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Physiological Ecology of *Enteromorpha clathrata* (Roth) Grev. on a Salt Marsh Mudflat

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Abstract

Each spring a bloom of *Enteromorpha clathrata*, a green alga, occurs in Richardson Bay, a small embayment in north San Francisco Bay, forming an extensive mat on the mudflat surface. Short-term photosynthetic experiments were conducted using manometric techniques to determine the light intensity, temperature, and salinity levels that would provide optimum growth for *E. clathrata.* Optimal growth conditions were found to be a light intensity of 240 μE m^{-2} sec^{-1} or higher; 30 °C; and 10‰ S. Estimated net annual primary production was 270 g C m^{-2}. Maximum biomass occurred in May when light and temperature were at their peak. Light and temperature on the mudflat were influenced by the frequency of daytime low tides. Tidal frequency and light intensity also apparently control the elevation at which *E. clathrata* is found on mudflats. Light intensity was found to affect the chlorophyll concentration in *E. clathrata.* Reduction in chlorophyll under high light intensities allowed *E. clathrata* to become more translucent and avoid the damaging effects caused by high irradiance. Increase in chlorophyll content at low light intensities allowed *E. clathrata* at the bottom of the algal mat to maximize its photosynthetic rate. Since peak light intensities and the largest frequency of daytime low tides were correlated with the bloom, it may be concluded that this is a light-limited system.

Introduction

Several studies have already examined the effects of varying light intensity, temperature and salinity on the photosynthetic rates of estuarine algae (Brinkhuis 1977a, Dawes *et al.* 1978, Fralick and Mathieson 1975, Hoffman and Dawes 1980, Kjeldsen and Phinney 1972). Other studies have indicated that photosynthetic rates of algae were closely related to seasonal light intensities (Brinkhuis 1977a, King and Schramm 1976). None of these studies, however, dealt with the macroalgae on mudflat areas adjacent to salt marshes. Productivity studies on mudflats have been concerned mainly with the microalgal constituents (Gallagher and Daiber 1974, Joint 1978, Pomeroy 1958). Because mudflats offer little suitable substrate for attachment, the macroalgae tend to be drift forms. Since these plants are floating or lying on an open mudflat, the influence of the salt marsh vegetation on their productivity is negligible. Further, these drift mudflat populations are adapted to a different set of environmental conditions than attached salt marsh algae. Light levels and temperatures on the mudflat may become quite high and the influence of the sediments in terms of nutrient exchange is just beginning to be understood (Owens *et al.* 1979, Welsh 1980).

The role of algal blooms in the marsh-mudflat ecosystem in San Francisco Bay has not been clearly established. A recent bloom of *Cladophora sericea* in north San Francisco Bay was viewed as a nuissance problem since large amounts of algae accumulated and decomposed along the shoreline (California State Legislature 1979). Nevertheless, algal blooms may act as a food source for amphipods and other invertebrates living on mudflats (Brenner *et al.* 1976, Levings 1980). During blooms, algae may be an important nutrient sink, removing significant amounts of nitrogen and other organic compounds from overlying water or sediments (Welsh 1980). Upon senescence these nutrients may be released back into the water or sediments (Owens *et al.* 1979).

Each year a bloom of *Enteromorpha clathrata* (Roth.) Grev. occurs in Richardson Bay, a small embayment in north San Francisco Bay near Mill Valley, California. *Enteromorpha flexuosa* (Roth) J. Ag. is also present,

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