Copyright ©

Kieler Meeresforsch., Sonderh. 5, 264 – 267. Kiel 1981

Succession of phytoplankton in chemostats under natural light

G. Kredel

Institut für Meereskunde an der Universität Kiel,
Kiel, Germany

This study traces the succession of phytoplankton under natural light and different concentrations of phosphate in continuous cultures.

Continuous culture experiments with typical autumn phytoplankton populations from Kiel Bight (2 m depth) were carried out in six 1.8 litre chemostats exposed to naturally alternating periods of light and darkness. On cloudless days the chemostats were protected by black netting which reduced the solar radiation by 50 % (as measured by a Lambda-Quantameter). For all experiments the water was filtered to eliminate potential grazers. The phytoplankton cultures were supplied with the culture medium after GUILLARD and RYTHER (1962) which was pumped at a constant rate of about 350 ml d^{-1}, the resulting overflow being used for daily cell counts and for determination of PO_4, Chl a and pH. F/10, the culture medium concentration, applied to all nutrients except phosphate which was supplied to the five culture vessels in the following concentrations:

1.11 µgat PO_4–P l^{-1} = F/25
1.39 µgat PO_4–P ,, = F/20
1.85 µgat PO_4–P ,, = F/15
2.78 µgat PO_4–P ,, = F/10
5.56 µgat PO_4–P ,, = F/5

Only in experiment 1 was one test carried out with F/4 (≈ 6.98 µgat PO_4–P, see Fig. 3). The phosphate added was in the form of $Na_2HPO_4 \cdot 12\ H_2O$. Magnetic stirrers and filtered air bubbling through the cultures served to keep the plankton cells in suspension. A constant temperature of 12°C proved difficult to maintain because of the extreme outdoor conditions (see Fig. 1 a).

Figures 1 a, 1 b and Figure 2 represent the trends observed in all chemostats for all experiments (phosphate concentration): 2.78 µgat PO_4 l^{-1} = F/10). Fig. 1 a shows the abiotic parameters. Light, the most important ecological factor of this study, was registered continuously with an integrating solarimeter (Kipp & Zonen) and expressed in cal cm^{-1} d^{-1} ≈ Ly · d^{-1}. Mean values of light intensities for the three experiments are:

Experiment 1: 138 Ly · d^{-1} = 0.1 Ly · min^{-1} (3.10.–10.10.1978)
Experiment 2: 113 Ly · d^{-1} = 0.08 Ly · min^{-1} (12.10.–29.10.1978)
Experiment 3: 48 Ly · d^{-1} = 0.03 Ly · min^{-1} (1.11.–26.11.1978)

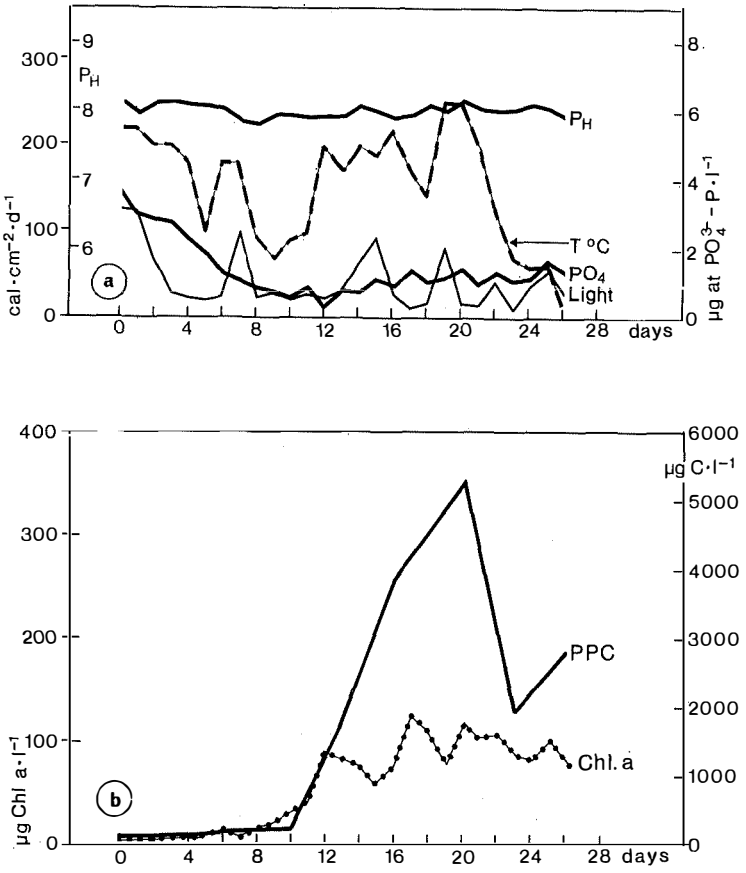

Figure 1

a Abiotic parameters: light, PO_4, temperature, pH – b Biotic parameters: chlorophyll a, phytoplankton carbon

EPPLEY and STRICKLAND (1968) state values of 0.03 – 0.1 Ly · min^{-1} as optimal for most marine phytoplankton species. The photo period decreased by approximately three hours from the beginning of experiment 1 to the end of experiment 3. Fig. 1 b traces the biotic parameters of chlorophyll a, determined by the SCOR/UNESCO method and of phytoplankton carbon, the determination of which was based on size and cell counts of individuals (according to STRATHMANN 1969) and transformed using the factors of SMETACEK (1975).

Together with the ten dominant species (see Fig. 2), the cells of all other phytoplankton organisms were included in the calculation. These less important species were: *Guinardia flaccida*, *Ceratium furca*, *Chaetoceros* sp., *Rhizosolenia alata*, *Rh. setigera*, *Nitzschia seriata*, *Ditylum brightwellii*, *Cerataulina bergonii* and *Distephanus speculum*. They are not taken into consideration in Fig. 2, where the development of dominant species only is illustrated. The main developmental tendency of the succession of these species was, with little variation, similar in all chemostats in all experiments. The diatoms except *Coscinodiscus* sp. always showed a marked

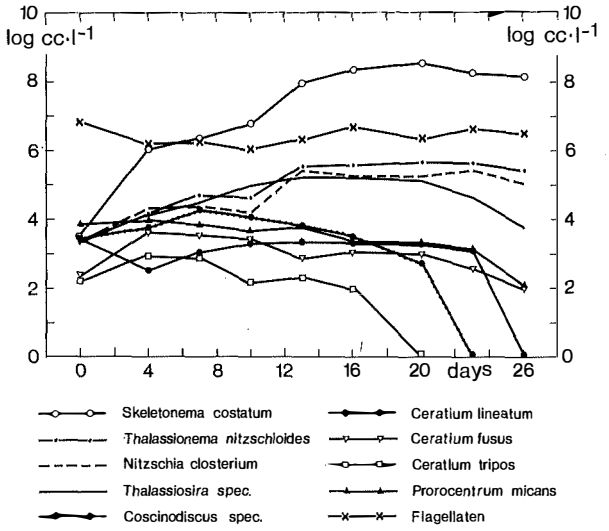

Figure 2
Development of dominant species

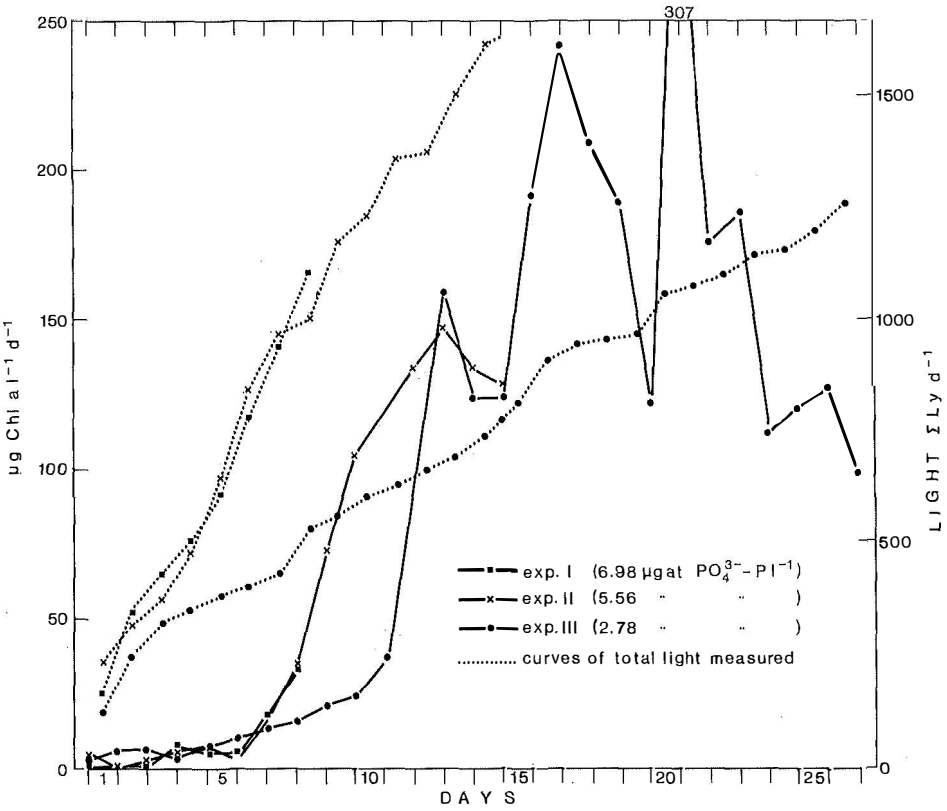

Figure 3
Chlorophyll a values of experiments 1–3 in relation to the total light measured

increase in cell numbers. The euryoecious alga *Skeletonema costatum* was found to be dependent on the phosphate concentrations. Dinoflagellates, which had the highest cell numbers initially, decreased rapidly and finally vanished. In nature, in Kiel Bight, *Ceratium* populations form the bulk of the biomass in October, followed in November by diatoms (SMETACEK 1975). The decrease in development of the dinoflagellates may be due to their greater sensitivity in culture (KNOPPERS 1976) and/or the restriction of the limited available factors in culture conditions. Fig. 3 displays compounded light curves and chlorophyll a concentrations (indicators of growth) at different phosphate levels.

In spite of the differences in phosphate concentrations and light quantities the development of chlorophyll a in the experiments 1 (8 days) and 2 (16 days) show very similar tendencies. In experiment 3, with a lower phosphate concentration and lower light intensity, the steep increase in chlorophyll values is delayed by three days.

From the result of these experiments it is difficult to state which of the parameter studies is most influential in determining the succession of phytoplankton in the cultures and further investigation of the succession phenomenon is necessary.

References

EPPLEY, R.W. and J.D.H. STRICKLAND, 1968. Kinetics of marine phytoplankton growth. In: M.R. DROOP and E.J. FERGUSON WOOD (eds.), Advances in microbiology of the sea, 23–62, London, New York.

GUILLARD, R.R.L. and J.H. RYTHER, 1962. Studies of marine planktonic diatoms. I. *Cyclotella nana* Hustedt and *Detonula confervacea* (Cleve). Gran. Can. J. Microbiol. **8**, 229–239.

KNOPPERS, B., 1976. Die Vertikalverteilung motiler Protozoen in Abhängigkeit von Umweltfaktoren und der Tageszeit in einer abgeschlossenen Wassersäule. Diplomarbeit, Universität Kiel. 77 pp.

SMETACEK, V., 1975. Die Sukzession des Phytoplanktons in der westlichen Kieler Bucht. Dissertation, Universität Kiel. 149 pp.

STRATHMANN, R.R., 1967. Estimating the organic carbon content of phytoplankton from cell volume or plasma volume. Limnol. Oceanogr. **12**, 411–418.