

Phytoplankton

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The term 'plankton' refers to the group of organisms which float in the surface waters of the rivers, lakes and oceans. The great majority of the floating plants in the oceans are the unicellular microscopic algae collectively called phytoplankton. Many phytoplankton species are curious and beautiful organisms contributing to the greater diversity of forms in the aquatic environments. These micro-algae are present throughout the lighted regions of all the seas and oceans including the polar regions. Their total biomass is many times greater than that of the total plants on land and they serve as the "pasture grounds" in the aquatic environment. Without phytoplankton, the primary producers, there would be no life in the seas and oceans and these micro-algae form the basis for the marine food-web process by way of fuelling energy to the higher trophic level organisms with the products of their photosynthesis.

Marine phytoplankton comprise a complex community of several thousand floating micro-algae in the sea, ranging in size from about 1 μm upto a few millimeters. Based on their size, phytoplankton can be classified as macroplankton (more than 1 mm), microplankton (less than 1 mm, retained by nets of mesh size 0.06 mm), nanoplankton (between 5 and 60 micrometers) and ultraplankton (less than 5 micrometers). Many phytoplankton species belong mainly to the nanoplankton and microplankton fractions.

Collection and Preservation

Qualitative Analysis

Plankton nets are widely used for sampling phytoplankton. The advantage of using nets is that large volumes of water can be filtered to concentrate the organisms. Different types of nets have been designed for collecting phytoplankton of which the most commonly used one is the standard net (Fig.1). It consists of a cone shaped gauze bag equipped with a metal or plastic ring at the wider end and closed at the narrow end by a detachable plankton – collecting vessel. The net mouth is

attached to the towing line by usually three rope bridles from the mouth ring. A weight is attached to the end of the towing cable. The front and tail parts of the net are reinforced with non-porous textile cuffs. The gauzes used in nets are made of different materials such as bolting silk, polyester, nylon *etc.* Sampling with small (mouth diameter 15 cm; length 110 cm) fine-mesh (5 or 10 μm) monofilament nylon nets has proved to be very successful in retaining high quality of phytoplankton.

Net hauls may be made at the surface or at any desired depth. As the net is in operation, the collecting vessel will receive most of the plankton. Some plankton that remain on the gauze must be washed into the bucket after the net operations is over. Generally the towing speed should not exceed 1 ms^{-1} (2 knots). When nets with fine meshes (less than 20 μm) are used, speed even below 0.3 ms^{-1} (0.5 knot) is advisable in order to reduce clogging to minimum.

Quantitative Analysis

Inverted-microscope Method (Utermohl Method)

This method involves a combined plate chamber consisting of a top sedimentation cylinder (10, 50 or 100 ml capacity) and a bottom-plate chamber. It is made of rectangular perspex plate, a ring and a circular base plate of cover slip thickness. The plate is designed in such a way to fit into the mechanical stage of the inverted microscope. The combined chamber is made ready for use by placing a sedimentation cylinder of desired capacity on the top of plate chamber. Well shaken preserved water sample is poured into the combined chamber to overflow and a square top plate is placed in position to eliminate dust and evaporation. After sedimentation (sedimentation time in hours to be at least three times the height of the sedimentation cylinder in centimeters), the sedimentation cylinder is slowly pushed away from the bottom-plate chamber by using the square top plate of the plate chamber.

To enumerate the phytoplankton, transect counts can be made at high magnification or the entire bottom can be scanned at low magnification in the Utermohl's inverted microscope (Sourins, 1978).

Fixation and Preservation

It is very important to fix to phytoplankton as soon as the collection is over to prevent the adverse effects of light and temperature which might cause rapid decay of organisms. Very many fixatives and preservatives have been described. Of these only a-few as given below are used extensively.

i) Neutralized Formaldehyde

20% Formaldehyde solutions 1l (HCHO) + Hexamethylene tetramine - 100 gm It is a general preservative for. all phytoplankton. (Add 100 ml of water sample to 2ml of the fixing/ preserving agent. For net samples, add the fixing/ preserving agent to make up about one-third of the volume if the samples is dense).

ii) Acidified Formaldehyde

20% Formaldehyde solution (HCHO)		1:1
+ 50 Glacial acetic acid (CH ₃ COOH)		

It is a good preservative for all phytoplankton especially diatoms but not for coccolithophorids as the acid may dissolve coccoliths (Add 2 ml for 100 ml of sample).

iii) Lugol's Solution

100 gm KI dissolved in 1l of distilled water + 50 gm I (Crystalline) + 100 ml of glacial acetic acid (CH₃ COOH)

This preservative is good for all phytoplankton but not for coccolithophorids as the acid may dissolve the coccoliths (Add 200 ml of sample to 0.4 to 0.8 ml of fixative).

Identification

For the identification of phytoplankton, a standard research microscope magnification X 1000, with phase-contrast illumination can be used.

The following and other available literature can be referred to for identifying the organisms:

Cupp, E.E. (1943). Marine plankton diatoms of the west coast of North America. *Bull. Scripps Inst. Oceanogr.*, **5** (1).

Dodge, J.D. (1982). Marine dinoflogellates of the British Ivles. H.M.S.O., London, 310 pp.

Hendey, N.I. (1964). An introductory account of the smaller algae of British Coastal waters. Fishery Investigations Ser. 4, Part 5: Bacillariophyceae (Diatoms), London, pp.1-317.

Simonsen, R. (1974). The diatom plankton of the Indian Ocean Expedition of R/V "Meteor" 1964-1965. "Meteor" Forsch. Ergebnisse, Reihe D, **19** : 1-107.

208 *Phytoplankton*

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- Subrahmanyam, R. (1946). The diatoms of the Madras coast. *Proc. Indian. Acad. Sci.*, **24** (B) : 85-197.
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Factors Affecting Biodiversity

Light

Phytoplankton are limited to the uppermost layers of the ocean where light intensity is sufficient for photosynthesis to occur. The light incidence at different depths of water depends on a number of factors, like absorption of light by the water, the wave length of light, transparency of the water, reflection from the surface of the water, reflection from suspended particles, latitude and seasons of the year. When light strikes the surface of the water, a certain amount of light is reflected the amount depends on the angle at which the light strikes the surface of the water.

For most phytoplankton, the photosynthetic rate varies with light intensity. Different species have different curves of photosynthetic rate when plotted against light intensity, giving different optimal light intensities for maximum photosynthesis.

Nutrients

The major inorganic nutrients required by phytoplankton for growth and reproduction are nitrogen (as nitrate, NO_3 , nitrite NO_2 , or ammonium NH_4) and phosphorus (as phosphate PO_4). Diatoms and silicoflagellates also require silicate (SiO_2) in significant amounts. Other inorganic and organic nutrients may be required in small amounts. All of those nutrients are the limiting factors for phytoplankton productivity under most conditions.

The upper layers of water usually have a reduced nutrients compared to lower waters. As the phytoplankton population grows in the upper 100m of water, the plants absorb more and more of the light. Less light means that the compensation depth begins to move upward and becomes shallower. The original 100m reservoir of nutrients is reduced, and as plants increase in numbers, more and more of the water column and nutrient supply become inaccessible to the phytoplankton, thus the total potential productivity is reduced. Finally, as the plants grow, they absorb the nutrients and these nutrients are not available to other plants.

Temperature

Temperature acts along with other factors in influencing the variation of photosynthetic production. Generally, the rate of photosynthesis increases with an increase in temperature, but diminishes sharply after a point is reached. Each species of phytoplankton is adapted to particular temperature. Temperature, together with illumination, influences the seasonal variation of phytoplankton production in the temperate latitudes.

Salinity

Besides light and temperature, salinity also is known to influence primary production. For example, *Skeletonema* showed an optimum rate of photosynthesis at salinities ranging from 15 and 20‰ although the process could go on in a much wider range of 11 to 40‰. Further, many species of dinoflagellates such as *Ceratium*, *Peridinium* and *Prorocentrum* reproduce actively at lower salinities.

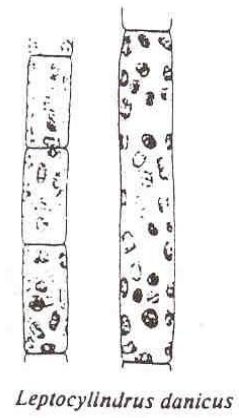
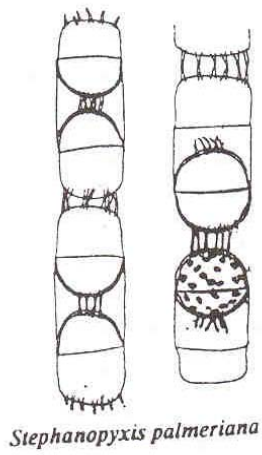
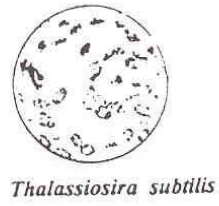
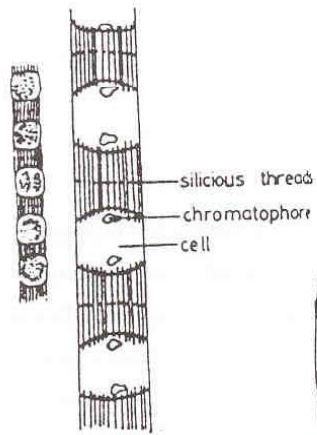
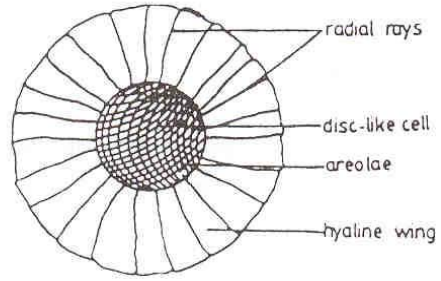
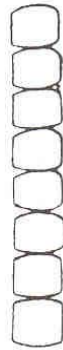
Grazing by Zooplankton

The grazing rate of zooplankton is one of the major factors influencing the size of the standing crop of phytoplankton, and thereby the rate of production. A sharp decline in the number of diatoms following their

210 *Phytoplankton*

spring outburst has been found to occur before the nutrients are fully exhausted. This is correlated with the increase in quantity of zooplankton, and so grazing by the zooplankton can be suggested as one of the causes for the decline in the standing crop of phytoplankton. An inverse relationship in the distribution of phytoplankton and zooplankton is usually discernible. Thus an explosion in the algal production is also due to the comparative scarcity of zooplankton. A phytoplankton bloom naturally results in the sudden depletion in the available nutrients in the euophotic zone and so such a bloom is usually followed by a lower rate of production.

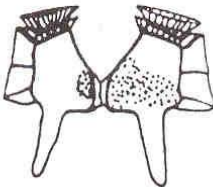
Diatoms



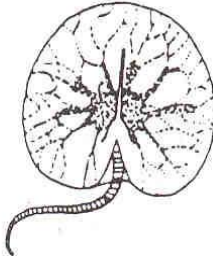
Dinoflagellates



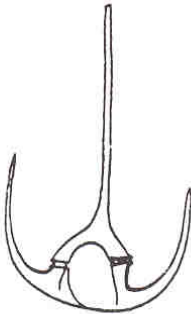
Prorocentrum micans



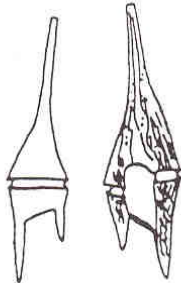
Dinophysis caudata



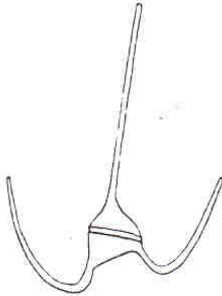
Noctiluca scintillans



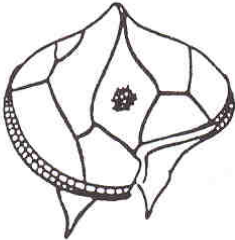
Ceratium tripos



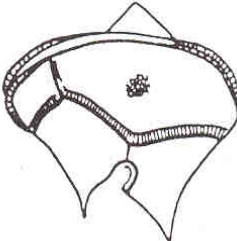
C. furca



C. macroceros



Protoperidinium depressum



P. pentagonum

