

APPLICATION OF THE RATE OF NUCLEIC ACID SYNTHESIS
TO THE STUDY OF MICROBIAL GROWTH
AND PRODUCTION IN SEAWATER

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ABSTRACT

The rate of nucleic acid synthesis was used as a measure of growth and production in planktonic marine microbial assemblages. Synthesis rates were measured by a new procedure which utilizes tritiated adenine as a precursor to both ribonucleic and deoxyribonucleic acid. This methodology provides a measure of the growth and production of the entire microbial community, including both the autotrophic and heterotrophic components, and represents an important advance in the study of aquatic microbiology.

The ^3H -adenine technique was extensively evaluated in the laboratory. Mathematical modeling was used to examine the relationship between the direct precursor to adenine incorporation and the nucleic acid endproduct. The technique was also calibrated with a variety of representative marine microbes grown under controlled conditions. These studies demonstrated that accurate rates of nucleic acid synthesis can be derived provided a few simple precautions are observed.

The procedure was applied to the study of microbial growth and production in both the euphotic and the mesopelagic zones of the oligotrophic oceans around Hawaii. In the euphotic zone, microbial growth rates ranged from

0.5 to 0.8 day⁻¹, and microbial production integrated over the 0 to 150 m depth interval was 400 mg C m⁻² day⁻¹. Microbial growth rates in the mesopelagic depth interval were greater than in the overlying waters, and production integrated over the 150 to 900 m depth interval was approximately twice as great as in the euphotic zone. It is hypothesized that organic matter is rapidly and efficiently recycled in the mesopelagic, or that an additional source of energy, beyond that derived from autotrophic production in the euphotic zone, exists in this environment. Direct comparisons were also made of microbial production, extrapolated from DNA synthesis measurements, and ¹⁴CO₂ primary production on a transect of the equatorial Pacific. In contrast to other direct comparisons of these parameters, microbial production greatly exceeded primary production. It is hypothesized that the ¹⁴CO₂ primary production technique may have underestimated autotrophic carbon production on this transect. Finally, diel nucleic acid synthesis rates were examined. It is concluded that, whereas some diel variation may exist, nucleic acid synthesis rates remain relatively constant in nature over 24 h periods.