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The biological consequences of a cold, stratified, high latitude, glacial ocean (Milutin Milankovic Medal Lecture)

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The ocean's mesopelagic organisms remineralize most organic export flux and their numbers respond geographically and temporally to variations of that flux. Few members of this community leave a fossil record but of those that do Radiolaria are the most abundant and diverse. The flux of selected deep- and shallow-living radiolarians can be used to measure biological activity in discrete intervals of the oceans water column. Deep-living (>200m) species, characterized by high percentages of *C. davisiana*, dominate late Pleistocene radiolarian flux in northwest Pacific sediments, while shallow-living (<200) species dominate Holocene flux, with the dramatic change in dominance occurring across the Pleistocene-Holocene boundary. These flux changes signal a major reorganization of the radiolarian fauna, probably driven by physical changes within the water column. Radiolarian flux dominated by deep-living species occur today only in the Sea of Okhotsk. This strongly stratified sea has a thin (10-20m) summer mixed layer within which primary productivity depletes major nutrients. Between 20 and about 150m a cold intermediate layer (-1 to 0 degrees C.), has low radiolarian concentrations compared with concentrations in the warmer intermediate water between 200 and 1000m where *C. davisiana* dominates (Nimmergut and Abelmann, 2002). This radiolarian stratification delivers a flux of greater deep- than shallow-living radiolarians to the sea floor characterized by high percentages of *C. davisiana*. A similar water structure in the glacial northwest Pacific is the probable cause of similar flux patterns. High *C. davisiana* percentages, in glacial deep-sea sediments of both hemispheres in latitudes above 45 degrees, suggest an Okhotsk like upper water structure was present in these latitudes as well. The resultant nutrient depletion, caused by this water structure, is in accord with some isotopic evidence and the biological stratification is evidence of a strong biological pump. Such a water and biological structure provides a means of transferring carbon dioxide from the atmosphere to the deep ocean.