



**Growth of *Anabaena circinalis* in
the Lower Murray River, South Australia**

by

Karen Jillian Westwood

Department of Environmental Biology
University of Adelaide

Cooperative Research Centre for
Water Quality and Treatment

A thesis submitted to the University of Adelaide for the
Degree of Doctor of Philosophy

January 2003

Summary

An increase in the incidence and severity of *Anabaena circinalis* blooms in the Murray-Darling Basin has reduced water quality over recent decades. The aim of this thesis was to examine the growth of *A. circinalis* and discern the factors that are primarily responsible for control. The project concentrated on the highly regulated lower Murray River that provides a vital water supply to urban and country areas in the state of South Australia. From current knowledge of *A. circinalis* and the attributes of the lower Murray River, it was hypothesised that phosphorus storage, nitrogen-fixation and buoyancy regulation are important for dominance.

The response of *A. circinalis* to nutrient availability in the river was examined using *in situ* diffusion chambers. Phosphorus and nitrogen additions had no influence on growth, although the heterocyst/vegetative cell ratio increased suggesting nitrogen-fixation. Laboratory bioassays on water taken from the lower Murray River suggested that the wider phytoplankton community was nitrogen limited. In contrast to previous years, a significant volume of water was diverted from the turbid Darling River into the lower Murray River and caused phosphorus concentrations to be elevated. As high inputs from the Darling River were sustained over the course of the project, the importance of phosphorus storage for dominance of *A. circinalis* was unable to be determined.

The lower Murray River is a turbid system and thermal structure may have a strong influence on light availability. Growth of *A. circinalis* was compared under persistent stratification, diurnal stratification and complete mixing to determine whether artificial destratification would be effective. The mixing patterns were simulated using *in situ* diffusion chambers that were adjusted to different positions in the water column throughout the day. A strong relationship between growth and average daily light dose was established and a model developed to examine how changes in vertical light attenuation (K_d), maximum mixed depth (Z_m), incubation time and cell flotation velocity may influence the outcome. Growth of *A. circinalis* was fastest under persistently stratified conditions with the possibility of bloom development within one week, assuming no loss factors. However, growth of neutrally buoyant populations under diurnally stratified conditions was slower than mixed populations as the majority of the population was trapped in darkness during the stratified period. Blooms of *A. circinalis* may only occur under diurnally stratified conditions in the lower Murray River if the flotation velocity of colonies is $> 0.5 \text{ m h}^{-1}$. The time for bloom development under these conditions is dependent on Z_m , but K_d had little influence.

Reasons for the decline of *A. circinalis* and dominance of the diatom *Aulacoseira granulata* under high flow conditions in the lower Murray River were also investigated. Unexpectedly, *in situ* growth of *A. circinalis* was faster than *A. granulata* at all Z_{eu}/Z_m ratios. Furthermore, growth of *A. circinalis* was not altered when grown in the same diffusion chambers as *A. granulata* suggesting lack of competition. However, the river was nitrogen limited during experimentation and *A. granulata* is unable to fix nitrogen. Under nitrogen replete conditions in the laboratory, photosynthesis of *A. granulata* was slower than *A. circinalis* under light saturation, but faster at sub-saturating irradiance ($< 93.3 \mu\text{mol m}^{-2} \text{s}^{-1}$ or $4.0 \text{mol m}^{-2} \text{day}^{-1}$). Regardless, no definite conclusions regarding the transition from *A. circinalis* to *A. granulata* could be made as nitrogen is rarely abundant in the lower Murray River. Interestingly, growth of *A. granulata* was stimulated when grown with *A. circinalis* in diffusion chambers. It is possible that *A. circinalis* contributes an important source of nitrogen to the lower Murray River through fixation of atmospheric sources.