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Phytoplankton Dynamics of Riverine Water Holes in the Dry Tropics of North Queensland, Australia

Thesis submitted by
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in September 2008

for the degree of Doctor of Philosophy
in Zoology and Tropical Ecology
within the School of Marine and Tropical Biology
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Abstract

Microalgae are key components of aquatic food webs and biodiversity, yet dynamics of algal assemblages in tropical systems are largely unknown. This study investigated algal assemblages and physico-chemical properties of remnant riverine water holes in the Burdekin River catchment, which is located in the seasonal Australian tropics. A seasonal survey was conducted of three sites in three rivers, followed by a more detailed study on one site at each river. Principle component analyses revealed significant differences in physico-chemical parameters between rivers and seasons. Non-metric multi-dimensional scaling demonstrated compositional differences in phytoplankton assemblages between seasons and rivers, and showed that conductivity and temperature were major physico-chemical correlates contributing to the observed differences. Since sites differed substantially in turbidity, it was expected that turbidity would be important in determining phytoplankton assemblages. Mulitvariate statistics confirmed that turbidity had a significant effect on phytoplankton assemblages. Although phytoplankton assemblages differed between season and river, the differences were not systematic. At a fine-scale within a single water hole, season had a large influence on phytoplankton assemblages at each site. Season, in the dry tropics, encompasses not only a change in temperature, but also levels of irradiance and flow regimes. Phytoplankton assemblages are largely governed by a rather obvious suite of physical and chemical variables, especially relating to seasonal change in, flow and temperature, and such factors as turbidity, pH and nutrient concentrations, which relate to lithology, soils and land use. A majority of the study sites showed dominance of Chlorophyta, followed by Cyanobacteria and diatoms. Overall, 138 phytoplankton species were identified; of these Chlorophyta were most species rich and Cyanobacteria were most abundant.

Major drivers of the phytoplankton assemblages identified from the field analyses – temperature and conductivity – were tested under a controlled environment on three monoclonal species of *Scenedesmus – S. quadricauda, S. dimorphus,* and *S. ellipticus* – cultured from field collections,. The conductivity experiments established significant differences in growth rates between the species. The temperature experiments revealed significant differences in growth rates between the species, although this was mainly due to the large growth rate changes of *S. ellipticus* at extreme temperatures (below 16° C and above 30°C). The laboratory experiments were designed to validate the identified drivers of phytoplankton community composition in the field. However, growth responses of *Scenedesmus* spp. to either temperature or conductivity changes alone under laboratory conditions did not show the same strong correlations as seen in the field, but in combination with main effect ANOVAs of field data the main drivers identified by multivariate statistics were confirmed.

The results provide an improved understanding of phytoplankton dynamics in seasonal tropical rivers. They are patchy systems, driven by both predictable (seasonal) change and stochastic events (flood, drought). Water holes develop their own characteristic assemblages, according to local factors, but those within rivers are more similar than those between rivers, as a result of underlying differences in catchment characteristic. The influences of water quality and other variables therefore operate at catchment scales for part of the annual cycle, but at a local scale for the majority of it. The tolerance of phytoplankton species to environmental parameters, especially those that can be linked to river health, needs further investigation. Currently, the use of algal assemblages for regular or routine assessment of tropical river health is not practical because of their patchy and variable distribution.

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This thesis is dedicated to and in memory of my mother
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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.

Carrie K. Preite	May 2009
	Date