DIURNAL DISTRIBUTION OF PHYTOPLANKTON FROM A SINGLE STATION AT THE MOUTH OF THE JAMES RIVER[1]

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ABSTRACT

Eight sets of water samples were taken to a depth of 36 ft during a 24 hr period. A homogeneity was found in the vertical distribution of the total phytoplankton in samples from 7 of the 8 hydrocasts. *Skeletonema costatum* and *Asterionella japonica* were the most numerous phytoplankters in every sample, with the majority of their counts each exceeding 500,000 cells per liter.

A twenty-four-hour study was made February 13, 1964, of the vertical distribution and composition of phytoplankton at one station in the James River. The station was selected for its position at the mouth of the James River between Fort Wool and Old Point Comfort. The waters of the James River enter lower Chesapeake Bay under the influence of a strong tidal exchange that almost continually contributes to horizontal currents, upwelling, and the mixing of sediment and plankton.

Early references to diurnal variations and the vertical distribution of phytoplankton in Chesapeake Bay were noted by Wolf et al. (1926) and Cowles (1930). More complete studies of the seasonal expression of phytoplankton species in lower Chesapeake Bay have been made by Mulford (1962; 1963) and Patten et al. (1963). Tidal exchange and current flow patterns of Chesapeake Bay have been discussed by Pritchard (1952; 1953), among others.

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METHODS

Eight sets of water samples were taken during a 24-hour period at the surface and at depths of 3, 6, 9, and 12 meters with a two-liter Kemmerer water sampler. The water depth at this station was 40 feet. After each hydro-cast, 500 ml were stored in glass bottles and fixed with a I_2-KI-acetic acid solution (Verduin, 1962). A settling and siphoning method was followed (Welch, 1948), until a 30 ml concentrate remained. Fractions of this concentrate were then examined on a microslide and the phytoplankton species counted in terms of cells per liter. At each sampling level, the temperatures were recorded with a Negretti and Zambra reversing thermometer and the salinity determined by specific gravity procedures.

RESULTS

There were 53 phytoplankters identified according to species or genera. Among these were numerous species that were not significant contributors to the total biomass. The major constituents were *Skeletonema costatum* (Clev.) Cl. and *Asterionella japonica* Cl. Moll. These two species occurred in every sample with the majority of their counts exceeding 500,000 cells per liter.

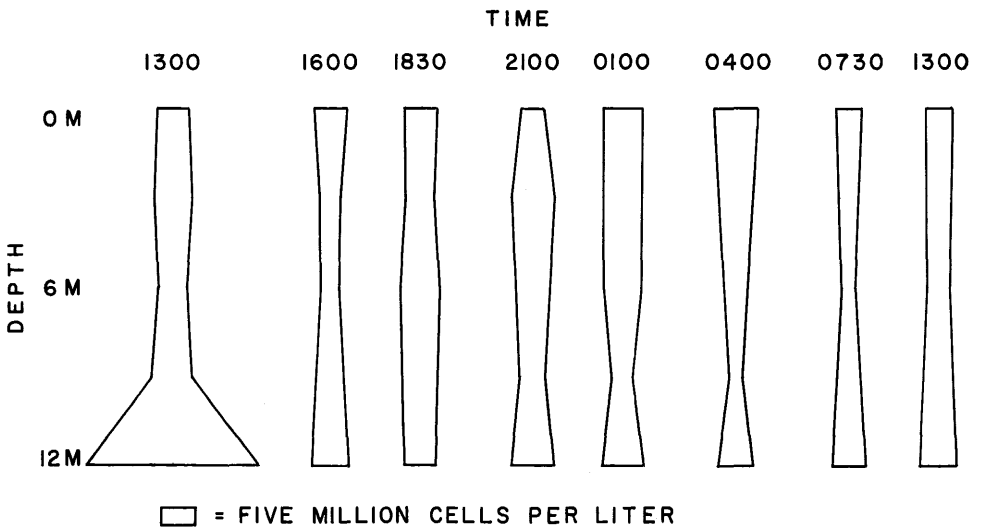

FIGURE 1. Vertical distribution of phytoplankton on February 13, 1964, at one station located at the mouth of the James River.

Other prominent species were *Nitzschia pungens atlantica* Cl., *Rhizosolenia alata* Brighlw., and several species of *Thalassiosira* and *Chaetoceros* that were found in lesser numbers. Although zooplankton data are not included in this report, it should be noted that the tintinnids (*Tintinnopsis davidoffi*, *T. beroidea*) were very abundant and appeared in all the samples. No temperature or salinity gradients were present.

Skeletonema costatum (Clev.) Cl. was the only major alga with a considerably greater concentration of numbers at one depth. This maximum population occurred at 1300 February 13, during ebb tide, when approximately 21,915,000 cells per liter were determined at 12 meters. The distribution of this species prior to this sampling period was not obtained and this population was subsequently dispersed by tidal currents. The other major species were distributed vertically in approximately equal numbers, with a slight increase in diatoms with depth

at 0100, preceding the next low tide. The vertical distribution of total phytoplankton was similar in the following seven sampling periods (fig. 1). The most abundant phytoplankters mentioned in this study correspond to the prominent species in other investigations of the Chesapeake Bay (Cowles, 1930; Morse, 1947; Patten et al., 1963).

DISCUSSION

The combination of tidal exchanges and water movement from the James River has a marked effect on the distribution of phytoplankton in the Fort Wool channel area. This turbulence has promoted vertical and horizontal movement of water masses that will easily deploy population concentrations to new locations and promote the entry of plankters settled on the bottom into the ambient waters. Chandler (1940) and Verduin (1962) have discussed similar vertical homogeneity of phytoplankton in western Lake Erie where turbulent mixing is initiated by seiche oscillation. Verduin has also related this action to the current flow patterns in marine estuaries. In extensive studies of the mixing zone between harbor and oceanic waters, Cassie (1959; 1960) has discussed the influence of tides and variable physical properties of the environment on plankton populations. Cassie presents correlations of the abundance of specific plankters to salinity and temperature, among other factors, as additional ecological determiners to their distribution patterns.

The homogeneity found in the vertical distribution of the phytoplankton in this study are in contrast to the results found by Wolfe et al. (1926) at stations in the Chesapeake Bay. They noted considerable variation in the vertical distribution of diatoms and protozoa, with an increase in these populations with depth. Cowles (1930) has indicated a reduction in the total diatom population at the mouth of the Chesapeake Bay and attributed this condition to the rapid flow of tidal currents that were present. However, the concentrations of the total phytoplankton in this study were above the mean annual concentrations found by Cowles and of the total surface phytoplankton of the five stations studied by Patten et al. (1963) in lower Chesapeake Bay.

LITERATURE CITED

Cassie, R. M. 1959. An experimental study of factors inducing aggregation in marine plankton. New Zeal. J. Sci. 2: 339–365.

———. 1960. Factors influencing the distribution pattern of plankton in the mixing zone between oceanic and harbor waters. New Zeal. J. Sci. 3: 26–50.

Chandler, D. C. 1940. Limnological studies of western Lake Erie I. Plankton and certain physical-chemical data of the Bass Islands region, from September 1938 to November 1939. Ohio J. Sci. 40: 291–336.

Cowles, R. P. 1930. A biological study of the off shore waters of Chesapeake Bay. Bull. Bur. Fish. 46: 277–381.

Morse, D. C. 1947. Some observations on seasonal variations in plankton populations, Patuxent River, Maryland. Chesapeake Biol. Lab. Publ. 65: 1–31.

Mulford, R. A. 1962. Diatoms from Virginia tidal waters. Va. Inst. Mar. Sci. Spec. Sci. Rep. (30): 1–33.

———. 1963. Distribution of the dinoflagellate genus *Ceratium* in the tidal and off shore waters of Virginia. Chesapeake Sc. 4: 84–89.

Patten, B. C., R. A. Mulford, and **J. E. Warinner.** 1963. An annual phytoplankton cycle in the lower Chesapeake Bay. Chesapeake Sc. 4: 1–20.

Pritchard, D. W. 1952. Salinity distribution and circulation in the Chesapeake Bay estuarine system. J. Mar. Res. 11: 106–123.

———. 1953. Distribution of oyster larvae in relation to hydrographic conditions. Proc. Gulf Carib. Fish. Inst. 1952: 123–132.

Verduin, J. 1962. Energy flow through biotic systems of western Lake Erie, Great Lakes Basin. Amer. Assn. Adv. Sci. Publ. 71: 107–121.

Welch, P. S. 1948. Limnological Methods. The Blakiston Co. Phil. 381 p.

Wolfe, J. J., B. Cunningham, N. F. Wilkerson and **J. T. Barnes.** 1926. An investigation of the microplankton of Chesapeake Bay. J. Elisha Mitchell Sci. Soc. 42: 25–54.