Reprinted from
J. Aquat. Plant Manage. 27: 49-51

Nitrogen and Phosphorus Uptake and Release by the Blue-Green Alga *Microcoleus lyngbyaceus*

CARL F. ZIMMERMANN[1]

INTRODUCTION

The blue-green filamentous alga *Microcoleus lyngbyaceus* (Kutzing) Crouan is an important component of the drift algae community in the Indian River lagoon, Florida (Benz, et al., 1979; Hall and Eiseman, 1981) and large scale natural blooms of this species have been reported (Humm, 1956; Phillips, 1963). A complete description of this alga's bloom sequence is presented by Blair and Meyer (1986). During bloom conditions, floating windrows of the alga, along with uprooted seagrasses produce rafts of considerable biomass. When these mats begin to decompose, local and dramatic increases in surface water ammonium and phosphate concentrations can occur (Zimmermann and Montgomery, 1984).

The purpose of this study was to characterize the ability of *M. lyngbyaceus* to remove nutrients from ambient and enriched waters, and also to follow the release of nutrients under dark conditions in an attempt to understand the impact of nutrient loading on this alga in the Indian River area.

MATERIALS AND METHODS

Samples of *M. lyngbyaceus* were collected in June 1985 from seagrass blades and the sediment surface in shallow (~ 1 m) water in the Indian River lagoon. After collection, the algae were maintained for 48 hours under ambient temperature and light conditions in a continuous flow-through water system containing unfiltered Indian River water (IRW). Aliquots of algae (2.5g wet weight) were placed in 350 ml glass jars containing 150 ml of unfiltered IRW; control jars (minus algae) contained only 150 ml of the unfiltered IRW. The algae and controls were then incubated at 25-26C under continuous fluorescent lighting (200, $\mu E \cdot m^{-2} \cdot s^{-1}$). Replicate jars containing the algae and one control were harvested at zero time and then at 2, 4, 8, 16 and 24 hours after zero time. A combined ammonium/phosphate enrichment series were also harvested in the same maner at the aforementioned times. To determine nutrient release rates, this same experiment using ambient and enriched water was performed simultaneously in the dark.

After harvesting the jars, a 50-ml water sample from each jar was filtered through a 25-mm GF/C filter and immediately frozen for later nutrient analyses. The remaining sample was filtered through a 47-mm GF/C filter and subsequently dried at 65C to determine the dry weight of the algae. Ammonium (NH_4), dissolved reactive phosphate (DRP) and nitrite + nitrate ($NO_2 + NO_3$) were determined on the filtrate using an AutoAnalyzer II system with modified Technicon procedures (Zimermann, et al., 1977).

Uptake and release rates of nutrients (R) were calculated using the formula:

$$R = \frac{(C(I) - C(X))\,(V)}{D\,(t)}$$

where: C(I) = initial concentration (μM)
C(X) = final concentration (μM)
t = time (h)
V = volume (l)
D = dry weight of algae in (g)
R = μmol g dry weight^{-1} h^{-1}

[1]Harbor Branch Oceanographic Institute, Inc., 5600 Old Dixie Hgwy., Ft. Pierce, FL 33450. Present Address: University of Maryland, Chesapeake Biological Laboratory, Box 38, Solomons, MD 20688. Received for publication March 9, 1988 and in revised form July 26, 1988.

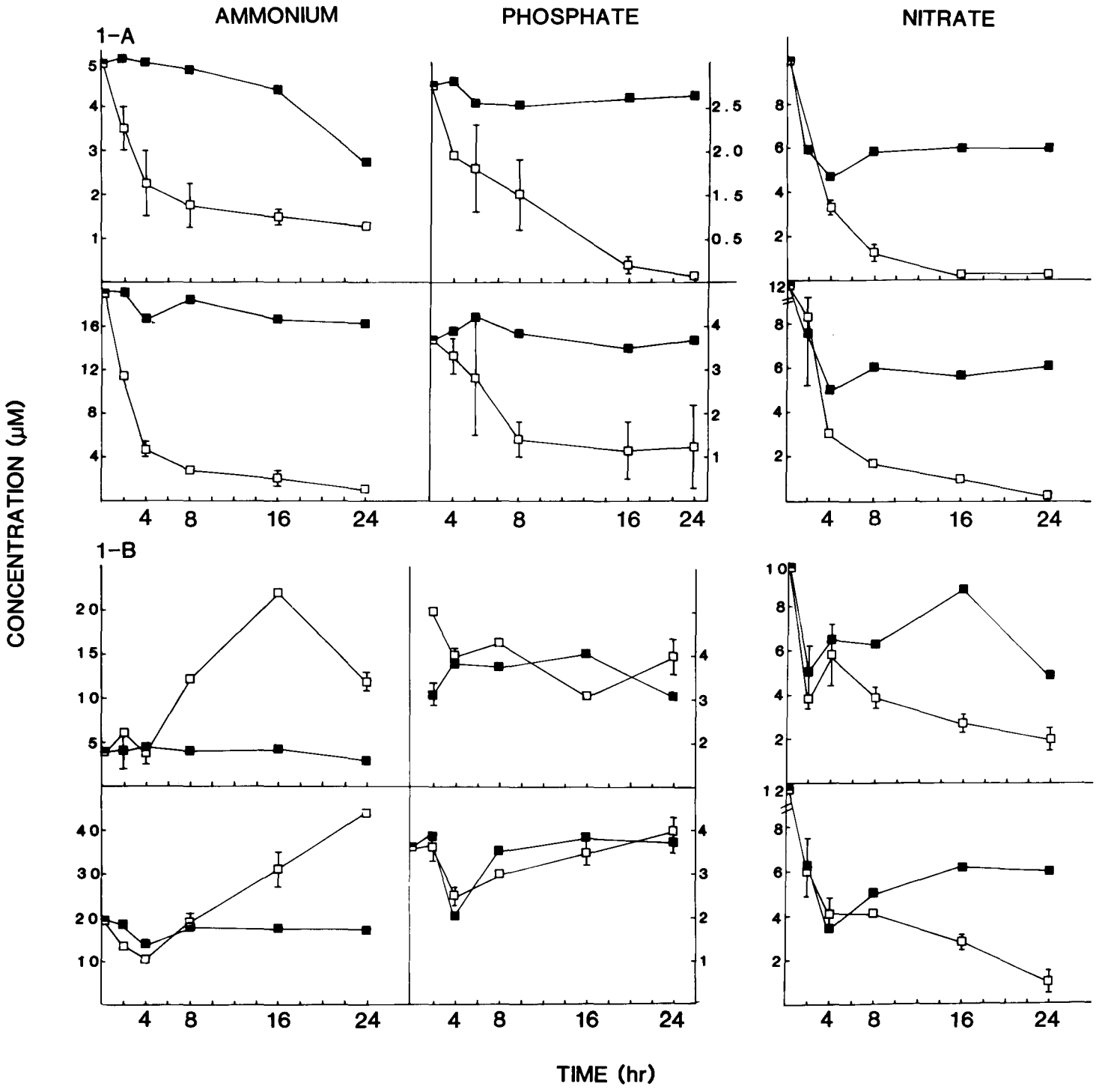

Figure 1-A. Change in incubation vessel nutrient concentrations between control (filled symbols, no algae) and algae (open symbols) during a 24 hour period under continuous light. The second panel is enriched with ammonium and phosphate. Figure 1-B. Change in incubation vessel nutrient concentrations between control (filled symbols, no algae) and algae (open symbols) during a 24 hour period in total darkness. The fourth panel is enriched with ammonium and phosphate. Error bars are 1 standard deviation and where not present, the error was too small to be noted.

The mean dry weight of algae was used in calculating these rates (0.277 g, n = 38, coefficient of variation 19%).

RESULTS AND DISCUSSION

The most rapid uptake of ammonium occurred in the first two hours (Figure 1A), where enriched ammonium uptake rates were more than an order of magnitude higher than those obtained under ambient nutrient concentrations (2.28 vs 0.16 μ Moles g dry weight^{-1}h^{-1}). Rates for the four hour incubation were 0.96 and 0.15 μ Moles g dry weight^{-1}h^{-1} for the ambient and enriched series, respectively. Ammonium concentrations in the control series showed a gradual decline during the first 16 h whereas a

rapid decline was noted in the ambient series for the last 8 hours of the experiment. This is probably due to phytoplankton uptake occurring in the unfiltered IRW.

The same trend was observed for $NO_2 + NO_3$ concentrations in the control series during the first eight hours after which control concentrations remained at approximately 6.0 μM. This rapid decrease in both inorganic nitrogen species was also observed in the series of incubations performed in the dark and it is felt that bacterial denitrification is responsible in both instances. Nitrite + Nitrate concentrations in both algal and control series declined during the first four hours of incubation indicating little, if any, removal of nitrate by the algae.

Phosphate uptake rates were variable. Highest rates occurred in the ambient series during the first two hours of incubation (0.21 μ Moles g dry weight^{-1}h^{-1}) while the enriched series indicated little change in rate over time (0.11 μ Moles g dry weight^{-1}h^{-1} after two hours incubation, 0.07 μ Moles g dry weight^{-1}h^{-1} after four hours and 0.15 μ Moles g dry weight^{-1}h^{-1} after eight hours).

M. lyngbyaceus incubated in the dark showed no uptake of phosphate in ambient or enriched conditions relative to controls (Figure 1B). However, *M. lyngbyaceus* released ammonium in both ambient and enriched treatments. Nitrite + nitrate concentrations in both treatments indicated an initial four hour period where bacterial denitrification occurred in the experimental and control jars after which *M. lyngbyaceus* appeared to be able to take up $NO_2 + NO_3$ in the dark.

Release of ammonium by *M. lyngbyaceus* in the dark began after eight hours of incubation, and was virtually identical for the ambient and enriched treatments: 0.54 vs 0.55 μ Moles g dry weight^{-1}h^{-1}, respectively. After 16 hours, the release rate was 0.32 and 0.42 μ Moles g dry weight^{-1}h^{-1} for the ambient and enriched treatment, and a release rate of 0.28 μ Moles g dry weight^{-1} h^{-1} was determined for the enriched treatment after 24 hours.

The release of ammonium by *M. lyngbyaceus* upon their senescence and decay can have serious effects on water quality in areas such as the Indian River which are already experiencing increased nutrient loading as a result of urbanization. Before we can control the magnitude and distribution of these blooms, the mechanisms which regulate these factors need to be determined.

ACKOWLEDGMENTS

The author would like to thank R. Zechman and S. Blair for collecting and identifying the algae and also to G. Muller-Parker, and C. D'Elia for reviewing earlier drafts of the manuscript. Harbor Branch Oceanographic Institute provided financial support and this is Harbor Branch Oceanographic Institute contribution number 657.

LITERATURE CITED

Benz, M. C., N. J. Eiseman, and E. E. Gallaher. 1979. Seasonal occurrenceand variation in standing crop of a drift algal community in the Indian River, Fla. Bot. Mar. 22:413-420.

Blair, S. M. and M. C. Meyer. 1986. Productivity of *Microcoleus lyngbyaceus Cyanophyceae; Oscillatriaceae*) in various light and temperature conditions. Bot. Mar. 29:279-287.

Hall, M. O. and N. J. Eiseman. 1981. The seagrass epiphytes of the Indian River, Florida. 1. Species list with descriptions and seasonal occurrences. Bot. Mar. 24:139-146.

Humm, H. J. 1956. Annotated check-list of the marine fauna and flora of the St. George's Sound—Apalachee Bay region, Florida Gulf Coast. In: R. W. Menzel (ed.) Contribution of the Oceanographic Institute, Florida State University. 66:1-77.

Phillips, R. C. 1963. Ecology of floating algal communities in Florida. Quart. Jrnl. Fla. Acad. Sci. 26:329-334.

Zimmermann, C. F., M. T. Price, and J. R. Montgomery. 1977. Operations, methods and quality control of Technicon AutoAnalyzer II systems for nutrient determinations in seawater. Report #11. Harbor Branch Foundation, Inc., Ft. Pierce, Fla.

Zimmermann, C. F. and J. R. Montgomery. 1984. Effects of a decomposing drift algal mat on sediment pore water nutrient concentrations in a Florida seagrass bed. Mar. Ecol. Prog. Ser. 19:299-302.