

Comparisons between the biological characteristics of
three co-occurring and reef-dwelling labrid species at two
different latitudes

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Submitted by
Elaine Lek Woon Hsia

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B.Sc. (Hons)
Murdoch University, Western Australia

I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary education institution.

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Elaine Lek Woon Hsia

ABSTRACT

The first aim of this PhD thesis was to obtain sound quantitative biological data for three abundant and co-occurring reef-dwelling labrid species, *i.e.* the Western King Wrasse *Coris auricularis*, the Brown-spotted Wrasse *Notolabrus parilus* and the Southern Maori Wrasse *Ophthalmolepis lineolatus*, in the Jurien Bay Marine Park (JBMP) and in the waters off Perth, 250 km to the south. These data were acquired to undertake the following. 1. Determine whether the maximum body size and age and the instantaneous growth rate of each of these species are consistent with the Metabolic Theory of Ecology (MTE). 2. Test the hypothesis that each species is a protogynous hermaphrodite and that the size and age at maturity and sex change of each species have a similar relationship to its maximum size and age. 3. Test the hypothesis that the food resources in temperate Western Australia are partitioned among each of the three species at both of the above locations and that the species compositions of the prey of each labrid species differs between locations as a result of the differences that are likely to be present in the relative abundances of prey at these two different latitudes. The specific aims associated with the different aspects of the biology and, where appropriate, hypotheses concerning those aspects, are given in the respective chapters.

The implications of the Metabolic Theory of Ecology (MTE) that certain variables for a species follow predictable trends with latitude, *i.e.* with temperature, was explored using data for three reef-dwelling species of labrid. The maximum length, mass and age of *C. auricularis*, *N. parilus* and *O. lineolatus*, when expressed as the average of the top 10 % of the values for those variables, were significantly greater (P generally < 0.001) in the waters off Perth at *c.* 32°S than in those of the Jurien Bay Marine Park at *c.* 30°S. While these latitudinal trends conform to the predictions of the MTE, the instantaneous growth rates of each species during the earlier part of life were similar at both latitudes. The greater rate of growth of each species throughout the

remaining and majority of life at the higher latitude suggests either that less energy is required for basal metabolism and/or physical activity in the cooler environment, or that these species are enzymatically better adapted to the lower temperature. In terms of interspecific comparisons, the rank order of maximum length, mass and growth (in terms of both length and mass at age) of these species is the same at both latitudes, but the precise order does vary slightly among these variables. This indicates that the three species respond to the differences between the temperature and other environmental variables at the two latitudes in a similar relative manner. The growth of *O. lineolatus* was least in both latitudes, irrespective of whether size was expressed in terms of length or mass. The growth of *C. auricularis* was greater, however, than *N. parilus* when using length, but either less or the same when employing mass, reflecting a greater body mass at length of the latter species. This difference is relevant as it would appear more appropriate to use mass as the indicator variable when considering predictions based on metabolic rate as this is related to temperature in ectotherms. Growth curves fitted to both the lengths and masses at age for the males of each species lay above and largely parallel to those for their females at all ages, indicating that sex change is size dependent. The rate of instantaneous growth at a given mass for each species, which began to diverge as mass increased, was consistently greater for the cooler than warmer environment (latitude), a trend that does not conform to the predictions of the MTE.

Examination of the histological characteristics of the gonads of a wide size and age range of *C. auricularis*, *N. parilus* and *O. lineolatus* from both the JBMP and waters off Perth, combined with the pattern of distribution of the lengths and ages of each sex, demonstrated that each of these three labrid species are protogynous hermaphrodites. The presence of two and young small *C. auricularis* with gonads consisting of both immature ovarian and testicular components suggests that this species, at least, may exhibit an early juvenile bisexual stage. All individuals of *C. auricularis*, *N. parilus* and

O. lineolatus with lengths less than 186, 162 and 223 mm, respectively, and ages less than 3.1, 3.0 and 4.7 years, respectively, were females, whereas the largest and oldest individuals of each species were males. The lengths and ages of the other bisexual individuals of *C. auricularis* and those of *N. parilus* and *O. lineolatus* all fell within the respective length and age ranges at which both females and males of those species were found. The oocytes of these bisexuals were all at the previtellogenic stage, whereas the testicular component always contained spermatocytes and sometimes advanced spermatids. These characteristics suggest that these individuals are changing from female to male.

While the spawning periods of each of *C. auricularis*, *N. parilus* and *O. lineolatus* in the two locations were similar, they differed markedly among those three species. This would reduce the potential for competition for food and space resources by the larvae and juveniles of these species. In the case of each species, a greater amount of energy was invested in gonadal development in the waters off Perth than in the JBMP, thereby paralleling the greater investment of energy in somatic growth in those waters. Thus, in the context of gonadal and somatic growth, each species is apparently better adapted to exploiting the environmental conditions found in the cooler temperatures at the higher latitude, *i.e.* waters off Perth, than to the warmer temperatures found at the lower latitude. *Coris auricularis* and *O. lineolatus* matured at a smaller length and younger age in the cooler waters off Perth than in the warmer environment of the JBMP, which is the converse of the pattern typically exhibited by ectothermic species. While *N. parilus* also matured at a younger age in the waters off Perth than in the JBMP, the difference was small and, in contrast to the other two species, maturation occurred at a greater length in the cooler environment.

This study confirmed that the dietary compositions of *C. auricularis*, *N. parilus* and *O. lineolatus* differed significantly with latitude (*i.e.* between JBMP at *c.* 30°S and

c. 32°S off Perth), changed with increasing body size and almost invariably differed among those species in the more offshore reefs in each location in which they co-occurred. Latitudinal differences in the dietary compositions of each species in exposed reefs typically reflected greater contributions by large crustaceans, bivalve molluscs, echinoids and annelids to the diets in the waters off Perth than in the JBMP, whereas the reverse was true for gastropods and small crustaceans. The diet of each species exhibited similar, but not identical, quantitative changes with increasing body size, with the contributions of small crustaceans declining and those of large crustaceans and echinoids increasing, while that of gastropods underwent little change. Within the JBMP, the dietary compositions of both *C. auricularis* and *N. parilus* were similar in exposed and sheltered reefs and the same was true for *N. parilus* in the sheltered reefs and interspersed areas of seagrass. The latter similarity demonstrated that, in both of those divergent habitat types, *N. parilus* feeds on prey associated with either the sand or the macrophytes that cover and lie between the reefs. Although the main dietary components of each species were the same, *i.e.* gastropods, small crustaceans (mainly amphipods and isopods), large crustaceans (particularly penaeids and brachyuran crabs) and echinoids, their contributions varied among those species, which accounts for the significant interspecific differences in diet. *Coris auricularis* had the most distinct diet, due mainly to ingesting greater volumes of small crustaceans, *e.g.* amphipods and isopods, and lesser volumes of large crustaceans, *e.g.* brachyuran crabs, which was associated with a relatively narrower mouth and smaller teeth and the absence of prominent canines at the rear of the jaw. The above intra and interspecific differences in dietary composition would reduce, on the south-west coast of Australia, the potential for competition for food among and within these three abundant labrids, each of which belongs to different genera within the Julidine clade.

Publication resulting from this study

Chapter 5 of this thesis has been peer reviewed and published:

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