

Botanica Marina
Vol. XIX, pp. 259–272, 1976

Primary Production in Lindåspollene, a Norwegian Land-Locked Fjord

C. Lännergren

Biological Station, Espegrend, N-5065 Blomsterdalen, Norway

(Received 11. 11. 75)

In situ primary production, chlorophyll *a*, and the quantitative and semiquantitative composition of phytoplankton were studied from March to November in two basins in a Norwegian land-locked fjord, which receives sewage effluent from 400 persons.

The seasonal production was 60 to 70 mg C/m², and the annual production was estimated at 90 to 100 mg C/m². The occurrence of phytoplankton was similar to what has been reported from unpolluted Norwegian waters, and the chlorophyll *a* concentrations were small after the spring bloom. Average assimilation numbers were 5.3 and 5.5. The highest assimilation numbers, 13.9 and 18.0, occurred in July, at the time of the smallest biomass. No correlation was found with temperature, light, or nutrients, and a correlation with the phytoplankton composition is suggested.

The two basins were in most respects alike, and it is concluded that the effects of the sewage effluent on primary production was negligible.

Introduction

The southern part of the Norwegian west coast is characterized by a large number of fjords and "polls", small land-locked fjords with tidal exchange and usually stagnant bottom water. Lindåspollene, situated about 40 km north of Bergen, are of special interest, since they contain a local herring population. This stock has been studied since 1970 (Dahl *et al.* 1973), and studies have been carried out on the hydrography, on hyperbenthic and pelagic zooplankton, on benthic fauna and diatoms, the microbial processes in the sediments, and on the *Ciona* population.

In 1972 the sewage outflow was about doubled, from 200 to 400 persons, and it was decided that the effects on water chemistry and on primary production should be studied within the framework of the Lindås project, a multi disciplinary project studying the impact of industrial development on the Lindås peninsula. The results of the chemical investigation have been published earlier (Lännergren 1975).

Lindåspollene are made up of three basins, with a total surface area of about 7 km² (Fig. 1). The maximum depth is in Spjeldnesosen 90 m and in Straumsosen 60 m. These basins, to which sampling was restricted, are separated from each other and from the fjord outside by shallow sills, with depths of 3–6 m. Precipitation amounts to 2000–2500 mm per year and the annual fresh-water supply from the watershed of 35 km² in area is about

70 · 10⁶ m³. The oxygen concentrations in the bottom waters were low, and after August 1973 hydrogen sulphide occurred in Straumsosen.

Materials and Methods

Samples were collected with a 2.7 l Ruttner sampler at one buoy in Spjeldnesosen and one in Straumsosen (Stns. 1 and 2, Fig. 1) at depths corresponding to 100, 75, 50, 25, and 10% of the incident radiation, as determined by Secchi-disc readings (Tyler 1968), assuming a logarithmic decrease of light with depth.

280 ± 1 ml were taken for *in situ* productivity measurements by the ¹⁴C method. 100 μl ¹⁴C solution (Charlottenlund, Denmark), corresponding to an activity of 0.4 μCi, were added and the samples were incubated for 24 hours, beginning at sunset. The filters (Millipore, 0.45 μ) were dried and treated with hydrochloric acid, and the activity was determined by liquid scintillation.

Total inorganic carbon was analysed by reading pH before and after the addition of 0.01 N hydrochloric acid (Strickland and Parsons 1968). Chlorophyll *a* was determined spectrophotometrically after extraction in methanol (Jensen and Sakshaug 1973). The algae were preserved with JJK (Lugol's solution); samples from the upper three depths were combined and counted in an inverted microscope (Utermöhl 1931). All samples were