

THE ECOLOGY OF REOCCURRING ASSOCIATIONS BETWEEN EUKARYOTIC  
PHYTOPLANKTON AND THE NITROGEN-FIXING CYANOBACTERIUM,  
*TRICHODESMIUM*

A THESIS SUBMITTED TO  
THE GLOBAL ENVIRONMENTAL SCIENCE  
UNDERGRADUATE DIVISION IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR THE DEGREE OF

BACHELOR OF SCIENCE

IN

GLOBAL ENVIRONMENTAL SCIENCE

MAY 2016

By  
Lisa Hall

Thesis Advisors

Matthew J. Church  
Yoshimi M. Rii

We certify that we have read this thesis and that, in our opinion, it is satisfactory in scope and quality as a thesis for the degree of Bachelor of Science in Global Environmental Science.

## ABSTRACT

Nitrogen is one of the basic elements of life; however, throughout much of the surface waters of the world's oceans, inorganic nitrogen substrates (*e.g.*, ammonium, nitrate or nitrite) are found in very low concentrations. A select group of organisms, diazotrophs, are able to assimilate nitrogen from the nearly inexhaustible pool of atmospheric nitrogen gas (N<sub>2</sub>) by reducing N<sub>2</sub> to biologically available forms. Our research focused on a specific association between the N<sub>2</sub>-fixing cyanobacterium *Trichodesmium* and eukaryotic phytoplankton, specifically various genera of diatoms. Both *Trichodesmium* and diatoms can be important contributors to biogeochemical cycling in the subtropical North Pacific Ocean, including playing key roles in influencing export of various bioelements to the deep sea. Based on initial microscopic observations, we hypothesized that a symbiotic interaction between specific types of diatoms and *Trichodesmium spiralis* play an important role in carbon and nitrogen cycling at Station ALOHA, the field site for the Hawaii Ocean Time-series program, located approximately 100 km north of the island of O'ahu, Hawai'i. Microscopic examination of upper ocean (0-175 m) seawater samples collected at near-monthly time scales over 8 months revealed that *T. spiralis* was most abundant in the well-lit upper 75 m, but that the prevalence of diatoms with *T. spiralis* did not demonstrate depth- or time-dependent patterns. Amplification and sequencing of diatom *rbcL* genes, the gene encoding the large subunit of the RuBisCo enzyme, from handpicked *T. spiralis* colonies revealed three major phylotypes of diatoms: two phylotypes clustered within diatoms belonging to the genus *Cylindrotheca* and one phylotype was phylogenetically closely related to diatoms belonging to the genus *Rhopalodia*. In addition, confocal and scanning electron microscopy were used to visualize the physical association between *T. spiralis* and the diatoms. Collectively, our results provide the first description of a

reoccurring association between two important groups of phytoplankton, with significant implications for the cycling of nutrient and carbon in the subtropical North Pacific Ocean.