ADENOSINE TRIPHOSPHATE (ATP) AND DEOXYRIBONUCLEIC ACID (DNA) CONTENT OF MARINE MICROALGAE AND BACTERIA WITH APPLICATIONS FOR MEASURING MARINE MICROBIAL GROWTH RATES AND PRODUCTION

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN OCEANOGRAPHY

MAY 1989

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ACKNOWLEDGEMENTS

Laboratory advice and assistance were generously provided by J. Hirata, U. Magaard, K. Selph, and G. Tien. Field assistance was provided by V. Asper, G. DiTullio, K. Klein, B. Tilbrook, and the Captain and crew of the R/V Moana Wave during the ADIOS cruises - P. Betzer, chief scientist. R. Feely supplied hydrographic data for those cruises. C. Winn provided access to much relevant unpublished data, and offered many helpful suggestions and criticisms. C. Folsome and the dissertation committee contributed substantially of their time, insight, and support.

ABSTRACT

Laboratory experiments were conducted to determine the relationship between DNA and ATP content of marine bacteria and microalgae. This relationship was used to estimate *in situ* living microbial DNA concentrations in the open ocean. These estimates, combined with measurements of microbial DNA synthesis rates, allowed calculation of microbial specific growth rates. In addition, the relationship between microbial DNA and carbon was used to estimate total microbial production.

Laboratory-derived DNA:ATP ratios ranged from 8.5 to 33 (wt:wt) for cultures of marine microalgae, and from 13 to 50 for exponentially growing cultures of marine bacteria, with an overall geometric mean ratio of 17. Laboratory-derived C:DNA ratios ranged from 33-176 (wt:wt) for the marine algae studied, and from 17 to 51 for the marine bacteria studied, with an overall geometric mean of 49. There were no statistically significant diel differences in DNA:ATP ratios for the marine algae studied. Significantly different DNA:ATP ratios were observed between high and low growth rates for N-limited cultures of *Amphidinium carteri* and *Cyclotella cryptica*, and between N- and P-limited cultures of *C. cryptica* at

high growth rates. No other significant differences due to growth rate effects or nutrient limitation effects could be demonstrated. Laboratory calibration experiments with cultures of marine algae confirmed that the observed DNA:ATP relationships could be used in conjunction with DNA synthesis rate measurements to estimate specific growth rates.

The laboratory-derived relationships were applied under field conditions during two cruises to 26°N, 155°W in the spring and fall of 1986. Total microbial specific growth rates ranged from 0.2-1.5 d^{-1} in the spring and from 0.1-1.3 d^{-1} in the fall, with subsurface maxima during both cruises near the bottom of the mixed layer. Overall integrated average growth rates were 0.76 d^{-1} in the spring, and 0.66 d^{-1} in the fall. Total microbial production between 0 and 150 meters was estimated at 718 $mgC \cdot m^{-2} \cdot d^{-1}$ in the spring and 490 $mgC \cdot m^{-2} \cdot d^{-1}$ in the fall. These production estimates were 1.7 and 1.1 times estimated net primary production during the spring and fall cruises respectively. Total microbial production integrated to the depth of the mixed layer was 1.3 and 1.2 times net primary production during the spring and fall, respectively. These estimates are considered conservative estimates.

It is concluded that microbial growth rates can be accurately estimated by the techniques used. Field results suggest that microbial communities in the study area were growing rapidly, at approximately one doubling per day. Accuracy of total microbial production estimates would be considerably improved by information concerning the partitioning of particulate ATP among members of the microbial community, and by knowledge of the turnover time of grazed microbial DNA.