Towards an *in situ* technique for investigating the role nutrients play in epilithon growth in an Australian upland stream

by

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Abstract

There is limited knowledge and understanding of the role of nutrients and effect of herbivore grazing on epilithon production in Australian upland rivers. Before investigating these processes, a method was required that will allow the study of factors (physical, chemical and biological) that affect epilithon abundance and distribution in lotic systems. The Thredbo River, Kosciusko National Park, New South Wales, provided an opportunity to conduct this investigation because it: is relatively undisturbed; has been intensely studied; is easily accessed; and is of appropriate width and depth to conduct in-stream experiments.

The specific goals of this research were the: (1) validation of the nutrient-diffusing substrate method for investigating epilithon responses to nutrients; (2) development of experimental channels in which to investigate nutrient/epilithon dynamics in an upland stream; (3) development of a method to inhibit macroinvertebrate grazing from *in situ* experimental channels, so that epilithon responses to nutrients with and without grazing pressure can be studied; and (4) assessment of the ecological implications of nutrient/ epilithon/macroinvertebrate interactions assessed from in-stream experiments.

Major achievements of my research, that advance the study of stream ecology, are as follows:

- The investigation of the features of nutrient release from terracotta nutrient-diffusing substrates showed that phosphorus does not readily diffuse through terracotta clay, probably because terracotta contains known binding agents for phosphorus, such as iron, and because pores are easily blocked. I concluded that this type of substrate is inappropriate for studying nutrient dynamics and epilithon responses to the nutrient(s) limiting growth. The outcomes of this research has implications for future research using nutrient-diffusing substrates, and of how nutrient limitation information is interpreted from past research using terracotta nutrient-diffusing substrates.
- I designed and tested in-stream experimental channels that were functional and provided near natural conditions for studying the interactions between nutrients/ epilithon/macroinvertebrates, without affecting physical variables not tested for.

The *in situ* method developed was successful in simulating 'real world' complexities. Clay paving bricks were used as standardized common surface for community development because their colour, size and surface texture are similar to those of natural stones.

- I developed a technique for successfully inhibiting macroinvertebrate grazing from designated areas, using electricity, without affecting flow and light. This technique will enable in-stream herbivory studies to assess the effects of macroinvertebrate grazing pressure on epilithon under natural conditions, including variability in flow, temperature, light and nutrients. It will allow the vexed question of whether epilithon biomass is controlled by bottom-up or top-down processes to be objectively addressed.

The construction of *in situ* experimental channels that simulate natural conditions, combined with the non-intrusive methods of macroinvertebrate exclusion and nutrient addition, resulted in a study design that will facilitate the investigation of biotic responses to nutrients in Australian upland streams. Using the method developed, I showed that variable flows in the upper Thredbo River appear high enough to slough epilithon, but not high enough to dislodge macroinvertebrates. This may mean that in systems such as the Thredbo River that experience frequent low level disturbance, the epilithon is unable to reach equilibrium. There is strong top-down control of epilithon in this stream, with nutrients, temperature and light playing a secondary role. I concluded that natural variability may be more important than previously considered and perhaps this, rather than constancy, should be studied.

This thesis adds support to the continuance of multiple factor investigations, and advocates that such studies be conducted under natural conditions so that the results are more relevant to natural systems than from studies conducted in controlled laboratory and outdoor artificial streams. Clearly, the in-stream channels, developed as part of the current research, will allow research that contributes to our understanding of community responses to the physical, chemical and biological processes operating in lotic environments.

Table of Contents

List of Tables

List of Figures

Chapter 6 In-stream channel experiments to investigate epilithon responses to nutrients and macroinvertebrate grazing