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Age, Growth, Reproduction and Population Biology of *Plectropomus spp* (Epinephelinae: Serranidae) on the Great Barrier Reef, Australia.

by

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Abstract

Size at age information provides an important basis for estimates of rates of growth, mortality and recruitment of fishes. Such estimates form the basis of fisheries stock assessment models necessary to estimate yields and monitor the responses of the populations to fishing pressure. The inshore coral trout *Plectropomus maculatus* and the common coral trout *P. leopardus* represent important commercial and recreational fishery resources on the Great Barrier Reef. The objectives of this thesis were to provide the information on age, growth and reproduction necessary to assess the effects of fishing on populations of *Plectropomus*.

In Chapter II, the age and growth of the inshore coral trout *P. maculatus* from the Central Great Barrier Reef region was determined by studies of annuli in whole and sectioned sagittae. The age and growth of the common coral trout *Plectropomus leopardus* from the Lizard Island area, Northern Great Barrier Reef is presented in Chapter IV. An alternating pattern of opaque (annulus) and translucent zones was clear in whole and sectioned otoliths of both species. A comparison of whole and sectioned otoliths of *P. leopardus* indicated that whole readings tended to underestimate age of older fish. The periodicity of formation of the annulus was validated through tetracycline labelling of mark-recaptured fishes in the wild and of captive fishes in aquaria. Results showed that for both species one annulus is formed per year during the winter and spring months. The von Bertalanffy growth curve for *P. maculatus* was $SL = 53.0 (1 - e^{-0.258 (t+1.0)})$, $r^2 = 0.766$. The oldest specimen examined was a 12 year old male of 58 cm SL. For *P. leopardus*, the von Bertalanffy model for

length (FL) was $L_t = 52.2 (1 - e^{-0.354 (t + 0.766)})$, $r^2 = 0.895$.. The oldest individual examined was 14 years of age. Line-fishing usually does not capture fishes smaller than 25 cm FL; thus, excluding most 0+ and 1+ year old fish and probably the slower growing 2+ year old fish. These first three years of life represent the period of fastest growth. Consequently, if the growth curve is fitted only to the line fishing data, the growth rate of the population is underestimated. Multiple regression was used to predict age of *P. leopardus* from otolith weight, fish length and fish weight. Otolith weight was the best predictor of age in the linear model and explained as much variation in age as did fish size in the von Bertalanffy growth curve.

In Chapters III and V, the reproductive biology of the inshore coral trout *P. maculatus* and the common coral trout *P. leopardus* respectively, were studied based on histological analyses of gonad material. Samples of *P. maculatus* were collected from inshore waters of the Central Great Barrier Reef. Samples of *P. leopardus* were collected from mid shelf reefs in the Central Great Barrier Reef, and mid shelf reefs and waters adjacent to Lizard Island in the Northern Great Barrier Reef. The mode of sexual development of both species was monandric protogynous hermaphroditism For the two species, a spawning period was observed from September through November, during which multiple spawning occurred. Sex change followed the usual protogynous mode with degeneration of ovarian germinal tissue accompanied by proliferation of male germinal tissue in the gonad. The sex/size and sex/age relationships indicated that sex-change can occur over a broad range of sizes and ages, but females were significantly smaller and younger than males. The stages of oocyte development for *P. maculatus* and *P. leopardus* are described in Appendix I.

In 1987 a zoning plan was established in the central section of the Great Barrier Reef Marine Park, Australia. Under this plan, fishing was excluded from some areas. Samples of *P. leopardus* were collected using line fishing at two reefs (Glow and Yankee) located in areas closed to fishing and in two reefs (Grub and Hopkinson) located in areas open to fishing. The four reefs were sampled in 1990 and 1991 two times per year, during June/July and September/October. The samples were compared to investigate the effects of this 3-4 year closure on the size, age and sex structure of coral trout populations (Chapter VI). There were no significant differences in mean size and age between protected reefs and unprotected reefs. However, the mean sizes and ages varied significantly between reefs. This result was due largely to variability between replicates, as the two open reefs were apparently not subject to the same fishing pressure.

In the two closed reefs, the population structure was dominated by the presence of a strong year class which settled in early 1984, indicating the occurrence of strong interannual fluctuations in recruitment. A similar pattern was not observed on the open reefs, with a corresponding mode not present at Grub reef and weak at Hopkinson reef. As Glow and Yankee reefs have been closed to fishing since 1987, and age of recruitment to the fishery is approximately 3 years, the individuals that settled onto Glow and Yankee in 1984 have been protected most of their lives. If the four reefs received a similar pulse of recruitment in 1984, fishing mortality has operated to largely decrease the abundance of this year class in the open reefs.

Sex-change occurred over a wide range of sizes and ages on the four reefs. The comparison of frequency of developmental stages between reefs showed significant variation. The mean size and age observed for each sexual stage seemed to reflect closely the size and age structure of each population. When immature males were pooled with mature males for the sex-ratio calculations, the resulting sex-ratio was not significantly different among reefs. It appears that while the distribution of developmental stages in the populations was different, the same final female: male balance was being achieved. This type of result suggests that for the coral trout, sex-change results from a combination of a developmental process, in which individuals are more susceptible to sex-change as they grow larger and older, and a social process through behaviourally induced stimuli.

Differences in age structure were more obvious than differences in the size structure between closed and open reefs, suggesting that age structure may be far more useful than size structure for comparisons of fishing effects on long lived fishes such as epinepheline serranids. Comparisons of open and closed reefs based solely on mean sizes may fail to detect important differences.

This thesis has demonstrated the existence of annuli in the hard parts of tropical fish. Such age determinations can be carried out relatively cheaply and easily. The advent of routine age-determination may eventually see a trend toward age-based population dynamic studies of tropical reef fish.

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