THE MEASUREMENT OF PRIMARY PRODUCTION: PROBLEMS AND RECOMMENDATIONS

edited by

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1. INTRODUCTION

At the end of 1980 a group of Dutch scientists (all members of the BION working group 'Aquatic Ecology') working on primary production measurements and the adjacent field of physiological ecology of phytoplankton decided to discuss their methods and to compare results obtained with different measuring techniques. Exchange of recently gained physiological knowledge and discussions of laboratory and field experiments and models should be expected to lead to better estimates and interpretation of primary production measurements. Moreover, current research was presented and discussed at an early stage. In this paper the most important results of the discussions are reported together with conclusions drawn and recommendations made.

In Dutch freshwater, brackish water and marine institutes scientists perform primary production measurements in widely different habitats, ranging from the hypertrophic freshwater lakes to the oligotrophic tropical oceans. All measurements are primarily intended to establish the level of the autotrophic particulate and dissolved organic carbon production. The results obtained form the basis of carbon budgets or carbon flux models in the Grevelingen, the Ems Dollard estuary, the Wadden Sea, the North Sea and the tropical Atlantic, as well as the oligotrophic lake Maarsseveen, the more eutrophic lake Vechten and the hypertrophic Randmeren.

The advantages and disadvantages of the O₂ and ¹⁴C method received attention. Differences in results obtained with these two methods were discussed. This topic was considered in relation to different habitats. Results of field and laboratory incubations were compared. Attention was paid to the effect of exposure time at constant and fluctuating irradiances. Well-known problems inherent to the ¹⁴C technique were reviewed by Peterson (1980). Artefacts due to procedures such as sampling, contamination with chemicals (nutrients, heavy metals) were evaluated in more detail. The interpretation of dark ¹⁴C fixation and excretion measurements also received further attention. Difficulties in estimating production from in situ oxygen profiles in deeper lakes and in sediments were recognised. The scatter in respiration and oxygen production data in situ was discussed in relation to incubation duration, time of sampling and different incubation depths. Production models based on incubation at fixed light intensities were compared to models in which the circulation of algal cells in a light gradient was simulated.

Incubations with laboratory cultures, grown under well defined conditions (continuous cultures), have shown that the photosynthetic response is largely influenced by the growth conditions. Relationships were established between growth- and photosynthetic parameters. The use of these data of laboratory populations as physiological indicators for the interpretations of primary production measurements in the field will be discussed.

2. COMPARISON BETWEEN O₂ AND ¹⁴C TECHNIQUE.

ON PQ VALUES.

(P. de Visscher, Delta Institute for Hydrobiological Research, Yerseke, The Netherlands)

The PQ value (photosynthetic quotient) can be defined as the ratio of the quantity of oxygen released to the quantity of assimilated carbon during photosynthesis. Theoretically this value is 1 on a molar basis and 1.37 on the basis of weight. The released oxygen, however, can be used intracellularly in different metabolic cycles depending on the sort of nutrient most available (NO₃ or NH₃; Williams et al., 1979), or on the general physiological condition of the organism. Since cells also need oxygen for maintenance (respiration) the use of a theoretically determined PQ value will result in erratic carbon assimilation numbers if derived from oxygen evolution data. The necessity of insight in the possible variation of