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JAMES COOK UNIVERSITY AUSTRALIA

THE RELATIONSHIP BETWEEN HABITAT USE AND THE POPULATION ECOLOGY OF CORAL-DWELLING FISHES (GENUS *GOBIODON*)

Thesis submitted by

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in Marine Biology

within the School of Marine Biology and Aquaculture

James Cook University

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ABSTRACT

The role of resource availability and competition in determining the distributions and abundances of species remains one of the most controversial subjects in ecology. In particular, the spatial scales over which these factors influence patterns of distribution and abundance is unclear. In this thesis I examine the effects of habitat selection, habitat availability and competition for space on the distribution and abundance of obligate coral-dwelling gobies (genus *Gobiodon*) at multiple spatial scales. I also examine the link between habitat specialisation and competitive ability, and assess the fitness consequences of inhabiting different species of coral. To achieve this I used a combination of comparative studies and manipulative experiments within and among four geographic locations, extending from the southern Great Barrier Reef to northern Papua New Guinea.

In a broad sense, all species of *Gobiodon* included in this study were found to be habitat specialists. However, some species inhabited only one or two species of coral and exhibited very conservative patterns of habitat use at all spatial scales examined. Other species exhibited a more flexible pattern of habitat use, particularly among geographic locations. Variation in the abundance of most species of *Gobiodon*, within and among locations, was closely associated with variation in the abundance of the corals they usually inhabit. Therefore, habitat availability appears to play a major role in determining the abundances of *Gobiodon* species at both local and regional scales. However, abundances were also correlated with reef zones, reef types and geographic locations, independently to coral availability. Therefore, as spatial scales increase a variety of other factors influence patterns of distribution and abundance of coral-dwelling gobies. A multiscale model of *Gobiodon* distribution and abundance is presented that includes: 1. Geographical differences in abundance, 2. Broad scale habitat selection of reefs within locations, 3. Finer scale habitat selection for reef zones and then individual coral colonies within zones and, 4. Competition for space within reef zones.

In laboratory experiments, species of *Gobiodon* differed in their ability to compete for preferred corals. Body size and prior residency of coral colonies also had

a significant effect on competitive ability. A competitor removal experiment in the field demonstrated that some species of *Gobiodon* compete for space. Following the removal of a dominant competitor (*G. histrio*) from replicate patches of reef at Lizard Island (Great Barrier Reef), the abundances of two species, *G. axillaris* and *G. brochus*, significantly increased in abundance. Moreover, there was a very close relationship between the change in abundance of *G. histrio* and the change in abundance of *G. axillaris* and *G. brochus* combined. *G. axillaris* and *G. histrio* inhabit and compete directly for the same species of corals in the field but exhibit habitat partitioning at larger spatial scales (reef zones and reef types). *G. brochus* is apparently forced to use an inferior species of coral as a result of competition with *G. histrio*. Three other species of *Gobiodon* did not compete for space with *G. histrio*, either because they inhabit different species of coral or are able to co-habit coral colonies with *G. histrio*. The results of the competitor removal experiment were largely predictable from knowledge of overlap in habitat use and an understanding of these species' competitive abilities. Experiments at other geographic locations indicate that the intensity of competition appears to decline in locations where the relative abundance of preferred corals is high.

Transplant experiments demonstrated significant differences in growth and survival of fish inhabiting different species of coral. Furthermore, estimated lifetime reproductive success differed by more than an order of magnitude for fish inhabiting different species of coral. Habitat related differences in fitness might explain habitat preferences of *Gobiodon* species and the intense competition for some species of coral. Differences in habitat structure between species of coral may be the mechanism underlying habitat related differences in fitness. The consequences of inhabiting different species of coral were similar at two locations on the Great Barrier Reef (Lizard Island and One Tree Island) and, therefore, habitat related differences in fitness appear to have general relevance to habitat preferences and competition among species of *Gobiodon*. For at least some species of *Gobiodon*, the degree of habitat specialisation exhibited appears to be linked to their competitive abilities and the fitness consequences of inhabiting different species of corals.

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STATEMENT ON SOURCES

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.

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