salinity. Light levels in the range of 0-2000 lux did not affect yolk utilisation efficiency.

Best larval rearing results, in terms of growth, survival and swimbladder inflation rate, were obtained using the 'greenwater' technique with rotifers, *Brachionus plicatilis*, followed by brine shrimp, *Artemia* sp., as the feeding protocol. Approximately 75% survival to metamorphosis, and 77% swimbladder inflation, were recorded using this method. Swimbladder inflation occurred between days 3-4, and the final inflation rate was unaffected by light levels in the range of 0-2000 lux. Larvae underwent metamorphosis between days 24-30, at which time their mean total length was 6.51 ± 0.8 mm. Weaning onto dry artificial food proceeded without difficulty. Juveniles showed some aggression in the form of 'tail-nipping' for a short period following metamorphosis.

Amino acid analyses for larval whole-body protein and rotifers, along with fatty acid analysis of fertilised eggs and rotifers, indicated that rotifers provided adequate essential amino acid nutrition, but were very low in HUFAs, particularly in DHA. The low HUFA content of bream eggs and high survival observed on HUFA-deficient rotifers are suggestive of the ability of this species to meet its HUFA requirements through bioconversion of shorter-chain fatty acids. This demands further investigation.

Juvenile yellowfin bream adapted well to netcage conditions, accepted artificial pellet food and showed high disease resistance. Survival through the first six months in netcages was estimated at over 85%, and for the following 18 months was 81%. Growth on pellet food formulated for barramundi (51.5% protein) was not rapid, with fish reaching 15 cm (85 g) in 12 months, and 22 cm (252 g) (approaching marketable size) in 25 months from hatch. Growth slowed considerably in winter months due to decreasing water temperatures and the onset of sexual maturity. There is, however, considerable scope for improvement in growth rate, and this is discussed. The food conversion ratio, gross growth efficiency and protein efficiency ratio were 1.72:1, 0.58, and 1.13:1 respectively.

The mangrove jack spawning season, as assessed from captive broodfish, extended for at least 6 months from mid-October to early April. Mature fish are dioecious, reaching sexual maturity at approximately 2.0-2.5 kg. Female mangrove jack are serial spawners with a 'group synchronous' ovary. The synthetic hormone LHRHa was capable of reliably inducing spawning of females with mean oocyte size over the threshold of approximately 400  $\mu\text{m}$ , while the hormonal preparation 'Ovaprim' had far less efficacy. A priming and resolving aqueous dose of 25  $\mu\text{g}/\text{kg}$  LHRHa, given 24 h apart, proved most satisfactory. Furthermore, at dosages of 50  $\mu\text{g}/\text{kg}$ , LHRHa significantly increased male milt production within 12 h of injection. Manual strip-spawning was necessary following difficulties experienced in obtaining synchronised spontaneous male and female spawnings. While administration of LHRHa as a pellet in a cholesterol/cellulose matrix was capable of inducing final egg maturation and ovulation, difficulty in estimating strip-spawn timing favoured aqueous administration of hormone.

Fertilisation rates from strip-spawnings varied from 3.8-92.8%, with mean 51.0%. The latent period between injection and ovulation, at 29-30°C, was near 36 h 20 min. A very brief window of fertilisation, of approximately 10 min, ensued, during which fertilisation was maximal, illustrating the critical nature of strip-spawn timing if high fertilisation was to be achieved. Individual spawnings varied from 8,400-2.26 million eggs with a mean of approximately 0.5 million, and total seasonal fecundity of over 1.7 million eggs/kg was estimated. Eggs were spherical, transparent, pelagic and positively buoyant. Mean egg and oil globule diameters were  $823.9 \pm 22.7 \mu\text{m}$ , and  $158.0 \pm 3.9 \mu\text{m}$ , respectively.

Incubation time at 29.0°C was 18 h 10 min, and mean total lengths at hatch and at first-feeding were 2.12 mm and 3.17 mm, respectively. Yolk absorption was complete at approximately 36 h post-hatch, and the oil globule was fully utilised at approximately 70 h. At 42 h post-hatch, larvae had pigmented eyes, an open mouth and anus, and were apparently first capable of feeding. Mouth width at this stage would suggest an optimum initial food width of approximately 75  $\mu\text{m}$ . Mangrove jack larvae exhibited a very brief window of initial feeding opportunity, rapidly succumbing to starvation. Maximum yolk utilisation efficiency and survival of yolk sac larvae occurred at 22 ppt salinity and 30.5-34.0°C.

Swimbladder inflation was observed between days 2-4, and rates of over 70% were achieved under 'clearwater' conditions. Six larval rearing trials were conducted, differing in their use of clearwater and greenwater techniques, and first food items offered. Screened rotifers, oyster trochophores, and screened wild zooplankton were all tested. A similar pattern of mortality was observed in all trials, whereby over 95% of larvae died between days 3-6, corresponding with the transition to exogenous nutrition, and after which complete mortality was observed by day 12.

Possible reasons for this mortality pattern are discussed, and it is concluded that while the primary cause of mortality appears to be starvation and a failure to accept exogenous food, this may be a secondary consequence of sub-optimal egg quality, physical rearing conditions, and/or the use of inappropriate initial food items. Based on similar experiences by other groups researching mangrove jack aquaculture, this species would appear innately difficult to rear due to the small endogenous energy reserves and consequent brief window of initial feeding opportunity.

Based on the biological findings and existing economic relativities, the potential of the yellowfin bream and mangrove jack for commercial aquaculture is considered.

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