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# **Spatial patterns of invertebrate communities in spring and runoff-fed streams**

**A thesis presented in partial fulfillment of the requirements for the  
degree of Doctor of Philosophy in Ecology At Massey University,  
Palmerston North, New Zealand**

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2004**

## **Abstract**

Invertebrate spatial patterns were investigated in 36 and 12 spring and runoff-fed streams in New Zealand and in Northern Spain, respectively. Moss biomass and resource levels were more abundant in springbrooks than in runoff-fed streams. Invertebrate densities were greater in spring habitats, but invertebrate richness was higher and lower at more stable sites in New Zealand and Spain, respectively. These differences in invertebrate diversity may be related to the larger diversity of invertebrate predators in New Zealand springbrooks, and the lack of temperature mediated life history cues in the New Zealand invertebrate fauna.

I carried out two experiments to look at the effect of local factors on the spatial distribution of invertebrate communities. The first experiment investigated the effect that algal biomass and habitat structure had on stream invertebrate communities. To do this I used artificial canopies to reduce algal growth and artificial substrates with different habitat complexities. Numbers of invertebrate taxa and individuals were both lower on bricks under the artificial canopies and on the simplest substrates. Algal productivity may enhance invertebrate richness by increasing the number of individuals in a given area, whereas habitat complexity may increase invertebrate richness by providing greater food and/or space resources.

The second experiment examined the effects of primary productivity and physical disturbance on stream invertebrates by using artificial canopies and by kicking and raking patches of the stream bed ( $10 \text{ m}^2$ ). We compared the effects of natural versus experimental disturbance on the benthic invertebrate fauna. Invertebrate fauna in high productivity patches recovered quicker than in low productivity patches after both experimental and natural disturbance. The experimental disturbance reduced number of invertebrate taxa and individuals to a greater extent than the spate. Primary productivity limited the recovery of the invertebrate fauna after the disturbances.

I also investigated temperature patterns in five runoff and seven spring-fed streams in the North and South Islands of New Zealand. The invertebrate fauna was sampled at 4 distances (0, 100, 500 and 1 km) from seven spring sources. Temperature variability was much larger for runoff-fed streams than for springs, and it increased with distance from the source. Flow, altitude, and the number and type (i.e., spring or runoff-

fed) of tributaries joining the springbrook channel determined the degree of temperature variability downstream of the spring sources. Moving downstream, invertebrate communities progressively incorporated taxa with higher mobility and those more common to runoff-fed streams. Changes in substrate composition, stability and invertebrate drift are more likely explanations of the observed longitudinal patterns in the invertebrate communities than changes in temperature regimes.

## **Acknowledgements**

Every chapter already contains an acknowledgements section, however I would like to recognize the contribution and assistance of many others who helped me through the different stages of my Ph.D.

Firstly, I am really grateful for all the support, patience, and encouragement that my supervisor Dr Russell Death has demonstrated throughout the entire project. He has helped me from the first sketches of the project, right through to designing the last experiment. We surveyed both the North and South Islands as well as in both Hemispheres. Thanks a lot for the tedious labour of teaching a Spanish-speaking person to write in understandable English. More importantly, thanks Russell for forming me as an ecologist, and introducing me to the matters of science; should I be grateful for this?. This would not have been possible without you. I'm also thankful to Fiona Death, who has also helped in the field and has always been there to listen to me and make me feel as if I were at home. Thanks also Fiona for proof reading some of the chapters and making them look more like English.

I'm really grateful to all the students that have gone through the Ecology department since I started with my research here, especially those people who shared supervisor and thus, troubles with me: Mark Hammer, Ema Zimmerman, Steve Minchin, Sjaan Charteris, Kirsty Francis, Angela Murray and Dawn Lemke. Thanks to all of you for all those lunches, coffees, beers, and dinners.

Thanks also to the student team of the Massey University Centre for Freshwater Ecosystem Management and Modelling for much discussion and chatting in general, especially to Kate MacArthur, Zoe Dewson, Alex James and Emily Atkinson.

Thanks also must go to lecturers Mike Joy and Ian Henderson who were both always very attendant to all my questions regarding any problem I came across.

This thesis would not have been written without the support and assistance of The Ecology Group Staff, thanks a lot to the technicians Carol Nicholson, Tracy Harris, Paul Barrett, Jens Jorgensen, Scott Carver and Cleland Wallace, and to Barbara Just, Erica Reid and Merryn Robson.

I'm very appreciative to the staff working at the Department of Conservation and different Regional Councils who helped us to locate pristine spring sources and provided physicochemical data for some of my study sites.

I would also like to thank my mum Sofia Ortiz and my sisters Ana and Marta Barquín for all the encouragement they have given to me during these four years. Thanks also to my brother Pablo Barquín, who came all the way from Spain to live with me for some months, and to my father Jose María Barquín, who has done a tremendous amount of work during these four years by organizing all the paperwork and establishing the necessary contacts to survey in Northern Spain.

Finally, I would like to thank Mike Winterbourn, who was the first person that I contacted six years ago with the intention of doing a doctoral thesis in New Zealand and who directed me to my supervisor Russell Death.

Thanks also must be given to the Basque Government for financing this study.

## **Note on text and authorship**

This thesis is a combination of five individual papers. This has resulted in some repetition in introductions, methods and site descriptions between chapters. Chapter 2 has been accepted for publication in *Archiv für Hydrobiologie*. Chapters 1 and 5 have been sent to the *Journal of the North American Benthological Society* and to *Freshwater Biology*, respectively, while chapters 3 and 4 have been sent to *Oikos* and to *Oecologia*, respectively. The only co-author is my principal supervisor Russell Death; this recognizes his contribution in developing the original project concept, editing manuscripts, overseeing project administration and discussing ongoing developments. For all chapters my input was the greatest. I planned the research, undertook all fieldwork, analyzed all data, and wrote all manuscripts.

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