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Harold G. Marshall
Old Dominion University, hmarshal@odu.edu

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Phytoplankton Studies Within the Virginia Barrier Islands. III. Phytoplankton Composition in a Saline Pond on Smith Island.

Harold G. Marshall
Department of Biological Sciences
Old Dominion University
Norfolk, Virginia 23508

ABSTRACT

The phytoplankton that characterized the Smith Island pond was diverse, with several species of diatoms, dinoflagellates, and bluegreen algae dominant throughout the year. A total of 146 species were noted, predominantly composed of ultra and nanoplankters, that includes representatives from coastal waters. The island ponds are considered eutrophic habitats whose composition is influenced by overwash conditions and in turn introduce populations to surrounding pools and water channels.

INTRODUCTION

Previous reports in this series presented the seasonal phytoplankton composition and population changes for Goose Lake, a small oligohaline lake located on Parramore Island, and the water channels among several of the Virginia Barrier Islands (Marshall, 1980; Marshall et al., 1981). A total of 154 species were noted in Goose Lake, where the populations were dominated by ultra and nanoplankton, with diatoms, chlorophyceans and cyanophyceans most common. Populations within the waterways were similar to offshore phytoplankters, and diatoms predominated throughout the year.

Smith Island is one of the southern most Barrier Islands located along the eastern coastline of the Delmarva Peninsula. It is in Virginia, located directly northeast of Cape Charles, between Fisherman and Myrtle Islands. Smith Island is approximately 12 km in length with an average width of about 0.85 km. A dune ridge is present on the seaward side, with a series of numerous, parallel and vegetative ridges in the southern end of the island. Extensive marsh and mud flats compose major portions of the island from the northern end southward to about 3/4 of its length. Higher elevation characterizes the southern portion, with salt marsh and scattered ponds located between the interior dune ridges. Based on field observations, a pond was selected in this southern sector as representative of the numerous ponds that characterize this low land area. This is a permanent pond, elongated in shape, varying in width from 1.5 to 3.5 meters and approximately 80 meters long, with a maximum depth of 0.65 meters. It is located within an open area, surrounded by wetlands plants (e.g. *Spartina alterniflora, Spartina patens, Distichlis spicata*), but contains no standing or submerged vegetation. The pond bottom is black in color, composed of a high silt composition mixed with sand and strands of the surrounding vegetation in various stages of decay. Upon disturbing the bottom substrate, H_2S is commonly noted. The pond water is usually light amber in color. Salt water intrusion occurs during high storm tides. Fluctuations in water depth were also noted during the year, being mainly influenced by periods of high precipitation and subsequent drainage into the pond, or the occasional tidal entry. Throughout the sampling period there was standing water present, with the lowest pond depth being 0.35 m.

The purpose of this study is to present the phytoplankton composition for one of the permanent ponds within the Virginia Barrier Islands complex. This is a common habitat within the island complex that represents a unique ecological setting for pond study. Seasonal assemblages and dominant species will be discussed for spring, summer, and fall months.

METHODS

Collections were taken during ten trips to Smith Island from 7 October 1981 to 9 October 1982. Two other trips during winter were aborted due to inclement weather conditions. 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 of a Zeiss inverted plankton microscope. Salinity readings were taken with a portable Beckman salinometer.

RESULTS AND DISCUSSION

The Smith Island pond would be classified as mixohaline, with a wide range of salinity values through the year. Those recorded during this study ranged from 12 to 30‰, with the majority of values less than 22‰. A total of 146 species were identified for this pond and are given in Table 1. The total phytoplankton was dominated numerically by small diatoms, cyanophyceans, and chlorophyceans. Maximum concentrations occurred during the summer, with greatest diversity of species in the fall and lowest concentrations in spring. No collections were made during winter.

Several patterns found in this pond study compare closely to those observed at Goose Lake on Parramore Island (Marshall, 1980). Summer was the period of highest cell concentrations with the dominant species in the ultra- and nanoplankton size categories. Several *Cyclotella*, *Anacystis*, and *Chlorella* species composed the prominent ultraplankton in both habitats. *Gymnodinium danicans* was also the dominant dinoflagellate at Goose Lake, but the dinoflagellates were more abundant and diverse at the Smith Island pond. Species in low concentrations, but seasonally common were *Amphora* sp., *Cylindrotheca closterium*, *Nitzschia longissima*, *Tropedoneis lepidoptera*, *Ochromonas* sp. and *Anacystis cyanea*. Approximately 40% of the species in the Smith Island pond were also noted in the Goose Lake study. Those phytoplankters that were only recorded in the pond were the more typical estuarine and marine types indicative of saltwater intrusion. In contrast, the species recorded at Goose Lake, but not in the pond, consisted of common lake species from the Atlantic coastal plain represented by broader representation from the chlorophyceae, euglenophyceae, and a different assemblage of bacillariophyceae. The greater influence of salt water intrusion was evident in the phytoplankton composition of the Smith Island pond. In contrast to these results, Nemeth (1969) observed a variety of chlorophyceans and cyanophyceans in eight fresh water ponds during a summer survey on Delmarva Peninsula. The dominant populations included a variety of desmids, *Scenedesmus* spp., *Tetraedron* spp., and *Spirogyra* spp. that were not found in the Smith Island Pond. The Cyanophyceae assemblage reported by Nemeth was also different, being characterized by numerous filamentous forms (e.g., *Oscillatoria* spp., *Phormidium* spp., and *Anabaena* spp.). In the Smith Island Pond, the dominant Cyanophyceae included *Nostoc commune*, *Lyngbya aestuarii*, and *Spirulina subsalsa*.

Further attention is needed for the unidentified category of cells noted in this study, which were grouped according to size (<3 µm, 3-5 µm). Most of these appeared to be either cyanophyceans or chlorophyceans. They were generally spherically to oblong in shape, non-flagellated, green in color, with a smooth surface. Species distinction within these cells, and within the *Chlorella* and *Anacystis* groups is often difficult. The author questions the separation of several of these into multiple species categories and supports the re-evaluation of the marine *Chlorella* species (*C. marina*, *C. salina*) and the status of *Nannochloris atomus* as discussed by Sarokin and Carpenter (1982). Gradations are common in this *Chlorella* "complex" and these forms appear to be habitat variations of *Chlorella vulgaris*.

In addition to the phytoplankton populations in Smith pond, mention of the prominent zooplankton fauna should be given. The zooplankton was dominated by rotifers, various nauplii stages, calanoid copepods, nematodes, and ciliates, with the occasional appearance of polychete and dipteran larvae. During the fall *Keratella cochlearis*, *Brachionus* sp., *Cephalodella* sp., and nauplii were most abundant. In late fall and early spring, nauplii, adult calanoid copepods, and nematodes were common. During the summer *Lecane* sp., *Cephalodella* sp., nauplii and nematodes were in high concentrations. The extent of the grazing influence of these zooplankton populations in determining the phytoplankton composition is unknown.

In summary, the Smith Island pond was mixohaline, shallow in depth, and lacking in submerged, and emergent vegetation. A permanent standing water habitat throughout the year, the phytoplankton composition was diverse, with ultra and nanoplankton sized species most abundant. The dominant species included diatoms, a chrysophycean, and a variety of cyanophyceans. These bluegreen algae have as a common dominant several *Anacystis* spp. along with a variety of filamentous species. The composition was also different from assemblages reported for fresh water ponds on Delmarva Peninsula.

The Virginia Barrier Islands contain a vast number of standing water habitats similar to the Smith Island pond. These sites and their biota are influenced throughout the year by overwash conditions which augment the population and assure the repeated entry of saline waters. The ponds receive drainage from the surrounding area, have a rich organic substrate, and frequently are visited by water fowl and small mammals that through defecation add to the nutrient base of the ponds. The populations that persist within these habitats are diverse, are mainly represented by small-sized species capable of a fast growth response, commonly found in high concentrations. These characterize an eutrophic condition within these pond habitats. The overwash conditions that flood these ponds will also influence the spreading of pond populations over the lower wetlands area to seed other ponds on the island, and to transport populations to the island channels and coastal waters. This innoculation and enrichment process functions in both landward and seaward directions, producing gradations of population similarities in the island ponds and coastal waters.

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Table 1. Phytoplankton identified in the Smith Island pond. Presence is noted with X; the more abundant species are indicated by A, B, C, with A being the most abundant.

	7 Oct 81	18 Oct	22 Nov	9 Mar 82	14 Apr	26 Jun	10 Jul	7 Aug	18 Sep	9 Oct
BACILLARIOPHYCEAE										
Amphiprora sp.	X	-	-	X	-	-	-	X	-	-
Amphiprora alata (Ehrenberg) Kützing	X	X	X	X	-	-	X	-	-	-
Amphiprora pulchra Bailey	X	-	-	-	-	-	-	-	-	-
Amphora sp.	X	X	X	X	X	-	X	X	X	X
Amphora coffeaeformis Kützing	-	-	-	-	X	-	-	-	-	-
Amphora granulata Gregory	X	X	-	-	-	-	X	-	-	-
Asterionella glacialis Castracane	-	X	-	-	-	-	-	-	-	-
Asterionella notata (Grunow) Grunow	-	X	-	-	-	-	-	-	-	-
Auricula complexa (Gregory) Cleve	X	-	X	-	-	-	-	-	-	-
Bacillaria paxillifer (Muller) Hendey	C	X	X	X	-	-	-	-	-	X
Biddulphia sinensis Greville	-	X	-	-	-	-	-	-	-	-
Caloneis westii (Smith) Hendey	-	X	-	-	-	-	-	-	-	-
Chaetoceros curvisetum Cleve	-	X	-	-	-	-	-	-	-	-
Chaetoceros debilis Cleve	-	A	-	-	-	-	-	-	-	-
Chaetoceros sociale Lauder	-	-	-	-	-	-	-	-	-	X
Cocconeis sp.	-	X	-	-	-	-	-	-	-	-
Coscinodiscus sp.	-	-	-	X	-	-	-	-	-	-
Cyclotella sp.	X	X	C	X	-	C	-	X	-	A
Cyclotella caspia Grunow	X	-	-	-	-	-	-	X	-	C
Cyclotella glomerata Bachman	-	B	-	-	X	-	-	-	-	A
Cyclotella meneghiniana Kützing	X	X	C	-	X	A	B	-	-	-
Cylindrotheca closterium (Ehrenberg) Reiman et Lewin	X	X	-	X	C	X	X	-	X	B
Cymbella sp. #1	X	-	-	-	X	-	-	-	-	-
Cymbella sp. #2	-	X	-	-	-	-	-	-	-	-
Diploneis crabro Ehrenberg	-	X	-	-	-	-	-	-	-	-
Ditylum brightwellii (West) Grunow	-	X	X	-	-	-	-	-	-	-
Eunotia praerupta Ehrenberg	-	-	-	-	X	-	-	-	X	X
Fragilaria sp.	X	X	X	-	X	-	-	-	-	-
Gyrosigma sp.	X	-	-	-	-	-	-	-	-	-
Gyrosigma balticum (Ehrenberg) Cleve	-	-	-	-	X	-	-	-	-	-
Gyrosigma wansbeckii (Donkin) Cleve	X	-	-	X	-	-	-	-	-	-
Hantzschia amphioxys (Ehrenberg) Grunow	-	-	-	X	-	-	-	-	-	-

Table 1. (continued)

	7 Oct 81	18 Oct	22 Nov	9 Mar 82	14 Apr	26 Jun	10 Jul	7 Aug	18 Sep	9 Oct
Leptocylindrus danicus Cleve	-	X	-	-	-	-	-	-	-	X
Licmophora sp.	-	-	-	X	-	-	-	-	-	-
Licmophora paradoxa (Lyngbye) Agardh	-	-	-	X	-	-	-	-	-	-
Melosira distans (Ehrenberg) Kützing	-	-	-	X	-	-	-	-	-	-
Melosira moniliformis (Muller) Agardh	X	-	-	-	X	-	-	-	-	-
Melosira nummuloides (Dillwyn) Agardh	-	-	-	-	-	-	-	-	-	X
Navicula sp. #1	X	-	-	-	X	X	-	-	X	X
Navicula sp. #2	X	X	X	C	X	-	X	-	-	-
Navicula arvensis Hustedt	-	C	-	X	-	-	X	-	-	-
Navicula spicula (Dickie) Clebe	-	-	-	A	-	-	-	-	-	-
Nitzschia sp.	X	X	X	X	-	-	-	-	X	-
Nitzschia clausii Hantzsch	X	-	-	-	X	-	-	-	-	-
Nitzschia longissima (Brébisson) Ralfs	C	B	X	-	-	X	X	X	X	-
Nitzschia paradoxa (Gmelin) Grun	-	X	-	-	-	-	-	-	-	-
Nitzschia sigma (Kützing) Smith	-	X	X	-	-	-	-	-	-	X
Nitzschia vermicularis (Kützing) Hantzsch	X	-	-	-	-	-	-	-	-	-
Pinnularia sp.	X	-	-	-	-	-	-	-	-	X
Pinnularia major (Kützing) Rabenhorst	X	-	-	-	-	-	-	-	-	-
Plagiogramma sp.	X	-	-	-	-	-	-	-	-	-
Rhizosolenia alata Brightwell	-	X	-	-	-	-	-	-	-	-
Rhizosolenia delicatula Cleve	-	X	-	-	-	-	-	-	-	-
Skeletonema costatum (Greville) Cleve	-	X	-	-	-	-	-	-	-	-
Stenopterobia anceps (Lewis) Brébisson	-	-	-	X	-	-	-	-	-	-
Stephanopyxis palmeriana (Greville) Grunow	-	X	-	-	-	-	-	-	-	-
Surirella sp.	-	-	-	-	-	X	-	-	-	-
Surirella fastuosa Ehrenberg	-	X	X	X	-	-	-	-	-	-
Surirella striatula Turpin	-	-	X	-	-	-	-	-	-	-
Synedra sp.	-	-	-	-	-	-	-	X	-	-
Thalassionema nitzschioides Hustedt	X	X	-	-	-	-	-	-	-	-
Thalassiosira sp.	-	-	X	-	-	-	-	-	-	-
Tropedoneis lepidoptera (Gregory) Cleve	X	X	X	-	X	X	X	-	X	X
Unidentified centrales	-	-	-	-	-	-	X	-	-	X
Unidentified pennales	X	X	-	-	X	X	-	-	X	X
CRYPTOPHYCEAE										
Chroomonas sp.	X	X	-	-	-	-	-	-	-	-
Chroomonas caroliniana Campbell	A	-	-	-	-	-	A	X	X	X
Cryptomonas sp. #1	C	-	X	-	-	-	X	-	-	-
Cryptomonas sp. #2	-	-	-	-	-	-	-	X	-	-
CHLOROPHYCEAE										
Chlamydomonas sp.	-	-	X	-	-	-	-	-	-	-
Chlorella sp.	X	X	-	-	-	-	X	X	X	X
Chlorella vulgaris Beyerinck	-	X	-	X	-	X	-	X	X	X
Cladophora sp.	X	-	-	-	-	-	C	X	A	-

Table 1. (continued)

	7 Oct 81	18 Oct	22 Nov	9 Mar 82	14 Apr	26 Jun	10 Jul	7 Aug	18 Sep	9 Oct
Cladophora glomerata Kützing	-	-	-	-	-	-	-	-	X	-
Nannochloris atomus Butcher	X	C	-	-	-	-	-	X	X	X
Oedogonium sp. #1	X	X	-	X	X	-	-	-	X	-
Oedogonium sp. #2	X	-	-	-	-	-	-	-	-	-
Scenedesmus sp. #1	-	-	X	-	X	-	-	-	-	-
Scenedesmus sp. #2	-	-	-	-	X	-	-	-	-	-
<u>CHRYSOPHYCEAE</u>										
Chrysococcus minutus (Fritsch) Nygaard	-	-	-	-	X	-	-	-	-	-
Ochromonas sp.	X	-	C	X	C	X	X	X	X	X
Ochromonas miniscula Conrad	X	X	-	-	-	-	-	-	-	-
Ochromonas variabilis Meyer	X	-	-	-	X	-	-	-	-	-
<u>CYANOPHYCEAE</u>										
Agmenellum quadriduplicatum (Meneghini) Brebisson	-	-	X	-	-	-	-	-	-	-
Anabaena confervoides Reinsch	-	-	-	-	-	-	-	X	-	-
Anabaena laxa Rabenhorst	-	-	X	-	-	-	-	-	-	-
Anacystis aeruginosa Drouet et Daily	C	-	X	-	C	-	-	X	X	X
Anacystis cyanea (Kützing) Drouet et Daily	X	X	X	-	X	-	X	X	A	X
Anacystis dimidiata (Kützing) Drouet et Daily	X	X	-	-	-	-	-	-	X	X
Anacystis marina (Hansgrig) Drouet et Daily	X	X	-	-	-	-	X	X	X	X
Aphanizomenon flos-aquae (L.) Ralfs	-	-	-	-	-	-	-	-	X	-
Calothrix aeruginea (Kützing) Thuret	-	-	-	-	-	-	-	-	X	-
Coccochloris elabens Drouet et Daily	-	-	-	-	X	-	-	-	-	-
Gomphosphaeria aponina Kützing	X	-	-	-	-	X	X	-	-	X
Johannesbaptistia pellucida (Dickie) Taylor et Drouet	X	X	-	C	X	-	X	-	-	X
Lyngbya aestuarii (Mert.) Liebmann	-	-	-	X	-	-	B	-	X	-
Lyngbya confervoides Agardh	X	X	-	-	-	-	-	-	-	-
Lyngbya semiplena Agardh	-	-	-	X	-	-	-	-	-	-
Microcoleus vaginatus (Vaucher) Gomont	-	X	X	-	-	-	-	-	-	-
Nodularia sp.	-	-	-	X	-	-	-	-	-	-
Nodularia spumigena Mertens	X	-	-	X	C	-	X	-	-	-
Nostoc sp.	X	-	-	-	-	-	-	-	-	-
Nostoc commune Vaucher	X	-	-	-	X	X	B	-	X	-
Oscillatoria sp. #1	X	X	-	X	X	-	-	-	-	X
Oscillatoria sp. #2	X	X	-	-	-	-	-	-	-	X
Oscillatoria curviceps Agardh	-	-	-	-	-	-	-	-	-	X
Oscillatoria erythraea (Ehrenberg) Kutzing	-	X	-	-	-	-	-	-	-	-
Oscillatoria ornata Kützing	-	-	-	X	-	-	-	-	-	-
Oscillatoria principes Vaucher	-	-	-	-	-	-	-	-	X	C
Oscillatoria submembranacea Ardissone et Strafforella	X	X	-	X	X	-	X	-	X	X

Table 1. (continued)

	7 Oct 81	18 Oct	22 Nov	9 Mar 82	14 Apr	26 Jun	10 Jul	7 Aug	18 Sep	9 Oct
Scytonema siculum Borzi	-	-	-	X	-	-	-	-	X	-
Spirulina subsalsa Oersted	X	X	X	-	X	C	X	-	X	X
EUGLENOPHYCEAE										
Euglena sp.	C	-	-	-	-	-	-	-	-	-
Euglena acus Ehrenberg	X	-	-	-	-	-	-	-	-	-
Euglena proxima Dangeard	A	-	X	-	-	-	-	-	-	X
Euglena pumila Campbell	X	-	-	-	-	-	-	-	X	-
Eutreptia lanowii Steuer	X	-	-	-	-	X	-	-	-	-
Eutreptia viridis Perty										
Trachelomonas hispida (Perty) Stein	-	-	X	-	X	-	-	-	-	-
DINOPHYCEAE										
Ceratium lineatum (Ehrenberg) Cleve	-	-	-	-	-	X	-	-	-	-
Glenodinium danicum Paulsen	C	C	X	-	-	-	-	X	C	C
Glenodinium rotundum (Lebour) Schiller	-	-	-	-	-	-	-	-	X	X
Gonyaulax sp. #1	-	X	-	-	-	-	-	-	-	-
Gonyaulax sp. #2	X	-	-	-	-	-	-	-	X	X
Gonyaulax orientalis Lindem	A	X	-	-	-	-	-	-	-	-
Gymnodinium sp.	-	-	-	-	-	-	-	B	X	X
Gymnodinium danicans Campbell	-	X	-	-	X	A	A	A	C	-
Gymnodinium roseostigma Campbell	-	X	-	-	-	-	-	-	-	-
Gyrodinium sp.	-	-	-	-	-	-	X	-	X	-
Gyrodinium estuariale Hulburt	X	-	-	-	-	-	-	C	X	-
Gyrodinium uncatenum Hulburt	-	-	-	-	-	X	X	X	-	X
Prorocentrum cassubicum (Woloszynska) Dodge	X	-	-	-	-	-	X	-	-	-
Prorocentrum lima (Ehrenberg) Dodge	-	-	-	-	-	-	X	-	-	-
Protoperidinium sp.	X	-	-	-	-	C	X	-	-	-
Protoperidinium brevipes (Paulsen) Balech	X	-	-	-	-	X	C	-	-	-
Protoperidinium aciculiferum Lemmermann	X	-	-	-	-	X	C	A	X	C
Protoperidinium oceanicum VanHoffen	X	-	-	-	-	-	-	-	-	-
Dinoflagellate cysts	X	-	-	-	-	X	-	-	-	-
Unidentified dinoflagellates	X	X	X	-	-	X	X	X	X	X
HAPTOPHYCEAE										
Hymenomonas roseola Stein	X	-	-	-	-	-	-	-	-	-
PRASINOPHYCEAE										
Pyramimonas sp.	-	-	-	X	-	-	-	-	-	-
Tetraselmis sp.	-	-	-	-	-	-	-	X	-	-
Tetraselmis gracilis (Kylin) Butcher	X	-	-	-	-	-	-	-	-	-

Table 1. (continued)

	7 Oct 81	18 Oct	22 Nov	9 Mar 82	14 Apr	26 Jun	10 Jul	7 Aug	18 Sep	9 Oct
Tetraselmis maculata (Kylin) Butcher	-	X	-	-	-	-	-	-	B	-
Tetraselmis striata Butcher	-	-	-	-	-	-	-	-	X	X
XANTHOPHYCEAE										
Stipitococcus sp.	-	X	-	-	-	-	-	-	-	-
Tribonema sp.	-	-	-	-	X	-	-	-	-	-
Tribonema minus (Willie) Hazen	-	-	-	-	-	-	-	-	X	-
Tribonema angustissimum Pascher	-	-	X	-	X	-	X	-	X	X
Tribonema taeniatum Pascher	-	-	-	-	X	-	-	-	-	-
Unidentified cells <3 µm	X	X	-	X	X	-	X	X	X	X
Unidentified cells 3-5 µm	X	-	-	X	-	X	X	X	-	X