The Ecological Significance of Body Size in Tropical Wrasses (Pisces : Labridae)

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Abstract

Among terrestrial organisms, body size exhibits predictable relationships with many characteristics including growth rate, mortality rate, longevity, reproductive traits, abundance, species richness and habitat use. However, the majority of studies identifying such relationships have looked at a limited range of terrestrial taxa, in particular mammals, birds and beetles. These patterns have received much less attention among marine organisms and consequently their generality is questionable. Factors influencing growth of organisms in terrestrial and marine environments may be fundamentally different. This variation could result in considerable differences in growth processes among marine and terrestrial organisms and influence constraints on body size among species in these environments. The principal aim of this study was to identify whether numerous body size-related patterns observed in terrestrial taxa were repeated in a group of coral reef fishes, and assess reasons for differences when predicted relationships were not detected.

This study employed a multispecific comparative approach to examine life history and ecological correlates of body size in coral reef fishes of the wrasse family (Pisces: Labridae), a group in which species range in length from 4cm to over 2m. To account for the influence of evolutionary history of species on the patterns observed, a working hypothesis for a wrasse phylogeny was derived for the sampled species. This phylogeny was integrated into the analyses for Chapters 2 and 3 of this thesis.

The study comprised four main data chapters examining relationships between body size and a range of life history traits and other ecological characteristics. In Chapter 2, the relationships between maximum body size of species and growth rate, mortality rate and longevity were examined among ten species of wrasses which encompassed a ten-fold size range. Based on current theory it was predicted that there should be a positive relationship between maximum size of species and maximum age and a corresponding negative relationship between maximum species size and mortality rate. Both of these relationships were detected for the wrasses studied here. Conceptual models indicating ways in which differences among body sizes of fish species can arise were developed and tested. It was found that in some species larger size was simply attained by growing at the same rate as smaller species but for a longer period of time. In other species faster growth enabled the attainment of larger body size but at the cost

of shortened life-span. There was limited evidence that by growing faster individuals became larger and less susceptible to predation sooner, resulting in larger body sizes and longer life spans. A further idea was that smaller species are smaller because they have determinate growth and stop growing sooner than larger species. Wrasse species studied here exhibited the range from indeterminate to determinate growth but there was no apparent relationship between maximum body size of species and growth strategy.

In Chapter 3 covariation between maximum size of species and reproductive characteristics was explored. It was predicted that smaller species should mature and change sex at a smaller proportion of maximum size and proportionally earlier in life than larger species. They were also expected to have greater reproductive effort than larger species. Despite this, none of these relationships between maximum species size and reproductive traits were evident. Relationships between maximum size and size at maturity and sex change were in fact opposite to those expected as smaller species matured and changed sex at a greater proportion of maximum size than larger species. Similarly, short-lived species matured and changed sex proportionally later in life than long-lived species. In general, body size appeared more important than age in determining when maturation and sex change occurred both among and within species. Energy invested per reproductive episode was not significantly related to species body size.

In Chapter 4, covariation among body size, growth rate, longevity, reproductive effort and size/age at maturity and size/age at sex change was examined in the wrasse *Halichoeres melanurus*. Individuals were sampled at four locations along a latitudinal cline. Consistent with patterns identified to date it was predicted that with an increase in latitude there should be a decrease in growth rate, and an increase in body size and longevity. Initial growth rate was slightly slower at the two higher latitude locations and the maximum body size and maximum age of individuals within populations did tend to increase with an increase in latitude. It was also considered that an increase in latitude should be associated with an increase in the proportion of adult size and age attained before maturation and sex change, and an increase in reproductive effort. However, there was no consistent relationship between the latitude at which individuals were sampled and the proportion of maximum size/age attained at maturity or sex change. In addition reproductive effort of individuals did not vary predictably as latitude increased. Individuals collected at the Palm Islands matured relatively earlier, exhibited greater

reproductive effort and changed sex proportionally earlier in life than those collected at Kimbe Bay, Lizard Island and Heron Island.

In Chapter 5, relationships between body size and ecological characteristics including local abundance, species richness, habitat use and depth range, were investigated among all wrasse species present at a range of locations. Based on patterns identified within both marine and terrestrial taxa it was predicted that the smallest species would not be the most abundant with abundances peaking in species of small to intermediate size. Very large species were expected to have low abundances. This relationship was expressed for the wrasse species examined here. In addition, the body size-species richness distribution of wrasses at a number of locations was log normal, with many species of small to intermediate size and low numbers of very small or very large species. Smaller reef fish species were expected to be associated with a smaller range of microhabitats than larger species, be more habitat specific and have smaller depth ranges than larger species. The small wrasse species examined here were found to use a small, intermediate or large diversity of available microhabitats, whereas the larger species consistently used a wide diversity of microhabitats. Depth ranges of small species lay on a continuum from very small to very large, whereas larger species consistently had large depth ranges.

Variation between some of the patterns observed in this study and those described in previous studies, demonstrates the need to replicate similar studies in a wide range of organisms inhabiting a wide range of habitats before their generality can be assessed. Repeating similar studies among species within a large range of reef fish families is crucial to determine the utility of species body size as a predictor of life history characteristics and other ecological variables in reef fishes.

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