**Discussion Paper 2: The evolutionary inheritance of elemental stoichiometry in marine phytoplankton**

**Summary:**

This research looks at the different ways that phytoplankton evolved. Fossil records were utilized to look at how two distinct plastid superfamilies developed. The green superfamily dominated Palaeozoic oceans but a shift that is not well understood caused the red superfamily to become dominant. This schism was not seen as profoundly in terrestrial plants.

The research was undertaken to understand what caused this shift and also to look at the evolutionary inheritance of these two groups of pelagic autotrophs. The study utilized elemental composition of the major macronutrients but also extended the analysis to include trace elements. The study design utilized 15 species of eukaryotic phytoplankton which were grown under controlled, experimental conditions. One interesting thing that they did was extend their compositional analysis to include trace elements including Fe, Mn, Zn, Cu, Cd, Co and Mo. Based solely on elemental composition the researchers were able to distinguish between the two superfamilies 85% of the time.

By analyzing complete genome sequences of both of these groups they found that 50 core protein-coding genes were shared amongst groups whereas 14 were only found among red plastids. By examining the elemental composition of chlorophyll-b and chlorophyll-c they were able to test their “plastid” imprint hypothesis. One interesting finding was that trace elements in phytoplankton did not resemble sea water composition but more closely seemed to match the Earth’s crust. The research suggests that changes to the redox state of the ocean played an important role in how these photosynthetic organisms evolved into these two distinct groups.

**Discussion**

The team working on this suggests that future research on the trace elements in the Proterozoic and Phanerozoic eons combined with genetic analysis could help understand details about how these elements inherited this trace element composition of phytoplankton. I think that future research could look at the evolution of other pelagic organisms utilizing computational biology methods. As processing power becomes more powerful it may become easier to utilize genetic material to continue to research like this.

I also was curious about the extent to which radioisotopes are utilized currently in ecological research and their potential usefulness. For instance, the isotope Mo-99 is radioactive with a short half-life of 66 hours. Perhaps irradiating samples of mixed elemental composition and utilizing spectroscopy to look at the output could lead to better understanding of phytoplankton. However, this would probably not be the best element to use as it is generally produced through highly enriched uranium.

**Reference:**

Quigg, A., Finkel, Z., Irwin, A. et al. The evolutionary inheritance of elemental stoichiometry in

marine phytoplankton. Nature 425, 291–294 (2003) doi:10.1038/nature01953