Notice of the Final Oral Examination
for the Degree of Master of Science

of

JENNIFER LONG

BSc (University of British Columbia, 2010)

“Shining a Light on Silica Production in the Oceans: Using a Fluorescent Tracer to Measure Silica Deposition in Marine Diatoms”

Department of Biology

Thursday, July 30, 2015
10:00 A.M.
David Strong Building
Room C130

Supervisory Committee:
Dr. Diana Varela, Department of Biology, University of Victoria (Supervisor)
Dr. Kerry Delaney, Department of Biology, UVic (Member)
Dr. Roberta Hamme, Department of Earth and Ocean Sciences UVic (Outside Member)

External Examiner:
Dr. Frank Whitney, Institute of Ocean Sciences, Fisheries and Oceans Canada

Chair of Oral Examination:
Dr. Perry Howard, Department of Biochemistry and Microbiology, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

This thesis presents improvements to a method for measuring the production of biogenic silica (bSiO$_2$) by diatoms, a group of microscopic algae with siliceous cell walls (frustules) that dominate the marine cycling of silicon (Si) and account for a significant proportion of global marine primary productivity. Using the fluorescent dye PDMPO, diatom bSiO$_2$ can be labeled as it is produced and then quantified using fluorometry to determine community-wide bSiO$_2$ production. A distinct advantage of PDMPO over more traditional tracers of bSiO$_2$ production is that combining measurements of PDMPO by fluorometry and by fluorescence microscopy allows for the quantification of cell (and thus taxa) specific bSiO$_2$ production within a mixed community. However, the robustness of PDMPO as a quantitative tracer of diatom bSiO$_2$ production has not been sufficiently investigated. To address this, experiments were conducted both in the lab, and at two field locations where diatoms are known to be abundant, namely the continental shelf off the west coast of Vancouver Island, and Saanich Inlet, a highly productive fjord located on southern Vancouver Island.

Laboratory culture experiments found that concentrations of PDMPO >500 nmol L$^{-1}$ reduced growth rate in the diatom *Thalassiosira pseudonana*, and affected the Si:PDMPO ratio of incorporation. Diatom species was also found to significantly affect the relationship of Si:PDMPO incorporation, though this effect was small (4%) when cells were lysed. From these experiments, a relationship between bSiO$_2$ production and PDMPO incorporation was determined, which predicted more bSiO$_2$ production for PDMPO incorporation than previous studies, and better agreed with bSiO$_2$ production rates determined using the radioactive tracer $^{32}$Si in Saanich Inlet. However, bSiO$_2$ production rates were over-estimated by the PDMPO method when rates were less than 1 μmol L$^{-1}$ d$^{-1}$. In a few cases, this occurred when dinoflagellates were numerically dominant, but, for the majority of samples, dinoflagellates were low in abundance, and over-estimation by PDMPO may be related to the dissolved Si concentration.

When microscopy procedures were optimized through use of a low numerical aperture objective and by calibrating incident light intensity, quantification of PDMPO by microscopy agreed with PDMPO measured by fluorometry. When PDMPO was measured by microscopy in the field, the contribution of diatom taxa to PDMPO fluorescence differed from their contribution to cell numbers. In many cases this was due to large diatom taxa producing more bSiO$_2$ per cell than smaller taxa. However, much of the difference between cell numbers and PDMPO fluorescence was not explained by differences in cell size. This suggests that diatom taxa present had different specific bSiO$_2$ production rates, which could be estimated using PDMPO. This thesis highlights the strength of the PDMPO tracer in understanding of diatom community dynamics and should allow the relationship between diatom community composition, growth and productivity to be better illuminated in the oceans.