Effects of Pollution on Phytoplankton Abundance in Coastal Waters of Dominica, W.I.

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Abstract:

Phytoplankton abundance is an important indicating factor for the health of coastal areas. Since they form the basis of the food web, their decline may indicate a decrease in the general health of the reef. In this study four sites were sampled (two polluted areas and two pristine areas), and cell counts were taken. Counts were then converted into the number of cells per milliliter of water volume. Results showed that the pristine areas have three times more phytoplankton than polluted areas. The obvious difference in abundance between polluted and pristine sites indicates that there are some potential problems that may affect the reef in the future. Further study should focus on increasing the numbers of samples taken and testing the water for what pollutants are present.

Introduction:

Phytoplankton are the primary producers in aquatic areas. The balance and maintenance of the food web depends upon the viability of the phytoplankton population in an area, since phytoplankton are the base of the web. Several factors affect the abundance of phytoplankton. Pollution, the factor considered in this study, changes the nutrient levels and the turbidity of the water. The marine planktonic diatom *Chaetoceros anastomosans* is affected by nutrient levels, and has been found to change from a vegetative cell phase to a resting spore phase in nitrate-depleted, high salinity water (Oku 1997). In a 1989 study on the dinoflagellates *Prorocentrum micans* and *Gonyaulax polyedra* by M. Vernet et al, it was found that, "in the near ultraviolet (UV), high attenuance and diminished photosynthetic effectiveness were observed in both dinoflagellates (Vernet 1989)." Thus, the wavelength of light reaching the phytoplankton can have an effect on their ability to photosynthesize.

In this study the differences in abundance of marine phytoplankton between polluted and pristine areas were examined. Samples were taken at four different sites along the Caribbean coast of Dominica, W.I.; two samples from polluted sites (Rodney's Rock and in front of Fort Young Hotel in Roseau), and two samples from pristine areas (Coulibistrie and Cabrits National Park).

Materials and Methods:

All samples were taken within a two-week period. The following is a list of sample sites and dates:

Rodney's Rock - May 23, 2000
Fort Young Hotel, Roseau - May 26, 2000
Coulibistrie - May 30, 2000
Cabrits National Park- May 30, 2000

The Rodney's Rock and Fort Young Hotel, Roseau, sample sites are both polluted areas. Pollution near Rodney's Rock originates from discharge from the Layou River and from wastes from the Colgate factory. The Fort Young Hotel sample site is near an urban area and a docking port for many large ships. The Coulibistrie and Cabrits National Park sample sites are both considered pristine areas, with no large amounts of pollutants being released or washed into the water.

Three different methods were used to collect the phytoplankton samples, all of which worked equally well. For the first sample, a ten meter long transect was laid out along the sea floor. Then a phytoplankton net was submerged in the water and towed while swimming above the line. For the second sample, the length along a pier was measured, and the net was towed for that distance by lowering the net into the water, and then walking along the pier. For the third and fourth samples, a distance was measured on the shore, and markers were placed at either end. After wading out to waist deep water, the markers were used as a reference of how far the net had been towed. The net was not placed in the water until the sample was to be taken, and was immediately removed from the water after being towed for the desired distance. This was to prevent inaccurate results. After returning to the beach, the sample was washed into a plastic sampling container by pouring fresh water down the outside of the net. To preserve the samples, they were stored in the refrigerator until they were ready to be analyzed.

To analyze the sample it was homogenized, two drops were placed on the counting grid of a Hemacytometer, and covered with a cover slip. The number of intact cells that were within the sixteen grid cells were counted; only intact cells were counted, because they were apparently alive just prior to preservation. Also, the phytoplankton cell had to be at least 50% inside a grid cell to be counted.

Using the knowledge that the volume of a sample above the 1 mm^2 grid is 0.1 mm^3, the number of cells found in the grid was multiplied by 10 to convert to the number of cells per mm^3, and then by 1000 to convert to the number of cells per milliliter (1 ml = 1 cm^3). Prior to sampling, the diameter of the phytoplankton net was measured (in cm), and the surface area of its opening was calculated using the following formula: S.A. = $(\pi)(\text{radius})^2$. The volume of seawater filtered by the net (in cm^3) was then calculated by multiplying the net surface area by the distance towed (in cm). Next, the number of cells per ml (calculated from the number of cells found on the grid) was multiplied by the volume of preserved sample to estimate the number of cells in the entire sample (total number of cells caught by the net). The number of cells in the entire sample was then divided by the volume of seawater filtered by the net to calculate the concentration of cells in the beachfront seawater at the time of sampling (number of cells per ml).

Results:

The amount of phytoplankton found in the polluted samples was conspicuously different from the amount found in the pristine areas (Table 1). There were approximately three times more cells per milliliter found in pristine samples than were in polluted ones. The types of cells found were very similar in both areas, although identification of the species was not possible due to limitations in the equipment.

Table 1: Phytoplankton Sampled - Polluted and Pristine Sites

Location	Date	Type of Area	Num. Cells/ml
Rodney's Rock	05/23/00	Polluted	4.5
Fort Young Hotel, Roseau	05/26/00	Polluted	5.8
Coulibistrie	05/30/00	Pristine	19.2
Cabrits National Park	05/30/00	Pristine	13.2

Discussion:

The obvious difference in abundance between polluted and pristine areas could indicate a potentially serious problem for organisms inhabiting the coastal waters of Dominica. If pollution is causing a decrease in phytoplankton abundance, the rest of the reef may soon decline, too. Bleaching is becoming a problem for coral species. This is caused by the loss of their zooxanthella, which are commensalistic phytoplankton that live inside the coral (S. Steiner, personal communication). One might speculate that the pollution is affecting the viability of the zooxanthella, thus leading to the death of the coral, since it cannot sustain itself without the algae.

Further study should focus on expanding the number of sample sites, and possibly doing a water quality analysis for the sample areas. This could help discern the exact types of pollutants in the water, and perhaps lead to a more definitive reason for the lower abundance of phytoplankton found in polluted areas. Two more excellent sample sites would be where wastes from the concrete factory are released into the Caribbean Sea (polluted area), and off of Scotts Head on the southern end of the island (pristine area).

References:

Works Cited

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Individuals Interviewed

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