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

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Philip L. Munday

13/10/99
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.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement of access</td>
<td>i</td>
</tr>
<tr>
<td>Abstract</td>
<td>ii</td>
</tr>
<tr>
<td>Table of contents</td>
<td>iv</td>
</tr>
<tr>
<td>List of figures</td>
<td>vi</td>
</tr>
<tr>
<td>Statement on sources</td>
<td>ix</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>x</td>
</tr>
<tr>
<td>Chapter 1: General Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Chapter 2: Interactions between habitat use and patterns of abundance in coral-dwelling fishes</td>
<td></td>
</tr>
<tr>
<td>2.1. Abstract</td>
<td>10</td>
</tr>
<tr>
<td>2.2. Introduction</td>
<td>11</td>
</tr>
<tr>
<td>2.3. Methods</td>
<td>13</td>
</tr>
<tr>
<td>2.4. Results</td>
<td>18</td>
</tr>
<tr>
<td>2.5. Discussion</td>
<td>32</td>
</tr>
<tr>
<td>Chapter 3: Habitat use of coral-dwelling fishes at multiple spatial scales</td>
<td></td>
</tr>
<tr>
<td>3.1. Abstract</td>
<td>37</td>
</tr>
<tr>
<td>3.2. Introduction</td>
<td>38</td>
</tr>
<tr>
<td>3.3. Methods</td>
<td>42</td>
</tr>
<tr>
<td>3.4. Results</td>
<td>48</td>
</tr>
<tr>
<td>3.5. Discussion</td>
<td>64</td>
</tr>
<tr>
<td>Chapter 4: Interspecific competition in a guild of coral-dwelling fishes</td>
<td></td>
</tr>
<tr>
<td>4.1. Abstract</td>
<td>69</td>
</tr>
<tr>
<td>4.2. Introduction</td>
<td>70</td>
</tr>
<tr>
<td>4.3. Methods</td>
<td>73</td>
</tr>
<tr>
<td>4.4. Results</td>
<td>78</td>
</tr>
<tr>
<td>4.5. Discussion</td>
<td>93</td>
</tr>
</tbody>
</table>
Chapter 5: Fitness consequences of habitat selection and competition among coral-dwelling fishes

5.1. Abstract ........................................................................... 99
5.2. Introduction .................................................................... 100
5.3. Methods ......................................................................... 102
5.4. Results ............................................................................ 106
5.5. Discussion ..................................................................... 114

Chapter 6: Experimental evaluation of geographic variability in recruitment and growth of coral-dwelling fishes

6.1. Abstract ........................................................................... 117
6.2. Introduction .................................................................... 118
6.3. Methods ......................................................................... 121
6.4. Results ............................................................................ 126
6.5. Discussion ..................................................................... 140

Chapter 7: General Discussion ........................................................................... 144

References: ........................................................................... 149

Appendix 1. Guide to coral-dwelling gobies, genus Gobiodon (Gobiidae), from Papua New Guinea and the Great Barrier Reef

Appendix 2. The ecological implications of small body size among coral-reef fishes

Appendix 3. Comparative efficacy of clove oil and other chemicals in anaesthetization of Pomacentrus amboinensis, a coral reef fish

Appendix 4. Settlement strategies and distribution patterns of coral-reef fishes

Appendix 5. Enhancement of recruitment to coral reefs using light-attractors
LIST OF FIGURES

Fig. 2.1. Map of Kimbe Bay, New Britain, Papua New Guinea showing sites sampled in this study. ................................................................. 27

Fig. 2.2. Total number of coral colonies from each species of Acropora examined for the presence of coral-dwelling gobies in Kimbe Bay. .......... 28

Fig. 2.3. Total number of each species of Gobiodon observed in each species of Acropora in Kimbe Bay .................................................. 29-30

Fig. 2.4. Relationship between habitat specialisation and the total number of each species of Gobiodon recorded in Kimbe Bay. .................. 31

Fig. 3.1. Predicted relationship between habitat abundance and fish abundance at two locations (open vs closed circles) where (a, b) habitat associations influence abundances in a similar manner between locations, (c) abundances between locations are also influenced by processes on large spatial scales and (d) habitat availability influences abundance at only one location. ................................................................. 58

Fig. 3.2. Study sites at (1) Kimbe Bay, PNG, (2) Bootless Bay, PNG, (3) Lizard Island, Great Barrier Reef and, (4) One Tree Island, Great Barrier Reef. ......................................................................................... 59

Fig. 3.3. Total number of colonies of coral species commonly used by Gobiodon at each geographic location. ........................................ 60

Fig. 3.4 Heterogeneity (mean ± SE) of coral assemblage at each exposure and geographic location. ....................................................... 61
Fig 3.5. Number of fish per transect (mean ± SE), for each species of *Gobiodon*, at each geographic location and exposure level. ................................. 62

Fig. 3.6 Number of individuals per transect (mean ± SE), for each species of *Gobiodon*, across reef zones at moderately exposed sites at south GBR, north GBR and north PNG. .................................................................................. 63

Fig 4.1. Design of aquaria used to test habitat preference and competitive ability of *Gobiodon................................................................................................................................. 88

Fig 4.2. Percent of trials in which preferred habitat used by each species of *Gobiodon* in the absence and presence of *G. histrio......................................................... 89

Fig 4.3. Proportion of colonies of *Acropora nasuta* recolonised by *G. histrio*, *G. axillaris* and *G. quinquesstriatus* at Lizard Island......................................................... 90

Fig 4.4. Mean change in abundance (± SE) of each species of *Gobiodon* in removal and control plots following the removal of *G. histrio........................................... 91

Fig 4.5. Relationship between change in abundance of *G. histrio* and combined change in abundance of *G. axillaris* and *G. brochus* in all plots (removals and controls) between the start and end of the competitor removal experiment. .................................................................................................................. 92

Fig. 5.1. Mean standard length ± SD of *G. histrio* and *G. brochus* after 0, 4 and 10 months inhabiting *A. nasuta* and *A. loripes......................................................... 110

Fig. 5.2. Percent survival of *G. histrio* and *G. brochus* after 4 and 10 months inhabiting *A. nasuta* and *A. loripes................................................................. 111

Fig. 5.3. Lifetime reproductive success estimated for individuals of *G. histrio* and *G. brochus* inhabiting *A. nasuta* and *A. loripes......................................................... 112
Fig. 5.4. Lifetime reproductive success estimated for individuals of *G. brochus* inhabiting only *A. loripes* only *A. nasuta* or moving from *A. loripes* to *A. nasuta* after 4 months.

Fig 6.1. Proportion of *A. nasuta* colonies occupied by *G. histrio, G. quinquestrigatus* and other species on sheltered reefs at One Tree Island, Lizard Island, and Kimbe Bay.

Fig 6.2. Proportion of coral colonies previously occupied by *G. histrio* that were recolonised by *G. histrio, G. quinquestrigatus* and other species of *Gobiodon* at Kimbe Bay, Lizard Island and One Tree Island.

Fig 6.3. Proportion of coral colonies previously occupied by *G. quinquestrigatus* that were recolonised by *G. histrio, G. quinquestrigatus* and other species of *Gobiodon* at Kimbe Bay, Lizard Island and One Tree Island.

Fig 6.4. Mean increase in standard length (SL) ± of *G. histrio* and *G. brochus* transplanted to *A. nasuta* and *A. loripes* at Lizard Island and One Tree Island.

Fig 6.5. Mean increase in standard length (SL) ± of *G. histrio* transplanted to *A. nasuta* at Kimbe Bay, Lizard Island and One Tree Island.

Fig 6.6. Mean interbranch space for *A. nasuta* and *A. loripes* at Kimbe Bay, Lizard Island and One Tree Island.
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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