ATTACHMENT "A"

AEC REPORT NO.	COO-2538-15
Title & Subtitle	INTERRELATIONSHIP BETWEEN CERTAIN HYDROGRAPHIC FEATURES ASSOCIATED WITH CURRENTS AND PRIMARY PRODUCTION ANNUAL PROGRESS REPORT
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DISCLAIMER

Abstract

The application of biochemical tests to implicate specific limiting factors has shown that for most of the growing season (spring through fall), nitrogen limits phytoplankton growth and more specifically controls the size of the blooms of phytoplankton in New England coastal waters. In light of recent emphasis a nitrogen metabolism of phytoplankton is not a surprising finding; however, but limitation of the size of the spring and fall blooms suggests that zooplankton grazing pressure does not overwhelm growth, and perhaps sinking is the dominant mechanism for removal of cells from the water column.

The seasonal sequence of phytoplankton appears to be a composite of two major blooms and numerous smaller outbursts of growth. The latter seem to be related to vertical turbulance which re-enriches the euphotic zone with nutrients. The cause or source of this turbulance is not clearly identified.

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In the course of study of the seasonal sequences of phytoplankton, the appearance of pulses of growth commonly known as "blooms" occupies a special place of interest to the biological oceanographer; it is reasoned that during bloom periods, critical factors for growth appear in some optimal configuration. Traditionalists argue that the seasonal sequence would be composed of two major blooms; early spring and late summer. Arguments for the cause of these include combinations and interactions of light, temperature, nutrients, trace metal/chelators, and vertical mixing of the water column. One factor consistent with all argument involves nutrients.

To more fully understand the causative factors we have employed an observational program at a single station in the Gulf of Maine about 10 miles from Boothbay Harbor. This station has been occupied once a week throughout the year. In cooperation with other programs in this laboratory supported by National Science Foundation, NASA and the Food and Drug Administration, several coastal cruises between Cape Ann, Mass., and Grand Manan Island have extended our observations throughout the Gulf of Maine and onto Georges Banks. Shipboard measurements include vertical profiles of temperature, salinity, nitrogen, phosphorous, silica, chlorophyll, chelation capacity, carbon fixation and downwelling irradiance.

In addition, experiments to assess the factors limiting photosynthetic rate are carried out while at sea. These experiments form the basis for our present conclusion that blooms and their magnitude are governed by the availability of nitrogen in the water column. In contrast, experiments concerning the role of inorganic phosphate show that it is never is limiting.

It is clear from our population stock data (chlorophyll) that the bloom sequence is a composite of two large and many smaller pulses of growth. The large blooms during early spring and fall are associated with the major climatic features associated with the formation or destruction of the thermocline. The occurrence of smaller pulses during the summer appear to be related to turbulent vertical mixing. The sources of these energies needed to overcome the stratification of the water column are not clearly identified; local upwelling, internal waves, tides and near shore circulation are likely candidates.

The original goals of the proposed research: "To pinpoint the cause of the onset of the spring bloom", now seem more difficult than previously supposed. In an attempt to reconstruct the seasonal sequences we have reviewed the earlier ideas associated with vertical mixing and phytoplankton growth (critical depth). In a general manner these have been applied to New England Coastal waters as an attempt at a first order estimate of the importance of critical mixing depths. The weakest aspect of the approach is the use of temperature-density as an index of vertical mixing and the lack of precise measurements of respiration. However, with "reasonable" estimates of these parameters vertical mixing appears to be very critical to coastal populations especially in shallow turbid waters. The rate of vertical mixing in the spring bloom sequence is further complicated by the intrusion of freshwater into the coastal waters. This is at a maximum during the period of the bloom. The freshwater from this system has a dual role consisting of 1) nutrient addition and 2) water column stabilization. Of the two, the nutrient problem appears to be the minimal one while the increased stability induced by freshwater can greatly restrict the vertical transport of phytoplankton in the water column. This allows the cells of the population to receive a larger share of the light energy in the water column, which accelerates growth.

The fall pulse clearly reflects the breakdown of the summer thermocline - with water temperature still high and abundant light energy - vertical mixing allows the euphotic zone to be replenished with nutrients. Thus, the impoverished population experiences accelerated growth.

One of the surprising things about these blooms is their rapid decline. This rate equals the rate of growth. It is difficult to argue high rates of grazing by zooplankton especially early during the season when so few animals are present. It would appear that the decline is attributed more to rapid sinking than grazing which again points to nitrogen limitation which causes the cells to lose buoyancy. If this is true, then the New England Coastal Ecosystem appears to be one composed of a water column primary producers with secondary consumers confined to the benthos.

Meetings

At the society of Limnology and Oceanography, Charles Yentsch presented a paper on the measurement of Photosynthetic radiation. Dr. Yentsch has been elected by NASA to the NIMBUS team concerned with Coastal Ocean Color detection.

Part 4. b. - Equipment

Amount charged to equipment account was partial payment on a refrigeration unit/freezer which was purchased jointly on an equally shared basis with funds we received from the State of Maine.

Part 4. e.

Costs consist of chemicals, glassware, and filters consisting of approximately $2,998.31 while the remaining $646.28 consists of minor electrical wiring which was required for the initiation of the experiments performed as well as one seagoing lab bench (cost of $175.00) which we consider expendable due to the fact its life expectancy is less than one year.