The Role of Habitat Structure in a Freshwater Food Web

By

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A thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy

University of Tasmania

December, 2002.

Declaration

This thesis contains no material which has been accepted for a degree or diploma by the University of Tasmania or any other institution, except by way of background information which is duly acknowledged in the text. To the best of my knowledge, this thesis contains no material previously published or written by another person, except where due acknowledgement is made in the text.

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Abstract

Habitat structure refers to the nature of the physical structure that provides an environment for biotic communities. Much of the research in marine and freshwater systems notes the importance of habitat in community organisation (for example, fish predators are commonly less effective as habitat structure increases), but few studies have specifically described the mechanisms by which it influences trophic interactions and thereby community structure. My research investigated the role of macrophyte structure in trophic interactions and community structure in the macrophyte beds of a lowland river.

One of the problems in assessing the role of habitat structure is the confusion over the definition, and therefore the measurement, of habitat structure, particularly in a way that allows comparison between different habitats and systems. I defined habitat structure as a combination of the qualitative and quantitative components of structure, so where macrophytes provide the habitat, this refers to their shape and density. While macrophyte density is relatively straightforward to quantify, macrophyte shape is more problematic which has lead to a variety of system-specific measures. I tested nine different indices of habitat complexity to determine which would best describe plant shape and best relate to the macroinvertebrate distribution on different macrophytes. I found a high degree of intercorrelation and redundancy between the structural indices such that they could be organised into two suites: one describing the interstitial space and the surface rugosity at coarse scales, the other describing the "whole plant" attributes of surface area and plant volume and the surface rugosity at fine scales. In particular, there were two indices which fell into both suites, an index of refuge space from predation, and the surface rugosity at 5 × magnification. Both these indices were also the most highly related to macroinvertebrate abundance and taxon richness, so I suggest they should be incorporated in the development of a broadly applicable index of macrophyte shape.

As macroinvertebrates responded to the refuge role of macrophytes, I tested if differences in both macrophyte density and macrophyte shape had any effect on the prey-capture success of two predators, the southern pygmy perch and a predatory damselfly. I used two predators to address the impacts of multiple predators; if habitat structure can mediate the outcomes of predator-prey interactions, then it may also

affect the outcomes of predator-predator interactions. I tested predator success in three macrophyte shapes at each of five macrophyte densities in a tank experiment. Surprisingly, there was no effect of plant density, but plant shape was important as fewer prey were captured, by each predator in isolation and by both predators combined, in the most structurally complex plant. This indicated that a more structurally complex plant can negatively affect the prey-capture success of predators, and also that macrophyte shape can mediate the outcomes of predator interactions.

The implications of this laboratory experiment prompted a field experiment to determine if the influence of macrophyte shape on fish predator success translated to field conditions and affected the macroinvertebrate and periphyton communities in macrophyte beds. I conducted a two-factorial, repeated measures, randomised complete block experiment using floating cages in existing macrophyte beds. I tested the factors of macrophyte shape (three types) and the presence or absence of fish predators using the native southern pygmy perch. I ran the experiment for eight months, sampling the macroinvertebrate and periphyton communities at 2, 6, 10, 26 and 30 weeks. Macrophyte shape had strong, consistent effects on both the macroinvertebrate and periphyton communities; both were most abundant on the most structurally complex plant. In contrast, pygmy perch affected only a subset of the macroinvertebrate community and had minor indirect effects on the periphyton composition. Contrary to expectations though, pygmy perch had their strongest effects on vulnerable invertebrate herbivores in the most structurally complex plant.

I concluded that in this system, macrophyte shape has a stronger influence than macrophyte density on trophic interactions, and constitutes a clear regulating influence on the macroinvertebrate and periphyton communities such that it precludes the conditions most likely to reveal strong effects of fish predation.

Acknowledgments

I would like to thank my supervisor Dr. Leon Barmuta for his guidance and advice throughout this project; his support, patience and assistance with drawing out the best features of this research were greatly appreciated.

I would also like to thank various people for encouraging and thought-provoking discussions of this research, namely Dr. Peter Davies, Dr. Simon Wotherspoon, Dr. Thomas Martin, Dr. Barbara Downes, Dr. William Elvey, Reg Majierowski, Jeff Meggs, John Gooderham, Kath Jerie, Paul Reich and the members of the Australian Society of Limnology (Tasmania).

I am indebted to Henry and Simon Foster for granting access to their property, and particularly for their support and tolerance in having my cages in the river for a year and a half.

With regards to the construction of my artificial plants and cages, and the fieldwork they required, many people kindly donated their time and help at various stages for which I am extremely grateful: Ash Warfe, Tom Halcombe, Will Elvey, Adam Uytendaal, Neil Meadows, Stu Meadows (and the rest of the Meadows clan), Mel Kelly, Pippa Dickson, Jody Bruce, Carl Grosser, Rob Musk, Michelle Gabriel, John Hanagan, Paula Sheehan, Lisa Meyer, Richard Holmes and Tom Sloane. I thank Brett Mawbey for generously donating his time for collecting pygmy perch, likewise Simon Talbot and Hugh Pederson for their underwater photography. I'd further like to thank Tom Sloane for his help with sample processing.

I am grateful to the technical staff of the School of Zoology for their assistance with various dilemmas; in particular, Richard Holmes provided invaluable assistance in the workshop.

I'd like to thank various friends and flatmates over the years for their understanding and comic relief – too many to name here but you know who you are.

Finally, but by no means least, I cannot thank my family enough for their unremitting emotional support and encouragement throughout the years I have been doing this. Thank-you.

I'm just sorry you missed this dad.

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