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Phytoplankton Studies Within the Virginia Barrier Islands
I. Seasonal Study of Phytoplankton in Goose Lake, Parramore Island

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Abstract—The phytoplankton of Goose Lake, an oligohaline lake on Parramore Island, was studied for one year. The populations consisted primarily of ultraplankton and nanoplankton sized forms with diatoms and chiorophyceans dominant most of the year. A general pattern of seasonally higher cell concentrations in early summer and fall was noted, with an unidentified ultraplankton sized component prominent throughout the collection period. A list of 154 species is given.

Introduction

Parramore Island is located on the eastern shore of the Delmarva Peninsula in Accomack County, Virginia. It is part of the barrier island complex under the management of The Nature Conservancy and is located approximately 50 km northeast of the Chesapeake Bay entrance (37°32' N. Lat., 75°37' W. Long.). Parramore Island is approximately 13.3 by 3 km in size, with its long axis in a general northeast direction. The Island's eastern shoreline is bordered by a parallel series of relict dunes that extend to the island's interior, with elevations up to seven m and a well-developed floral cover. The island topography decreases in elevation along the southern and western margin where the vegetation blends into an extensive salt marsh. Goose Lake has formed between two of these relict dune lines, is finger-shaped and up to 1.5 mi in depth, with an area of approximately 0.07 km². The size varies with seasonal periods of heavy rain, and the occasional inundation of seawater through the southern end. To the south an earlier channel to Swash Bay and the numerous tidal guts of the bordering marsh have been blocked due to vegetational growth and the accumulation of autochthonous material. During flood periods from storm tides, saltwater entry may occur at this end of Goose Lake. The lake substrate consists of a mixture of silt, sand, detrital material, and various inorganic substances. It is black in color, soft in texture, and its anaerobic state is indicated by the hydrogen sulfide odor common to the bottom samples. More detrital material is found along the shoreline, where a variety of marginal wetland plants are established. A common submergent is Ruppia maritima.

Several previous phytoplankton studies have been conducted in the general area of the Barrier Islands. Nearshore phytoplankton, in the vicinity of Assateague Island, was studied by Marshall and Bowker (1976) regarding the composition and concentration of cells in relation to chlorophyll values. Their samples were dominated by several species of diatoms and the dinoflagellate Ceratium tripos, with the diatoms representing 55% of the composition at the station nearest Assateague Island. In a seasonal study of the phytoplankton within the channels of the Barrier Island complex, Marshall, Nesius and Cibik (1980) found Skeletonema costatum the dominant species throughout the year. They noted the most common species in these channels were similar to the dominant phytoplankters in the continental shelf waters. A list of summer chlorophyceans and cyanophyceans from Accomack and Northampton Counties was made by Nemeth (1969), but none of his stations were on any of the Barrier Islands. His study emphasized fresh water sites and he recorded 102 chlorophyceans, 43 cyanophyceans, and 15 other species.

Methods

Goose Lake is centrally divided into a northern and southern half by an earthen mound constructed for the placement of a road across the island. Free flow between the 2 halves of the lake takes place through a culvert approximately 0.3 m in diameter placed at basin level. During each of the eight collection trips between October 1978 and October 1979, samples were taken from two stations located in each half of the lake. These surface water samples (500 ml) were preserved immediately with a buffered formalin solution. A settling and siphoning procedure was followed to obtain a 20-ml concentrate which was subsequently examined in a settling chamber with a Zeiss Inverted Plankton Microscope. Salinity readings were taken with a portable Beckman salinometer. The classification used in this report is based mainly on the revisions by Hendey (1974) and Parke and Dixon (1976).

Results and Discussion

Goose Lake is considered an oligohaline lake with generally low saline values (<5°/oo). Readings throughout the lake for the collection period indicated rather consistent salinities between 2 and 3°/oo. Occasionally, storm tide entry will occur from the southern end of
Goose Lake. Such an event was noted by Dr. James Matta of Old Dominion University on 25 October 1978. He took salinity readings at that time that indicated average values of 20.7°/oo in both the southern and northern sections of the lake. By 26 January 1979 the average salinity value for the entire lake had decreased to 2.5°/oo, where it remained at approximately that level into October 1980, with only slight variations between both sections.

A total of 154 phytoplankters was identified within the samples. The breakdown of species for the various taxonomic groups was as follows: Bacillariophyceae (61), Euglenophyceae (22), Cyanophyceae (18), Dinophyceae (8), Chlorophyceae (21), Cryptophyceae (2), Xanthophyceae (3), Haptophyceae (2), Prasinophyceae (2), Rhodophyceae (1), and one vascular plant Lemma minor. The phytoplankton community was dominated throughout the year by various diatoms and chlorophyceans, with various cyanophyceans prominent (see Table I). Seasonally there were early summer and fall maxima of numbers, with later summer and winter minima. Lowest concentrations occurred during winter (Figure 1).

The winter phytoplankton possessed two diverse size groups of diatoms. The large cells of Suriella striatula and Tropidoneis leptodoptera were very common in all the samples with the more abundant smaller diatoms, such as Navicula salinarum, Amphora coffeaeformis, Navicula sp., Navicula maculata, and Nitzschia vermicularis. Nannochloris atomus was also dominant with several cyanophyceans (Anacystis marina, A. dimidiata, Oscillatoria submembranaceae), and the chlorophycean, Chlorella vulgaris, common in all samples. Lowest concentrations for the collection period were noted on 2 February 1979 when average cell counts were 67,240 cells/l. One of the dominant species during this period was unidentified, but under light microscopy resembled oocystaceans previously described in the literature (Bourrelly, 1966; Simpson and Van Valkenburg, 1978). This species was round, 4-5u in size, occurring often in groups of four, with what appeared as a "rough" and thickened outer wall.

The spring samples and the early summer bloom consisted mainly of several Pennales diatoms that were less than 30 um in length and several small Centrales forms. Navicula sp., Navicula arvensis, Epithemia argus, Stauroeis anceps and Nitzschia amphibia were found in high concentrations. Cyclotella meneghiniana and Ch. caspia were also prominent. Other conspicuous species included Euglena ehrenbergii, Nannochloris atomus, and Kirchneriella lunaris. High concentrations of green round to irregularly shaped forms, 1.2 to 2.5 µm in size, were in all the spring samples, plus an unidentified Centrales diatom with an average diameter of 3.6 µm. The unidentified 1.5 to 2.5 sized "cells" were not included in the cell counts, but easily would have surpassed the other taxa in number.

The early summer bloom continued into July with nanoplankton diatoms still dominant. However, the dominant phytoplankton assemblage was diverse in composition. Chaeotoceros debilis, Suriella striatula, Cyclotella striata, Navicula arvensis, Rhabdomena minutum, and the unknown Centrales (Cylindroprestis profunda?) were abundant. Phytoflagellates included Trachelomonas hyspida, T. volovicina var. puncta, Gymnodinium danicans, and Phacus longicauda. There were high concentrations of Anacystis marina, A. montana minor, and A. thermals. An unidentified Srenedesmus sp. was also abundant with Nannochloris atomus, Tetraedrom muticum, and Kirchneriella lunaris. The highest concentrations of the study occurred at this time with 1.78 million cells/l recorded on 27 June 1978. During this period there were large concentrations of Euteromorpha intestinalis common in the benthos in both sections of the lake. The broken fronds of this alga were floating at the surface and part of the phytoplankton community.

The phytoplankton in late summer was dominated by an early bloom of Cyclotella striata and Cyclotella caspia, with C. caspia retaining high concentrations into fall. A mixture of these and other small sized diatoms (< 30 µm) and blue green algae (Anacystis montana, Nostoc communae, Oscillatoria submembranacea) dominated the late summer flora. Several Oedogonium species were present, with Lemma minor (common duckweed) found in high concentrations at the surface in the southern section of Goose Lake. The lowest concentrations for summer were noted in late September with Cyclotella caspia, C. striata, and Nitzschia communis var. hyalina the dominant species.

The early fall period was accompanied by a sharp rise in the nanoplankters, with chlorophyceans, dia­
toms, and phytoflagellates abundant. The diatoms consisted of mainly Rhabdomena minutum, Nitzschia closterium, Cocconeis pendiculata, Nitzschia sp., and Cyclotella sp. The major flagellates were Chrysococcus minuta, and Cryptomonas sp., with the green algae Nannochloris atomus, Chlorella ellipsoidea and Chlorella vulgaris also numerous. Of interest was the

![Graph](https://via.placeholder.com/150)
presence of several *Euglena* species, mainly composed of *Euglena agilis*, *Euglena pumila*, and *Euglena ehrenbergii*. In addition, *Phacus* sp. #1 was also common. This seasonal bloom was distinct but smaller in magnitude in comparison to the early summer bloom.

The productivity pattern resulting from phytoplankton growth for the period of study was peak development during early summer (where average counts reached 1.7 million cells per liter on 29 June 1979). A marked reduction followed with a second surge of growth in fall reaching 0.9 million cells per liter on 29 October 1979 (Table 2). The pattern from fall 1978 was a gradual decline into winter, where lowest values occurred in February (67,240 cells/liter).

The seasonal populations at Goose Lake represented combinations of what are considered typical marine and fresh water species throughout the year, with fewer of the more common fresh water species found in winter. This pattern differs from composition studies made in the channels of the Barrier Islands and the coastal waters where marine diatoms dominated (Marshall et al., 1980; Marshall and Bowker, 1976). However, the unidentified ultraplankton component noted in Goose Lake was similar to what Marshall et al. (1980) reported within the Barrier Island channels. Different population assemblages were also present within the chlorophycean, cyanophycean, and euglenophycean groups in Goose Lake in comparison to those noted on the nearby mainland by Nemeth (1969).

### Table 1.

<table>
<thead>
<tr>
<th>Date</th>
<th>South Section</th>
<th>North Section</th>
<th>Average</th>
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<tbody>
<tr>
<td>13 Oct 78</td>
<td>364,320</td>
<td>539,400</td>
<td>452,000</td>
</tr>
<tr>
<td>2 Feb 79</td>
<td>46,800</td>
<td>87,800</td>
<td>67,240</td>
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<td>3 Jun 79</td>
<td>1,784,800</td>
<td>1,487,400</td>
<td>1,735,600</td>
</tr>
<tr>
<td>29 Jul 79</td>
<td>308,480</td>
<td>981,920</td>
<td>744,200</td>
</tr>
<tr>
<td>17 Sep 79</td>
<td>242,640</td>
<td>168,280</td>
<td>151,460</td>
</tr>
<tr>
<td>1 Oct 79</td>
<td>210,080</td>
<td>432,640</td>
<td>321,360</td>
</tr>
<tr>
<td>29 Oct 79</td>
<td>1,029,060</td>
<td>773,760</td>
<td>901,310</td>
</tr>
</tbody>
</table>

The nanoplankton composition has been generally defined by Strickland (1960) as having a size range of 10 to 50 µm, with those forms having sizes between 0.5 to 10 µm as belonging to the ulplanplankton. Using this classification, the major nanoplankton components in Goose Lake were the ultraplankton with another major group consisting of nanoplankters in the 10- to 20-µm size category. The more abundant ultraplankton were the diatoms *Cylindrotheca caspia*, *Navicula ato-

### Acknowledgements

Appreciation is given to Virginia Environmental Endowment for supporting this study under Grant 78-02. Further thanks is given to Dr. James F. Matta and Mr. James Cowan for assistance during the collection trips to Pamaramore Island.
Table 1. (continued)

<table>
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<th>Prasinophyceae</th>
<th>Chlorophyceae</th>
<th>Xanthophyceae</th>
<th>Chrysophyceae</th>
<th>Haptophyceae</th>
<th>Euglenophyceae</th>
<th>Dunaliella salina</th>
<th>Chromatocystis salina</th>
<th>Cryptomonas salina</th>
<th>Ochromonas salina</th>
<th>Chrysochromulina affinis</th>
<th>Ochromonas rhizophorae</th>
<th>Ochromonas variabilis</th>
<th>Ochromonas minutissima</th>
<th>Oocystis affinis</th>
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</table>

### Literature Cited


