PHYLOGENETIC ANALYSIS OF MARINE PHYTOPLANKTON

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7.1 INTRODUCTION

The world's oceans cover 70% of the Earth's surface and are dominated numerically by microscopic protists and prokaryotes. The marine phytoplankton are major components of both groups and are, by definition, high-dispersal taxa with large population sizes. These small photosynthetic organisms contribute the bulk of primary production in oceanic and neritic waters. Until recently most of our knowledge about marine phytoplankton was derived from net samples and bulk process measurements, such as chlorophyll *a* and ^{14}C biomass estimates. However, whole water samples and new analytical methods, e.g. flow cytometry, epifluorescence microscopy and HPLC, have revealed previously unrecognized groups (such as *Prochlorococcus*), size classes (the picoplankton <2 μm) and hidden biodiversity (Pelagophyceae). Surprisingly, up to 90% of the photosynthetic carbon in certain areas may be contributed by the picoplankton (Campbell *et al.*, 1994; Fogg, 1995). Among this smallest size fraction of the marine phytoplankton are the picoeukaryotes and *Prochlorococcus/Synechococcus*, whose importance in the open-ocean oligotrophic ecosystems has only been discovered within the last 20 years (Johnson and Sieburth, 1979, 1982; Waterbury *et al.*, 1979; Chisholm *et al.*, 1988; Andersen *et al.*, 1996).

With these new revelations of phytoplankton biodiversity, we may question just how accurate our knowledge is about the genetic diversity of marine phytoplankton. We probably know very little about groups, such as the phytoflagellates, where even α-level taxonomy is lacking, or about groups, such as the picoeukaryotes, where there are few morphological markers upon which to determine species identification. In addition we know almost nothing about population structure in the plankton. Population structure in the plankton may be very different from that on land because marine planktonic organisms live in an ever-changing three-dimensional environment. Many taxa may have little genetic structure over very large geographic areas. Further, recent evidence suggests that speciation and dispersal mechanisms in marine planktonic organisms may be very different from those on land (Palumbi, 1992). Thus, it is unlikely that generalizations about terrestrial plant diversity and population structure can be extrapolated to marine ecosystems.

The advent of molecular biological techniques has greatly enhanced our ability to analyze phytoplankton. Previously our knowledge of phytoplankton diversity and population structure has been hampered by their small size and paucity of morphological markers, the inability to bring many into culture, and the difficulty of obtaining samples for long-term seasonal studies in

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