THE EFFECTS OF ENVIRONMENTAL FACTORS ON THE GENERAL PATTERNS OF CARBON METABOLISM IN MARINE PHYTOPLANKTON

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ABSTRACT

A study was made of the effects of variation in light, temperature, growth rate and diurnal periodicity on the general patterns of carbon metabolism in order to describe the physiological state of two species of marine diatoms. The marine diatom Thalassiosira allenii was grown in continuous culture at a set dilution rate and under combinations of three light levels and four temperatures. The marine diatom T. fluviatilis was grown in continuous culture under constant light and temperature conditions, at four dilution rates and at three sample times through the light/dark cycle at each dilution rate.

The partitioning of carbon into protein, lipid and polysaccharide was determined at each set of environmental conditions for the diatoms using a sequence of chemical separations. The amount of carbon incorporated into each of the organic fractions was correlated with the general chemical composition of the population and to environmental conditions.

It was found that the incorporation of ^{14}C into protein relative to polysaccharide may by an index of environmental stress. High values of % protein ^{14}C combined with low values of % trichloroacetic acid-soluble ^{14}C (mostly polysaccharide) indicate some degree of light or temperature stress was experienced by the population.

The rate of protein synthesis was found to be closely correlated to the rate of nitrogen assimilation under a wide variety of conditions for the two marine diatoms. Based on this result a method has been developed for the estimation of the nitrogen assimilation rate which is accurate and simple to apply. It is suggested that this method be routinely applied in conjunction with phytoplankton productivity studies.

A method for the estimation of both the living phytoplankton carbon biomass and the specific growth rate in terms of carbon has been developed. Results indicate that after 12 or 24 h incubations, the chlorophyll *a* pool of a population can become uniformly labeled with ^{14}C. For uniformly labeled cells, the inverse specific activity of carbon in chlorophyll *a* (μg Chl *a*-C/dpm) is the same as the inverse specific activity of the population POC (μg POC/dpm). From this fact and the total ^{14}C incorporated by the population one can accurately estimate both the living phytoplankton carbon biomass and the specific growth rate.

Two carbon partitioning experiments were performed in Kaneohe Bay, Hawaii. Both the method for the estimation of N assimilation rate and the method for the estimation of carbon biomass and specific growth rate gave reasonable results for the two experiments. The relative incorporation of ^{14}C into protein and TCA-soluble material indicate that the populations had not experienced either temperature or light stress.