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Progress Report for PlanktonTech

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Work carried out in 2010

The aim of current research in the Knoll lab is to understand how and why the use of silica by marine microplanktonic organisms has changed throughout their evolutionary history, in the context of the global silica cycle. The evolutionary innovation of biomineralization tied both radiolarians and diatoms to this biogeochemical system. Thus, the increasing participation of biology in the cycle has not only affected the system itself, but changes in the system have also influenced the evolution of the organisms involved. By documenting changes in the morphology of the siliceous skeletons of diatoms and radiolarians through time, we hope to elucidate the evolutionary strategies and mechanisms favored as silica dwindled as a resource in surface oceans.

In 2010, we continued our efforts to quantify the degree of silicification of diatom frustules through the Cenozoic using FIB-SEM (focused ion beam scanning electron microscopy). We were able to implement an automation procedure using milled registration marks, which allows cross sections of multiple specimens to be cut sequentially while the tool is unattended (for example overnight). However, the milling procedure turned out to be so time-intensive—around 1 frustule per day at best—as to be unfeasible for obtaining statistically meaningful data on silicification in whole diatom assemblages through time.

We also continued to pursue the construction of a morphospace based on categorical descriptors of diatom morphology. We have compiled morphological descriptions for all of the 147 diatom genera recorded in the Neptune database of Cenozoic microfossil occurrences in deep sea sediments, and summarized these as 128 discrete morphological characters. We are in the process of coding the morphologies according to these discrete character states, which will allow us to construct the morphospace. By linking this morphospace to the occurrence data in the Neptune database we will be able to explore how, and under what conditions, this morphospace became occupied through evolutionary time.

We are also in the process of collecting data for a study of Cenozoic radiolarian silicification in six individual evolutionary lineages. We have designed and programmed a software-supported protocol with a user interface for making morphometric measurements and storing these in a relational (SQL) database. This interface will allow us to make large numbers of measurements efficiently, and subsequently calculate evolutionary changes in silicification along lineages. This will provide insight into the evolutionary mechanisms behind observed changes in radiolarians as a group.

Our plan is to complete our studies of diatom morphospace and radiolarian lineage trajectories over the next 14 months, the time table for completion of Ben Kotrc's Ph.D.

dissertation. The diatom research in particular should provide opportunities to collaborate with other planktonTech researchers studying the functional morphology (e.g., crushing strength) of diatom frustules. Future work planned under the auspices of PlanktonTech also includes an attempt to uncover the true diversity history of the diatoms. Recent publications have suggested very different trajectories for diatom diversity (and, by implication, of the silica cycle) based on algorithms used to correct for differences in sampling intensity through time. We hope to clarify this by critically examining the data and the algorithms used to date and bringing a new technique to bear on this question.

There were no publications in 2009 where PlanktonTech was mentioned. There were no PlanktonTech Bachelor or Masters students at Harvard, nor any press coverage.