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SUMMARY

Research on the ecology of Delaware's tidal salt marshes has focused on nutrient and energy budgets of such areas. The flux of various forms of phosphorus and nitrogen in the water entering and leaving the marshes has been investigated, the role of bacteria in nutrient cycling has been studied and the production of the angiosperms has been estimated. The role of algae in this system has not been previously investigated. In this study some aspects of the algae's role in the nutrient and energy cycles and the ecological factors that influence this role have been measured.

Five distinct algal communities were found in the marsh. The composition of the communities changed with changing season. The productivity of these communities also varied over the year. In some areas productivity was highest in the warmer months, while in others it was greatest in late winter and early spring. The high productivity in late winter and early spring is especially significant since it occurs at a time when the grasses are not producing. At that time the algae represent the only input of living material at the bottom of the food pyramid.

The ecological factors influencing the community structure and productivity of the salt marsh algae that were measured

indicated that these organisms are often subjected to severe stress. Nutrient levels fluctuated widely, salinities were often much higher than sea water, temperatures at the soil surface reached 10 to 15° C above air temperature, and light intensity changed from a few hundred foot candles to many thousand as leaves moved in the wind.

Experimental evaluation of some of these ecological factors on community structure and productivity is planned for 1970-71.

INTRODUCTION

Research on the ecology of Delaware's tidal salt marshes has focused on nutrient and energy budgets of such areas. The flux of various forms of phosphorus and nitrogen in the water entering and leaving the marshes has been investigated, the role of bacteria in nutrient cycling has been studied and the production of the angiosperms has been estimated. The research covered in this report deals with certain aspects of the roles the edaphic algae and the sediment communities play in the marsh ecosystem.

Five stations were established which were typical of those areas comprising almost the total acreage of the marsh. Figure 1 indicated the location of the Canary Creek Marsh and Figure 2 shows the location of the five stations within the marsh.

This report includes field data collected from July 1969 through May 1970. Most of the laboratory data for that time period is also included, although some samples have not yet been completely processed.

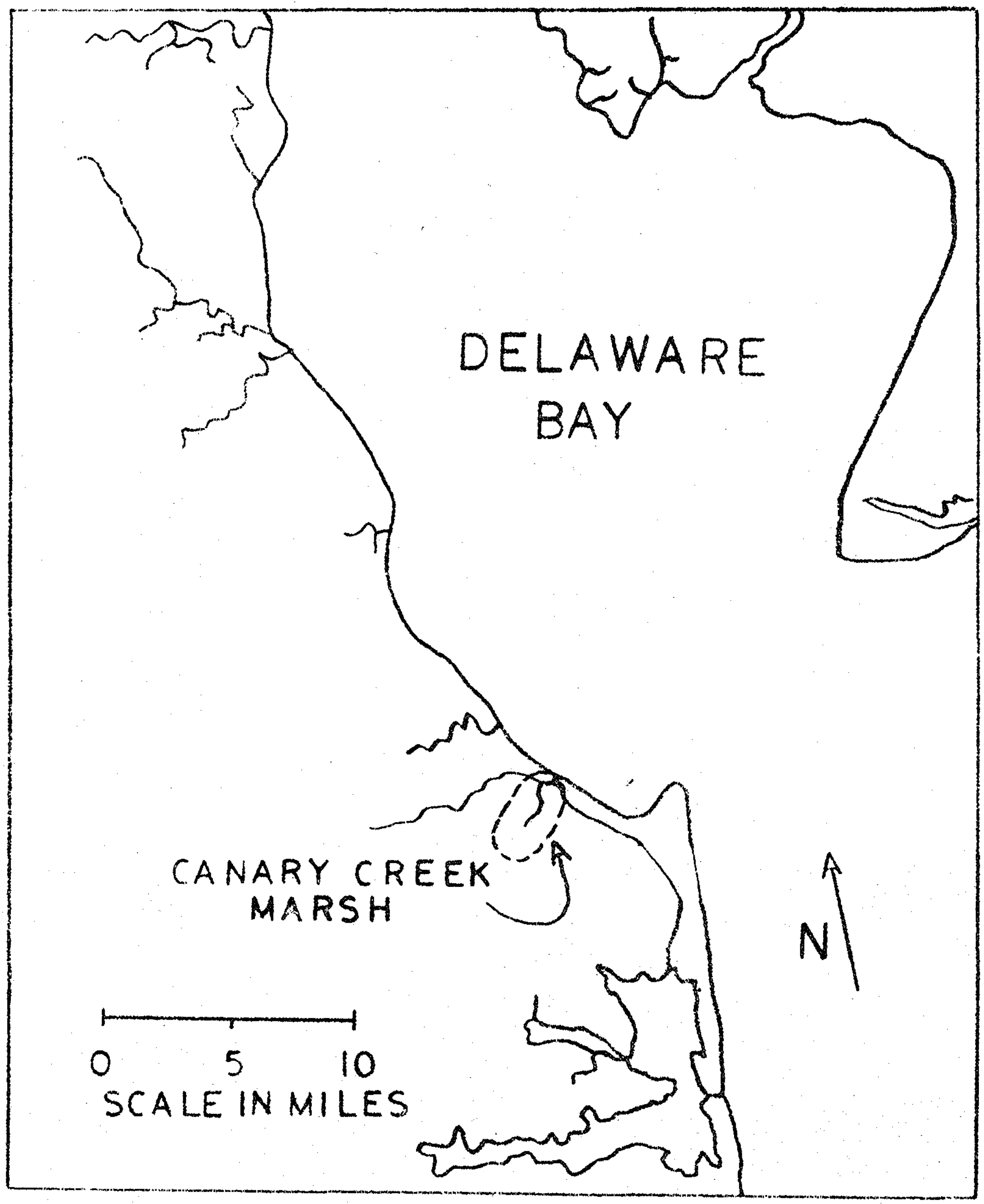


Figure 1. A map of the Delaware Bay region showing the location of the Canary Creek Marsh.

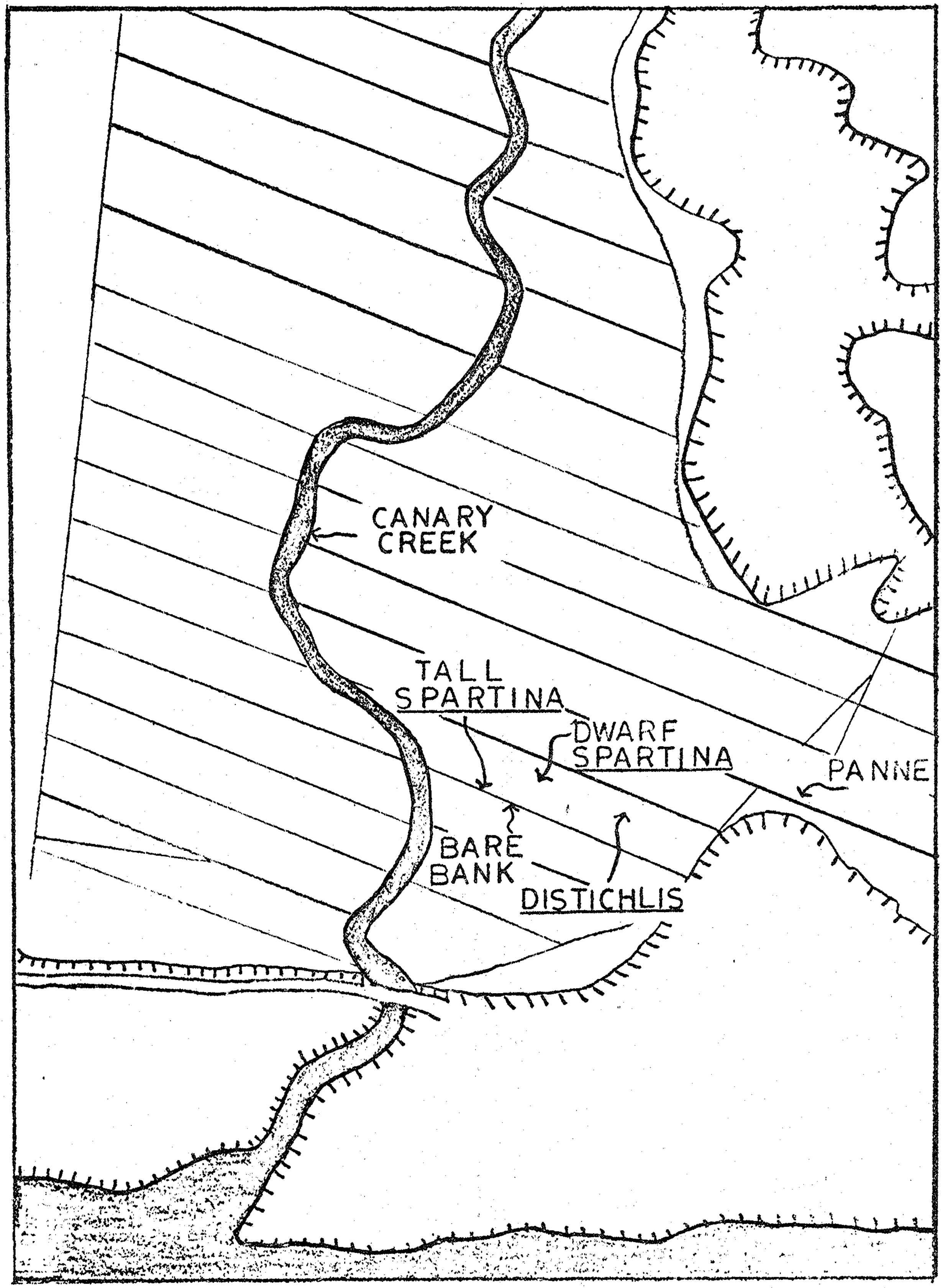


Figure 2. A map of the lower Canary Creek Marsh showing the location of the stations.

ENVIRONMENTAL CHARACTERIZATION

This section of the report presents details of the attempt to characterize some of the environmental factors which influence the life processes of the edaphic communities. The factors measured were light intensity, temperature, salinity (surface and interstitial water), pH (surface water and sediment), nutrients in the surface water (inorganic phosphate, total soluble phosphorus, nitrite, nitrate) and the nitrogen and phosphorus contents of the *Spartina alterniflora*, dwarf form.

Light

Materials and Methods.

The light intensity at the soil surface and four feet above the surface was determined at each station at the time of each collection. A Weston Master V light meter fitted with a Weston Invercone was used for all readings. The field meter was calibrated in the laboratory against a Weston Illumination Meter Model 756.

Results and Discussion.

The percentage of the illumination at four feet reaching the surface of the marsh at each station is shown in Table 1 and the height of the spermatophyte cover at each station is

Table 1. Percentage of the light intensity at four feet reaching the marsh surface at the Canary Creek Marsh stations.

Date	Station				
	Tall Spartina	Bare Bank	Dwarf Spartina	Distichlis	Panne
7/24/69	18	100	31	13	100
8/13/69	3	100	21	12	100
9/3/69	6	100	31	43	100
9/27/69	2	100	42	3	53
10/18/69	5	100	27	17	100
11/8/69	23	100	36	31	100
11/29/69	7	100	36	10	100
12/20/69	35	100	21	10	100
1/10/70	**	**	**	**	**
1/27/70	68	100	29	41	100
2/21/70	29	100	36	8	100
3/14/70	25	100	27	15	100
4/4/70	25	100	29	16	100
4/25/70	30	100	24	25	100
5/16/70	16	100	24	39	100

** no determination made.

shown in Table 2. The percentage of light reaching the marsh surface depends on many factors, the most important of which is the spermatophyte cover. Factors such as cloud cover, angle of the sun, water depth and wind are among those that contribute to the percentage of light penetrating to the marsh surface.

Since the collections were timed to take place when the tide was fairly low, a layer of water was not present when the measurements were made on the bare bank. The other area without spermatophyte cover, the panne, was covered with a shallow layer of water (1-2 cm) during 75% of the collections. The reduction of the light penetration to 53% of the total on 27 September was caused by a 6 centimeter layer of water on the panne.

Of the three areas with spermatophyte cover, only tall <u>Spartina</u> exhibited an appreciable change in height. From Table 2 it appears that the most rapid growth in height occurs in August. This burst of growth corresponds to the time of flower spike elongation. The next dramatic change in cover height occurred in November when the stems lodged. Although the light intensity reaching the surface was higher than it was during the late summer and early fall, the broken stems still formed a fairly effective screen. The new growth became a factor in May. In the other two areas the dead stems and leaves remained upright throughout the winter.

The percentage of light reaching the surface in the tall <u>Spartina</u> area corresponds well with spermatophyte height. The

Table 2. Height of spermatophyte cover in centimeters at the Canary Creek Marsh stations.

Date	Station: Tall Spartina	Bare Bank	Dwarf Spartina	Distichlis	Panne
7/24/69	85	0	20	23	0
8/13/69	80	0	25	32	0
9/3/69	157	0	32	32	0
9/27/69	135	0	25	30	0
10/18/69	125	0	30	30	0
11/8/69	135	0	25	26	0
11/29/69	125	0	30	30	0
12/20/69	40	0	25	26	0
1/10/70	**	**	**	**	**
1/27/70	30	0	25	30	0
2/21/70	30	0	25	30	0
3/14/70	35	0	25	30	0
4/4/70	20	0	25	28	0
4/25/70	20(16*)	0	25(11*)	30(8*)	0
5/16/70	20(40*)	0	25(20*)	30(15*)	0

* new growth
** no determination made

greatest seasonal change in the percent of mid-day illumination reaching the marsh surface (2-68) was also seen in this area. In the areas studied, dwarf *Spartina* and *Distichlis* were almost identical in height, but since the growth habits of the two species are much different, the light regimes are much different. *Spartina* is upright, fairly widely spaced and provides a fairly uniform screen. The dwarf form, which normally doesn't flower, provides a relatively constant screen throughout the year. *Distichlis*, on the other hand, forms a less uniform screen. The fine-stemmed plants grow in thick stands which tend to lodge, creating a dense screen in some places while providing a more open habitat in others.

It should be kept in mind that although the light readings in Table 1 are averages of several observations they represent only one time during the day, and that except for general trends they can only be used to indicate the situation at a given time and place.

In summary, the areas without spermatophyte cover receive full sunlight except when water covers the marsh. The greatest seasonal variation in mid-day light reaching the surface occurs in the tall *Spartina* where light intensities are lowest in summer. Compared to the *Distichlis*, the screening effect of the dwarf *Spartina* is less, but more uniform from season to season. The quality of the light getting through the vegetation no doubt changes as the pigment content of the leaves changes. This aspect of the algal environment could be an area for future study.

pH

Materials and Methods.

The pH of the surface water was determined with an Orion Specific Ion Meter (Model 401) equipped with a Fisher combination electrode. Soil pH was determined with the same meter using a soil solution composed of one volume of soil and two volumes of distilled water which had equilibrated for ten minutes.

Results and Discussion.

The results are shown in Table 3. A comparison of the surface water pH values for the tall *Spartina* station which is in the lateral ditch, the mouth of which is known in previous annual reports as Station 5 is interesting. The values found at low slack water at Station 5 in 1968-69 correspond closely with those in the tall *Spartina* area in 1969-70 until February. At that time the pH in the tall *Spartina* area rose above 8.00 for the next four collections. This change can probably be attributed to the increased algal productivity at this time and the consequent depletion of CO_2 in the water back from the mouth of the ditch. A similar increase in pH of the surface water in the *Distichlis* area can be seen in association with the late winter and early spring algal activity.

The highest surface water pH rose above nine several times.

Table 3. pH of the surface water and sediments at the Canary Creek Marsh station.

		Station				
Date	cm Depth	Tall Spartina	Bare Bank	Dwarf Spartina	Distichlis	Panne
7/24/69	+1	7.57	*	7.56	7.32	8.81
	0	**	**	**	**	**
	-1	**	**	**	**	**
	-2	**	**	**	**	**
8/13/69	+1	**	*	7.25	7.79	9.15
	0	7.65	7.25	6.45	7.60	9.00
	-1	7.75	7.35	6.30	7.40	7.90
	-2	7.85	7.20	6.75	7.10	8.00
9/3/69	+1	7.40	*	*	7.50	*
	0	7.57	7.00	6.25	7.20	7.20
	-1	7.60	7.10	6.29	7.64	6.85
	-2	7.60	7.10	6.55	7.40	6.90
9/27/69	+1	**	*	**	**	**
	0	7.32	7.35	6.70	7.23	7.35
	-1	7.63	7.30	6.50	7.20	7.20
	-2	7.90	7.30	6.55	7.10	7.02
10/18/69	+1	7.75	*	7.58	7.73	8.45
	0	7.75	7.30	6.85	7.30	7.80
	-1	8.05	7.34	6.85	7.38	7.20
	-2	8.13	7.37	6.65	7.38	7.25
11/8/69	+1	7.25	*	7.95	7.83	7.63
	0	7.25	7.43	6.90	7.05	7.40
	-1	7.40	7.35	6.60	7.30	7.33
	-2	7.75	7.53	6.35	7.12	7.13
11/29/69	+1	7.95	*	*	7.37	*
	0	7.70	7.73	7.50	7.60	7.84
	-1	7.92	7.57	6.95	7.40	7.80
	-2	8.30	7.83	7.20	7.45	7.25
12/20/69	+1	**	*	*	**	*
	0	7.45	7.55	7.00	7.00	7.15
	-1	7.63	7.70	6.97	7.10	7.35
	-2	7.90	7.65	7.00	7.35	7.15
1/10/70		Marsh frozen				

Table 3 continued.

Date	cm Depth	Station: Tall Spartina	Bare Bank	Dwarf Spartina	Distichlis	Panne
1/27/70	+1	7.87	*	8.13	7.90	8.22
	0	7.35	6.87	6.80	7.35	7.58
	-1	7.50	6.93	6.58	7.35	7.20
	-2	7.70	6.75	6.60	7.50	6.90
2/21/70	+1	8.10	*	*	8.44	*
	00	7.72	7.92	6.93	7.40	7.73
	-1	7.80	7.72	6.78	7.40	8.05
	-2	8.15	7.66	6.72	7.13	7.35
3/14/70	+1	8.40	*	8.45	8.35	9.10
	0	7.85	7.55	7.30	7.23	7.55
	-1	7.95	7.50	7.30	7.30	7.70
	-2	8.00	7.10	6.90	7.28	6.75
4/11/70	+1	8.44	*	8.15	8.25	8.80
	0	7.57	7.58	6.80	6.95	7.50
	-1	7.70	7.55	6.70	6.80	7.63
	-2	7.83	7.50	6.57	7.05	6.85
4/25/70	+1	8.01	*	7.92	8.40	8.80
	0	7.80	7.10	7.20	6.90	7.35
	-1	7.93	7.40	7.04	7.20	7.60
	-2	8.10	7.45	6.95	7.05	7.20
5/11/70	+1	7.70	*	*	*	*
	0	7.83	7.80	6.63	7.50	7.80
	-1	8.00	7.30	6.13	7.30	7.10
	-2	8.00	6.80	6.43	7.40	6.88

* no water
** no determination made

The high pH probably reflects algal activity and the isolation of the area from frequent tidal inundation.

Although the pH of solutions such as the surface water is rather straight forward, the pH of the soil is an uncertain quantity both with regard to measurement and interpretation (Lyon, Buchman and Brady, 1950). In soil-water systems that are not too concentrated, pH approximates the hydronium ion concentration of the soil water. The pH of the interstitial water in turn depends on the cation exchange capacity of the clays and organic matter present. In spite of the cautions which must be expressed, several generalizations can be made even before an extensive study of the problem is made. First, the pH of the soil in the dwarf *Spartina* area was usually much more acid than that of the other areas. Second, increasing pH with increasing soil depth for the first few centimeters in the tall *Spartina* area seems to be a pattern which is fairly consistent. Third, the difference in the pH between the overlying water and the soil pH is least, as would be expected, in the two areas where the soil-water interface is the least distinct, the tall *Spartina* and the *Distichlis*.

Nitrogen and Phosphorus Content of *Spartina*

Materials and Methods.

Samples of dwarf form *Spartina alterniflora* were collected from an area adjacent to the dwarf *Spartina* station. The above-ground parts and the underground parts still embedded in the soil, to a depth of 20 centimeters, were collected and returned to the laboratory in plastic bags. The soil was carefully washed from the plants and the leaves, crowns, rhizomes, primary and secondary roots were separated and the dried samples were run at leisure. Total nitrogen and phosphorus content (as percent dry weight) were determined by the methods in Official Methods of Analysis (Association of Official Agricultural Chemists, 1965).

Results and Discussion.

The percentage of nitrogen and phosphorus in various parts of *Spartina alterniflora*, dwarf form, at various times during the year are seen in Table 4. Only a relatively few samples have been analyzed, but a few trends are emerging. The secondary roots have a consistently high nitrogen content, whereas the leaves appear to be highest when they are young. An explanation for the apparent increase in the nitrogen content of the dead leaves in late winter and spring would be only a speculation at this time.

In the case of phosphorus, the content of the leaves paralleled fairly closely that of nitrogen. As with the nitrogen data, more samples must be assayed before the potential effect of the nutrients in the living and dead *Spartina* on the ecology of the algae can be assessed.

Table 4. Nitrogen and phosphorus contents (% of dry weight) of various structures of the dwarf form of <u>Spartina alterniflora</u> from Canary Creek Marsh.

Date	Leaves N	Leaves P	Crowns N	Crowns P	Rhizomes N	Rhizomes P	Primary Roots N	Primary Roots P	Secondary Roots N	Secondary Roots P
13 Aug.	1.163	.204	*	*	*	*	.876	.114	1.689	.058
27 Sept.	1.216	.280	.947	.101	.550	.088	*	.088	1.183	.202
8 Nov.	1.094	.171	1.030	*	.753	*	1.027	.085	1.662	.170
20 Dec.	.744	.134	1.105	.040	.887	.033	1.158	*	1.639	*
27 Jan.	.751	.122	.855	.104	.695	*	.619	*	1.598	*
14 Mar.	.987	.188	.959	.067	.776	.096	.820	.034	1.603	.199
25 Apr.	' 1.133 '' 1.849	.212 .244	.556	*	.827	.144	.639	*	1.598	.250

' old

'' new

* no determination made because insufficient sample material could be collected.

Nutrient Content of Surface Water

Materials and Methods.

Surface water samples were collected from the tall *Spartina*, dwarf *Spartina*, *Distichlis*, and Panne stations. The surface water was drawn off by means of a syringe and collected in stoppered bottles. After their collection, the samples were immediately filtered through Gelman glass fibre filters (type A) at a pressure of 80-100 Hg upon return to the laboratory. The filtered samples were then frozen until analysis. The entire process from collection of the sample until freezing normally took less than 3-4 hours. The samples were analyzed for the following and the procedures used were: nitrate (Kahn and Brezenski, 1967); nitrite (Strickland and Parsons, 1968); dissolved inorganic phosphorus (Murphy and Riley, 1962) and dissolved total phosphorus (Menzel and Corwin, 1965).

Results and Discussion.

Although the values fluctuate widely in some cases for each of the chemical species analyzed (no surface water was present in some cases) some interesting trends can still be seen. The concentrations of each chemical for the four stations are given in Tables 5 through 8.

There are two periods of low nitrate concentrations for the four stations which includes the fall collections (10/18/69 and 11/8/69) and the spring collections (3/14/70, 4/11/70, and

Table 5. Nitrate concentration (μg-at/l) in surface water covering study areas of the Canary Creek Salt Marsh.

Date	Tall Spartina	Dwarf Spartina	Distichlis	Panne
7/24/69	3.10	2.61	1.64	1.15
8/13/69	11.33	20.19	4.07	2.42
9/3/69	5.43	N.W.	8.15	N.W.
9/27/69	5.33	3.29	4.55	8.34
10/18/69	1.74	0	0	1.93
11/8/69	0	0.08	1.15	0.96
11/29/69	8.73	N.W.	3.48	N.W.
12/20/69	1.93	N.W.	1.74	N.W.
1/27/70	20.00	5.72	3.58	2.22
2/21/70	19.90	N.W.	0	N.W.
3/14/70	0	1.93	**	4.85
4/11/70	0	0	0	0.47
4/25/70	2.51	0.18	0	0
5/16/70	2.90	N.W.	N.W.	N.W.

N.W. indicates no surface water present at that station.

** determination not made.

0 indicates concentrations below level of detection.

Table 6. Nitrite concentration (µg-at/l) in surface water covering study areas of the Canary Creek Salt Marsh.

Date	Tall Spartina	Dwarf Spartina	Distichlis	Panne
7/24/69	.551	.007	.007	.026
8/13/69	2.735	1.021	.090	.035
9/3/69	.993	N.W.	.330	N.W.
9/27/69	1.390	.671	1.602	1.675
10/18/69	.404	.026	.044	.063
11/8/69	.284	.035	.017	.275
11/29/69	.634	N.W.	.090	N.W.
12/20/69	.284	N.W.	.035	N.W.
1/27/70	.588	.284	.256	.146
2/21/70	1.362	N.W.	.053	N.W.
3/14/70	.100	.044	.035	.081
4/11/70	.100	.072	.100	.081
4/25/70	.570	.109	.090	.072
5/16/70	.764	N.W.	N.W.	N.W.

N.W. indicates no surface water present at that station.

Table 7. Dissolved inorganic phosphorus concentration (µg-at/l) in surface water covering study areas of the Canary Creek Salt Marsh.

Date	Tall Spartina	Dwarf Spartina	Distichlis	Panne
7/24/69	6.357	0.667	1.596	2.167
8/13/69	0.619	0.286	5.881	2.571
9/3/69	25.23	N.W.	67.26	N.W.
9/27/69	1.333	0.476	1.333	1.595
10/18/69	14.83	0.786	1.500	0.643
11/8/69	9.214	0.643	0.738	0.810
11/29/69	1.714	N.W.	4.667	N.W.
12/20/69	4.214	N.W.	1.643	N.W.
1/27/70	0.857	0.476	0.928	0.357
2/21/70	1.667	N.W.	1.143	N.W.
3/14/70	1.571	0.429	1.048	0.429
4/11/70	0.476	0.405	2.690	0.262
4/25/70	1.976	7.857	0	0.268
5/16/70	5.950	N.W.	N.W.	N.W.

N.W. indicates no surface water present at that station.

O indicates concentration below level of detection.

Table 8. Total dissolved phosphorus concentration (µg-at/l) in surface water covering study areas of the Canary Creek Salt Marsh.

Date	Tall Spartina	Dwarf Spartina	Distichlis	Panne
7/24/69	7.000	1.252	2.329	2.605
8/13/69	0.837	3.710	7.549	4.013
9/3/69	26.92	N.W.	57.57	N.W.
9/27/69	1.720	0.948	1.720	1.859
10/18/69	16.11	1.141	3.489	1.307
11/8/69	2.411	0.699	1.472	0.754
11/29/69	1.831	N.W.	5.671	N.W.
12/20/69	24.90	N.W.	2.301	N.W.
1/27/70	1.085	1.362	1.619	1.714
2/21/70	2.108	N.W.	2.080	N.W.
3/14/70	2.356	1.472	1.583	**
4/11/70	1.169	2.881	3.710	2.356
4/25/70	3.461	3.406	3.958	1.638
5/16/70	7.290	N.W.	N.W.	N.W.

N.W. indicates no surface water present at that station.

** determination not made.

4/25/70). Low nitrate concentrations in the late fall and in the spring are in agreement with the results of the annual report of 1969. The nitrate values in the spring were frequently zero which is in agreement with the great surge of activity supported by productivity data found later in this report. On the average, the nitrate concentration in the tall Spartina station was the highest.

The nitrite concentrations were generally higher in the fall for each of the four stations, and usually the highest at the tall Spartina station. It should be noted that the highest values for both the tall Spartina and dwarf Spartina stations occurred in the August 13 collection.

The dissolved inorganic phosphorus concentrations in the summer and early fall correspond favorably with the low slack values of the 1969 annual report. Although the August 13 and September 27 collections may appear to be anomalies, the recorded values correspond with the high slack values found in the 1969 annual report. On these collection dates the tide was quite high and was in the flood stage with the water depth 24 and 10 cm respectively as opposed to the usual 1-2 cm, thus diluting the surface water covering the marsh surface. Dissolved inorganic phosphorus values were low during the winter collections.

Further analysis of the nutrient data will be made when samples have been collected and analyzed for a period of at least one year.

Temperature

Materials and Methods.

A Yellow Springs instrument model 42 SC thermistor was used to measure the temperature at the following levels:

(1) at 1.2 meters (4 feet) above ground level, the probe being shaded.

(2) at 3 cm, 2 cm, and 1 cm above the marsh surface and the marsh surface itself, the probe being exposed to sunlight.

(3) at 1 cm and 2 cm below the marsh surface.

Results and Discussion.

The temperature at each of the levels listed above are given for each station in Table 9. Graphs showing the temperature at the 1.2 meter level and at the marsh surface for each station are given in Figures 3 through 7, and the discussion will be based upon these.

In the tall *Spartina* the air temperature is greater than that of the marsh surface during the warmer months of the year. The tall *Spartina* plants insulate the tidal water in the ditch and is the cause of the above. From 3/14/70 to 4/25/70 the reverse is true, whereby the previous year's growth and the new growth insulate and warm up the surface water.

The marsh surface at the bare bank station is almost always

Table 9. Temperature in degrees centigrade for each study area of the Canary Creek Salt Marsh.

Date	Level	Tall Spartina	Bare Bank	Dwarf Spartina	Distichlis	Panne
7/24/69	1.2 m	22	23.5	23.5	23	21.5
	3 cm	21	24	24.5	23	22
	2 cm	21.5	24	24	23	22
	1 cm	22	24.5	23.5	23.5	22
	0 cm	22	26	23	23	22
	-1 cm	22	26	23.5	23	23
	-2 cm	22	25	23.5	23	23
8/13/69	1.2 m	26.5	26.5	25.5	27	29
	3 cm	25	28	26	28	29
	2 cm	25	29	26.5	29	30
	1 cm	25	29.5	27	29.5	34
	0 cm	26.5	32	25.5	29	35
	-1 cm	25	31.5	24.5	26	34.5
	-2 cm	24.5	29.5	23.5	25	32
9/3/69	1.2 m	26.5	26.5	28	29.5	27.5
	3 cm	25	27	28	28.5	28
	2 cm	25	27	28	28	28
	1 cm	24.5	27	28	28	28
	0 cm	24	28	27.5	26.5	29
	-1 cm	24	27.5	27	25.5	30
	-2 cm	23.5	26.5	26.5	25	28.5
9/27/69	1.2 m	24.5	24.5	24	24.5	26.5
	3 cm	23	23	23	23	21.5
	2 cm	23	23	22	23	21.5
	1 cm	23	23	21	23	21.5
	0 cm	22	24	22.5	23	22
	-1 cm	21	23.5	23	22	21.5
	-2 cm	21	23.5	22	21	21
10/18/69	1.2 m	13.5	17	14.5	16.5	19.5
	3 cm	13	16	15	16.5	19
	2 cm	13	16.5	15	16	19.5
	1 cm	13	16.5	15	15	20
	0 cm	11	18.5	14	13	22.5
	-1 cm	10	16	13.5	12	21
	-2 cm	10	13.5	12.5	11.5	18.5

Table 9 continued.

Date	Level	Tall Spartina	Bare Bank	Dwarf Spartina	Distichlis	Panne
11/8/69	1.2 m	11	11.5	10.5	10	11.5
	3 cm	12.5	12	11.5	10	11.5
	2 cm	12.5	12	11.5	10	13
	1 cm	12.5	12.5	11.5	10	13
	0 cm	12.5	17	12	11.5	13
	-1 cm	12	16.5	11.5	11	13
	-2 cm	12	16	11.5	11	13
11/29/69	1.2 m	8.5	11	10	9	9
	3 cm	8.5	11	14	9	10
	2 cm	8.5	11	14	10	10.5
	1 cm	8.5	11	14	12	11
	0 cm	8.5	11	12.5	10	14
	-1 cm	8.5	9	11	8.5	13
	-2 cm	8.5	8	10	8	11
12/20/69	1.2 m	1	2	2	3.5	2
	3 cm	1	2	2	3	2
	2 cm	1	2	2	3	2
	1 cm	1	2	2	3	2
	0 cm	1	1	2	2	3
	-1 cm	1	0	1	1.5	2.5
	-2 cm	1	-1	1	1.5	2
1/27/70	1.2 m	3	3	2	4	5
	3 cm	1	1.5	3.5	6	7
	2 cm	1	1.5	3.5	6	7.5
	1 cm	1	1.5	3.5	6	14
	0 cm	1	1.5	3	5.5	14
	-1 cm	1	1.5	2.5	5	12
	-2 cm	1	1.5	2	4.5	10
2/21/70	1.2 m	1	.5	2	1.5	3
	3 cm	-1	1	4	2.5	4
	2 cm	-1	1.5	4.5	3.5	4.5
	1 cm	-1	2	5	8	5
	0 cm	- .5	2.5	4	11	8
	-1 cm	- .5	0	- .5	5	5
	-2 cm	- .5	-1.5	- .5	2	2

Table 9 continued.

Date	Level	Tall Spartina	Bare Bank	Dwarf Spartina	Distichlis	Panne
3/14/70	1.2 m	5	5	5.5	7	7
	3 cm	5.5	8.5	9	8.5	10
	2 cm	6	9	9	10.5	11
	1 cm	6.5	9	10	10.5	16
	0 cm	7	12	9	10.5	16.5
	-1 cm	6.5	11	7	10	14.5
	-2 cm	5	9	5	7	12
4/11/70	1.2 m	7.5	9	9	11	10
	3 cm	10	10	12	14	13
	2 cm	10.5	10.5	14.5	14.5	13
	1 cm	11.5	11	15	22.5	21
	0 cm	12	16	19	24	22
	-1 cm	11.5	16	17	18	21.5
	-2 cm	11	14.5	15	14	19.5
4/25/70	1.2 m	17.5	18	19	19	20
	3 cm	18	18.5	19.5	19.5	24
	2 cm	18	18.5	20	20	28
	1 cm	20	19	23.5	23	28
	0 cm	19.5	22	24	24	28
	-1 cm	18.5	22	21	22	26.5
	-2 cm	16.5	19	16	21	22
5/16/70	1.2 m	19.5	18.5	18	17	21
	3 cm	19.5	18.5	18.5	18	21
	2 cm	19	18.5	19	18	21.5
	1 cm	18.5	19.5	19.5	18.5	22
	0 cm	18.5	23	21	20	29.5
	-1 cm	17	23	20	19	28
	-2 cm	16	21.5	18.5	17.5	22

Figure 3. Temperature (°C) at 1.2 meters above ground level and at the marsh surface for the tall *Spartina* station.

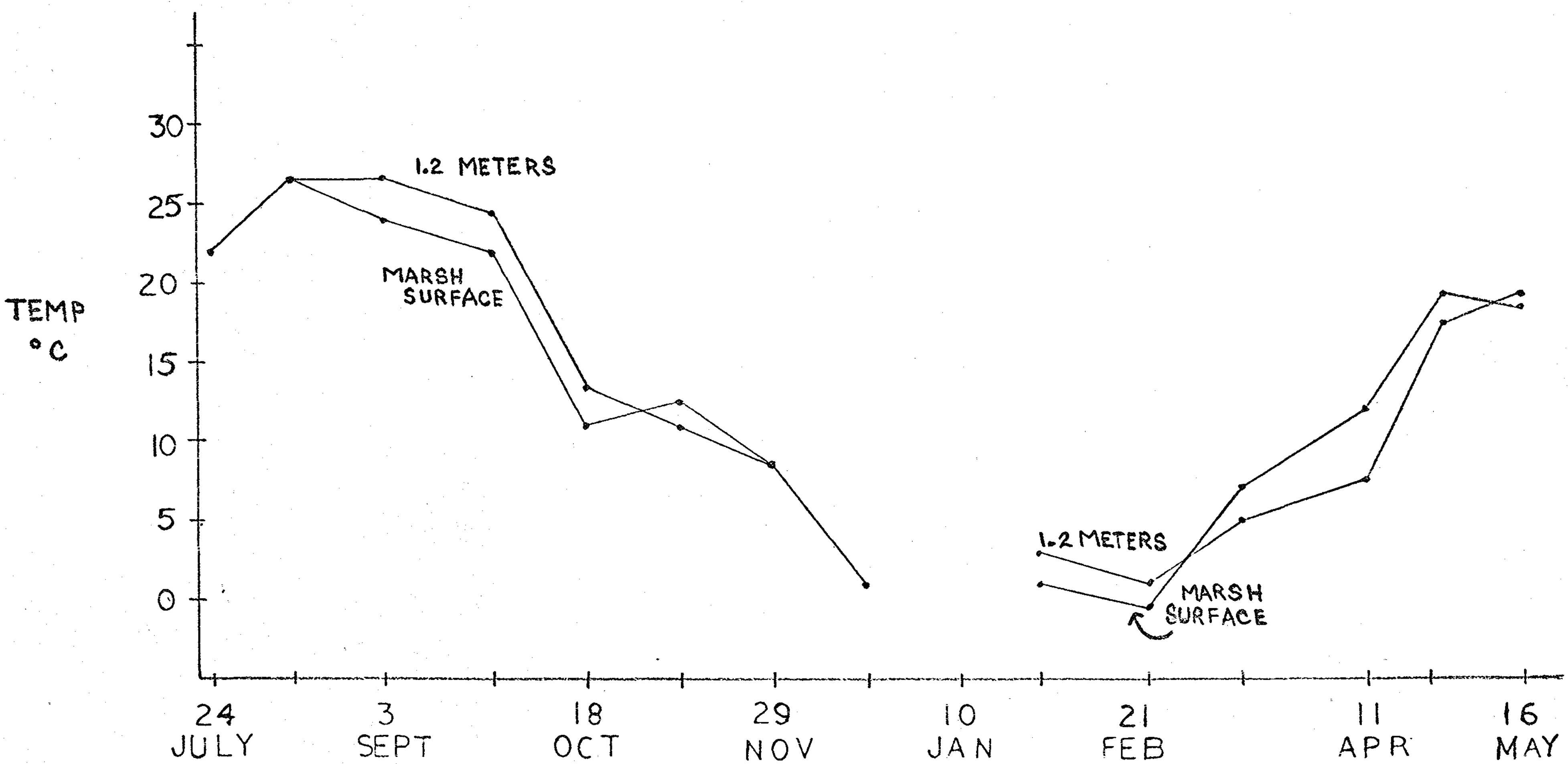


Figure 4. Temperature (°C) at 1.2 meters above ground level and at the marsh surface for the Bare Bank station.

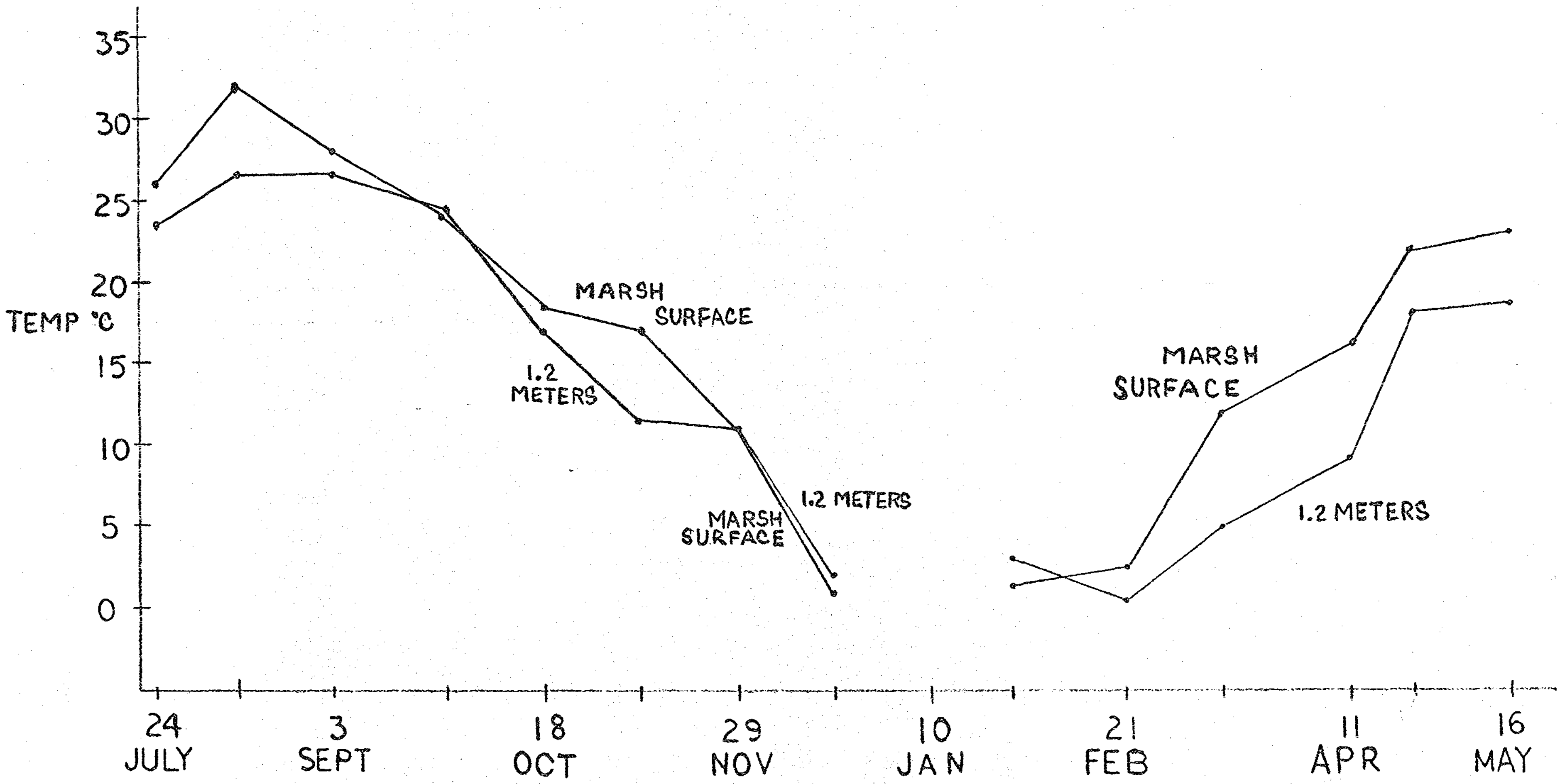


Figure 5. Temperature (°C) at 1.2 meters above ground level and at the marsh surface for the dwarf <u>Spartina</u> station.

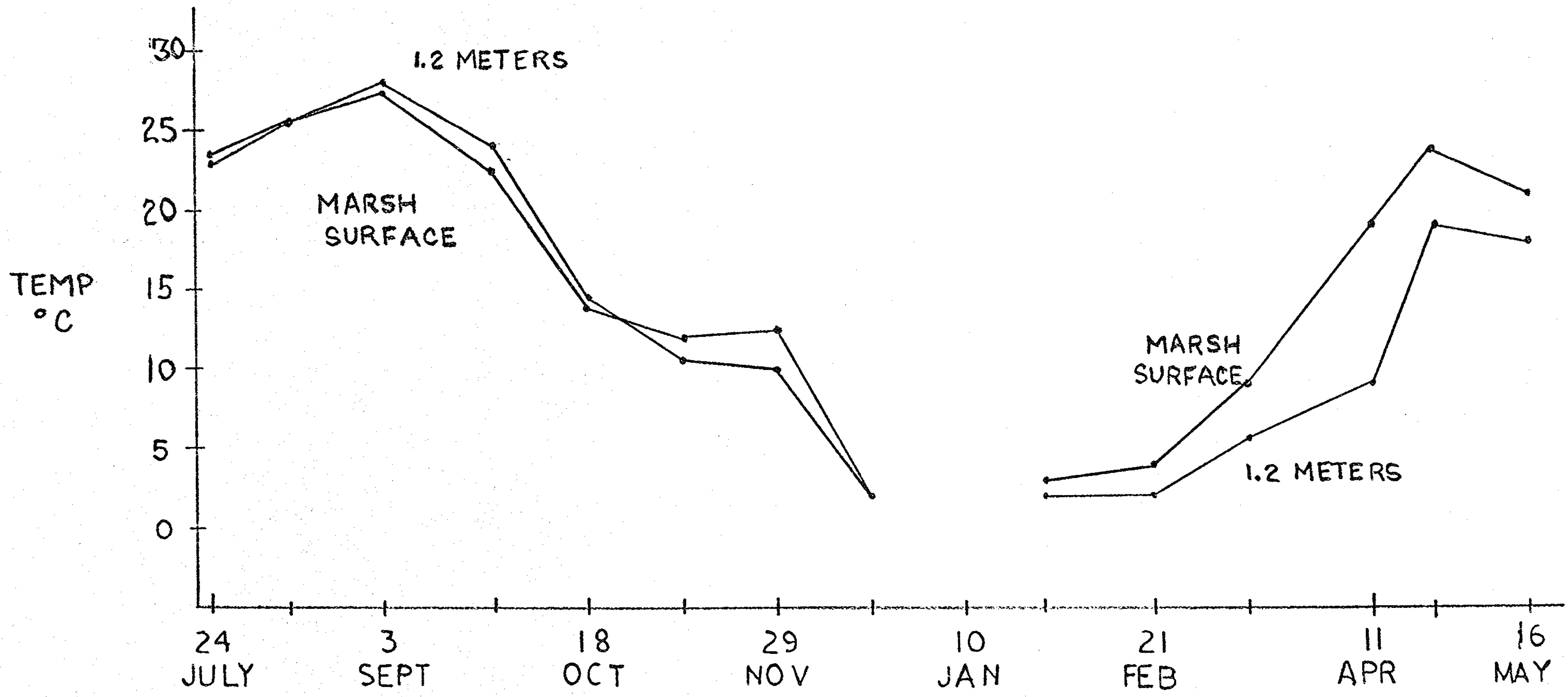


Figure 6. Temperature (^{o}C) at 1.2 meters above ground level and at the marsh surface for the *Distichlis* station.

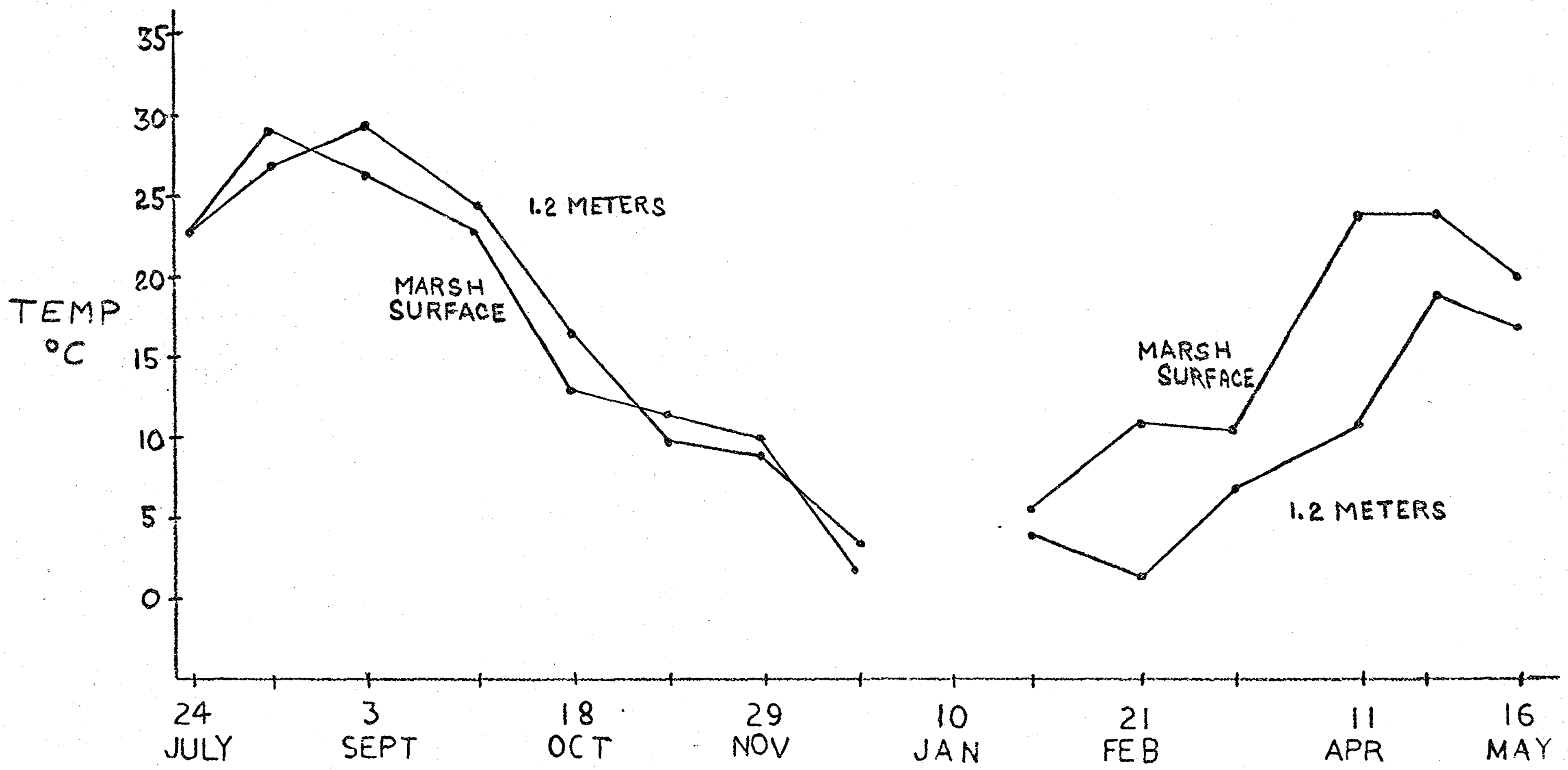
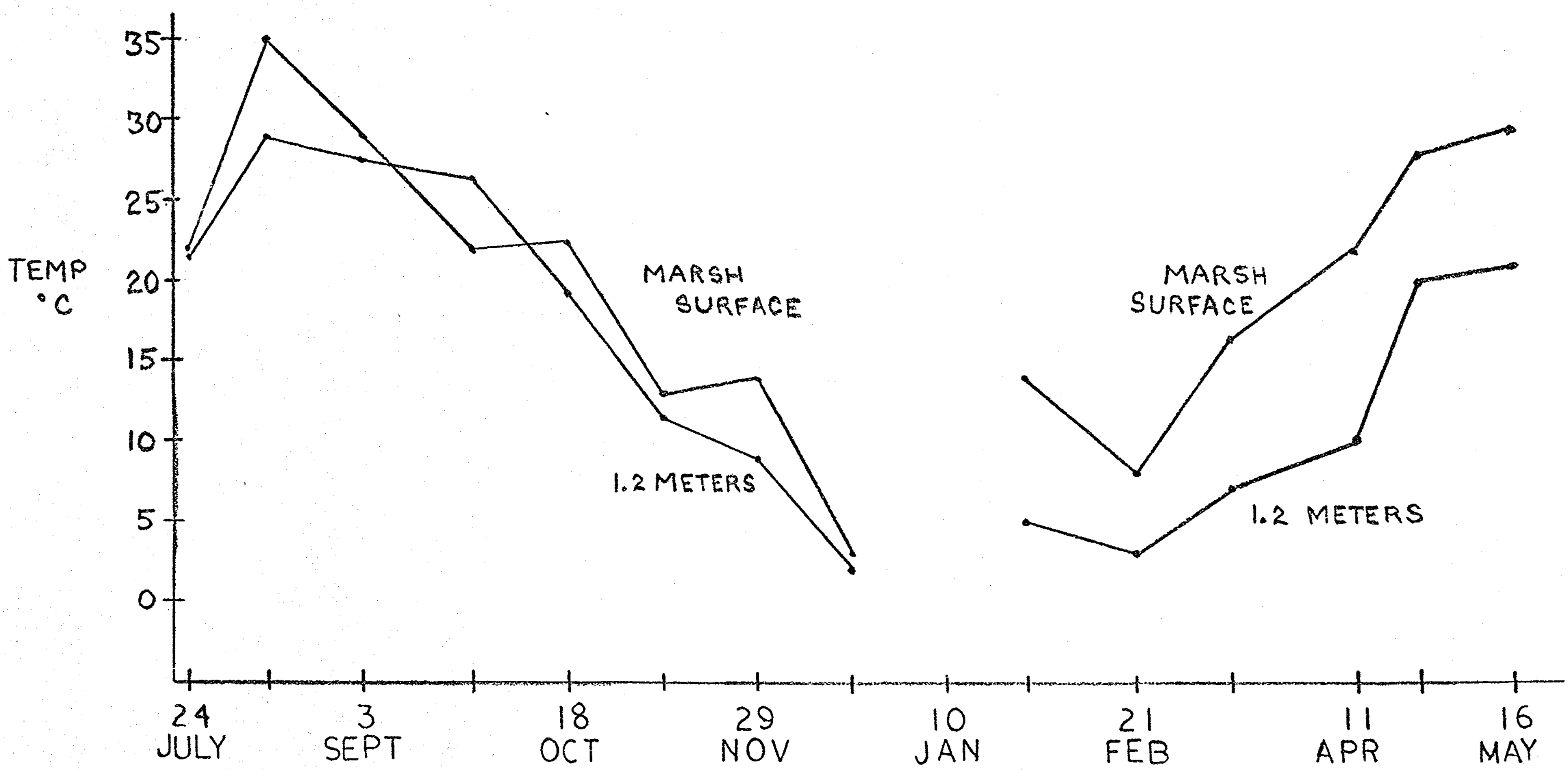


Figure 7. Temperature (^{o}C) at 1.2 meters above ground level and at the marsh surface for the Panne station.



warmer than the air temperature with the effect most pronounced in the spring months. This station is always sampled at the lower stage of the tidal cycle, thereby exposing the bare bank to the warming incident radiation.

The temperature of the air and the marsh surface of the dwarf Spartina station is very nearly the same from July 24 to December 20. The spacing of the dwarf Spartina plants is such to permit adequate aeration to accomplish this. From January 27 through May 16 the temperature of the marsh surface is always the highest. The plants themselves and the surface water are probably responsible for this result.

The dense growth of the Distichlis plants provides an insulating cover for the marsh surface which was covered with surface water except for the May 16 collection. The effect of this is slightly evident in the warmer months of the year and quite pronounced in the spring months.

The September 27 collection was the only one in which the air temperature was higher than that of the marsh surface for the panne. The panne is covered with a mat of blue-green algae in association with a diatom community. This algal mat may somehow absorb radiant energy in considerable amounts. The greatest temperature difference between the air and marsh surface occurred on March 14 and April 11 when there was one cm of water covering the algal mat. The surface water temperature was within one degree of that of the marsh surface on both collection dates.

Salinity

Materials and Methods.

The salinity of the surface water, if present, and the interstitial water of the marsh soil was determined. The surface water at each station was carefully drawn up with a syringe and its salinity was measured with a Goldberg refractometer. No surface water was ever present at the bare bank station, since sampling was always done at low tide. At each of the five collecting sites the salinity was measured at the following levels: the marsh surface, 1 centimeter and 2 centimeters below the soil horizon. The salinity of the interstitial water for each level was obtained by squeezing the soil sample in No. 2 filter paper in a syringe, until enough drops of soil-free water were obtained to get an accurate reading on the refractometer.

Results and Discussion.

The salinity of the surface water and interstitial water for each station is given in Table 10.

The salinity of the bare bank station ranged from 25.5 o/oo to 40 o/oo in the period from July 24 to February 21. Most values ranged between 30 o/oo and 35 o/oo. Peak values of 85 o/oo on April 11 and 135 o/oo on May 16 were recorded in the soil horizon. The May 16 collection resulted in the highest salinities for all the other stations except the tall *Spartina* due to the low tidal heights and weather conditions.

Table 10. Salinity in parts per thousand at each study area of the Canary Creek Salt Marsh.

Station	1969 7/24	1969 8/13	1969 9/3	1969 9/27	1969 10/18	1969 11/8	1969 11/29	1969 12/20	1970 1/27	1970 2/21	1970 3/14	1970 4/11	1970 4/25	1970 5/16
Bare Bank														
marsh surface	33.5	37	31.5	33.5	35.5	32	35	34	18	30	64	85	36	135
-1 cm	26.5	38	31.5	34	33	27.5	37	32	22	28	37	68	32	92
-2 cm	25.5	40	31.5	33	30	27	35	30	24	26	32	45	30	55
Tall *Spartina*														
surface water	29	26.5	30	*	30	*	28	28	28	22	26	30	22	24
marsh surface	32	27.5	31	29.5	31	29.5	31	32	26	22	30	29	24	26
-1 cm	29.5	29	31	29.5	31	29	30	30	27	28	33	28	25	28
-2 cm	29	28	32.5	29.5	30.5	28.5	32	30	28	28	29	28	26	30
Dwarf *Spartina*														
surface water	28	36	N.W.	*	30.5	*	N.W.	N.W.	18	N.W.	22	30	27	N.W.
marsh surface	31.5	34.5	49	31	34	28.5	34	34	16	26	32	32	32	53
-1 cm	30	37	47.5	31	34	28.5	34	32	18	22	31	30	32	50
-2 cm	31	35	47.5	33	34	29.5	34	33	24	25	32	26	29	40
Distichlis														
surface water	28	29	34	*	30.5	*	32	32	27	23	27	27	25	N.W.
marsh surface	30	30	34	31	33	28.5	32	32	32	28	30	32	26	44
-1 cm	29.5	30	34	32.5	32	29	31	30	38	30	30	32	26	40
-2 cm	31.5	30	34.5	33	33	28.5	32	32	34	28	32	32	27	34
Panne														
surface water	29	34	N.W.	*	31	*	N.W.	N.W.	24	N.W.	28	35	28	N.W.
marsh surface	50	44	98	35	35.5	32	58	60	32	40	30	38	31	185
-1 cm	44	39	76.5	32	35.5	31.5	48	48	32	34	32	38	30	115
-2 cm	56	38	57.5	37	36.5	32	42	51	34	37	38	42	35	75

N.W. indicates no surface water present at that station.
* indicates no determinations made.

The tall *Spartina* is found to be rather constant in the recorded salinities, being under constant influence of the tide and always having surface water unlike the other stations. The salinity of the surface water ranged from 22 o/oo to 30 o/oo while that of the interstitial water ranged from 22 o/oo to 32.5 o/oo. The values for the latter were almost always higher than that of the former.

In the dwarf *Spartina*, *Distichlis*, and panne, the highest salinities were always measured when there was no surface water. The high for the dwarf *Spartina* was 53 o/oo, for the *Distichlis*, 44 o/oo, and for the panne, 185 o/oo. All were measured on May 16 and represented interstitial water samples from the marsh surface. Whenever the salinity of the marsh surface was 44 o/oo or greater, the salinity decreased with depth. No such generalized pattern was found for the marsh as a whole. The salinity of the surface water for the above three stations varied between 18 o/oo and 36 o/oo, usually being in the 28 o/oo to 32 o/oo range. The interstitial salinity of the dwarf *Spartina* was on the average higher than that of the *Distichlis*, the latter more closely approximating the tall *Spartina*. The panne usually had the highest surface water and interstitial water salinities.

Looking at the marsh as an entity within itself, it is immediately evident that the interstitial environment has a highly variable salinity, being greater than that of the Broadkill River at the point it intersects with Canary Creek and sometimes reaching very high values. The end result is that a very saline environment usually exists and probably exerts great stress on the animal and plant communities living in the soil.

PRODUCTIVITY OF EDAPHIC MARSH ALGAE AND RESPIRATION AT THE MARSH SURFACE

Materials and Methods.

At approximately three week intervals, collections were made at the five aforementioned Canary Creek Marsh stations. Collections were always begun in the forenoon and finished by early afternoon. This procedure was followed in order to avoid the complication of sampling at different phases of any diurnal rhythms in photosynthesis, respiration and chlorophyll content which may exist.

A series of quadrats were established at each station and the ones to be sampled during each collection were selected from a table of random numbers. Four selected cores for pigment analysis were taken with cylindrical 1.65 cm diameter aluminum tubes. An additional core was taken from each of the productivity and respiration cores following the incubations. Samples were frozen in dry ice and held at -5° to -10°C until they were processed according to the procedures for spectrophotometric determination of chlorophylls and total carotenoids in Strickland and Parsons (1968).

The values reported in Tables 11 through 14 were computed using the trichromatic method. Chlorophyll a and phaeopigments reported in Tables 15 and 16 were determined by the acidification technique.

One randomly selected core for respiration and productivity measurements was taken with a 6.8 cm diameter acrylic plastic tube from each of the five areas. These explants were held at temperatures approximating those experienced in the field until the samples were processed the following day. Production and respiration were determined by measuring the change in dissolved oxygen level of water overlying the marsh explants in the light and in the dark. Temperatures during the incubation periods were close to those found at the time of collection and were held to within $\pm 1^{\circ}C$ of the stated temperature by a Forma-temp water bath. Light intensity was regulated by a mixture of fluorescent and incandescent bulbs with a maximum output of 21,500 lux.

Incubation times were one to two hours when the temperature was high and three hours when it was lower. The change in incubation time was necessary because of the changing seasonal respiratory and photosynthetic rates and the change in dissolved oxygen capacity of the water with changing temperature. At the end of the incubation period, triplicate water samples were siphoned from the cylinder and processed according to the method for dissolved oxygen determination of Strickland and Parsons (1968).

Table 11. Chlorophyll a (mg/M^2) in the upper centimeter of the marsh soil in Canary Creek Marsh.

	STATION									
Date	Tall Spartina Core	Tall Spartina Mean	Bare Bank Core	Bare Bank Mean	Dwarf Spartina Core	Dwarf Spartina Mean	Distichlis Core	Distichlis Mean	Panne Core	Panne Mean
24 July	27		63		225		178		518	
	94		75		357		148		754	
	157		50		292		177		339	
	99		93		266		149		1002	
	162		75		296		162		558	
		108		71		287		163		634
13 Aug.	339		94		377		445		589	
	122		79		333		202		963	
	329		290		285		179		760	
	132		79		237		**		774	
	154		59		412		139		756	
		215		120		329		241		768
3 Sept.	119		70		355		150		597	
	133		78		298		151		386	
	102		73		273		150		413	
	108		65		276		211		453	
	105		66		266		139		692	
		114		71		294		160		508
27 Sept.	137		41		306		194		508	
	157		62		253		154		471	
	57		86		263		206		644	
	102		65		267		54		413	
	**		16		187		160		906	
		113		54		255		154		588
18 Oct.	178		85		340		198		264	
	177		75		249		248		225	
	170		99		257		241		299	
	147		91		206		217		338	
	129		104		299		206		288	
		160		91		270		221		303
8 Nov.	148		103		262		200		457	
	202		84		230		207		863	
	249		85		367		136		750	
	200		105		316		205		687	
	196		93		375		187		685	
		199		94		310		187		688

Table 11 continued.

Date	STATION: Tall Spartina Core	Tall Spartina Mean	Bare Bank Core	Bare Bank Mean	Dwarf Spartina Core	Dwarf Spartina Mean	Distichlis Core	Distichlis Mean	Panne Core	Panne Mean
29 Nov.	222		113		307		189		208	
	237		89		505		641		692	
	206		88		294		135		680	
	346		110		297		262		1037	
	262		106		430		253		451	
		255		101		367		296		614
20 Dec.	202		111		336		242		480	
	192		111		230		258		334	
	231		108		319		109		738	
	63		331		294		230		434	
	236		93		294		197		500	
		185		151		295		207		497
27 Jan.	200		111		414		268		500	
	272		101		337		148		524	
	233		86		313		170		527	
	290		139		449		132		464	
	293		118		348		161		346	
		258		111		372		176		472
21 Feb.	315		116		422		251		338	
	396		118		504		266		388	
	323		129		510		370		420	
	422		179		300		309		581	
	237		106		371		182		530	
		339		130		421		276		452
14 Mar.	410		112		382		225		509	
	551		230		346		172		718	
	419		140		334		236		**	
	524		102		283		311		685	
	436		110		336		177		530	
		468		139		336		224		610

* produced calculated negative value.
** no determination made.

Table 12. Chlorophyll b (mg/M^2) in the upper centimeter of the marsh soil in Canary Creek Marsh.

	STATION									
Date	Tall Spartina		Bare Bank		Dwarf Spartina		Distichlis		Panne	
	Core	Mean	Core	Mean	Core	Mean	Core	Mean	Core	Mean
24 July	123		39		122		100		247	
	51		48		195		74		477	
	76		37		154		101		152	
	53		56		144		78		469	
	80		38		154		84		254	
		77		44		154		87		320
13 Aug	*		46		200		36		277	
	56		43		125		98		280	
	*		*		147		89		148	
	65		43		121		**		186	
	85		60		208		83		172	
		41		38		160		76		212
3 Sept.	64		46		262		81		251	
	68		54		183		86		218	
	56		43		157		81		222	
	64		37		145		131		266	
	54		40		90		83		489	
		61		44		167		92		289
27 Sept.	44		12		96		56		286	
	41		43		82		40		346	
	52		28		68		53		110	
	33		27		85		61		158	
	**		46		59		44		375	
		42		31		78		51		255
18 Oct.	44		21		94		54		263	
	43		26		70		55		243	
	50		14		68		58		298	
	40		27		56		56		324	
	39		31		83		71		110	
		43		24		74		59		247
8 Nov.	9		10		72		54		192	
	58		*		62		53		175	
	64		22		100		40		133	
	38		27		88		54		178	
	58		*		2		36		144	
		46		12		65		47		164

Table 12 continued.

	STATION									
Date	Tall Spartina		Bare Bank		Dwarf Spartina		Distichlis		Panne	
	Core	Mean	Core	Mean	Core	Mean	Core	Mean	Core	Mean
29 Nov.	57		20		80		63		69	
	71		30		207		149		196	
	51		35		87		43		205	
	18		32		86		68		388	
	42		33		130		78		161	
		48		30		118		80		204
20 Dec.	59		21		82		84		116	
	54		36		80		73		92	
	63		32		222		35		198	
	126		97		85		73		129	
	85		33		85		49		144	
		77		44		111		63		136
27 Jan.	53		33		121		69		108	
	71		32		82		41		127	
	62		26		78		53		153	
	81		25		143		36		126	
	85		30		85		38		85	
		70		29		102		47		120
21 Feb.	88		36		114		67		391	
	99		35		153		74		126	
	76		48		143		92		101	
	94		55		83		91		162	
	58		38		93		59		112	
		83		42		117		76		178
14 Mar.	30		40		111		62		131	
	134		65		98		56		146	
	92		42		92		68		**	
	104		39		70		77		201	
	107		41		100		50		134	
		94		45		94		63		120

* produced calculated negative value.
** no determination made.

Table 13. Chlorophyll <u>c</u> (mg/M^2) in the upper centimeter of the marsh soil in Canary Creek Marsh.

	STATION									
Date	Tall Spartina Core	Tall Spartina Mean	Bare Bank Core	Bare Bank Mean	Dwarf Spartina Core	Dwarf Spartina Mean	Distichlis Core	Distichlis Mean	Panne Core	Panne Mean
24 July	161		28		84		68		152	
	43		55		142		58		863	
	88		34		138		86		73	
	43		35		121		49		699	
	91		68		97		63		218	
		85		48		116		65		401
13 Aug.	*		57		149		*		187	
	62		34		648		70		258	
	*		*		120		56		135	
	77		56		79		**		113	
	82		33		160		62		165	
		44		36		231		47		172
3 Sept.	98		32		227		66		328	
	74		38		157		94		190	
	53		38		81		51		158	
	80		53		79		36		302	
	43		20		136		57		*	
		70		36		136		61		196
27 Sept.	79		322		181		96		853	
	82		17		152		68		979	
	97		70		169		117		308	
	58		44		168		98		451	
	**		74		106		85		1046	
		63		105		155		93		727
18 Oct.	97		27		175		75		532	
	99		33		142		111		539	
	111		48		134		125		548	
	75		53		95		102		736	
	73		58		179		107		166	
		91		44		145		104		544
8 Nov.	410		362		146		101		298	
	121		366		122		92		577	
	123		36		206		36		868	
	447		55		165		80		585	
	127		376		307		443		522	
		246		239		190		150		570

Table 13 continued.

	STATION									
Date	Tall *Spartina*		Bare Bank		Dwarf *Spartina*		*Distichlis*		Panne	
	Core	Mean	Core	Mean	Core	Mean	Core	Mean	Core	Mean
29 Nov.	110		41		150		101		137	
	138		47		255		381		531	
	102		74		104		72		590	
	74		58		133		128		1142	
	129		75		266		158		283	
		110		59		182		168		540
20 Dec.	114		52		216		138		245	
	114		63		*		164		249	
	111		69		89		79		564	
	198		190		148		139		178	
	*		27		148		99		330	
		108		80		120		124		313
27 Jan.	134		59		281		172		258	
	171		64		201		84		425	
	146		48		188		105		516	
	214		60		252		69		258	
	209		69		188		79		241	
		175		60		222		102		340
21 Feb.	156		68		274		134		890	
	219		77		236		142		264	
	185		78		259		233		158	
	257		89		158		207		613	
	146		66		185		142		338	
		192		76		222		172		453
14 Mar.	281		92		219		129		285	
	347		151		175		94		539	
	233		113		202		143		**	
	271		81		171		178		912	
	226		65		161		101		347	
		272		100		186		129		521

* produced calculated negative value.
** no determination made.

Table 14. Carotenoids (m-SPU) in the upper centimeter of the marsh soil in Canary Creek Marsh.

	STATION									
	Tall Spartina		Bare Bank		Dwarf Spartina		Distichlis		Panne	
Date	Core	Mean	Core	Mean	Core	Mean	Core	Mean	Core	Mean
24 July	73		28		99		*		133	
	60		*		66		*		*	
	129		4		204		9		54	
	51		26		109		53		*	
	115		*		158		159		27	
		86		12		127		44		43
13 Aug.	103		*		118		153		153	
	70		21		126		103		162	
	66		24		112		96		156	
	78		15		95		**		165	
	96		6		126		50		206	
		83		13		115		100		168
3 Sept.	73		*		196		62		47	
	90		19		102		66		27	
	52		12		76		79		144	
	67		20		86		107		32	
	55		11		120		63		*	
		67		12		116		75		50
27 Sept.	42		16		102		144		*	
	97		11		80		76		4	
	65		8		72		94		*	
	64		18		141		48		152	
	**		6		42		14		*	
		54		12		87		75		31
18 Oct.	119		21		110		149		161	
	91		27		96		27		123	
	85		62		87		100		102	
	85		31		63		157		144	
	130		28		90		148		*	
		102		34		89		116		106
8 Nov.	73		54		102		127		161	
	83		27		99		138		227	
	112		20		128		48		*	
	102		15		116		158		66	
	108		34		138		97		266	
		96		30		117		114		144

Table 14 continued.

Date	STATION: Tall Spartina Core	Tall Spartina Mean	Bare Bank Core	Bare Bank Mean	Dwarf Spartina Core	Dwarf Spartina Mean	Distichlis Core	Distichlis Mean	Panne Core	Panne Mean
29 Nov.	89		*		89		97		114	
	133		26		126		*		64	
	87		32		59		55		39	
	89		30		66		144		*	
	132		*		119		148		59	
		106		18		92		89		55
20 Dec	84		17		130		145		*	
	87		35		98		167		40	
	88		18		110		30		115	
	88		81		75		131		47	
	165		28		75		95		4	
		102		36		98		114		41
27 Jan.	83		33		235		199		235	
	110		83		174		74		78	
	97		20		167		**		25	
	184		40		210		55		140	
	190		38		172		83		80	
		133		43		192		103		112
21 Feb.	173		61		195		162		85	
	163		43		152		174		50	
	159		48		180		161		125	
	210		68		118		212		225	
	143		47		102		107		154	
		170		53		149		163		128
14 Mar.	177		25		122		157		149	
	220		76		105		86		119	
	181		45		107		147		**	
	195		36		102		176		*	
	206		28		138		107		158	
		196		42		115		135		106

* produced calculated negative value.
** no determination made.

Table 15. Chlorophyll a (corrected for phaeopigments) (mg/M^2) in the upper centimeter of the marsh soil in Canary Creek Marsh.

	STATION									
Date	Tall Spartina Core	Tall Spartina Mean	Bare Bank Core	Bare Bank Mean	Dwarf Spartina Core	Dwarf Spartina Mean	Distichlis Core	Distichlis Mean	Panne Core	Panne Mean
24 July	*		20		65		52		344	
	3		5		97		30		309	
	17		*		115		65		224	
	3		0		90		27		571	
	27		*		82		33		382	
		10		5		90		42		366
13 Aug.	493		27		74		553		416	
	12		0		72		80		947	
	496		502		52		17		857	
	14		8		63		**		885	
	80		18		316		70		840	
		219		111		115		180		789
3 Sept.	25		25		0		48		461	
	17		25		99		31		220	
	27		17		43		80		241	
	*		8		85		52		288	
	0		20		35		42		458	
		14		19		52		51		334
27 Sept.	17		*		99		34		690	
	5		10		30		55		0	
	29		25		95		76		509	
	0		9		42		*		277	
	**		12		30		33		753	
		13		11		59		39		446
18 Oct.	33		26		116		67		224	
	43		26		76		63		208	
	48		24		87		99		262	
	46		5		69		56		270	
	24		4		98		27		269	
		39		17		89		62		247
8 Nov.	6		*		104		65		338	
	63		14		104		137		1387	
	91		26		124		30		1250	
	20		36		258		84		479	
	63		*		167		46		538	
		48		15		152		72		798

Table 15 continued.

	STATION									
Date	Tall Spartina		Bare Bank		Dwarf Spartina		Distichlis		Panne	
	Core	Mean	Core	Mean	Core	Mean	Core	Mean	Core	Mean
29 Nov.	77		16		43		31		114	
	34		20		211		391		313	
	64		24		115		33		274	
	337		172		104		70		1069	
	170		35		141		124		206	
		136		53		123		131		395
20 Dec.	29		17		133		74		303	
	31		25		558		115		172	
	47		6		*		31		474	
	*		114		714		81		283	
	40		21		714		93		342	
		30		37		424		79		315
27 Jan.	65		36		277		146		359	
	115		22		158		52		356	
	80		12		115		50		320	
	108		51		194		64		291	
	164		38		174		42		213	
		106		32		183		71		308
21 Feb.	137		33		177		90		*	
	171		38		213		103		254	
	159		17		200		200		269	
	192		63		98		155		367	
	30		21		142		-70		347	
		138		34		166		124		247
14 Mar.	167		57		145		36		360	
	287		52		153		74		461	
	57		82		153		99		**	
	140		25		61		172		459	
	205		36		144		93		334	
		171		51		131		95		404

* produced calculated negative value.
** no determination made.

Table 16. Phaeopigments (mg/M^2) in the upper centimeter of the marsh soil in Canary Creek Marsh.

Date	Tall Spartina Core	Tall Spartina Mean	Bare Bank Core	Bare Bank Mean	Dwarf Spartina Core	Dwarf Spartina Mean	Distichlis Core	Distichlis Mean	Panne Core	Panne Mean
24 July	81		76		278		220		304	
	158		122		453		204		793	
	242		112		309		196		199	
	166		161		307		210		755	
	233		135		370		224		308	
		176		121		344		211		472
13 Aug.	*		116		524		*		304	
	189		136		453		212		25	
	*		*		404		280		*	
	204		123		302		**		*	
	131		74		173		121		*	
		105		90		371		153		66
3 Sept.	163		80		623		176		241	
	201		94		349		208		293	
	130		98		400		123		303	
	192		100		332		278		296	
	182		82		394		171		421	
		174		91		420		191		311
27 Sept.	205		182		352		272		*	
	257		91		381		167		835	
	53		105		285		220		222	
	174		97		384		287		239	
	**		12		268		217		281	
		172		97		334		233		315
18 Oct.	246		99		381		215		93	
	226		84		294		313		57	
	206		127		288		240		96	
	173		146		232		273		150	
	180		170		342		305		202	
		206		125		308		269		120
8 Nov.	242		179		268		228		210	
	237		120		214		118		*	
	267		100		412		179		*	
	308		116		97		206		354	
	228		163		344		243		246	
		256		136		267		195		162

Table 16 continued.

Date	STATION: Tall Spartina Core	Mean	Bare Bank Core	Mean	Dwarf Spartina Core	Mean	Distichlis Core	Mean	Panne Core	Mean
29 Nov.	246		163		448		269		162	
	346		118		506		421		646	
	241		112		304		174		694	
	6		*		328		324		*	
	154		120		492		220		421	
		199		103		416		282		385
20 Dec.	296		158		344		287		298	
	273		148		*		243		275	
	312		173		579		133		450	
	684		370		*		255		256	
	333		122		*		177		270	
		379		195		185		219		310
27 Jan.	229		127		235		207		235	
	267		134		302		162		284	
	260		126		335		206		357	
	309		148		435		115		293	
	220		136		294		202		226	
		257		134		320		179		279
21 Feb.	302		142		415		273		1438	
	381		137		495		277		231	
	277		192		527		289		255	
	389		199		343		263		368	
	352		146		387		191		310	
		340		163		434		258		520
14 Mar.	404		94		403		320		251	
	447		302		329		167		433	
	612		100		308		232		**	
	649		132		375		234		392	
	392		126		328		143		333	
		501		151		349		219		352

* produced calculated negative value.
** no determination made.

Results and Discussion.

The results of the pigment analysis are shown in Tables 11 through 16. The amount of chlorophyll a present can be used as a means of assessing productivity since all energy fixed by the plant must pass through this pigment. Since many other factors regulate productivity, chlorophyll a has limited value in this respect, at least in the complex marsh habitat. Pigments can, however, give an estimate of the standing crop of algae and the ratios of various pigments may give a clue to the make-up of the community since different groups of algae have different pigments. The diatoms, for example, contain chlorophylls a and c, whereas the green algae contain a and b. Blue-green algae have only chlorophyll a. With the acidification technique an approximation of the proportion of the chlorophyll pigment which is active and that which is not can be obtained. The results of the analysis of the pigments in the marsh surface must be interpreted cautiously since degradation production of the pigments are also present in the soil and absorb similarly to the undegraded pigments. For this reason comparison of pigment concentration from this study with that obtained from offshore plankton samples is not valid.

The data obtained in this study has not as yet been statistically analyzed, but large differences between areas are apparent. Some algal productivity figures obviously show high correlation with the pigment analysis; notable is the upsurge of chlorophyll a in the late winter and early spring cores from the tall Spartina area. It is probably not appropriate to say more until the data is evaluated statistically.

The respiration at the soil-water interface, as measured by oxygen consumption of the explants is shown in Table 17 and Figures 8 through 12. Respiration at the interface represents that oxygen consumed by spermatophyte roots, snails, mussels, crabs, nematodes, bacteria, etc., as well as whatever chemical oxidation is taking place at the soil surface (Teal and Kanwisher, 1961). No attempt has yet been made to separate the utilization into its various components. When macro-fauna was observed the size and abundance of the various species was recorded and their contribution to the total can be evaluated later.

The general pattern of high respiration in the warm summer months and low in the cool winter months was seen in all areas. An interesting observation was the reversal of the upward spring trend at the mid-May sampling. Salinities in the interstitial water were the highest found since the beginning of the study. The reduced respiration rates were probably related to the effects of drought, direct or indirect, on biological activity.

Living stems were not included in the explants from the tall Spartina, bare bank, dwarf Spartina, and panne. Due to the dense nature of the Distichlis stand living stems were included. The very high respiration rates found in this area may be due

Table 17. Respiration (mg. oxygen/M^2/hr) at the marsh surface from five stations in Canary Creek Marsh.

Date	Tall *Spartina* Sample	Tall *Spartina* Mean	Bare Bank Sample	Bare Bank Mean	Dwarf *Spartina* Sample	Dwarf *Spartina* Mean	*Distichlis* Sample	*Distichlis* Mean	Panne Sample	Panne Mean
24 July	109.9		51.5		90.9		179.2		49.3	
	108.3		48.0		86.1		176.3		50.4	
	105.1		46.4		107.5		173.4		52.0	
		108.3		48.8		94.9		177.1		50.7
13 Aug.	107.2		170.2		112.3		188.6		103.2	
	109.6		64.3		94.7		172.6		103.2	
	105.3		101.9		94.7		177.1		103.2	
		107.4		112.0		100.5		179.5		103.2
3 Sept.	0.8		42.1		66.7		126.4		112.0	
	88.5		51.5		109.9		106.4		102.4	
	95.2		70.7		85.9		97.3		78.9	
		61.6		54.7		87.5		110.1		97.9
27 Sept.	88.5		97.3		71.2		147.8		68.0	
	86.1		90.4		61.1		135.5		58.9	
	78.1		94.9		71.2		129.3		61.3	
		84.3		94.1		67.7		137.9		62.7
18 Oct.	64.0		13.9		28.3		41.9		26.9	
	54.7		22.4		15.5		38.9		24.0	
	49.3		13.6		25.1		49.6		27.7	
		56.0		16.5		22.9		43.4		26.1
8 Nov.	21.1		42.7		39.7		44.3		43.2	
	24.5		42.7		37.1		49.9		43.2	
	23.5		42.7		32.5		37.9		40.0	
		22.9		42.7		36.5		43.7		42.1

Table 17 continued.

	STATION									
	Spartina		Bare Bank		Spartina		Distichlis		Panne	
Date	Sample	Mean	Sample	Mean	Sample	Mean	Sample	Mean	Sample	Mean
29 Nov.	49.3		52.0		29.3		33.9		40.3	
	38.7		32.5		25.9		31.5		42.4	
	49.3		19.5		14.7		25.6		32.5	
		45.9		34.7		23.5		30.4		40.0
20 Dec.	74.4		19.7		12.0		28.0		38.1	
	69.1		23.5		32.8		37.9		35.7	
	74.4		19.7		36.3		31.7		40.3	
		72.5		21.1		26.9		32.5		38.1
10 Jan.	*		*		0.8		*		*	
	*		*		3.2		*		*	
	*		*		3.2		*		*	
		*		*		2.4		*		*
27 Jan.	1.1		30.4		40.8		15.5		62.9	
	8.5		30.4		34.1		13.1		50.7	
	10.7		35.2		34.1		13.1		57.6	
		6.9		32.0		36.3		13.9		57.1
21 Feb.	46.1		20.8		36.8		76.8		30.9	
	43.7		25.9		40.3		77.9		24.0	
	41.6		22.1		35.7		73.1		29.9	
		43.7		22.9		37.6		76.1		28.3
14 Mar.	53.3		52.3		58.4		53.1		69.3	
	42.1		33.1		46.9		43.7		40.5	
	36.0		26.1		42.4		53.3		43.7	
		43.7		37.3		49.3		50.1		51.2

Table 17 continued.

	STATION									
	Tall Spartina		Bare Bank		Dwarf Spartina		Distichlis		Panne	
	Sample	Mean	Sample	Mean	Sample	Mean	Sample	Mean	Sample	Mean
11 Apr.	41.3		47.7		68.3		97.3		-1.9	
	29.1		45.3		67.2		74.1		49.3	
	42.4		- 4.3		52.0		63.7		48.0	
		37.6		30.1		62.4		78.4		31.7
25 Apr.	106.4		34.1		80.0		117.9		72.8	
	104.5		38.9		72.3		116.3		69.9	
	115.5		40.0		71.2		112.8		66.9	
		108.8		37.6		74.4		115.7		69.9
16 May	58.9		2.7		44.3		72.3		48.8	
	57.6		49.3		48.0		67.7		53.6	
	53.6		49.3		44.3		63.2		41.6	
		56.8		33.9		45.6		67.7		48.0

* no determination made.

Figure 8. Respiration (mg oxygen/M^2/hr) at the marsh surface in the tall <u>Spartina</u> area.

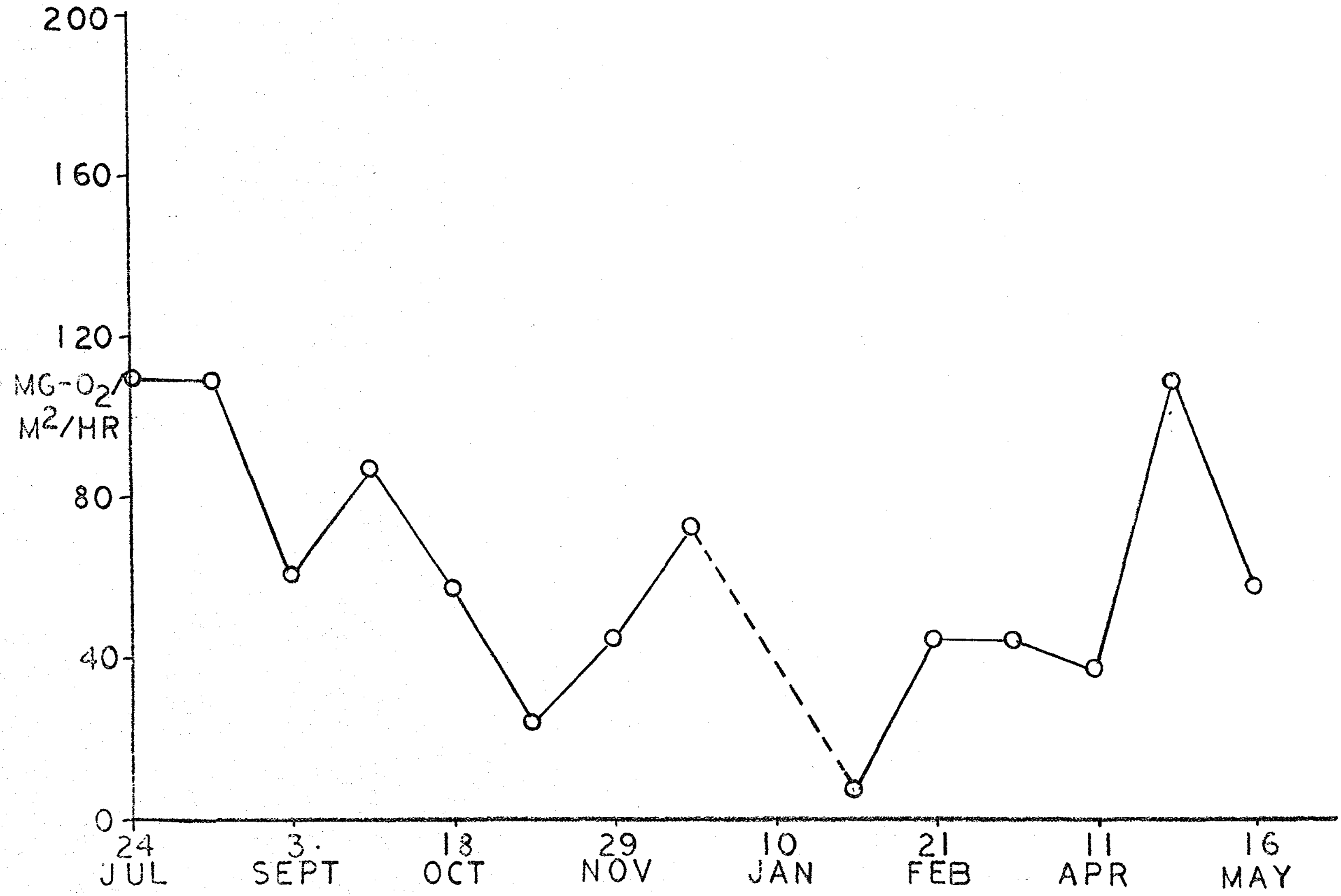


Figure 9. Respiration (mg oxygen/M^2/hr) at the marsh surface in the bare bank area.

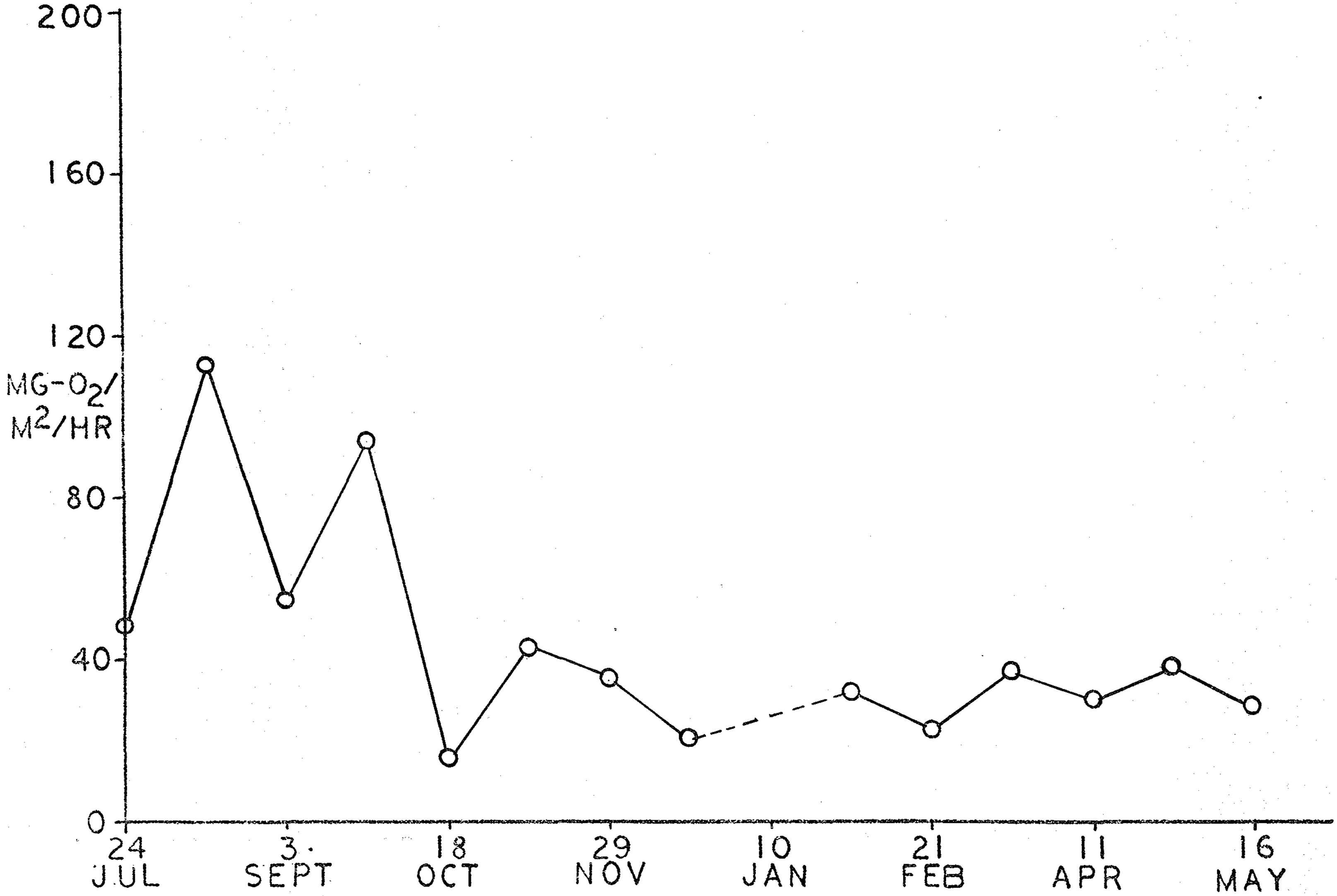


Figure 10. Respiration (mg oxygen/M^2/hr) at the marsh surface in the dwarf <u>Spartina</u> area.

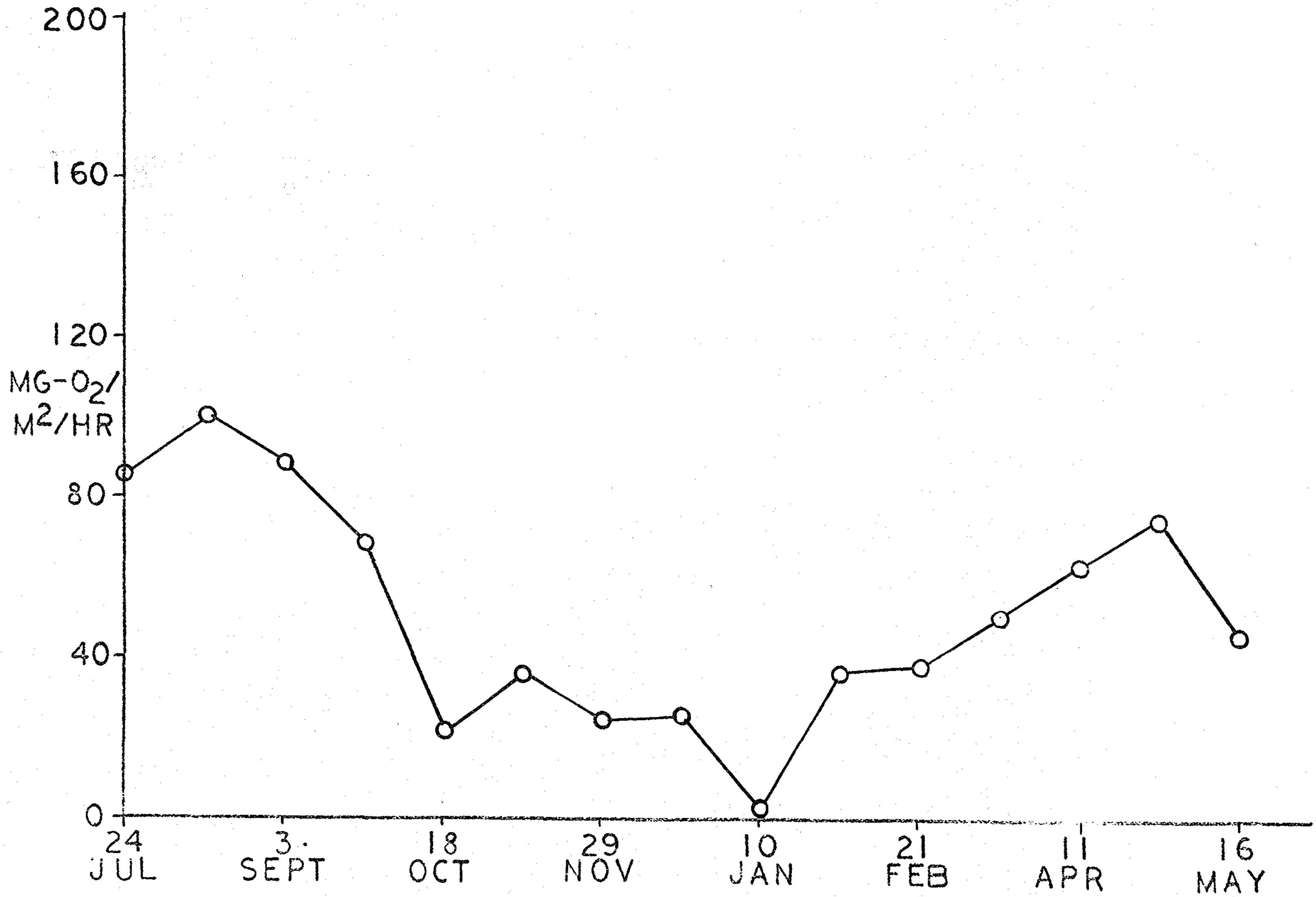


Figure 11. Respiration (mg oxygen/M^2/hr) at the marsh surface in the Distichlis area.

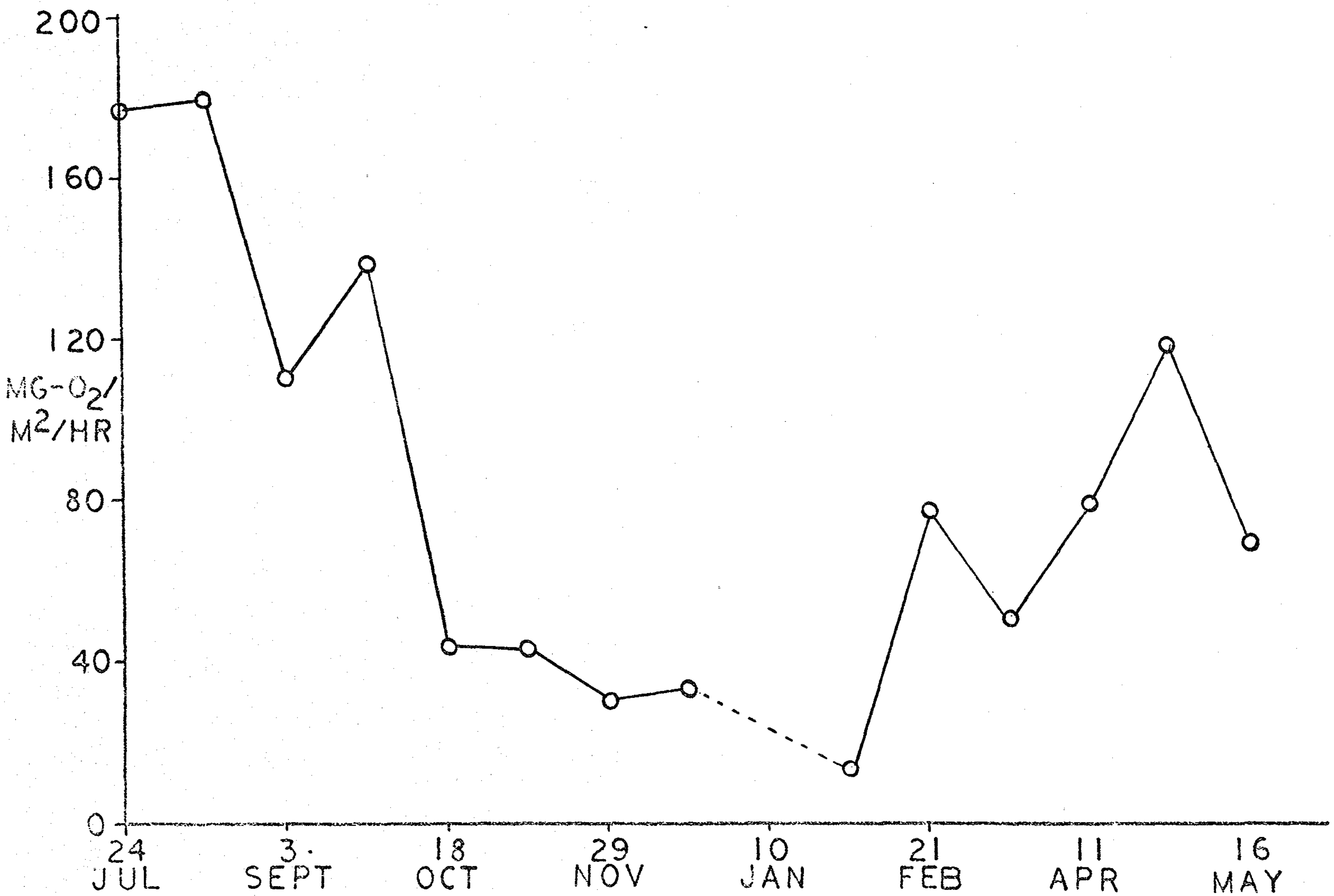
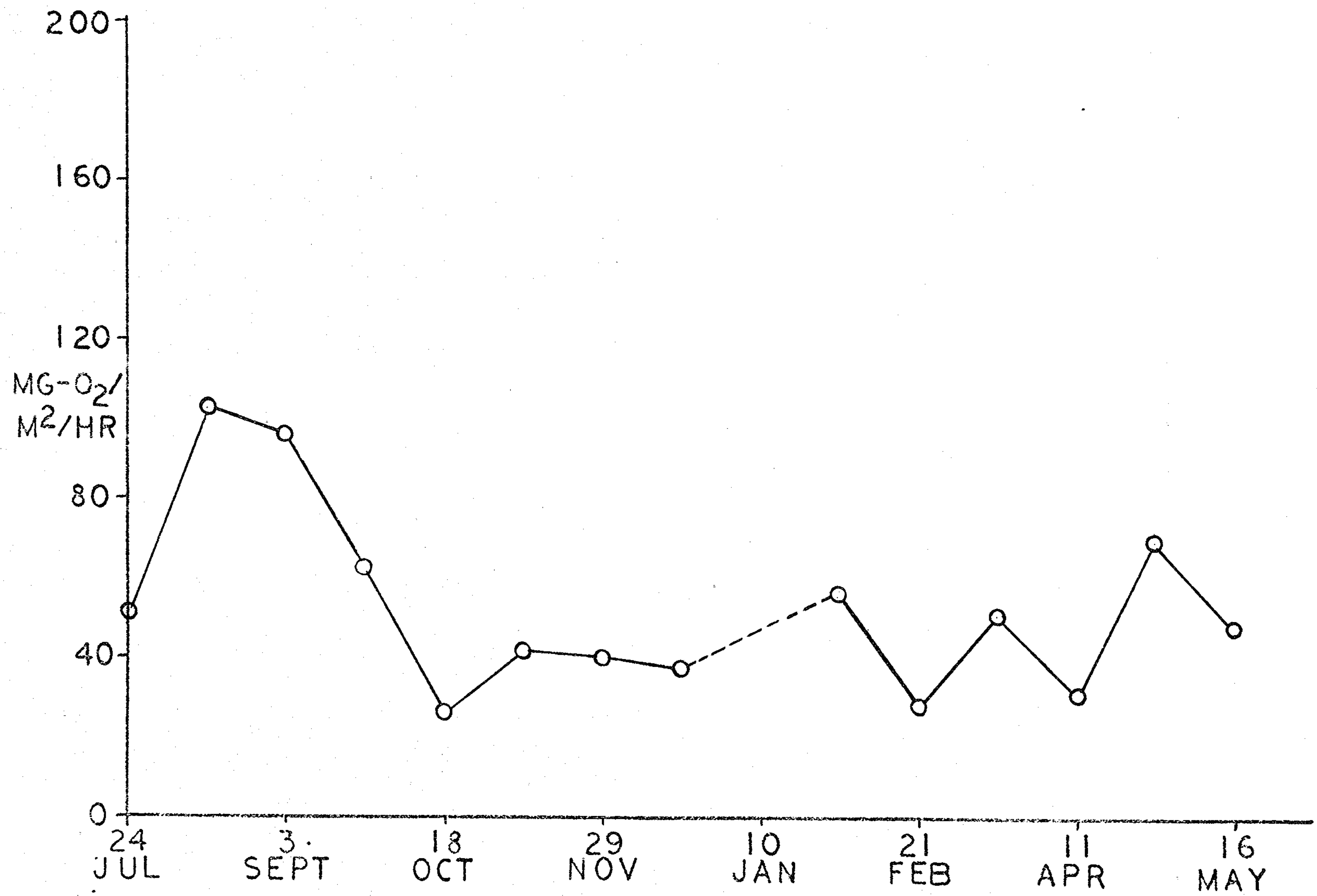


Figure 12. Respiration (mg oxygen/M^2/hr) at the marsh surface in the panne area.



in part to the cut end of these stems. Teal and Kanwisher (1961) found high respiration rates for the cut stems of Spartina plants. It would be expected therefore, that Distichlis stems would also have a high oxygen absorption rate.

Net primary production of the edaphic community, as measured by the change in oxygen level of the water overlying the marsh explants is seen in Table 18. The overall pattern that can be seen is low net production in the summer with the marsh average net production becoming positive for the first time on 18 October. The marsh average net production remained positive through the end of the reported studies. Net production was highest in late January. This is due to the combined effect of greater diatom productivity and lower respiratory demand of the soil.

Individual stations exhibited patterns much different than the average. The panne, for example, was relatively consistent throughout the year, whereas the tall Spartina and Distichlis areas exhibited strong seasonal fluctuations.

The gross production by the edaphic algal community is shown in Table 19 and Figures 13 and 17. The highest productivity over the time reported was in the dwarf Spartina and the panne. Production in the tall Spartina area was third, the Distichlis area was fourth and least on the bare bank. Production in the tall Spartina and bare bank areas was due primarily to diatoms. Green algae such as Rhizoclonium were important members of the

Table 18. Net production (mg C/M^2/hr) of the edaphic marsh algae, as measured by oxygen evolution, from five stations in Canary Creek Marsh.

	STATION									
Date	Tall Spartina		Bare Bank		Dwarf Spartina		Distichlis		Panne	
	Sample	Mean	Sample	Mean	Sample	Mean	Sample	Mean	Sample	Mean
24 July	-28.1		-5.4		29.1		-58.9		27.0	
	-20.0		-5.4		29.9		-57.5		28.2	
	-25.2		-14.6		34.5		-60.2		41.7	
		-24.5		-8.5		31.2		-58.9		32.3
13 Aug.	43.8		-51.5		59.9		-83.6		4.3	
	50.6		-49.2		69.5		-70.4		-0.6	
	50.6		-41.3		69.5		-68.4		6.5	
		48.3		-47.3		66.3		-74.1		3.43
3 Sept.	-19.8		-0.6		-4.3		-18.0		-17.9	
	-15.1		1.3		-1.7		-10.6		- 6.8	
	-23.4		-0.6		-9.2		- 9.4		1.6	
		-19.4		0.0		-3.0		-12.6		-7.7
27 Sept.	-28.4		-29.1		-23.6		-73.3		-1.3	
	-31.4		-29.1		-20.5		-67.0		-5.1	
	-25.5		-27.2		-20.5		-60.9		21.2	
		-28.4		-28.4		-21.5		-67.0		5.0
18 Oct.	-24.0		14.2		33.5		-19.6		31.6	
	-22.3		12.4		25.6		-20.3		32.0	
	-21.5		13.4		24.8		-16.4		33.5	
		-22.6		13.3		28.0		-18.78		32.4
8 Nov.	22.9		-0.2		11.6		2.3		26.1	
	23.3		-1.7		9.6		-1.4		20.8	
	19.7		-0.5		9.6		-1.6		13.7	
		22.0		-0.7		10.2		1.3		20.2

Table 18 continued.

Date	STATION									
	Tall Spartina		Bare Bank		Dwarf Spartina		Distichlis		Panne	
	Sample	Mean	Sample	Mean	Sample	Mean	Sample	Mean	Sample	Mean
29 Nov.	1.0		13.6		5.7		4.5		25.8	
	-0.3		19.3		6.5		5.0		23.2	
	-4.7		10.0		7.4		3.1		22.4	
		-1.3		14.3		7.1		4.2		23.8
20 Dec.	-27.1		4.1		-6.6		18.6		23.8	
	-30.9		-1.4		16.2		15.2		35.5	
	-30.9		4.3		-2.7		14.7		14.2	
		-29.6		2.3		2.3		16.2		24.5
10 Jan.	*		*		16.2		*		*	
	*		*		-4.4		*		*	
	*		*		-2.5		*		*	
		*		*		3.1		*		*
27 Jan.	70.6		-2.9		21.2		42.8		43.4	
	73.2		-2.9		17.8		39.6		43.8	
	80.5		-1.1		17.0		39.6		40.8	
		78.1		-2.3		18.7		40.7		42.6
21 Feb.	20.1		10.5		10.5		23.4		18.7	
	19.0		7.8		8.0		22.0		22.8	
	19.9		5.1		3.0		24.8		21.3	
		20.0		7.7		7.2		23.4		20.9
14 Mar.	92.6		21.2		30.0		22.8		24.5	
	89.3		15.3		36.5		10.4		18.7	
	87.0		14.9		16.3		13.5		15.2	
		89.6		17.1		27.6		15.6		19.4

Table 18 continued.

Date	STATION									
	Tall Spartina		Bare Bank		Dwarf Spartina		Distichlis		Panne	
	Sample	Mean	Sample	Mean	Sample	Mean	Sample	Mean	Sample	Mean
11 Apr.	45.5		6.1		49.2		26.7		35.2	
	36.8		2.8		39.5		27.7		29.8	
	40.4		-1.9		30.3		23.8		26.6	
		40.9		2.3		39.6		26.1		30.5
25 Apr.	21.9		24.2		62.4		39.0		22.5	
	20.8		17.1		53.6		35.3		19.6	
	21.9		22.4		46.2		27.4		5.6	
		21.6		21.2		54.1		33.9		15.9
16 May	1.0		6.0		29.2		5.3		1.0	
	3.7		2.8		27.2		7.0		1.4	
	-0.6		3.9		27.2		.5		1.4	
		1.34		4.3		27.9		4.3		1.3

* no determination made.

Table 19. Gross production (mg $C/M^2/hr$) of the edaphic marsh algae, as measured by oxygen evolution, from five stations in Canary Creek Marsh.

Date	Station: Tall *Spartina*	Bare Bank	Dwarf *Spartina*	*Distichlis*	Panne
24 July	16	10	67	8	51
13 Aug.	65	0	104	0	42
3 Sept.	4	21	36	29	29
27 Sept.	3	7	4	0	28
18 Oct.	0	19	37	0	42
8 Nov.	31	15	24	18	36
29 Nov.	16	27	16	16	39
20 Dec.	0	10	12	28	39
10 Jan.	*	*	4	*	*
27 Jan.	81	10	32	46	64
21 Feb.	36	16	21	52	32
14 Mar.	106	31	46	34	39
11 Apr.	55	14	63	56	42
25 Apr.	62	35	82	77	42
16 May	22	17	45	30	19

* ground frozen, sample not obtained.

Figure 13. Gross productivity (mg C/M^2/hr) of the edaphic algae associated with the tall *Spartina* station.

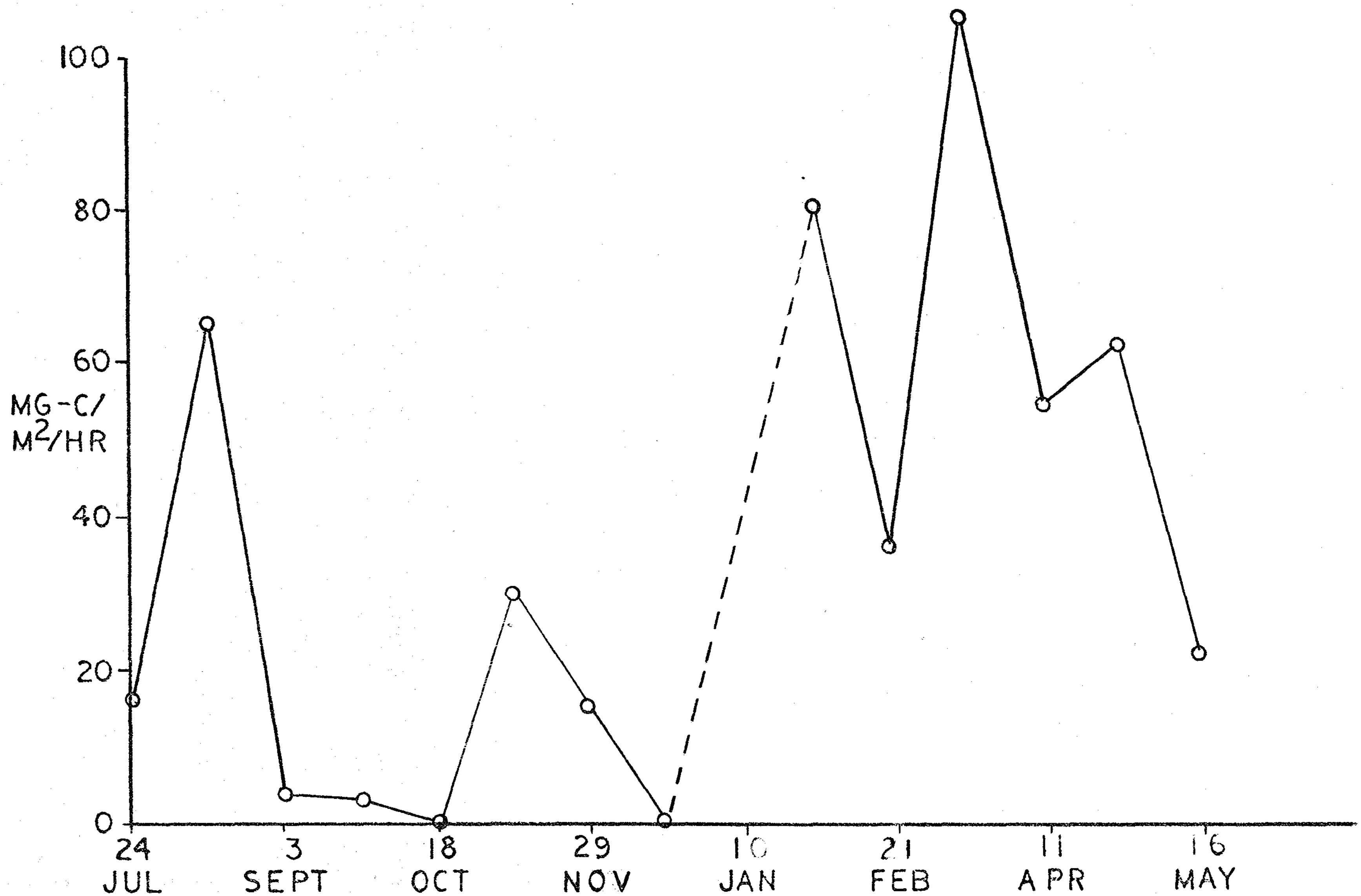


Figure 14. Gross productivity (mg $C/M^2/hr$) of the edaphic algae associated with the bare bank station.

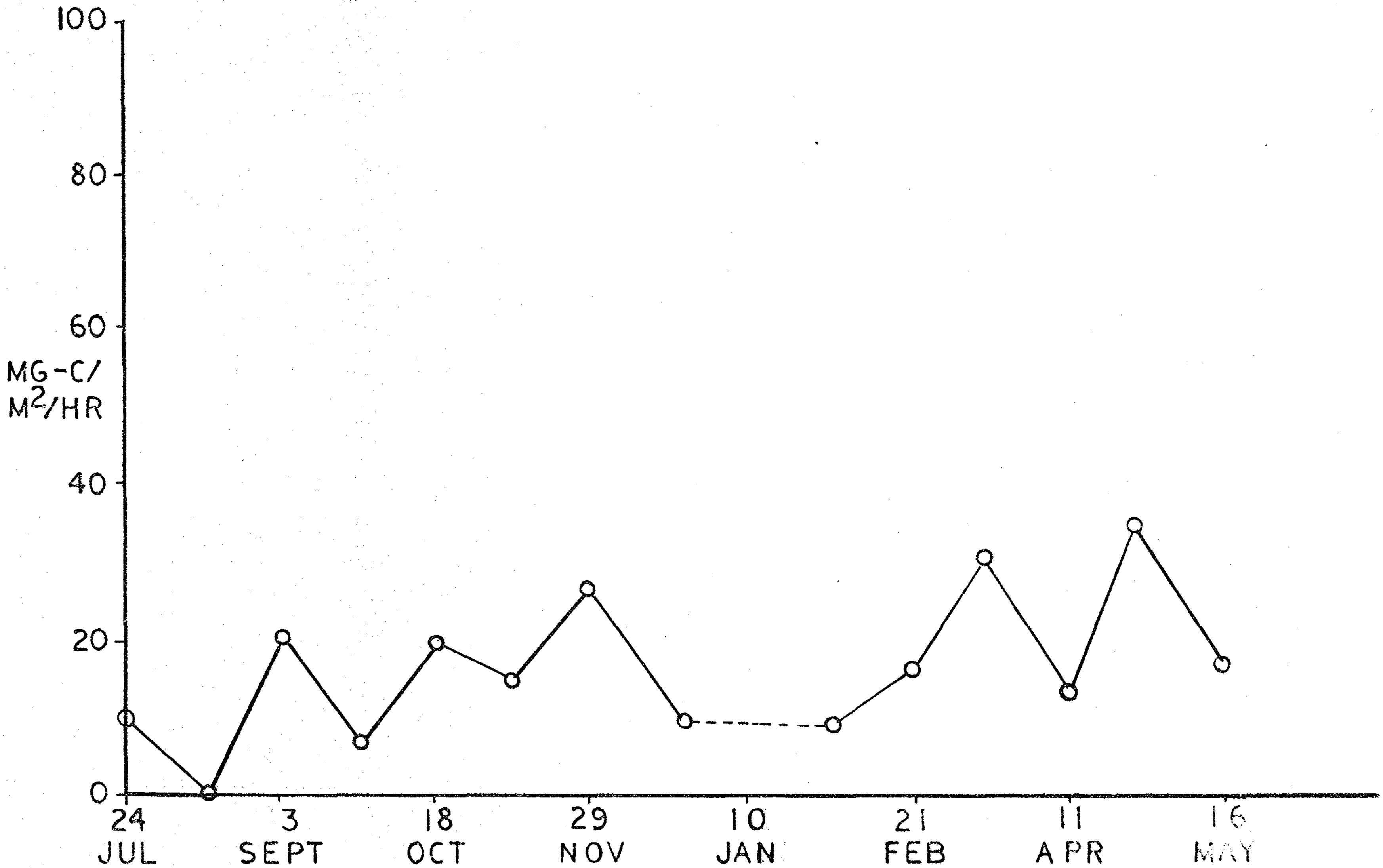


Figure 15. Gross productivity (mg C/M^2/hr) of the edaphic algae associated with the dwarf <u>Spartina</u> station.

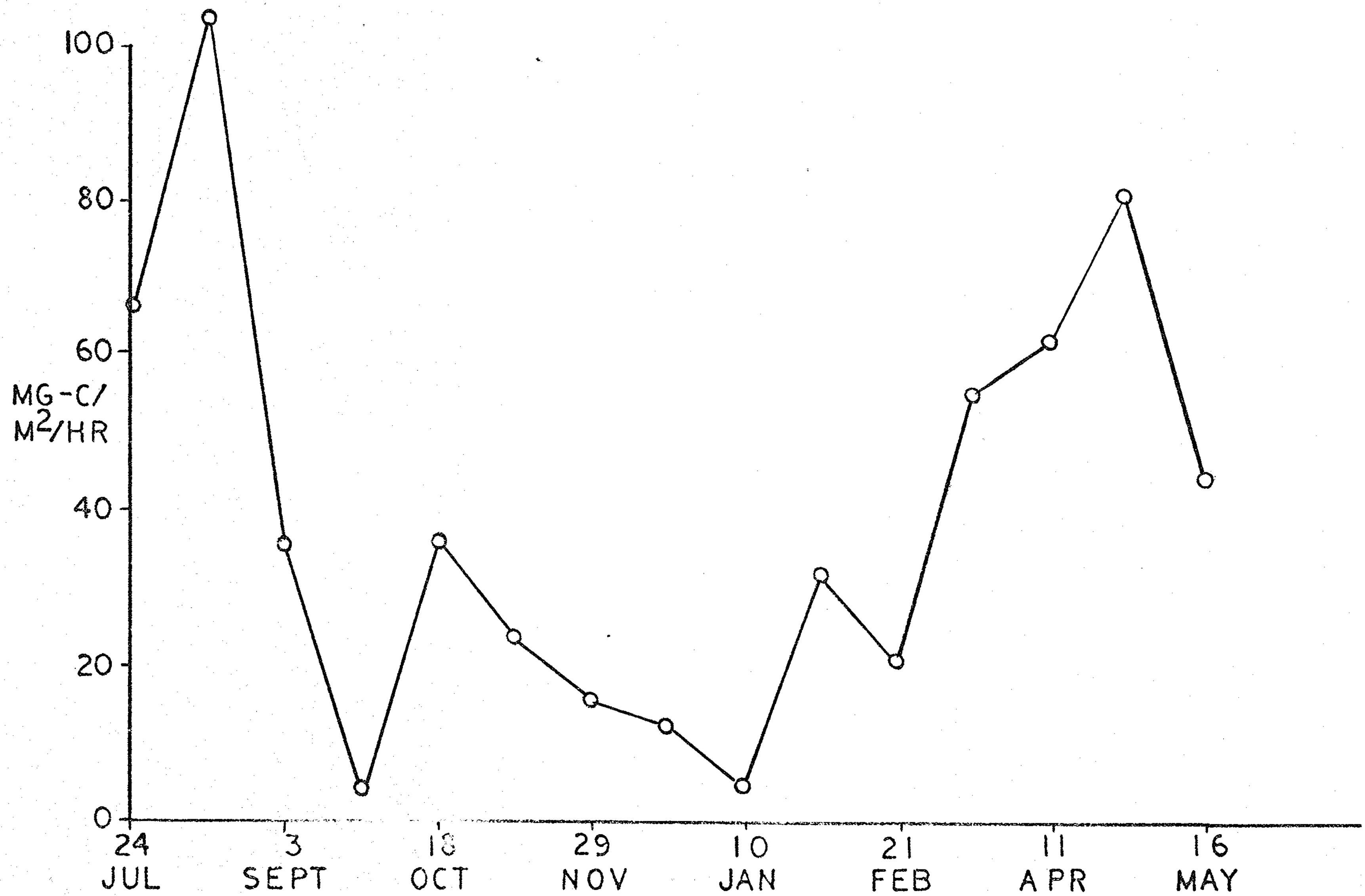


Figure 16. Gross productivity (mg C/M^2/hr) of the edaphic algae associated with the *Distichlis* station.

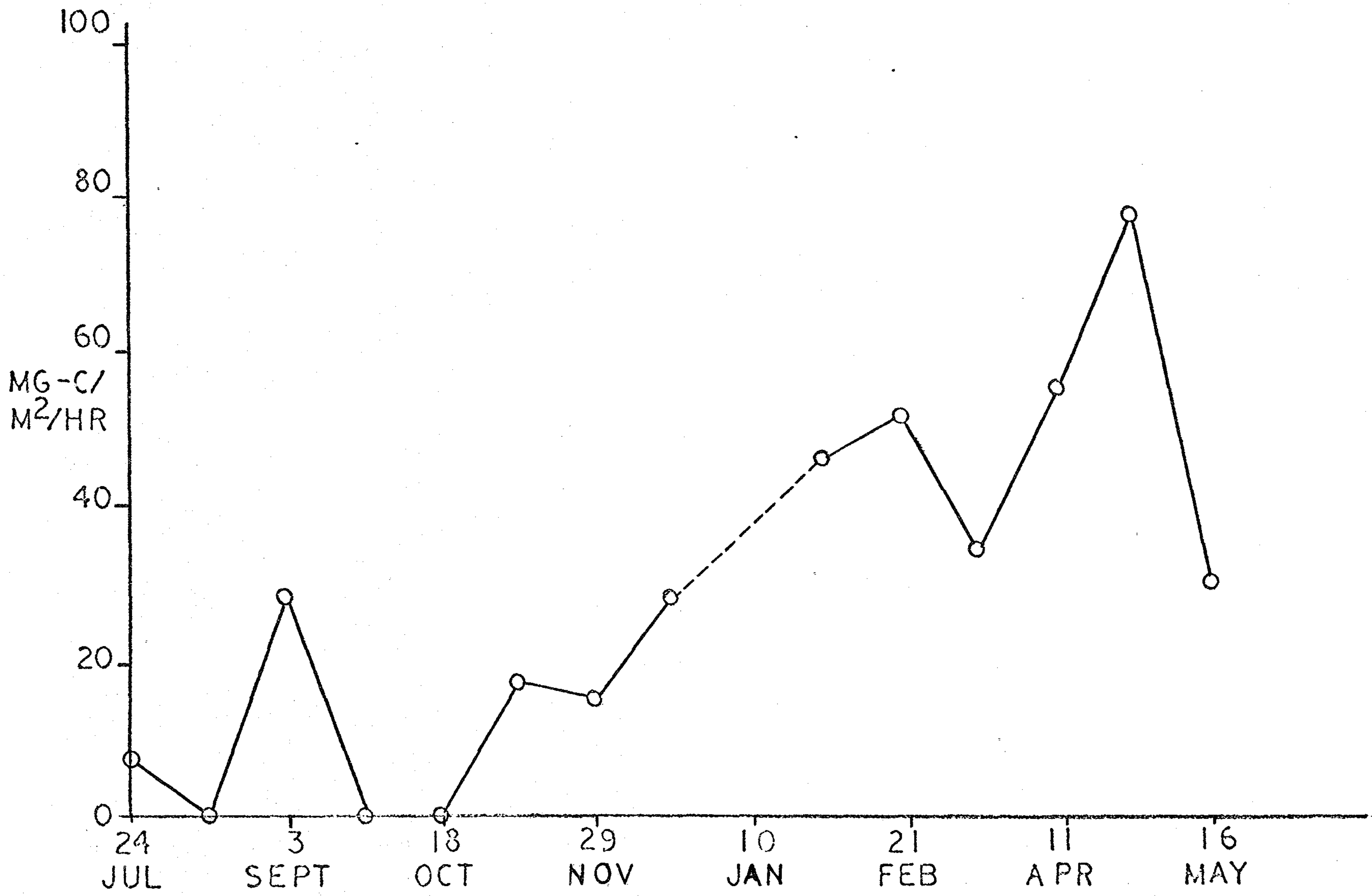
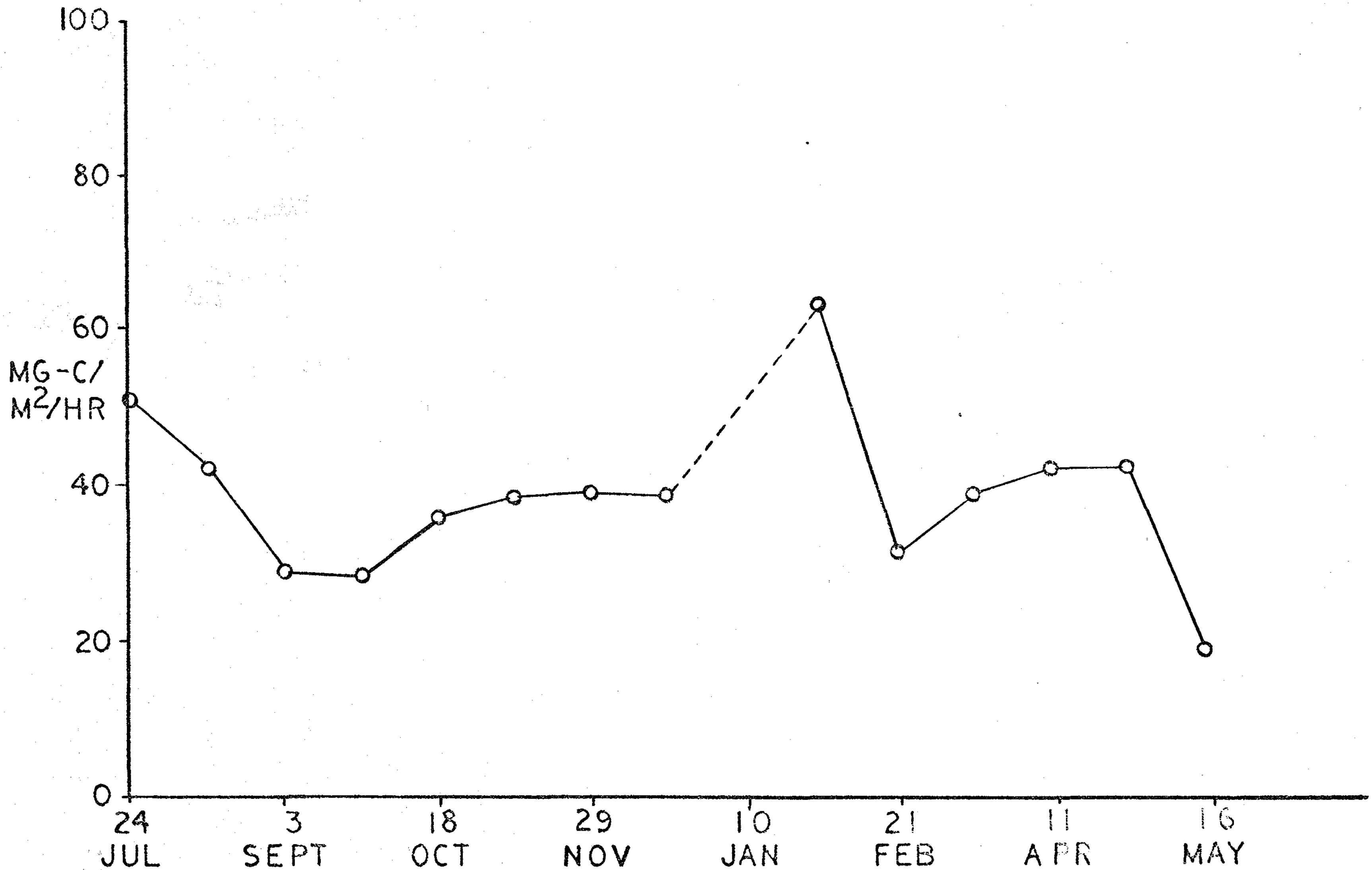


Figure 17. Gross productivity (mg $C/M^2/hr$) of the edaphic algae associated with the panne station.



autotrophic community in the dwarf Spartina and Distichlis stations. The panne was dominated by diatoms and blue-green algae.

The panne and bare bank didn't exhibit a strong seasonal variation in productivity. Algal productivity in the tall Spartina area was generally lowest in the summer and full and highest in late winter and spring. Maximum productivity was observed in the dwarf Spartina area from late winter until late summer. In the Distichlis area the pattern differs in that productivity starts to increase in the fall and reaches a peak in mid spring and declines as summer approaches. The different patterns found in the last two cases are probably due in part to the different growth habits of the two species of spermatophytes as mentioned in the section dealing with light.

A more complete evaluation of the productivity and respiration will be possible when the full year's study is completed and statistical analyses have been completed.

EDAPHIC DIATOM SPECIES DISTRIBUTION

Methods and Materials.

Samples were collected every three weeks from each study area of the marsh. Cores of the marsh were taken with a Kaufman glass tube open at both ends, with a length of 10 inches and a diameter of 4 inches. The samples were taken at random from each study area. Upon return to the laboratory, a filter paper was laid over the top of each sample and moistened with filtered sea water. At 11 a.m. the next morning the trapped diatoms were harvested by removing the filter paper and made ready to be cleaned. Eaton and Moss (1966) describe this method to remove 90% of the diatoms, and more important only the live cells.

The filter paper with the trapped diatoms is boiled according to the procedure described by Patrick and Reimer (1966), except that nitric acid is used in place of sulphuric acid. After boiling, the diatoms are washed in distilled water to remove the acid.

Slides are made using Hyrax, a medium with a high refractive index, with the procedure again described by Patrick and Reimer (1966). A drop of water with contained diatoms is heated on a coverslip to evaporate the water, then inverted and placed on a slide with Hyrax. Five slides are made for each study area.

A slide is picked at random for each study area, and starting from a random point on the top of the mount, the diatoms are counted and identified until no new species occur, and the relative frequencies remain constant. This requires a different count for each study area and for each different collection date. The slides are viewed with an American Optical Microstar microscope under oil immersion at 1000 X.

Results and Discussion.

A list of the diatom genera and their relative abundance for each study area are given in Tables 20 through 24. A list of the important diatom species for each station is given in Tables 25 through 29. The following discussion will be based upon these tables.

The bare bank station had the lowest diversity of genera and species with the exception of the panne. Here the genus *Navicula* is by far most dominant in percent abundance. *Navicula cincta* and *N. digitoradiata* were usually present in the greatest numbers. *Rhaphoneis surirella* remained important throughout the year, as did the centric diatom *Coscinodiscus sublineatus*. *Amphora exigua* was abundant in the summer and fall, but declined to very low numbers in the winter and spring. This was also true for the other four stations. In regard to numbers of individuals present, the diatom community of the bare bank was always the least developed.

Table 20. Distribution of diatom genera having an abundance of 3% or greater on the bare bank.

Diatom Genus	1969							1970			
	8/13	9/3	9/27	10/18	11/8	11/29	12/20	1/10	1/27	2/21	3/14
Navicula	61	35	42	44	61	79	66	78	44	87	85
Nitzschia	8	21	11	12	20	5	10	8	7	3	3.5
Amphora	26	18	15	6	4	--	--	--	4	--	--
Coscinodiscus	--	4	--	8.5	4	3	7	--	6	--	3.5
Cyclotella	--	3	5	7	--	--	---	--	6	--	--
Denticula	--	--	--	4	--	--	--	--	--	--	--
Rhaphoneis	--	7.5	12	3	3	--	4	--	8.5	--	--
Bacillaria	--	--	6	4	--	4	--	--	--	--	--

-- indicates percent abundance less than 3 or not present in count.

Table 21. Distribution of diatom genera having an abundance of 3% or greater in the tall Spartina.

Diatom Genus	1969							1970			
	8/13	9/3	9/27	10/18	11/8	11/29	12/20	1/10	1/27	2/21	3/14
Navicula	70	48	48	38	45	48	53	72	71	58	68
Nitzschia	10	20	22	13	18	9.5	--	6	--	--	--
Amphora	12	8	7	5	3.5	--	3	--	--	3.5	4
Coscinodiscus	--	5	3	11	9	10	16	3.5	5.5	5	--
Cyclotella	--	3	5.5	5	5.5	3	--	--	--	--	--
Denticula	--	5	--	6	5	--	--	--	--	--	--
Raphoneis	--	6	7	8	5	5	5	--	--	--	--
Bacillaria	--	--	--	3	3	--	--	--	--	--	--
Stauroneis	--	--	--	--	--	--	8.5	3	12	21	18
Gyrosigma	--	--	--	--	--	--	--	--	--	3.5	--

-- indicates percent abundance less than 3 or not present in count.

Table 22. Distribution of diatom genera having an abundance of 3% or greater in the dwarf *Spartina*.

Diatom Genus	1969							1970			
	8/13	9/3	9/27	10/18	11/8	11/29	12/20	1/10	1/27	2/21	3/14
Navicula	61	45	43	40	52	50	55	54	76	72	69
Nitzschia	9	22	17	26	14	19	13	12	4	4	7
Amphora	14	8.5	5	4	--	--	--	--	--	--	3.5
Denticula	8	18	16	14	12	12	4.5	--	4	--	--
Coscinodiscus	--	--	3	--	3	5	8	12	5	4	3.5
Cyclotella	--	--	--	--	3	--	4	--	--	--	5
Synedra	--	--	3.5	--	--	--	3.5	--	--	4	--
Gyrosigma	3	--	--	--	4	--	--	--	--	--	--
Achnanthes	--	--	3	--	--	4	--	--	--	--	--
Bacillaria	--	--	3	3.5	--	--	--	--	--	--	--
Raphoneis	--	--	--	--	--	--	3.5	4	--	3	--

-- indicates percent abundance less than 3 or not present in count.

Table 23. Distribution of diatom genera having an abundance of 3% or greater in Distichlis.

Diatom Genus	1969							1970			
	8/13	9/3	9/27	10/18	11/8	11/29	12/20	1/10	1/27	2/21	3/14
Navicula	45	50	44	50	55	47	32	31	47	53	36
Nitzschia	22	7	8	7	11	22	24	17	31	12	44
Amphora	13	16	7	7	3	--	3	3	--	7.5	3
Pleurosigma	3	--	--	--	--	--	--	--	--	--	--
Bacillaria	--	3	4	7.5	3.5	8.5	5.5	4.5	3	--	--
Synedra	3	8	6	--	9.5	3.5	7	6.5	6.5	--	--
Denticula	--	5	9	4	--	--	--	--	--	--	--
Raphoneis	--	8	--	--	--	--	--	3	--	3	--
Achnanthes	--	--	8	--	4.5	4.5	7	--	--	5.5	--
Coscinodiscus	--	--	--	4	--	3	7.5	6	--	--	4.5
Cyclotella	--	--	3	--	--	---	--	--	--	--	--
Diploneis	--	--	--	4	--	--	--	--	--	--	--
Stauroneis	--	--	--	--	--	--	--	--	--	7.5	--
Meloseira	--	--	--	--	--	--	3.5	18	--	3	--

-- indicates percent abundance less than 3 or not present in count.

Table 24. Distribution of diatom genera having an abundance of 3% or greater in the panne.

	1969							1970			
Diatom Genus	8/13	9/3	9/27	10/18	11/8	11/29	12/20	1/10	1/27	2/21	3/14
Nitzschia	76	66	28	38	29	21	23	38	20	14	28
Rhopalodia	--	--	--	13	11	5.5	12	3.5	4.5	3.5	3.5
Navicula	10	22	25	10	9	60	56	40	56	59	58
Amphora	6	6.5	11	--	3	--	--	--	--	--	--
**Amphora X	--	--	33	27	41	6.5	--	10	4.5	14	7
Coscinodiscus	--	--	--	--	--	--	--	--	4.5	--	--

-- indicates percent abundance of less than 3 or not present in count.

** This diatom is either a member of the genus Amphora or Cymbella, but most probably Amphora. I have not been able to find it in over 15 very good references. It may very well be a new species.

Table 25. Diatom species verified and considered important to the diatom community of the bare bank.

Amphora exigua

Coscinodiscus sublineatus

Cyclotella meneghiniana

Navicula cincta

N. cryptocephala var. *veneta*

N. digitoradiata

N. heufleri var. *leptocephala*

N. salinarum

N. tripunctata

Nitzschia epithemioides

N. grana

N. granulata

N. hungarica

Rhaphoneis surirella

Table 26. Diatom species verified and considered important to the diatom community of the tall *Spartina*.

Amphipleura rutilans

Amphora exigua

Coscinodiscus excentricus

C. litos

C. sublineatus

Cyclotella meneghiniana

Denticula subtilis

Gyrosigma fasciola

Navicula arenaria

N. cryptocephala

N. cryptocephala var. *veneta*

N. ramosissima var. *mollis*

N. rhynchocephala

N. salinarum

N. taraxa

N. tripunctata

Nitzschia granulata

N. hungarica

N. littoralis

Rhaphoneis amphiceros var. *rhombica*

R. surirella

Stauroneis salina

Table 27. Diatom species verified and considered important to the diatom community of the dwarf *Spartina*.

Amphora exigua

Coscinodiscus litos

C. sublineatus

Cyclotella meneghiniana

Denticula subtilis

Gyrosigma eximium

G. wansbeckii

Navicula cryptocephala

N. cryptocephala var. *veneta*

N. heufleri var. *leptocephala*

N. pygmmaea

N. rhynchocephala var. *amphiceros*

N. rhynchocephala var. *germainii*

N. salinarum

N. taraxa

Nitzschia grana

N. granulata

N. littoralis

Rhaphoneis surirella

Table 28. Diatom species verified and considered important to the diatom community of *Distichlis*.

Achnanthes hauckiana

A. lancelota

A. subsessiles

Amphora exigua

Bacillaria paradoxa

Caloneis brevis var. *vexans*

Coscinodiscus excentricus

C. sublineatus

Denticula subtilis

Diploneis pseudovalis

Meloseira nummuloides

M. sulcata

Navicula halophila

N. heufleri var. *leptocephala*

N. mutica

N. salinarum

N. taraxa

N. tripunctata

Nitzschia granulata

N. hungarica

Synedra affinis var. *gracilis*

S. fasciculata var. *truncata*

Table 29. Diatom species verified and considered important to the diatom community of the panne.

Amphora exigua

***Amphora* X

Navicula cryptocephala var *veneta*

N. salinarum

Nitzschia filiformis

Rhopalodia musculus

** This diatom is either a member of the genus *Amphora* or *Cymbella*, but most probably *Amphora*. I have not been able to find it in over 15 very good references. It may very well be a new species.

The genera found in the tall *Spartina* are similar to those of the bare bank, but the diversity in regard to species was much greater for the former than the latter. Species with high abundance were *Navicula salinarum*, *N. cryptocephala* var. *veneta*, and *N. ramosissima* var. *mollis*. Both *Rhaphoneis surirella* and *R. amphiceros* var. *rhombica* were common in the summer and fall, but occurred in small numbers in the winter and spring. *Nitzschia hungarica* and *Gyrosigma fasciola* are characteristic of this station. The genus *Coscinodiscus* was very common throughout the year, while the genus *Cyclotella* persisted through the winter and spring, even though its abundance dropped to less than 3%. These preceeding two genera are most common in the tall *Spartina* station.

The appearance of two species in the tall *Spartina* may be of considerable importance. Although small in numbers, *Amphipleura rutilans* showed up solely in the winter and early spring collections of only this area. Appearing first in the December 20 collection, the species *Stauroneis salina* established itself as a conspicuous member of the tall *Spartina* diatom community, reaching abundances of 21% and 18% in the February 21 and March 14 collections respectively. It was also present in the samples from the other stations, but its abundance always ranged from 0 to less than 3% for all but one case.

Genera and species diversity were greatest in the dwarf *Spartina* and *Distichlis* stations. All the species listed under the genus *Navicula* for the dwarf *Spartina* were present throughout the study, with the exception of *N. taraxa* which disappeared after the December 20 collection. This disappearance was also observed in the tall *Spartina*. A species of *Navicula*, as yet unidentified, is very characteristic of the dwarf *Spartina* and was only found in an abundance of greater than 3% in this station. The genera *Coscinodiscus* and *Rhaphoneis* became important in the winter and spring. *Denticula subtilis* had its greatest importance in the dwarf *Spartina*, replacing the genus *Amphora* as third in rank during the summer and fall collections.

Many species were particularly characteristic of the *Distichlis* station that did not occur in the other stations or occurred in these areas with very low frequencies. Species such as *Achnanthes hauckiana*, *A. lancelota*, *A. subsessiles*, *Caloneis brevis* var. *vexans*, *Diploneis pseudovalis*, *Meloseira sulcata*, *Navicula mutica*, *Synedra affinis* var. *gracilis*, and *S. fasciculata* var. *truncata* are examples. The genera *Achnanthes* and *Synedra* were by far the most abundant at the *Distichlis* station. The occurrence of three different species of Achnanthes at this station is significant. Members of this genus are frequently epiphytes, and probably attach themselves to the dead *Distichlis* stalks lying in the soft marsh surface. Of further interest is the occurrence of *Achnanthes subsessiles* and *A. hauckiana* in this rather saline environment with a heavy concentration of organic matter. Hendey (1964) reports that *A. subsessiles* is seldom found in water with a salinity of greater than

20 o/oo, while Patrick and Reimer (1966) observe that *A. lancelota* does not occur in large numbers under conditions of heavy organic enrichment.

The genus *Navicula* did not have percent abundance values as high as were found in the preceeding stations. *N. taraxa* was generally found to be abundant throughout the year, which was not the case at any of the other stations. A flood of *Meloseira nummuloides* occurred in *Distichlis* on January 10 with an abundance of 17.5%. Its percent abundance was never more than 2% on all other collection dates. Why it occurred in such great numbers at only this station is at present unknown, but presents an interesting paradox. *Bacillaria paradoxa* also had its greatest abundance at this station.

It was found that the lowest genera and species diversity occurred in the panne. The genus *Nitzschia* was generally dominant up to the October 18 collection and the genus *Navicula* became dominant in the November 29 collection and continued throughout the study. The appearance of *Amphora* X (designation explained in Table 24) in the September 27 collection and its continued abundance is also of interest. This species is only found at the panne station.

Nitzschia filiformis, found more or less exclusively in the panne, was found to be the dominant member of its genus from the fall to the present. The sole representative of its genus, *Rhopalodia* musculus, was also found to occur exclusively on the panne. The sudden dominance of the genus Navicula was mainly due to a tremendous increase in the numbers of Navicula salinarum. Only once did another genus reach an abundance greater than 3%. This occurred on January 27 when Coscinodiscus had an abundance of 4.5%.

A general review of the important diatom species identified and their succession at each station has already been discussed. The question naturally arises of what factors are responsible for this phenomena and what is the relative contribution of each factor. Differences in the diatom community of each station have also been pointed out and it is assumed that it is possible to characterize each station as distinct from all the others in its diatom community make-up and ecological conditions that persist there. The data support this hypothesis and it is a simple matter to know what station a slide comes from by merely examining it under oil immersion for a few minutes. Certain key species and associations of species are responsible for the significant differences between neighboring diatom communities, some being separated from each other by only a few meters.

Patrick (1948) describes diatom species as being specific in their salt requirements, possibly explaining the existence of different diatom communities at each station. In the salinity section under environmental characterization significant differences in interstitial soil salinities were pointed out for the different stations. The high salinity values found in the panne and their large fluctuations may cause the low diversity of species found in the panne. It can also be postulated that only those diatom species that can successfully compete with the large blue-green algae population found there are those which will be identified from the core taken there.

The effect of the macroscopic vegetation at the tall Spartina, dwarf Spartina, and Distichlis stations must be very important. The absence of such on the bare bank and panne must also have important consequences. It is likely that the interaction of the macroscopic plants with the environment defines the conditions under which the associated diatom communities live. The diatom communities themselves must also have an effect on the environment and may be primarily responsible for the low late winter and early spring nutrient levels as great surges of activity were taking place. This association of macroscopic and microscopic organisms is extremely complex as are the interactions of environmental parameters measured during each collection. Perhaps the distinct diatom communities found at each station can be attributed to a summation of environmental parameters, sometimes similar but usually different at each station, that produce conditions permitting only certain species to exist and not others. These same conditions and possible inhibition of species by already esisting ones can also explain succession in each area. The low winter temperatures seem to be responsible for the emergence and establishment of Stauroneis salina and the great reduction in abundance of Amphora exigua and Denticula subtilis, but it must be remembered that other factors may be acting along with temperature to be the controlling factors.

At this point in the study two very important facts have been established:

1. that significantly different diatom communities have been established for each station under investigation, and

2. that these diatom communities change significantly both in species composition and the abundance of the species themselves along with changing environmental parameters.

The above association has been attributed to a complex of environmental factors, and a hypothesis for the changes in this association has been put forth based on the available data. After a full year's data is secured and all the species have been identified and their abundance calculated, it is hoped that a better understanding of the reciprocal relationship between the diatom community and its environment will result.