PLANKTON DIATOMS FOUND IN THE VICINITY OF ST. ANDREWS, N. B.

P L A N K T O N   D I A T O M S

found in the

VICINITY OF ST. ANDREWS, N.B.

by

CLARA W. FRITZ, B.A.

Plankton Diatoms in the Vicinity of St. Andrews, N.B.

Introduction.

If a bottle of water be drawn from the sea and examined with the naked eye nothing presents itself but the clear, sparkling liquid; but if this same sample be centrifuged for half an hour and the residue examined under the microscope, it will be found that many organisms of unparalleled beauty have been extracted. Chief among these are the diatoms, unicellular plants, exquisite in beauty of symmetry and design. The object of the investigations recorded in the following pages is to add ~~some facts~~ to ~~the~~ our present knowledge of ~~these~~ int~~eresting~~ ~~forms~~. diatom flora of St A NB

Collections of material were made throughout the year from October 1916 to October 1917 at various points in Passamaquoddy Bay and the adjoining waters of the Bay of Fundy. Careful examination of these has revealed the presence of eighty-two species, representative of twenty-six genera. Material collected during the different months was found to vary greatly. Attention was, therefore, given to the seasonal distribution and relative abundance of the many forms. Ordinary tows were taken at the surface and at a depth of from five to six metres, but, during the summer of 1917, a series of samples were drawn from certain stations at various definitely recorded depths, and the contents examined in order to ascertain the bathymetric range of species.

Diatom cultures were also maintained at the Atlantic Biological Station, St. Andrews, N.B. during the summers of 1916 and 1917, and at my laboratory in East Angus, Quebec, during the winter 1917 - 18. The results of these are duly recorded with special attention to the development of Melosira hyperborea, Grun.

The account is completed by a systematic list of the eighty-two species found, together with figures of several forms, especially those which are rare, or, owing to their similarity, difficult to classify. The system of classification used is that introduced by W.L. Smith and followed by Van Heurck (1) and by the Challenger Report (3).

I desire to take this opportunity of expressing my thanks to Dr. A. Willey, under whose guidance the problem was commenced; to Dr. A.G. Huntsman, Director of the Biological Station, and to his assistants, for their careful attention to the collection of material; and to Prof. C. M. Derick for assistance and suggestions, which she has kindly given.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Locality and Collection of Material.

Passamaquoddy Bay is situated at the south west corner of New Brunswick, where it serves as a boundary between that province and the State of Maine. Into it empty the waters of the St. Croix river; and its waters are in turn mingled with those of the Bay of Fundy by the ~~ever changing~~ tides which sometimes reach a height of twenty-four feet. A group of islands of which the largest are Deer and Campo Bello form a partial barrier, through which the tides flow swiftly and with force.

Collections were made with more or less regularity throughout the year at each of the seven stations marked on the appended map: Prince Stations 1,3,4,5,6,9, and 10. Particular attention was given to tows taken at Sta. 6, which it will be noted is at the mouth of the St. Croix river and directly opposite to the Atlantic Biological Station. Here material was obtained with great regularity: at first twice a week and later, when it was ascertained that changes in the content were not rapid, weekly. All collections made were taken in a net of No. 20 silk bolting cloth. The same net was used on all occasions, and was towed for twenty minutes behind a boat, the speed of which was kept as uniform as possible for all the tows. Culture material was immediately emptied into a large jar of water; material for examination was preserved in two to three per cent formalin.

Seasonal Distribution and Relative Abundance.

Station 6.

Tows, as recorded above, were taken twice a week at the surface and at a depth of from 5 - 6 metres during the months of October and November. Later weekly collections were deemed sufficient, and during the winter, material was gathered even less frequently. ~~Owing to a~~ misunderstanding only surface tows were made for a few weeks after the first of May. Enough ~~has been~~ was obtained, however, to give an accurate idea of the monthly possibilities. Tables 1 - 4 give a record of representative five metre tows throughout the year at Station 6; and from these the gradual increase and disappearance or general constancy of the different forms can be traced. Since, with the counting apparatus employed, it was possible to use only a 16 mm. objective, I was unable to determine with accuracy species which are distinguished by minute details of structure, such as some of the Coscinodisci. In the tables I have, therefore, grouped together the Thalassiosirae and the allied species *Coscinosira polychorda*; and have included under their respective generic names all the Naviculae, Asterionella, Surirella, Campylodisci and Coscinodisci.

After the material of each tow had been examined and all the species recorded, a careful estimate of the num-

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Table I

Station 6. Oct. - Dec. 5m. Tows.

	Oct. 6	12	16	24	27	Nov. 7	15	Dec. 4	13	19	27
Navicula				2000				666		300	
Pl. fasciola . . .	3000	2000	50	50	50	2000	1333	800	300	600	
Pl. angulatum . .	3000	2000	50		1333	2000	666	500	2000	1400	200
Pl. strigosum . .							1333	200	400		400
Pl. Balticum . . .							666	200	200		
Pl. formosum . . .								200	100		200
Asterionella . . .					5333				200		
Synedra		4000		2000				100	300		
Tabellaria							50	600	4500		
Rhabdonema									100		
Surirella								100	200	200	200
N. seriata	13000	72000	2000	18000	50						
N. closterium . . .		2100						50			
N. bilobata										200	
N. sigma										300	
Thal. nitzschioides	6000	8000							1500		
Thal. longissima .	522000	92000	8000	2000	50	2000	2000	100	800	1000	
R. shrubsolei . . .	141000	188000	156000	72000	10666	2000	666		100		
R. obtusa	15000	26000	2000	50			666				
R. hebetata	12000	2000	2000	2000				100	100		
R. faeröensis . . .		2000	4000			4000					
Corethron		2000									
Ditylium	99000	82000	38000	48000	9333	12000	3333	50	200		
Ch. gracile	3000		2000	6000	1333	4000	50	100	100	200	
Ch. debile . .			14000	50	2666	50			1000	1800	
Ch. sociale . .	108000	126000	10000								
Ch. Willei . .		16000									
Ch. diadema . .		16000	32000	16000		6000		800			
Ch. laciniosum . .	3000	12000	16000	50	50	50			400		
Ch. constrictum . .				50					400		
Ch. decipiens . .	3000	8000	2000	50	50	50					
Ch. criophilum . .		4000									
Skeletonema . . .									2500		
Mel. Borreri . . .								50			
Mel. hyperborea . .							100	50			
Mel. sulcata . .			8000	4000	1333	6000	4000	1100	5400	6600	2800
Mel. crenulata .										800	
Thalassiosira			50	4000							
Ceratulina . . .	9000		6000			6000					
Bid. aurita .						3000			400	1200	600
Bid. mobiliensis .											200
Actinoptychus . .	3000		50		50	2000	666	200	400	800	800
Coscinodiscus . .	3000	10000	10000	10000	1333	6000	4666	700	4100	3000	2000

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Table II.

Station 6. Jan. - Mar. 5m. Tows.

	Jan. 8	13	24	Feb. 9	23	Mar. 8	15	23	28
Navicula					100	100			
Pl. fasciola	400		100		100	200	100	600	300
Pl. angulatum	100		500	50	100		200	100	
Pl. strigosum	400	400	600	2200	800	1200	400	1400	400
Pl. Balticum			100	200	100	100		100	100
Pl. formosum	100			100	100		100		100
Pl. elongatum			200	500					
Achnanthes						700		100	
Fragilaria				200					
Tabellaria				2000			1500	3500	3500
Grammatophora				400					
Rhabdonema	300		100	100	100		300	300	
Surirella			100	100		100			
Campylodiscus			100	100			100		100
N. sigma	100			100					
Thal. nitzschioides	400	400	2200	2100	2100	4200	600	400	600
R. hebetata		100	600	100	100	300	200	300	100
Ch. debile				600		700	400	3300	4400
Ch. diadema	1500		800	1200	1100	300			
Ch. laciniosum	600			800		300		500	4200
Ch. decipiens	200		500	50					
Skeletonema	700	500	2500	3800		3000	500	1700	900
M. Borreri					400	300	200	100	
M. hyperborea					500		100	400	100
M. sulcata	1500	1100	2200	2400	300	2200	900		300
M. crenulata						400			
Thalassiosira				300	200	500	500	17000	309500
Biddulphia	400	100	1100	200	1500	9900	20300	19300	18900
Actinoptychus	200		200	100	100		100	200	100
Coscinodiscus	3800	700	3100	400	1100	1900	2200	1000	1800

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Table III.

Station 6. Apr. - July 5m. Tows.

	Apr. 7	14	20	May 1	June 20	25	July 3	11	17	23
Navicula	500					333	1000			250
Pl. fasciola	2500	2000	1666	50	3333	333	500	1000	750	250
Pl. angulatum	500		1666		2666	333	500	2000	50	250
Pl. strigosum	5750	2500	1666			333		1000		
Pl. formosum	250	50					500		750	
Asterionella		50		50	8000	7666	2500			
Synedra		1000				333				
Fragilaria					6666	2666				
Tabellaria	13750	50								
Grammatophora					2666					
Rhabdonema	250					50				
Surirella					50					
Campylodiscus	500									
N. seriata							2500	2000	50	
N. closterium									750	50
Thal. nitzschioides	2225	2000	5000		2000	1333	2350	29000	5250	
R. hebetata	500	50		50	1333	666	500			50
Ch. debile	30000	36500	255000	40000	418000	106333	3420000	3600000	4267000	622000
Ch. sociale	36750		95000	207500	8666	50				
Ch. diadema	6500	9500	13333	46250	16000		40000	11000	96000	
Ch. laciniosum	12250	15000	8333	23750	10000	15333	73000	102000	75750	5000
Ch. constrictum									4500	
Ch. decipiens					3333	12000.	5500	3600	50	50
Ch. contortum									27000	1500
Ch. convolutum									15000	
Skeletonema	17500	10500	41666	6250			7500	240000	48750	50
M. Borreri	750		21666							
M. hyperborea	7500		50		50					
M. sulcata	6500			50	6000	1666	50	50.		50
M. crenulata					50	5666				
Thalassiosira	769500	952500	3770000	8750000.	722000	138666	1760000.	39000	1500	1500
Leptocylindrus							7500		12000	1500
Eucampia							50			
Biddulphia	59750	48500	305000	83750			500			500
Actinoptychus		500								
Coscinodiscus	1500	2000	3333	1250		1000		2000		250

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Table IV.

Station 6. Aug. - Oct. 5m. Tows.

	Aug. 2	8	14	20	28	Sept. 6	13	20	Oct. 5
Navicula	1000			1000		66			
Pl. fasciola	2000				28		133	400	666
Pl. angulatum	1000	250			28		66		333
Pl. strigosum							66	200	1000
Pl. Balticum		50					66		
Pl. formosum		250							333
Asterionella							933	600	
Fragilaria				6000					
Tabellaria						750			
Rhabdonema							66		333
N. seriata	8000	500	16666	11000			1133	1600	21333
N. closterium	3000		1666	1000	28		400		333
Thal. nitzschioides	9000	500	19666	27000	428		133	400	666
Thal. longissima					143	50		200	666
Bacillaria									1000
R. hebetata	50	250	3666	1000	171	150	466	1800	4000
R. obtusa					28		66	406	3333
R. faeröensis	7000		666		28				
Ditylium								800	1666
Ch. gracile	1000	250					66	200	333
Ch. debile	7000000	6625	440000	810000	455		866	1000	
Ch. sociale	4000		16666	121000	114	280000		160000	
Ch. Willei							466	1200	
Ch. diadema		50			714		8466	160000	3000
Ch. laciniosum	54000	500	40333	118100	143	50	6400	5200	1666
Ch. constrictum	7000	1750					133	800	
Ch. decipiens		50	5766	46000	55		200	400	11000
Ch. contortum	24000			6000				800	
Ch. danicum					228	50	666	2000	333
Ch. convolutum		50		1000			200	400	
Skeletonema	61000	750	2666		428	300	1466	1200	13666
M. sulcata	17000	1500	50	5000	55		2466	800	7333
Thalassiosira	6000	1125	2666	900	371		200	2400	6666
Leptocylindrus	3000		2333	40000	85	50	2000	11200	333
Cerataulina		375	3666	4000					
Bid. aurita									333
Coscinodiscus		50	666	1000	55		266	200	12333

bers present was made in the following manner. The volume of water, in which the organisms had been preserved, was increased to from 50 to 500 cc according as the amount of material was slight or abundant. In each case the final volume was recorded. Counting was done by means of a Rafter cell as recommended by Winter (12). This consists of an ordinary glass microscope slide, on which is fastened a rectangular rim of metal 5 cm × 2 cm and 1 mm in depth. This, therefore, when filled and covered with a slip contains 1 cc of liquid. To facilitate counting a disc, on which was ruled a square, 1 mm in area was used in the eyepiece. The material was well stirred to ensure a thorough mixing and to prevent the accumulation of heavy forms at the bottom. While still in motion 1 cc was quickly drawn off and placed in the cell. At least forty squares were counted in each preparation and several slides were used from each collection. From the forty or more squares counted the contents of each cc was reckoned; an average of the contents of the several cells was then taken and this multiplied by the number of cc in the prepared material is an estimate of the number of individuals present.

It will be noted that both in numbers and diversity of form the genus Chaetoceras stands far in the lead. In September eleven species are recorded. The ranks are then gradually thinned until during the winter only four species, Ch. debile, diadema, laciniosum and decipiens are found; and these are but scantily represented. The addition of Ch. sociale in the spring adds greatly to the numbers; and from July onwards the remaining forms appear. The great predominance of Ch. debile, which on August 2nd. gives the record count of 7,000,000 frustules, is to be noted. The graceful spiral chains of this species are a characteristic feature of summer gatherings. But the maximum for diversity of form is, as recorded above, in September.

The allied genera, Corethron, Ditylium and Rhizosolenia, also attain their maxima in the autumn. Corethron criophilum appears only occasionally; but the beautifully modelled Ditylium Brightwelii is a dominant plankton form from the end of September until the first of December. In the autumn four species of Rhizosolenia are abundant, but throughout the winter and until the following August only R. hebetata is found. McMurrich (13) has recorded a distinct spring maximum for R. setigera in 1915 but this was not repeated in 1917.

Another dominant autumn form is Thalassiothrix longissima, which attains a sudden maximum in October, but holds its position of prominence for but a brief period. Its allied species T. nitzschioides is present in varying, but never great numbers throughout the year.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

A prevalence of free living, compact forms is to be noted in winter. Pleurosigma, but scantily represented during the autumn, presents six species in February. The only one, however, which can be said to be characteristic of any season, is P. strigosum, which abounds from February until April. December brings in Rhabdonema and Surirella, and January the Campylodisci; Actinoptychus undulatus and the Coscinodisci persist and the latter presents an increase in the number of species. The majority of the more delicate forms, Leptocylindrus, Cerataulina etc. fail; but filamentous forms are not entirely lacking for Skeletonema costatum and Melosira are taken in practically every collection.

The prevailing spring forms are Biddulphia and Thalassiosira. The former is introduced in December and occurs in small numbers during the winter. It then gradually increases and attains a distinct maximum in the middle of March, after which its numbers decrease; and it is rarely found after May. For B. sinensis a similar maximum has been recorded by Ostenfeld (16) in the North Sea, but it there prevailed throughout the summer and reached its height in November. Thalassiosira appears in February. Five species T. gravida, nordenskioldii, hyalina, condensata and Coscinosira polychorda are grouped together in the tables. These dominate the plankton during April and May and on

May 1st. give the enormous total of 8,750,000 frustules.

It is seen that in general the autumn plankton is characterized by the presence of slender, elongated forms such as Thalassiothrix and Rhizosolenia, together with numerous species of Chaetoceras. The winter presents the solid, compact forms while in spring and summer the long, graceful chains of Thalassiosira and Chaetoceras prevail. Other species appear occasionally, or are present in small numbers throughout the year, but at no time does any other form a characteristic, seasonal feature.

Station 3.

Station 3. is situated in the Bay of Fundy, eleven miles south east of Swallow Tail Light, Grand Manan. The results of monthly collections from the first of January to the end of July are recorded in Table V. A comparison with the previous tables, immediately reveals the similarity of the flora to that of Station 6. But the more exposed waters of the Bay of Fundy are clearly not so favourable to diatom production, for at all seasons the numbers, both of species and individuals are greatly reduced. One new species, Chaetoceras atlanticum, is the only addition to the former records; and Ch. danicum is found to persist throughout the year.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Table V

Station 3. Jan. - July 5m. Tows.

	Jan. 3	Feb. 8	Apr. 9	May 4	June 15	July 4	July 31
Navicula						50	
Pl. angulatum	50						
Pl. strigosum	50	300	50				
Asterionella				1800		200	1400
N. seriata							600
N. closterium							1000
Thal. nitzschioides	600		4300	3900		100	
R. shrubsolei		50					
R. hebetata	150	50	500	2600	50	50	200
Corethron							200
Ch. debile			1200	88400		1700	10200
Ch. sociale				80000			4000000
Ch. Willei							2000
Ch. diadema	350	150	6100	6100	350	1650	4400
Ch. laciniosum			3500			200	6200
Ch. decipiens	150			500	200	1450	6800
Ch. danicum	50		100	100			
Ch. atlanticum			500	200			800
Ch. convolutum			200	800		100	20000
Skeletonema			7200	4400			10000
M. sulcata			200				
Thalassiosira			250000	880000	50	4300	
Leptocylindrus						100	
Bid. aurita	100	50	1200	500			
Bid. mobiliensis	50						
Actinoptychus	50	50					
Coscinodiscus	1600	550	200	2200	200	700	200

Other stations.

The remaining stations lie in the order 10, 4, 9, 1, in the channel leading from the Biological Station toward the Bay of Fundy; and Station 5 is in the Bay of Fundy, midway between the northern end of Campo Bello and The Wolves. As only surface tows were taken at these points, the results recorded in Tables VI and VII do not bear comparison with those of the former tables. They serve in themselves, however, as a means of comparing the floras of the different localities. Two seasons, October and May are presented. As the result of an accident the October material of Station 5 was lost before a count was made; the species found are, therefore, merely marked in the table, and I may add that I have recorded that the diatoms present were few.

As would be expected from the force of the constantly changing tides, it is the predominant forms, which prevail over the whole area. No form attains its maximum at one particular point. Thus in May Chaetoceras debile, Ch. sociale and Thalassiosira are always present in large numbers; and in the autumn the prevailing species Thalassiothrix longissima, Rhizosolenia shrubsolei and Dityllum Brightwellii are taken at every point. The constantly persistent forms, Chaetoceras diadema and Coscinodiscus appear uniformly at all stations at both seasons, while the less abundant forms are occasionally obtained at the various points. Two species,

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Table VI

5m. Tows in May from Stations 6,10,4,9,1,5,3.

Stations	6	10	4	9	1	5	3
Navicula	400.						
Pl. fasciola	400	800.		200	200		
Pl. angulatum	400			200		250	
Pl. strigosum	50			200		250	
Pl. formosum	200						
Achnanthes	100						
Asterionella				400			
Synedra	1000.						
Grammatophora				800			
Rhabdonema				400			
Thal. nitzschioides	3000.	2000.		400	800.	1750.	3900.
Bacillaria							
R. hebetata	1200.	800	800		300.	250.	2600.
R. faerõensis	400	800					
Ch. debile	101000.	254000.	112000	23000.	22700.	23000.	88400.
Ch. sociale	33000	12000.	60000.	39600	23300	7500.	80000
Ch. Willei		2000					
Ch. diadema	19000.	50800	12000.	9400	5600	5500	6100
Ch. laciniosum	10000	11200	1600				3500
Ch. decipiens		800					500
Ch. contortum		800					
Ch. danicum							100.
Ch. atlanticum				600			200
Ch. convolutum	50						800
Skeletonema	50.			11200	4300	10000	4400
M. sulcata	2000					1000	
Thalassiosira	81500000	6000000	8400000	2900000	570000	266000	880000
Bacterosira				3200			
Bid. aurita				5600	2200	22500	500
Actinoptychus					100		
Coscinodiscus.	400	800	2400	200		750	2200

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Table VII

5m. Tows of October from Stations 6,10,4,9,1,5,3.

Stations	6	10	4	9	1	5
Pl. fasciola	2000	100			600	
Pl. angulatum		100				P.
Pl. strigosum		100				
Pl. formosum				50	300	
Tabellaria					600	P.
Rhabdonema					30000	P.
Surirella					300	
Campylodiscus		100			600	P.
N. seriata	50	8800	1800	2850	300	
N. closterium	2000				2400	
N. sigma						
Thal. nitzschioides		200				
Thal. longissima	2000	300	400	1700	4800	P.
Bacillaria				100		
R. shrubsolei	66000	80000	30000	7340	4200	P.
R. obtusa	1400	1000	200	150		
R. alata		100		50	600	
R. hebetata	8000	700	300	250		
R. faeröensis					900	
Ditylium	24000	30000	20000	8000	14400	P.
Ch. gracile		100	200			
Ch. sociale	124000					
Ch. debile	16000	2100				
Ch. Willei		200				
Ch. diadema	6000	13600	600	4100	13200	P.
Ch. laciniosum	10000	1200				
Ch. constrictum			800			P.
Ch. contortum		500				
Ch. decipiens	50	300	600	100	1200	
Ch. danicum		400	600			
Ch. convolutum				150		
Ch. criophilum	50					P.
Skeletonema		200		250		
M. sulcata	50	300		250	1800	P
Cerataulina		500	400			
Bid. aurita		100				P.
Bid. mobiliensis		100				P.
Isthmia					600	
Actinoptychus	2000	100			600	P.
Coscinodiscus	10000	1000	400	250	4800	P.

¶ Isthmia nervosa and Isthmia enervis, obtained at Station 1, are the only addition to the previous lists.

In brief we may conclude that with respect to seasonal distribution the members of the phytoplankton may be included in three groups; firstly, those species which persist in considerable abundance over the whole area throughout the year; secondly, those which occur occasionally at all seasons; and thirdly, those which attain a marked predominance at one season and then either entirely disappear or occur at rare intervals.

Bathymetric Range.

Station 6. A comparison between surface and 5 metre tows.

To ascertain the more favourable depth for the gathering of material a comparison was made between the numbers obtained in monthly tows at the surface and at a depth of 5 metres. Each species was considered separately and each presented the same irregularity of distribution. Most frequently, however, the greater numbers came from the lower level, for out of 183 comparisons made, the five metre collections proved the greater in 103 cases. No species showed a preference for the surface waters, nor did any fail to appear in them. A synopsis of the results for eleven of the most abundant genera will be found in Table VIII.

Stations 3 and 6.

Station 3 offers the best conditions for a study

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Table VIII

Comparison of Surface and 5m. Tows. Station 6.

		Oct. 6	Dec. 4	Dec. 27	Jan. 24	Mar. 15	Apr. 14	June 21	July 11	Aug. 8	Sept. 6
Pleurosigma	S.	2000	1350	450	4300	450	250	300	4000		200
	5m.	9000	1900	800	1300	800	4550	6000	4000	550	
Thalassiothrix	S.	200000	400		50	400	400	50	8000	800	500
	5m.	528000	100		2200	600	2000	2000	29000	500	50
Rhizosolenia	S.	24000	50			200		50	4000		650
	5m.	168000	100		600	200	50	1300		250	150
Dity lium	S.	24000									
	5m.	99000	50								
Chaetoceras	S.	156000	900	400	2200	850	9800	37400	1842000	1000	8200
	5m.	216050	800	800	500	400	61000	455900	3716000	9225	100
Skeletonema	S.			1200	1800	7500	1000		274000	300	
	5m.				2500	2500	10500		240000	750	300
Melosira	S.	50	2400	3800	700	650	100	1875	2000	200	300
	5m.	50	1150	2800	2200	1100		6050	50	1500	
Thalassiosira	S,					800	98000	53750	106000		
	5m.					500	952500	722000	39000	1125	
Biddulphia	S.			200	100	22800	11000				
	5m.			600	1100	20300	48500				
Actinoptychus	S.	2000	400	600	600	200	50				
	5m.	3000	200	800	200	100	500				
Coscinodiscus	S.	10000	2000	1800	1800	400	400	250	2000		350
	5m.	3000	700	2000	3100	2200	2000		2000	50	

of the bathymetric range, since at that point the water has a depth of 175 metres; at Station 6 it ranges from 26 to 30 metres. At the former station eleven samples were taken on July 31. at intervals of 10 or 25 metres. Later an estimate was made in the following manner of the average diatom content of 50 cc at each level. From each of the eleven samples four volumes of 50 cc each were centrifuged for half an hour, it having been previously ascertained that that period sufficed for the extraction of all the plankton organisms. The water was then siphoned off leaving the residue in 2 cc. The organisms were again counted in the Rafter cell, but in this case the cover slip was divided into forty squares, each measuring .25 sq. cm. The frustules of each species were counted in 10 squares in each of the two slides made from a preparation; and the average of these multiplied by 80 gives the total content of the 50 cc. The average results obtained from the four similar 50 cc samples drawn from each level will be found in Table IX. These show a distinct maximum at 10 metres, and then a rapid decrease. Below 20 metres the decrease is gradual and somewhat irregular until at 150 metres few diatoms are found. At the bottom, however, a decided increase will be noted due to an abundance of *Melosira sulcata*. The latter is the only form which is found to increase with descent.

Table IX

Bathymetric Range. Station 3. July 31.

Meters	0	10	20	30	40	50	75	100	125	150	175
Navicula						8				8	24
Synedra						8					8
N. seriata	1144	1912	16	40		8	8	16	8		
N. closterium	144	456	8				8				
Thal. nitzschioides		24	24	8		16			8		
R. hebetata									8	8	
Chorethron								8			
Ch. debile	280			72		16					
Ch. diadema										8	
Ch. laciniosum	240	40		88							
Ch. decipiens	8	32									
Ch. convolutum		32		32							
Skeletonema	976	4584	16		16	88		32			72
M. sulcata						56		48	108		512
Thalassiosira	160	3288	456	176	88	56	24	8			
Leptocylindrus			24					160			
Bid. aurita			16								
Coscinodiscus		24	8			8					8

Records similar to the above were made for Station 6 on July 27. and August 15. and are listed in Tables X and XI. In the former a maximum was obtained at 22 metres, below which a marked decrease was evident. In the latter we find an exception to results previously recorded, for the surface waters were found to contain a distinct maximum, chiefly due to the great abundance of Skeletonema costatum and Chaetoceras sociale, forms of extreme delicacy.

I regret that time did not permit a more thorough examination of the conditions at Station 3. From the results obtained it appears that the most favourable level is from 10 - 20 metres, and that below that depth a rapid decrease may be expected. One form, Melosira sulcata, which is not uncommon in surface waters, has been found on one occasion to be greatly increased at lower depths. Diatoms are by no means rare at a depth of 175 metres.

Cultures.

To ascertain whether other diatoms were present at any level in such small numbers that their presence was undetected by centrifuging, or were perhaps present in the form of spores, too minute for observation (3), cultures were started from water obtained at each level from Station 6. To this end a beaker of one litre volume was half filled with water drawn from each level. The water was treated by Miquel's method (18) as improved by Allen (9). This treatment is dealt with in a later section on Culture Methods.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Table X

Bathymetric Range. Station 6. July 27.

	0 m.	7 m.	12 m.	17 m.	22 m.	27 m.
Navicula	48	8	16	16	32	
Pl. fasciola	24					
Pl. angulatum		8	16	32		
N. seriata	64			16	24	
N. closterium	8	8				
Thal. nitzschioides	128	80	40	32	88	
R. hebetata	104	24			8	
Ch. debile	800	1640	2952	3392	3416	1944
Ch. laciniosum	32	32	88			
Ch. convolutum						16
Skeletonema		304	112	456	368	40
M. sulcata	56	360	176	56	104	72
Thalassiosira	8	88	48	32	104	
Leptocylindrus					112	
Actinoptychus					8	
Coscinodiscus			8			

Table XI

Bathymetric Range. Station 6. Aug. 15.

	0 m.	7 m.	12 m.	17 m.	22 m.	27 m.
Navicula	32	24	24		24	16
Pl. fasciola	8		8			
Asterionella		16			40	32
Synedra						8
N. seriata	4496	4088	3232	3200	1904	2240
N. closterium	184	256	200	208	112	112
Thal. nitzschioides	120	160	160	104	56	88
R. hebetata		80	8	8		16
R. faeröensis	56					
Ch. gracile		72	8	24	8	
Ch. debile	2728	2200	1024	608	2640	3552
Ch. sociale	1136	1184	2360	2604	608	432
Ch. diadema				80		
Ch. laciniosum	848	440	264	256	392	54
Ch. decipiens	32	136		40		
Skeletonema	5384	2076	3288	5240	1864	1736
M. hyperborea		176		8	216	24
Thalassiosira	136	32	80	96	304	32
Leptocylindrus		848	520	136	744	344
Cerataulina	48	48	40	40	48	72
Coscinodiscus		24			8	

The six cultures were then placed in the most favourable situation for growth. No strictly planktonic forms other than those listed in the tables, developed; but Schizonena Grevillei, roped in long beautiful strands, appeared in abundance in every beaker; and Melosira Borreri produced several normal chains in the water from 7 metres. It may then be concluded that other forms were lacking for, although the specific differences are such that diverse conditions are necessary for obtaining permanent cultures of the many forms, I have found that the method here employed has given a more greater or less initial growth for all the plankton diatoms so treated.

DIATOM CULTURES.

Preliminary Experiments.

In the summer of 1916 cultures were started at the Atlantic Biological Laboratory with the object of providing food for marine copepods. The particular species sought was Nitzschia closterium, but owing to its rare occurrence it was found necessary to make trial of other forms. I have since found, however, that when present Nitzschia closterium grows with great luxuriance, and will in a mixed culture rapidly replace many forms and is persistent.

The first experiments dealt with the form of vessel best suited to the organisms and to this end cultures were started in : beakers, petri dishes and Erlenmeyer flasks of various sizes. Each was partly filled with ordinary sea water, placed in diffuse light and kept at room temperature. No profuse growth was obtained, but in ten days a decided increase was noted in the following: *Coscinodiscus subbulliens*, *Skeletonema costatum*, *Chaetoceras debile* and *Thalassiosira nordenskioldii*. It was seen that the form of the vessel did not influence growth. Therefore for convenience and uniformity subsequent cultures were made in Erlenmeyer flasks of 125 cc volume.

An attempt was next made to increase the growth by the addition of nutrient salts. Having noted the success of Allen and Nelson (9) in the culture of several plankton species I adopted the solutions used by them. These had been adapted by Allen from the nutrients employed by Miquel (18) in working with fresh water and bottom forms and were as follows:

Solution A. Dissolve 20.2 grm potassium nitrate in 100 cc distilled water.

Solution B. Dissolve 4 grm sodium phosphate in 40 cc distilled water. Add 2 cc pure, concentrated hydrochloric acid, then 2 cc ferric chloride dissolved by gentle heating. Add 4 grm calcium chloride dissolved in 40 cc distilled water.

These solutions were used in the proportion of 2 cc of A and 1 cc of B per litre of sea water. The addition of B throws down a precipitate, which an analysis has shown to contain most of the iron, a little phosphorus and some calcium. This was allowed to settle and then removed. The sea water used was first raised to 70°C and maintained at that temperature for 30 minutes in order that all plant life might be destroyed.

With a view to isolating individual species prepared sea water was inoculated with from two to six drops of plankton to 100 cc of water, and poured into petri dishes. These were kept in a stationary position and it was hoped that individual species would develop in separate colonies, which could be picked out to form the nucleus of pure cultures. Colonies of *Coscinodiscus subbulliens* soon appeared and were transferred to erlenmeyer flasks, half filled with prepared sea water. For about two weeks *Coscinodiscus* survived and showed some development - in one case especially gaining very considerable headway - but eventually its development was in every case inhibited by the very luxuriant growth of *Schizosonema Grevillei* or small navicular forms, which are not strictly speaking planktonic. It was evident that these forms had entered in the drops of water used for inoculation, since the rest of the water had been freed of living forms by heating. It was also clear from these and subsequent experiments that the plankton forms, which in the open seas hold their own against these organisms, which are there mingled with them in small numbers, stand little chance of development in their presence under artificial conditions. Several very profuse growths of small navicular forms were obtained, and proved decidedly more luxuriant in treated than in untreated water.

Other cultures were attempted by picking out with a pipette under a dissecting microscope individual frustules or chains, passing them through several changes of sterilized sea water and then transferring them to flasks prepared as above. ~~But~~ This method met with no success.

It was my intention to continue cultures during the winter and to that end arrangements were made whereby plankton would be forwarded to me at intervals in thermos bottles; but, owing to the difficulties in transport and the consequent loss of material, the attempt was abandoned until the following summer. One good culture of Coscinodiscus radiatus and one of Biddulphia aurita were obtained in treated sea water, but they showed no interesting developments and became exhausted in two months,

Mixed Cultures.

Plankton was collected on July 4. 1917. The collection contained nineteen species, of which the prevailing forms were Chaetoceras debile and Thalassiosira nordenskioldii. In the hope of more effectively isolating individual species than in previous work a method of subdivision in test tubes was employed. A tube of prepared sea water was inoculated with two drops of plankton and divided into six test tubes. The contents of each was then added to an erlenmeyer flask of 125 cc volume, which had been half filled with prepared sea water. Three series were arranged and with each a control in untreated, sterilized sea water was run. The sets were placed in: (1) a window receiving afternoon sun, (2) a window receiving no sun; (3) flasks covered with cheesecloth.

No development was obtained in the untreated water except in one flask in Position 2; and this was very slight and disappeared in ten days. In Position 1 three flasks produced each a mixed culture of Thalassiosira nordenskioldii and Skeletonema costatum. These were at their height on July 18., after which one became exhausted and the other two presented Nitzschia closterium and Melosira hyperborea. On August 6. these forms were showing rapid increase and on August 25. when the work was closed at the Biological Station were in excellent condition. New flasks were inoculated from these and formed the source of material for winter studies.

In Position 2 five mixed cultures were obtained and one pure culture referred to later. Thalassiosira nordenskioldii was always the dominant form, but was accompanied by Skeletonema costatum, Chaetoceras debile and Melosira hyperborea, singly or in combination. All forms except Melosira lost their vitality in a few weeks. One culture was swamped by Nitzschia closterium and another by Chaetoceras sp.?, a small, delicate form, found singly or in pairs, of which the compressed frustules were rectangular in zonal view and furnished with delicate setae. The others became exhausted. The initial mixed growth obtained in this position showed a decided superiority to that of Position 1, but it lasted not more than a week longer, and the final development of Nitzschia and Melosira was superior in Position 1. In Position 3 no growth was obtained.

It is noticeable that although Chaetoceras debile was one of the dominant plankton forms it developed in but one culture and then to but a slight extent. Another series started on July 11. from plankton in which Ch. debile was even more abundant gave a similar result. Two other species of Chaetoceras also, diadema and laciniosum, were more abundant than Skeletonema costatum but gave much less growth. Although chains of all three could be found for several weeks with the aid of a microscope and the numbers were decidedly greater, in comparison with the amount of water, than under natural conditions, no visible growth was obtained.

In considering the results from the three positions it may be said that the majority of forms thrive best in strong, diffuse light, but that some forms, Nitzschia and Melosira, are uninjured by direct sunlight. Subsequent work, however, has shown that even they are unable to persist, when the light is too intense. The majority of plankton forms show, also, an aversion to crowding and die out after a slight increase. This may be due to the exhaustion of some essential nutrient and suggests that interesting developments may be met along such lines; or the exhaustion may be due to the influence of the products of metabolism, the injurious effects of which are emphasised by Vernon (15) in reference to members of the animal kingdom. The power of living in a crowded area is decidedly greater in some forms than in others, among the least persistent being the members of the genus Chaetoceras.

A mixed culture maintained during the autumn gave a very considerable development of several species. Skeletonema costatum was the prevailing form, but Asterionella japonica was remarkably abundant and healthy. One colony was seen to contain eighty-five frustules, and the colonies were numerous. This culture was started on August 25. and its position was changed several times before it was finally placed on September 9. in a permanent position opposite to a bright, south window. Until the latter date little development was noted, but later it continued to increase until

November 13., when the maximum development was obtained. Chaetoceras sociale, Nitzschia bilobata, Coscinodiscus subbulliens and Thalassiothrix nitzschioides were present in numbers.

Pure Cultures.

In position 2 (a window receiving no sun) one very luxuriant, pure culture of Thalassiosira nordenskioldii was obtained. By a pure culture is intended one quite free from other organisms. It reached its maximum in two weeks and remained in excellent condition until the end of July, when the chains began to break up. When at its height the water was filled with a brown cloud of suspended chains. Several flasks were inoculated from this, and for some time showed excellent growth; but after the middle of August its vitality seemed lost. for no further cultures could be started from the original and those already started rapidly deteriorated, so that by August 25. very few healthy frustules could be found. The original was retained but showed no subsequent revival. It may be noted that the death of Thalassiosira in the cultures corresponds somewhat closely to its disappearance from the plankton, for at the end of August it is very rare in plankton collections..

Later a pure culture of Skeletonema costatum was obtained in addition to those of Nitzschia closterium and Melosira hyperborea already mentioned. Only the two later forms, however, proved persistent. In all cases, except when a culture was swamped by the development of Nitzschia or some navicular form, the most profuse growth was obtained in the pure cultures. In these, at the end of two weeks, diatoms were present in such numbers that the water was visibly filled with clouds of their chains.

Summary. of culture experiments ?

The following plankton species may be recorded as developing to a greater or less extent in culture vessels of prepared sea water:

Pleurosigma fasciola	Chaetoceras debile
Asterionella japonica	" diadema
Tabellaria sp.?	" laciniosum
Nitzschia closterium	" contortum
" seriata	" decipiens
" bilobata	" convolutum
Thalassiothrix nitzschioides	Biddulphia aurita
Skeletonema costatum	Coscinodiscus subbulliens
Melosira hyperborea	" radiatus

Nitzschia closterium.

As I have previously stated Nitzschia closterium has been found capable of developing in great luxuriance; and of replacing, under artificial conditions a variety of forms. Its optimum temperature is from 18° - 20° C.; but it will endure a range of 0° - 23° C. without loss of vitality. A preference for bright light is revealed by a comparison between two cultures, which were grown for two months, the one opposite a bright window and just out of the direct sunlight and the other in a northern exposure. In the former the frustules attained an average length of 59 micr., contained rich, dark brown chromatophores, and were very active; in the latter the average length was 35 micr., the form irregular, the chromatophores greenish and the movement sluggish. These two cultures were grown in flasks lightly plugged with cotton, but the best growth obtained was an uncovered beaker culture, developed later under optimum conditions of light and heat. In this the frustules attained a length of 112 micr., and showed a tendency to form chain-like colonies. In one chain nine frustules were counted and these moved over one another actively, with a motion similar to that of Schizonema Grevillei. This would seem to indicate that the free access to a considerable air surface is beneficial. In less favourable conditions the frustules are frequently grouped in irregular masses of coleoderm. As regards size and habit of growth it may be concluded that the environment may exert a very considerable influence.

Melosira hyperborea. Grun.

Cultures of Melosira hyperborea, set up from material developed from the plankton collection of July 4., were

were maintained from September 14. 1917 to March 22. 1918, and dealt with the following conditions: (1) air and light, (2) salinity. (3) temperature, (4) development in artificial sea water.

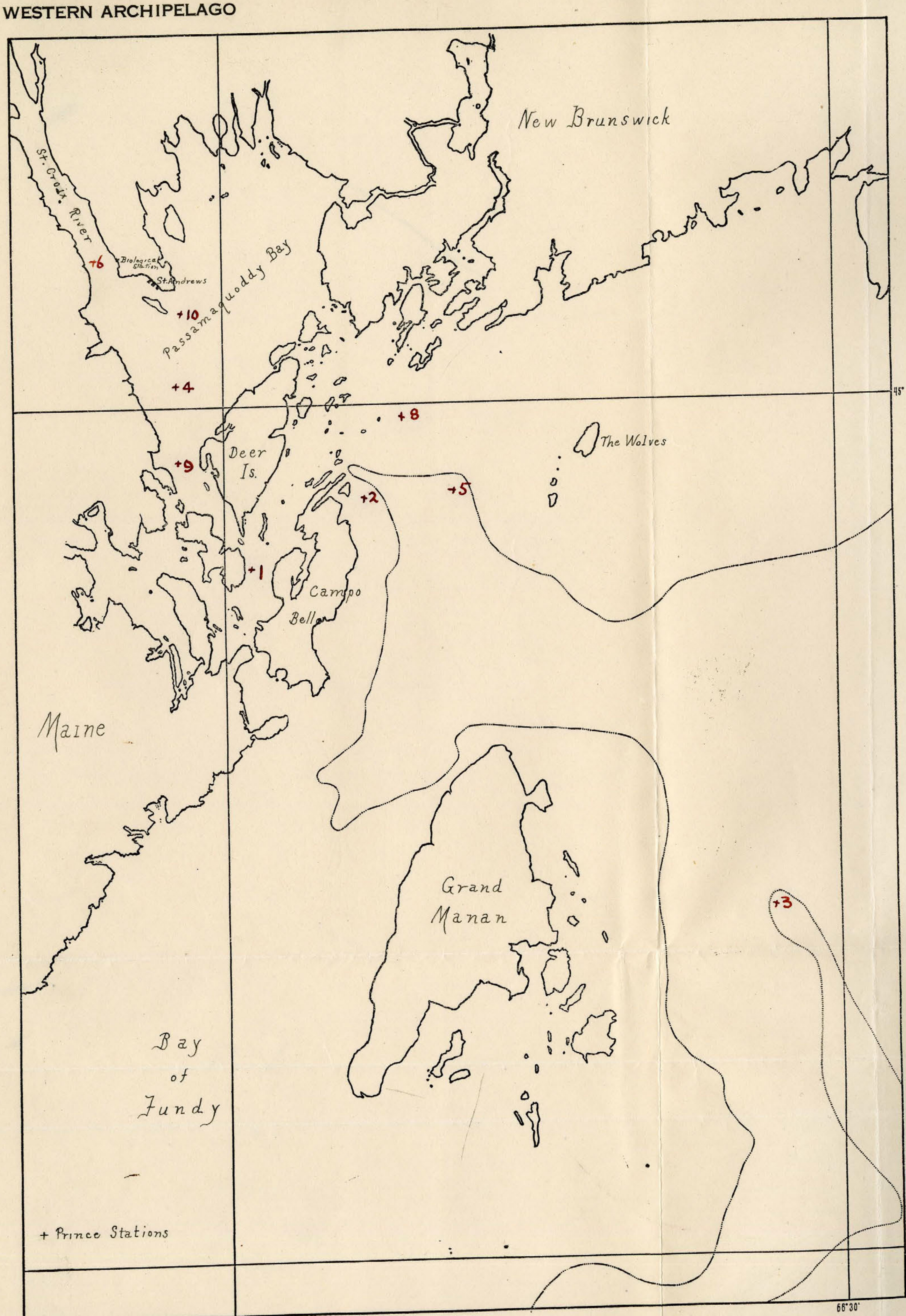
I. Air and Light.

Since it had been previously ascertained that Melosira required the addition of nutrient salts, all cultures were grown in sterilized, treated sea water. Cultures were set up on September 14. in open flasks and in others plugged with cotton and placed: (1) in north window, (2) in south window, (3) opposite south window just beyond the direct rays of the sun, (4) in dark. The following table briefly summarizes the results:

			Sept. 21.	Oct. 6.	Oct. 28.	Nov. 18.
1	North	1. Open flask	-----	Excellent	Good	Fair
		2. Closed	-----	Good	Poor	Dead
2	South	1. Open	Good	Good	Good	alive Life
		2. Closed	Slight	Life	Life	Few living
3	Opposite South	1. Open	-----	Excellent	Best of series	Same
		2. Closed	-----	Good	Good	Good

From the above it may be judged that the most favourable development may be expected in strong, diffuse light and with access to the air. It may be added, however, that the difference between the flasks in Position 3 was one of

WESTERN ARCHIPELAGO



quantity and not of quality. Both contained long, beautifully formed chains, without any signs of disintegration; and a later trial showed that if the plug were removed every few days to permit a change of air, the growth could be maintained. To prevent the entrance of foreign substances and undue evaporation the latter plan was then adopted.

In several of these cultures the terminal frustules frequently enlarged to form large globular cells. The outer valve was cast off and the contents of the whole frustule issued, but remained closely bound to the inner valve, and encased in a firm, transparent wall. These cells were filled with dark, dense contents. Later they divided to form long, regular, broad chains. These enlarged end cells and consequent broad chains were most abundant in the flasks placed in the south window, and particularly so in that which was closed; a few appeared in the north window, and an even smaller number were noted in Position 3. A further consideration of these will be given in a later section.

The cultures placed in the dark showed a very considerable development. Growth was not profuse but after two months many chains were still in good condition. At that date it was noted that no globular terminal cells had developed, that the chromatophores were decidedly greener than those in the light and that the divisions were often irregular and the frustules distorted. The material was then divided and part removed to favourable light conditions. There it revived to a considerable extent, but the chains displayed much more malformation then in normal cultures. The portion left in the dark continued to live and on January 12. a few enlarged end cells were noted. On March 15., six months after the culture was set up, living cells were still to be found, although they were not abundant. Most of the chains were empty and it is worthy of note that fully half of them had developed from the enlarged terminals cells noted on January 12,, for they were on an average 36 micr. in width.

A culture in which broad chains were particularly numerous produced, when removed from the south window, a fairly healthy, normal colony, in which no broad chains were found after two months development. It may then be inferred that in an actively growing culture the older cells are dissolved and thus retard the exhaustion of food material by the growing cells. In the colony exhausted by life in the dark dissolution did not take place and the empty cases remained.

II Salinity.

To test the development with respect to the concentration of salts a series of cultures was set up in treated sea water, strengthened by evaporation, or diluted by the addition of tap water. The latter was used owing to the lack of distilled water and I am indebted to Prof. Alex. Vachon for the following analysis of its contents. The sample analysed contained 0.0225 grm. of residue per thousand, which was composed of a trace of chlorides, a little calcinum carbonate and fine sand. The series was set up on November 25, and gave the following results:-

Concentration	Dec. 9.	Jan. 27.
Tap water	Fair	Deteriorated
" + Miquel sol.	Dead	——
10% Sea	Good	Deteriorated
25% "	"	Improved
40% "	Excellent	Excellent
50% "	"	"
60% "	"	"
75% "	"	"
90% "	"	"
100% "	"	"
125% "	"	Fair
150% "	——	"
175% "	——	Poor
200% "	——	Little life.

It is seen at once that Melosira hyperborea will endure a great diminution of salts and can live for some time even in tap water in which salts are practically lacking. The addition of Miquel nutrients, however, instead of acting favourably proved fatal in a short time.

The above table has reference merely to the state of the chains examined microscopically and not to the increase in size of the colony. With a reduction to lower than 40% little development occurred; but in from 40 to 100% the colonies were practically equal in size as well as uniform in quality. Increased concentration acted as a check to growth and caused disintegration in proportion to the degree of concentration. ~~The latter~~ caused also much malformation due to thickening of the walls, inward curving of the zone and irregular divisions.

III Temperature.

A healthy, normal colony was divided into sections as nearly equal in size as possible and each was placed in a separate flask, half filled with treated sea water. The temperature of each was then slowly lowered, or raised over steam to the required degree. To prevent contamination the thermometer was in each case kept in a second flask, one of which had been prepared for each of the series. When the desired temperature was reached it was maintained for three minutes and then allowed to return to normal. The series was set up on February 3. and gave the results tabulated below:

Temperature		March 3.	March 15.
60° C.		Dead	----
50°		"	----
45°		"	----
40°	27 sq.mm.	Fair	Improved
35°	54 " "	Excellent	Excellent
30°	48 " "	"	"
25°	40 " "	"	"
20°	45 " "	"	"
15°	32 " "	"	"
10°	25 " "	"	"

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Temperature		March 3.	March 15.
5° C.	24 sq.mm.	Excellent	Excellent
0°	54 " "	"	"
-5°	Scattered;	Best of series	Best of series
Frozen	15 sq.mm.	POOr	Disintegrated.

It was noted in preliminary work that some frustules seemed capable of resisting a temperature of 50° C, but it was evident from the development of the series that their vitality was so impaired that subsequent growth was inhibited. That which was raised to 40° revived and after six weeks presented a colony 90% of the frustules of which were in excellent condition. An increase or decrease of 20° was found to be no hindrance to development; but I regret that time did not permit of ascertaining the length of time to which the organism might be submitted to the changed condition. One variation due to change of temperature, which was noted, was the great ease with which the frustules could be separated. This indicates a change in the mucilaginous substance by which the frustules are bound together.

The flask lowered to -5°, which is recorded above as showing the best development, was accidentally overturned and the contents scattered through the flask. It was found that the chains in this were remarkably good, practically no disintegrated frustules occurring. From this it may be inferred that in other flasks some disintegration may have been due to crowding.

On March 3. many enlarged end cells, of like nature to those found in the experiments on light, were noted in all the flasks, even in the unheated controls. In the -5 flask some had already divided. On March 15. all the cultures contained beautiful, long, broad chains; and on March 22. they were still in the process of division. The broadest chains noted had attained a diameter of 39 micr., and in advanced cultures all gradations were found down to a diameter of 10 micr. The enlarged terminal cells were clearly not due to the stimulus of temperature, since their presence was also noted in the controls. In the latter, however, they were least numerous, and it is probable that a change in condition induced their profuse production. The same may be said regarding light. Darkness did not prevent, but merely delayed their appearance; optimum conditions produced them in small numbers; while excess of light acted as a strong stimulus. It may be inferred that they are a normal means of increasing vitality, which may be stimulated by abnormal conditions.

IV Artificial Sea Water.

An artificial sea water based on the analysis of Dittmar (14) was employed. Gram molecular solutions of the salts to be used were made up and combined in the following proportions: 480.8cc Na Cl ; 10.28cc K Cl;10.86cc $CaCl_2$;26.70cc $MgCl_2$; 29.06 $MgSO_4$; 2cc $NaHCO_3$. The total was then diluted with distilled water to a volume of one litre.

Cultures were set up on September 14. Allen (10) has recorded that for the growth of Thalassiosira gravida in water of a similar composition the presence of a small quantity, 1% - 4%, of natural sea water is essential. To ascertain whether a similar condition was necessary in the case of Melosira hyperborea, all trace of the natural sea water was removed by passing the material through several changes of artificial sea water before finally transferring it to the prepared flask. Two cultures were started, one in artificial sea water, and one in artificial plus Miquel nutrients in the proportion previously employed. These were examined at intervals, and twice during the winter the medium was renewed. Its concentration was maintained by the addition of distilled water. Very fair growth resulted, and though it did not equal in quantity that obtained in natural sea water, the material was uniformly healthy. The growth in untreated water was only 25 per cent of that obtained in the treated, but it also was normal in quality. It is worthy of note that in neither culture did enlarged terminal cells appear. It therefore is concluded that the substance whose presence is essential to the development of Thalassiosira gravida is unnecessary to the growth of Melosira hyperborea. And this seems to support the conclusion that the exhaustion of the mixed cultures recorded above may be due to the loss of some essential nutrient, which the initial growth of some species exhausts; while the persistence of Melosira is permitted by its lack of dependence on that substance.

Summary. (Of what portion of paper)

Melosira hyperborea can endure a great variety of light conditions, but the optimum development will be obtained in strong diffuse light. Its growth is regulated to some extent by the solution of gases from the air. It can endure a range of forty degrees of temperature, and a diminution to forty per cent of natural sea water. It can even exist for a time in tap water. Miquel solutions act as a stimulus to growth in all cases except when added to tap water; they then rapidly prove fatal. Increased concentration of natural sea water is detrimental. Excellent, persistent cultures may be obtained in artificial sea water. A comparison with the work of Allen on Thalassiosira gravida points to fundamental, specific differences in the nutrient requirements of plankton diatoms.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Systematic List

Diatomaceae

TRIBE 1. RAPHIDIEAE.

Navicula Bory.

Frustules free; valves with three nodules in median line; raphe straight; valves marked with transverse striae or ribs; chromatophores: two large plates.

N. distans, W.S.

Valves elliptical, tapering to rather acute ends; raphe surrounded by a distinct clear area, which is dilated around the median nodule; striae strong, 4 in 10 micr., running obliquely toward the raphe; zonal view broadly elliptical with squared ends. Length about 100 micr.; width 18 micr. Occasionally throughout the year.

N. aspera, Ehr.

Valves elliptical with sub-acute ends; raphe surrounded by a very narrow, clear area, which is greatly expanded around the median nodule, where it gradually broadens until it almost reaches the margin; remainder of valve covered with striae formed of large dots, which run obliquely toward the raphe, 10 in 10 micr; zonal view broadly elliptical, middle slightly contracted, ends squared. Length 150 micr: width 30 micr. Throughout the year, but rare.

N. digito-radiata, Greg.

Valves elliptical with rounded, obtuse ends; raphe surrounded by a narrow clear area, dilated around the median nodule; striae oblique, straightening toward ends, about 6 in 10 micr; zonal view rectangular with slightly rounded ends. Length 90 micr; width 15 micr. Rare.

N. Rhynchocephala, Kütz.

Valves elliptical, at first tapering, then slightly expanding to form a knobbed end; raphe surrounded by a narrow, clear area, dilated to a rounded space around the median nodule; striae oblique, straightening toward end, 10 in 10 micr; zonal view rectangular, with slightly rounded corners. Length 60 micr., width 10 micr. Rare.

N. brevis Greg.

Valves elliptical, tapered from middle to rather acute ends; raphe surrounded by a distinct clear area, dilated around the median nodule to a wide rounded space; striae fine, 12 - 14 in 10 micr., oblique. Length 120 micr. width 35 micr. Rare.

N. retusa, Breb.

Valves elliptical, ends sub-acute; raphe bordered by a narrow clear area, dilated around the median nodule; striae oblique, 11 in 10 micr: zonal view broad, contracted in middle, ends squared. Length 50 micr; width 14 micr. Rare.

Navicula sp ?

Valves elliptical, tapering to acute ends; ribs fine, at right angles to and almost touching raphe. Length 80 micr; width 14 micr. Rare.

Navicula sp ?

Resembling the last but ribs stronger, 7 in 10 micr., slightly oblique and leaving a small, clear area around the median nodule. Rare.

Pleurosigma W.S.

Frustules free, lanceolate; valves more or less sigmoid; raphe distinct, more or less sigmoid; striae of fine dots, giving under lower powers the appearances of two or three sets of intersecting lines, either running obliquely in opposite directions toward the raphe, or one set longitudinal and another crossing it at right angles; chromatophores two long, intricately bent bands.

P. angulatum, Cleve.

Valves broadly lanceolate, slightly sigmoid and more or less angled at the middle; raphe slightly sigmoid; stauros distinct; striae of fine dots very clearly arranged in oblique lines, giving the appearance of three intersecting sets, about 20 in 10 micr: chromatophores forming an intricate pattern. Length 180 - 260 micr: width 35 - 40 micr. Throughout the year.

P. elongatum, W.S.

Valves elongated, smoothly sigmoid; raphe slightly sigmoid; stauros distinct; striae as in P. angulatum, but finer, about 25 in 10 micr., and crossing at a more acute angle. Length 350 - 450 micr; width 30 - 40 micr. Spring: rare.

P. strigosum, S.

Valves smoothly sigmoid, ends acute; raphe sigmoid; stauros distinct; striae oblique, very delicate; chromatophores as in P. angulatum. Length 300-400 micr; width 20-30 micr. Throughout the year: abundant from Feb. - April.

P. formosum, W.S.

Valves elongated, narrow, sigmoid, ends rounded; raphe strongly sigmoid; striae strong, oblique, cutting at about a right angle, formed of rather coarse dots studded very close together, about 10 in 10 micr. Length up to 450 micr.

Occasionally throughout the year.

P. fasciola, W.S.

Valves strongly sigmoid, ends narrowed and much elongated; raphe sigmoid; striae delicate, longitudinal parallel to raphe and more easily distinguished than the transverse. Length 80-100 micr. Throughout the year.

P. Balticum, W.S.

Valves straight, with ends obtuse and decidedly sigmoid: raphe sigmoid at the extremities; striae about 15 in 10 micr., parallel and at right angles to the raphe; zonal view elliptical: Length 200-350 micr. Sept.-Apr: not abundant.

Scoliopleura latestriata. Grun.

Frustules free; valves elliptical with ends sub-obtuse; raphe sigmoid, bordered by a clear area, which is dilated around the median nodule; parallel to the raphe, on each side, is a linear longitudinal furrow; ribs strong, alternating with double rows of fine dots: zonal view wide, with median contraction. Length about 160 micr. Rare.

Achnanthes brevipes. Ag.

Frustules united into bands by the cohesion of valve faces; valves linear, with rounded ends and median contraction; striae 7 in 10 micr., composed of large dots; outer valve lacking raphe, but inner having raphe bordered by clear area; zonal view brace bracket shaped; zone finely striated. Length 90 micr., width 14 micr. Feb, Rare.

TRIBE II. PSEUDO-RAPHIDIEAE.

Asterionella. Hassal.

Frustules linear, one end enlarged, united at the larger end into star-shaped colonies.

A. Bleakeleyi, W.S.

Frustules with ends unequally enlarged; walls delicate; chromatophores numerous. Length 54-70 micr. width 1.5-3 micr. Mar.- July.

A. japonica, Cleve.

Frustules with basal end triangular and apex prolonged with a long hairlike process; chromatophores two, not extending into the projection. Length 48-88 micr. Aug. and Sept: not abundant.

Synedra affinis. Kütz.

Frustules free, linear, straight- valves tapering toward the ends, which are rounded; zonal view rectangular; valves ornamented with delicate, transverse, marginal striae, which leave a central unmarked line and clear median area. Length 90-130 micr. Occasionally throughout the year.

Fragilaria islandica, Grun.

Frustules linear, united into slightly curved chains by the cohesion of valve faces; valves diminished toward the ends, ornamented with transverse striae which leave a clear, central line and unmarked median area; zonal view rectangular; zone marked with longitudinal striae; chromatophores two. Length 20-55 micr. June - Aug. Rare.

Tabellaria sp ?

Frustules linear united into long ribbon-like chains: zonal view rectangular: walls delicate: chromatophores two. Length about 40 micr. Occasionally throughout the year.

Grammatophora marina, Kütz.

Frustules free or united into zig-zag chains by cushions formed at the corners: valves elongated, elliptical, narrowing near the extremities and then expanding to form rounded ends: striae fine, about 20 in 10 micr., ends unmarked; zonal view rectangular with rounded corners, from each end run two strongly marked septae, curved at first, then parallel and each terminated by a longitudinal thickening. Length 75 micr. width of zonal view 15 micr. Winter. Rare.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

<u>RHabdonema arcuatum, Kütz.</u>

Frustules united into long ribbon-like chains; valves narrowly elliptical; broad zonal view rectangular or square, seemingly marked with numerous parallel ribs, which, however, extend to the interior forming partial partitions; the addition of fine, longitudinal, intercostal striae give the wall a latticed appearance; corners unmarked. Length 45-58 micr. Occasionally throughout the year.

<u>Surirella Turpin</u>.

Frustules free: valves broadly elliptical or oval, marked with strong transverse ribs.

S. gemma, Ehr.

Valves broadly elliptical with ends sub-obtuse: ribs strong at the ends curving to meet the straight median line, toward middle straight and oblique; intercostal striae very delicate; zone decidedly cuneiform. Length 70-125 micr. Jan. - June: not abundant.

S. ovalis, Breb.

Valves oval: ribs strong, terminal ones curving to meet in the median line, central ones straighter and leaving a broad, clear, median area; marginal depressions at the ends of the ribs, giving the periphery a ridged appearance. Length 125 micr. Rare.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Campylodiscus, Lyn.

Frustules free, saddle shaped; valves circular, with well marked costae; medium lines of the two valves at right angles, forming a cross; chromatophores two plates.

C. Thuretii, Breb.

Valves circular: costae strong, short, curved: central area ornamented with fine, transverse striae, which are interrupted by the median line and two furrows parallel to it; periphery marked with strong dots. Diam. 50-65 micr. Jan. - March.

C. hibernicus, Ehr.?

Valves circular; costae well marked, short, curved; central area studded with fine dots which leave a median line. Diam. 50-80 micr. Rare.

Nitzschia, Hassal.

Frustules spindle-shaped or linear, free or united into chains; valves showing clear, longitudinal line, resembling raphe; chromatophores two.

N. seriata, Cleve.

Frustules spindle-shaped, united by the cohesion of overlapping end surfaces to form long, thread-like chains; valves ornamented with very delicate transverse striae, about 18 in 10 micr. Length about 100 micr., width 5 micr.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

July - Oct. abundant.

N. closterium, W.S.

Frustules free, motile, spindle-shaped with ends prolonged into long, hair-like, flexible processes, the curving of which make the cells straight or crescent-shaped. Length 40-60 micr. July - Dec: not abundant.

N. longissima, Grun.

Frustules free, linear, elongated, much enlatged in the middle, both ends gradually curving in the same direction: edge lined with a single row of dots. Jan. Rare.

N. sigma, W.S.

Frustules free: valves linear, tapering gradually to acute ends: keel of strong dots, slightly sigmoid; striae very delicate; zonal view decidedly sigmoid, ends squared. Length 150-250 micr. Jan. and Feb. not abundant.

N. bilobata, W.S.

Frustules free or in pairs; valves linear, ornamented with fine striae about 18 in 10 micr; zonal view broad with deep median contraction; frustules slightly twisted at the middle. Length 80-180 micr; width of zonal view 25-60 micr. Aug. Rare.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N. B.

Thalassiothrix, Cleve.

Frustules linear, free or united into star-shaped or zig-zag colonies by gelatinous cushions at the angles: chromatophores numerous, small.

T. nitzschioides, Grun.

Frustules united into zig-zag chains: zonal view rectangular with slightly rounded corners; edges lined with a single row of fine dots. Length 50-60 micr., width about 5 micr. Jan. - Oct: abundant.

T. longissima, Cleve.

Frustules free, thread-like, slightly curved, somewhat expanded toward middle; ends in valve view rounded, in zonal view slightly contracted near the end, then expanded to ordinary cell width and ended squarely; cross section almost square: edges each lined with a single row of fine dots, about 17 in 10 micr. Length 1.5 - 3 mm. Aug. - Dec: very abundant.

Bacillaria paradoxa, Gmel.

Frustules linear, united by valve faces into irregular colonies, in which the cells move over one another with characteristic motion; valve view with acute ends; zonal view rectangular; chromatophores two. Length 90-240 micr. Oct.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

TRIBE III. CRYPTO-RAPHIDIEAE.

Rhizosolenia, Brightw.

Frustules free or united, cylindrical, tapering asymmetrically and sometimes terminated by a hair-like process, or abruptly rounded and furnished with a delicate eccentric spine; end usually furrowed by the impression of the end of a sister cell; valves formed of many plates the overlapping of the edges of which forms a pattern of delicate lines; chromatophores numerous, small.

R. obtusa, Hensen.

Valve very slightly tapered to a short, straight, blunt, hollow, eccentric spire, at the base of which is clearly visible the groove into which the process of a sister cell had fitted. Diam. 5-10 micr. Sept. - Nov.

R. alata, Brightw.

Frustules free, tapering to a broad, blunt, curved, hollow process. Length 350-450 micr., width 20-30 micr. Sta. 9. Oct. Rare.

R. shrubsolei, Cleve.

Valve narrowed gradually to a short conical spire, which ends abruptly in a delicate spine, about 10 micr. in length; plates rhomboidal and very finely striated.

Length 180-250 micr., width 10-15 micr. Oct. and Nov: abundant.

R. hebetata semispina, Hensen.

Valve gradually narrowed to an asymmetrical cone, which tapers to a long, delicate spine, hollow at the base: great variation in size, very broad forms being found in spring. Length 150-300 micr., width 5-25 micr. Throughout the year. (<u>Note</u>: This is probably the Passamaquoddy form previously classified as R. setigera, Brightw., but since the base of the spine is hollow and individuals are frequently found of lesser diameter than that recorded for R. setigera, I have judged it to be R. hebetata, Hensen).

R. faeröensis, Ostenf.

Frustules cylindrical with rounded corners, united into short chains: valve furnished with a delicate, oblique, eccentric spine, which fits into a groove in a sister cell. Length 60-80 micr., width 40-60 micr. Aug. - Nov: not abundant.

<u>Corethron criophilum, Castr.</u>

Frustules free, cylindrical, with strongly arched valves and broad zone; cell wall delicate; margin of each valve furnished with a circle of long, hair-like setae; chromatophores numerous, small plates, Diam. 20-30 micr. Rare.

Ditylium Brightwellii, Grun.

Frustules free, triangular prism-shaped or more nearly cylindrical; ends rounded; valve with a single long, hollow, central spine, the end of which is expanded and open; valve bordered with a fringe of delicate spines; chromatophores numerous, small. Length up to 250 micr. width 30-60 micr. Sept. - Dec: abundant.

Chaetoceras, Ehr.

Frustules single or in chains; cushion shaped; valve view elliptical; from each corner springs a long seta: frustules united by the linking of the processes of neighbouring cells; walls delicate and unmarked; chromatophores one to many. sometimes extending into the setae.

Ch. gracile, Schütt.

Frustules free: broad zonal view rectangular with angles slightly drawn out; setae long, hair-like, those on the same side at first parallel, then broadly diverging; structure delicate; chromatophores two. Width of broad zonal view 8-11 micr. Aug. - Dec.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Ch. debile, Cleve.

Frustules united into long spiral chains: setae hair-like, springing from a point slightly inside the margin, all similar and curved toward the chain axis; chromatophore, one, relatively large; width of zonal view 14-30 micr. Auxospores centrally placed, each valve showing two irregular humps: outer valve with two short, blunt processes extending toward the corners of the mother cell. Throughout the year; very abundant in summer.

Ch. sociale Lauder.

Frustules united into short twisted chains, which are massed together in sperical colonies; walls delicate; spaces distinct, slightly contracted in the middle; setae long, hair-like, springing from slightly inside the margin, those of neighbouring frustules united somewhat beyond the corners; chromatophore, one. Width of zonal view 6-12 micr. April - Oct: common.

Ch. Willei, Gran.

Frustules much compressed; setae delicate, those of neighbouring cells united at the corners; terminal setae long, slightly diverging; no zonal constriction; spaces very narrow; chromatophore one, Width of broad zonal view 15-22 micr. Rare.

Ch. diadema, Ehr.

Chains long, often twisted; broad zonal view rectangular with corners drawn out to acute angles; zonal constriction clearly marked; setae delicate, those of neighbouring cells uniting at point of insertion, then diverging in many directions; terminal setae stronger, broadly diverging in broad zonal view; spaces narrow with median constriction and acute ends; chromatophore large, single. Width of broad zonal view 25-50 micr. Auxospores centrally placed in mother cell; one valve smooth, the other furnished with several branched processes. Throughout the year.

Ch. laciniosum, Schütt.

Chains long; broad zonal view rectangular with corners drawn out to acute angles; zonal constriction clearly marked; setae short, delicate, those of neighbouring cells linked beyond the point of insertion, then extending at right angles to the chain; spaces broad with rounded ends and middle slightly constricted by the somewhat convex valve surfaces; end setae stronger, in broad zonal view parallel, in narrow zonal view crossing; chromatophores two large plates. Width of broad zonal view 25-38 micr. Auxospores smooth; one valve decidedly arched, the other slightly convex; not centrally placed in mother cell. Throughout the year.

Ch. constrictum, Gran.

Chains curved; broad zonal view rectangular or square with corners prolonged to acute angles; deep zonal constriction; setae long, delicate, curved, springing from the angles, where those of neighbouring cells are united; terminal setae long, diverging; spaces narrowly elliptical with acute ends; chromatophores two; width of broad zonal view 15-28 micr. July - Oct. Rare.

Ch. decipiens, Cleve.

Chains long with clearly differentiated, slightly diverging end setae; valve narrowly elliptical, broad zonal view rectangular with corners prolonged to acute angles; zonal constriction clear; spaces narrowly elliptical with acute ends; setae long, hair-like, linking beyond the corners, then stiffly diverging at an acute angle; chromatophores six to ten small plates. Width of broad zonal view 30-60 micr. Throughout the year; common.

Ch. contortum, Schütt.

Chains curved; frustules cylindrical; valves arched; setae very delicate, springing from inside the margin and linking well beyond the corners, thus forming broad spaces; walls delicate; no zonal constriction; chromatophores numerous, small. Diam. 8-20 micr. July - Oct.

Ch. danicum, Cleve.

Frustules free or in short chains; valves circular to elliptical arched; zonal view rectangular with clear zonal constriction; setae very long and beset with delicate spines setae of the same valve in one straight line and the cell so twisted that in valve view the processes on each side diverge at an acute angle; chromatophores numerous extending into setae. Diam. 8-20 micr. Sta. 3. Common.

Ch. atlanticum, Cleve.

Chains straight and stiff; valves furnished with short median spine; distinct zonal constriction dividing the cell into thirds; setae broad, hollow, springing from inside the margin, linking well beyond the cell and then diverging at an acute angle; corresponding setae of the many frustules of the chain parallel; terminal setae short and stiff; chromatophores numerous, extending into the setae. Diam. 25-40 micr. Sta. 3. Apr. - July.

Ch. convolutum, Castr.

Chain curved; valves dissimilar, outer strongly arched, inner flat; setae of outer arising near the centre, those of the inner near the margin; setae relatively slender, tapering toward the end, beset with strong spines, all curved toward one end of the chain; deep zonal constriction dividing the cell into thirds; chromatophores numerous, extending into setae. Diam. 17-27 micr. Sta. 3: very abundant in July.

Ch. peruvianum, Brightw.

Frustules similar to those of Ch. convolutum except: zone never more than one quarter of the cell length; setae widen considerably before they taper to the extremity, at base smooth, toward the end beset with strong spines. Sta. 3: July: rare.

Ch. criophilum, Castr.

Frustules similar to Ch. convolutum except: no zonal constriction; setae slender near the cell but widening for some distance before tapering toward the extremity, beset with spines which are very long toward the end. Diam. about 25 micr. Sta. 1: July: not abundant.

<u>Skeletonema costatum, Grev.</u>

Frustules cylindrical; valves strongly arched, each bordered by a regular circle of long, hair-like setae, which are parallel to the long axis of the cell; setae of neighbouring cells fused, thereby forming long chains; whole structure very delicate; chromatophore one. Diam. 6-14 micr. Throughout the year.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Melosira. Ag.

Frustules cylindrical or disc-shaped, closely united, usually by gelatinous cushions between the valve faces, into long straight chains: valves convex; chromatophores numerous, small plates.

M. Borreri, Grev.

Frustules cylindrical, with rounded corners; zone broad and ornamented with transverse striae; cells united by valve faces. Diam. 38-60 micr. Feb. - Apr: not abundant.

M. hyperborea, Grun.

Frustules spherical or cylindrical; valves strongly arched; long chains formed by cohesion of valve faces; zone broad and prominent; summit of valve ringed by a clearly projecting keel. Diam. 14-23 micr. Occasionally during the year.

M. crenulata, Bail.?

Frustules cylindrical; valves flat; valve faces closely united; zone about one-fifth of cell length, deeply constricted; valves studded with fine dots. Diam. about 13 micr. March - June: not abundant.

M. sulcata, Kütz.

Frustules disc-shaped, very thick walled, heavily sculptored, and tightly bound together into stiff chains; zone studded irregularly with strong dots; side of valve ornamented with horse-shoe shaped ridges from the top of each of which runs a short, well defined longitudinal rib; interior of frustule small. Diam. 22-45 micr. Fairly abundant throughout the year.

Thalassiosira, Cleve.

Frustules united into long chains, resembling strings of beads, by a single, central gelatinous thread; valves circular; chromatophores numerous, small.

T. Nordenskiöldii, Cleve.

Frustules in zonal view octagonal, wider than long; at each end of the long sides is a short obliquely set spine; valve slightly concave in middle; thread between frustules short. Diam. 20-45 micr. Mar - Aug.; very abundant.

T. hyalina, Grun.

Frustules disc-shaped with rounded corners; valve flat bordered with a single row of fine apiculi; thread fairly long, distance between frustules varied. Diam. 22-45 micr.. Apr. - Aug.; fairly common.

T. condensata, Cleve.

Frustules cylindrical, with rounded corners; length and width about equal-; valve slightly convex, bordered with a single row of fine apiculi. Diam. 25-50 micr. Summer: not abundant.

T. gravida, Cleve.

Frustules cylindrical with rounded ends; valves flat, with rows of long unequal setae radiating from the periphery; thread and cell length about equal. Diam. 30-50 micr. Mar. - June: fairly abundant.

<u>Coscinosira polychorda, Gran.</u>

Frustules short cylinders with rounded ends, united into chains similar to those of Thalassiosira, but held together by from four to nine gelatinous threads; valve round, flat, periphery circled by a row of fine apiculi; chromatophores small, numerous. Diam. 35-55 micr. May - July: not abundant.

<u>Bacterosira fragilis, Gran.</u>

Frustules cylindrical, almost as wide as long, ends slightly rounded; valves round, depressed in middle, bordered by a single row of fine apiculi; frustules united by cohesion of valve faces: small central spaces formed by valve depressions: chromatophores numerous, small. Diam. 20 micr. Rare.

PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Leptocylindrus danicus, Cleve.

Frustules slender, cylindrical, united into long filaments by cohesion of valve faces of neighbouring cells; cell walls delicate and unmarked; chromatophores numerous, small. Length about 50 micr., width 8-10 micr. July - Oct: not abundant.

Cerataulina Bergonii, Perag.

Frustules cylindrical; valves convex and furnished with two short, blunt marginal processes; long, straight chains formed by the cohesion of processes of neighbouring cells; spaces very small; chromatophores numerous, small. Diam. 30-48 micr. Aug. - Oct: not abundant.

Isthmia, Ag.

Frustules trapezoidal with rounded corners, united into irregular colonies by blunt, angular processes by which they are also often attached to other algae; zone broad, walls studded with circular thickenings, which under a high power are resolved into clusters of dots; chromatophores numerous, small.

I. nervosa, Kütz.

Zonal thickenings smaller and more regularly circular than those of valve; the latter arranged between strong, longitudinal ribs. Width about 230 micr. Sta. 1.

Oct. and Feb.; common.

I. enervis, Ehr.

Similar to I. nervosa except; valves lack ribs, frustules smaller. Width about 150 micr. Sta. 1. Feb; rare.

Eucampia Zoodiacus, Ehr.

Valves elliptical with two blunt, marginal processes; projections of neighbouring cells united, thereby forming long spiral chains; spaces between cells circular or elliptical; chromatophores numerous. Width 25-60 micr. July: Rare.

Biddulphia, Gray.

Frustules united into straight or zig-zag chains; valve and narrow zonal view elliptical; broad zonal view rectangular; valves convex with corners drawn out into blunt processes, by which the frustules are united; walls studded with dots or finely meshed; valves usually furnished with two short spines; chromatophores numerous, small plates.

B. aurita, Breb.

Chains usually straight; valve arched in middle, with two spines centrally placed; zone very prominent; width of broad zonal view 35-75 micr. Dec. - July; very abundant very abundant in spring.

B. mobiliensis, Grun.

Chains short, straight; valves flat in middle; two spines near margin; no zonal constriction; cell wall delicate, finely meshed; broad zonal view 120-200 micr. Winter: not abundant.

Actinoptychus undulatus, Bail.

Frustules free; valves circular, clearly marked into six sectors; central area clear; sectors showing network of rather irregular hexagonal mesh; alternate sectors depressed giving zonal view an undulating appearance; chromatophores numerous, small. Diam. 50-110 micr. Oct. - July: not abundant.

Coscinodiscus, Ehr.

Frustules free, short cylinders or discs; valves round, ornamented with hexagonal meshes; chromatophores numerous, small plates.

Cos. subbulliens, Jörg.

Valves arched; meshes strong; irregular central rosette; zone wide. Diam. 80-150 micr. Throughout the year: common.

Cos. centralis, Ehr.

Valves arched; meshes strong; irregular central rosette;

marginal row of rectangular meshes; near the periphery a well defined circle of fine apiculi. Diam. 140-260 micr. April; not abundant.

Cos. concinnus, W.S.

Valves arched; wall structure very fine; irregular central rosette; near the periphery a circle of radiating fasciculi which end near the margin in fine apiculi; zone very broad. Diam. 200-450 micr. Spring. Common.

Cos. radiatus, Ehr.

Frustules slightly arched; zone narrow; valve structure strong, the meshes arranged in curved, radiating lines and diminishing toward periphery. Diam. 50-120 micr. Throughout the year.

Cos. marginatus, Ehr.

Frustules disc-shaped; meshes strong, somewhat irregularly arranged; periphery circled with a row of short, radiating lines, which form somewhat irregular rectangular meshes. Diam. 70-100 micr. Nov. - Mar.; not abundant.

Cos. excentricus, Ehr.

Valves flat, circled near the periphery by a row of fine apiculi: meshes strong, arranged in intersecting curved lines. Diam. 50-90 micr. Mar. - April: common.

Cos. curvatulus, Grun.

Valves flat, divided by slightly curved radii into 10-20 sectors, which are ornamented with fine meshes; zonal view narrow, corners slightly rounded. Diam. 50-88 micr. June - July; rare.

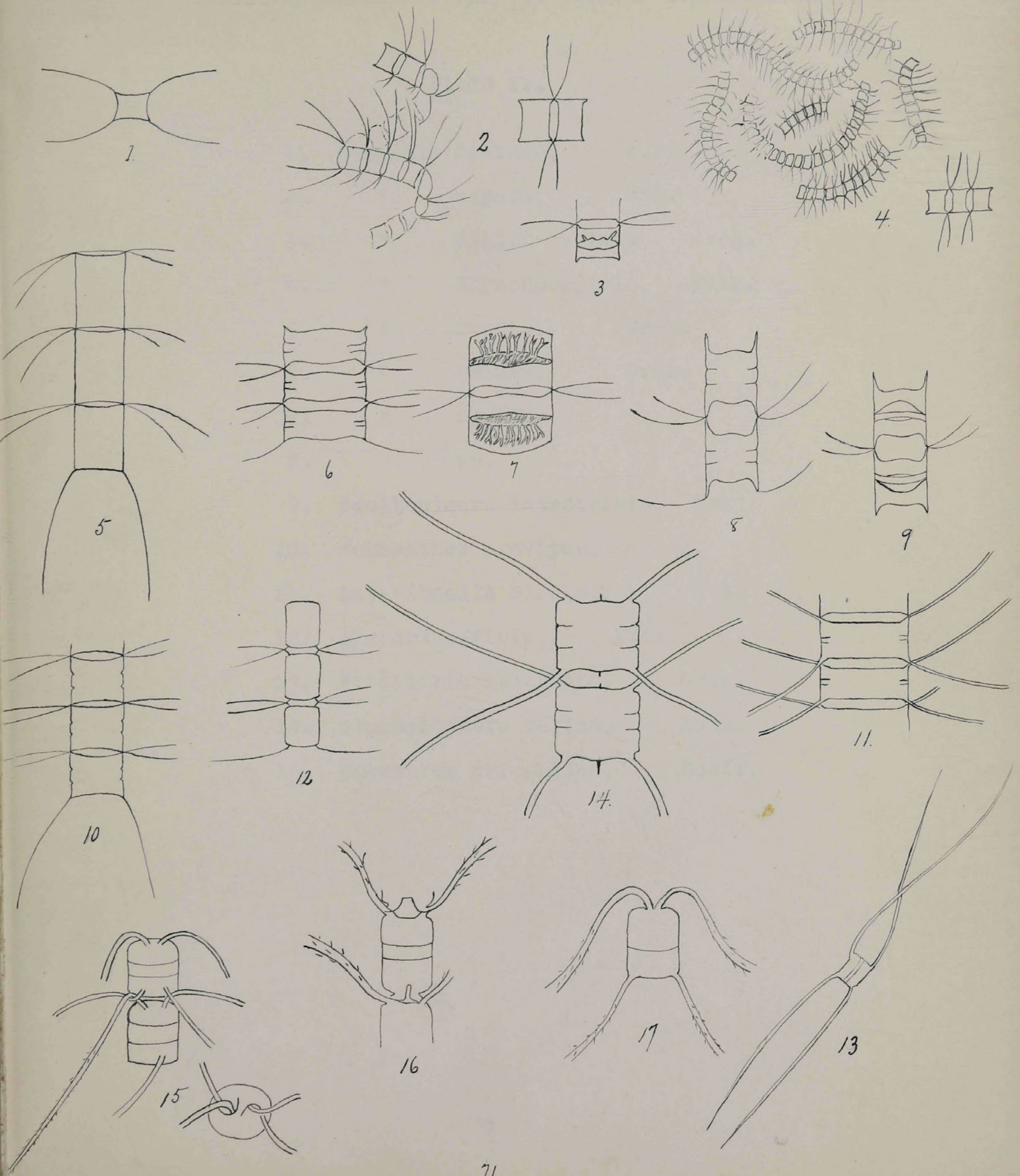
PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

PLATE I.

<u>Chaetoceras Ehr.</u>

1.	Ch.	gracile,	Schütt
2.	"	debile,	Cleve
3.	"	"	with spores
4.	"	sociale,	Lauder
5.	"	Willei,	Gran.
6.	"	diadema,	Ehr.
7.	"	"	with spores
8.	"	laciniosum,	Schütt
9.	"	"	with spores
10.	"	constrictum,	Gran.
11.	"	decipiens,	Cleve
12.	"	contortum,	Schütt
13,	"	danicum,	Cleve
14.	"	atlanticum,	Cleve
15.	"	convolutum,	Castr.
16.	"	peruvianum,	Brightw.
17.	"	criophilum,	Castr.

Plate I

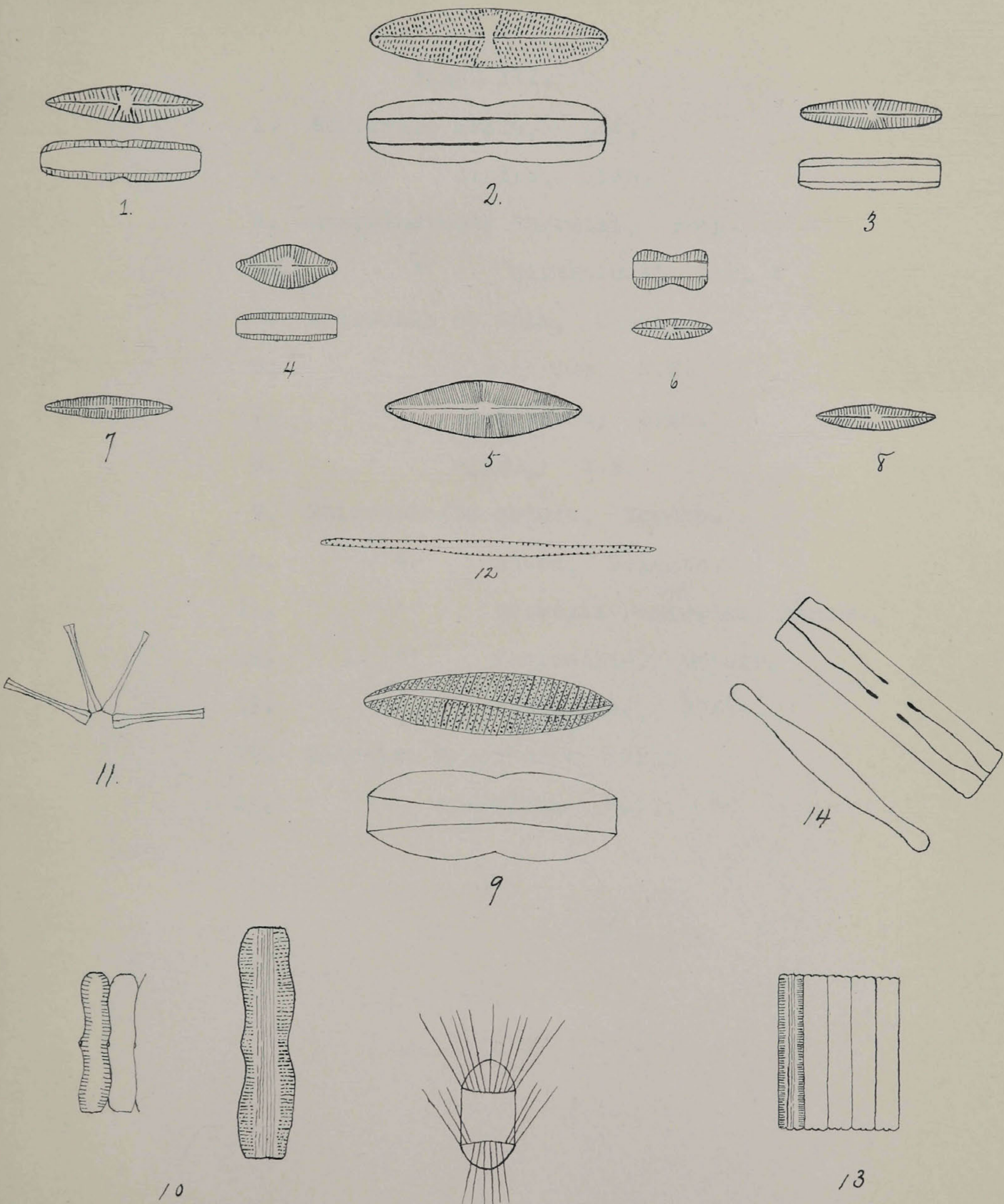


PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

PLATE II.

1. Navicula distans, W.S.
2. " aspera, Ehr.
3. " digito-radiata, Greg.
4. " Rhynchocephala, Kütz.
5. " brevis, Greg.
6. " retusa, Breb.
7. " sp. ?
8. " sp. ?
9. Scoliopleura latestriata, Grun.
10. Achnanthes brevipes, Ag.
11. Asterionella Bleakeleyi, W.S.
12. Synedra affinis, Kütz.
13. Fragilaria islandica, Grun.
14. Grammatophora marina, Kutz.
15. Corethron criophilum, Castr.

Plate II

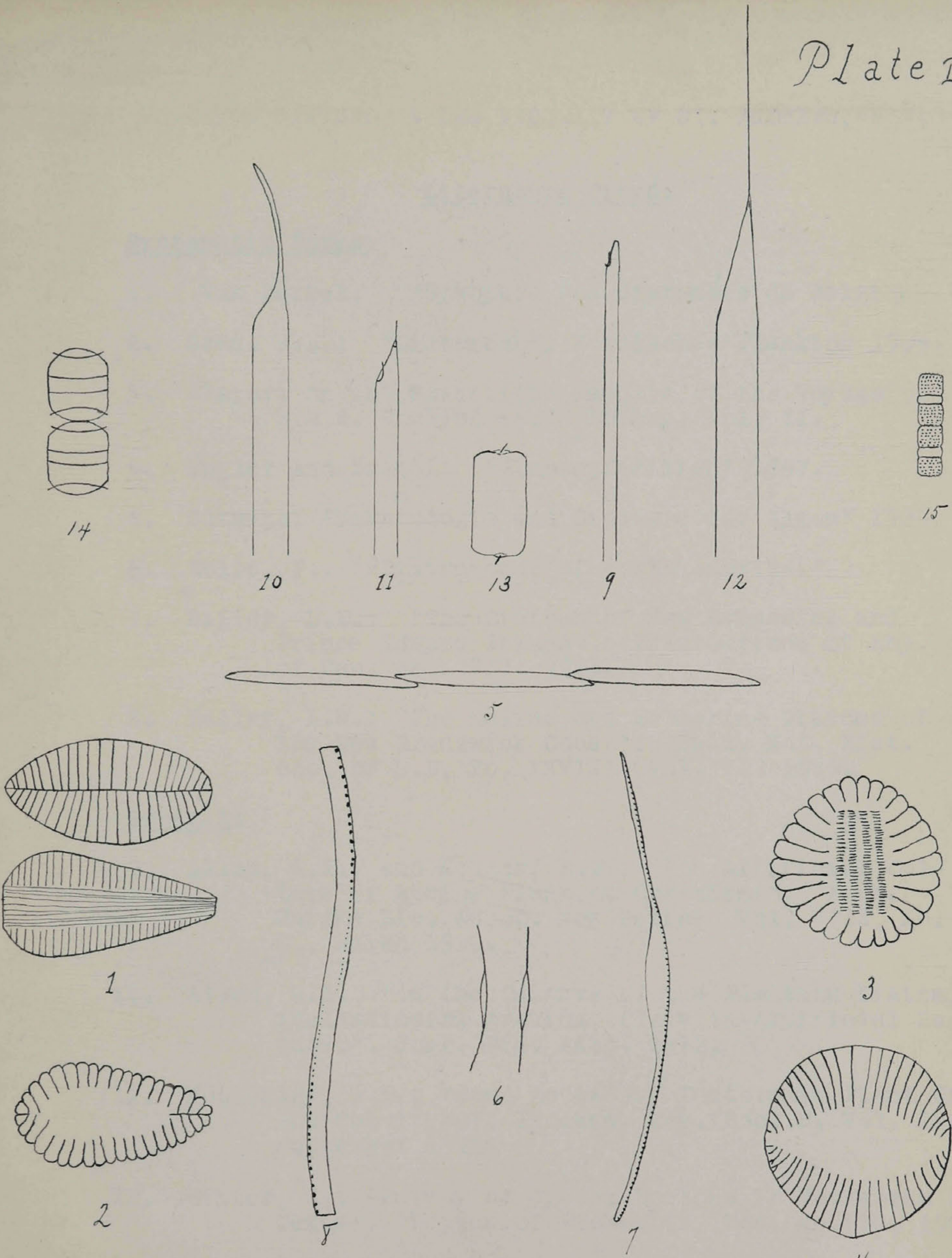


PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

PLATE III.

1. Surirella gemma, Ehr.
2. " ovalis, Breb.
3. Campylodiscus Thuretii, Breb.
4. " hibernicus, Ehr. ?
5. Nitzschia seriata, Cleve.
6. " closterium, W.S.
7. " longissima, Grun.
8. " sigma, W.S.
9. Rhizosolenia obtusa, Hensen.
10. " alata, Brightw.
11. " hebetata semispina, Hensen.
12. " faeröensis, Ostenf.
13. " shrubsolei, Cleve.
14. Melosira hyperborea, Grun.
15. " crenulata, Bail. (?)

Plate III



PLANKTON DIATOMS IN THE VICINITY OF ST. ANDREWS, N.B.

Literature Cited.

Systematic Works:

1. Van Heurck: "Synopsis des Diatomées de Belgique."

2. Gran. H.H.: "Diatomeen", Nordisches Plankton 1905.

3. "Report on the Scientific Results of the Voyage of H.M.S. Challenger," Botany, Vol. II.

4. Engler and Prantl: "Planzenfamilien" 1897.

5. Oltmans: "Morphologie und Biologie der Algen" 1904.

6. Wolle, F.: "Diatomaceae of North America."

7. Bailey, L.W.: "The Diatoms of New Brunswick and Prince Edward Island". Transactions of Roy. Soc. of Can. Sec. III. 1913.

8. Bailey, L.W.: "The Marine and Estuarine Diatoms of the New Brunswick Coast": Bull. Nat. Hist. Soc. of N.B. No. XXVIII (Vol. VI) 1910.

General:

9. Allen, E.J., and Nelson, E.W.: "On Artificial Culture of Marine Plankton Organisms": Jour. Marine Bio. Assoc. New Series, Vol. VIII, No. 5., March 1910.

10. Allen, E.J., "On the Culture of the Plankton Diatom, Thalassiosira gravida, Cleve in Artificial Sea Water". Jour. Bio. Asso. 1912.

11. Bottomley, W.B.; "Some Accessory Factors in Plant Growth and Nutrition", Proceed. Roy. Soc. B. Vol. LXXXVII September 1914.

12. Winter, I.: "Survey of Oyster Bottoms in Metagorda Bay, Texas". Bureau of Fisheries, Doc. No.610, 1907

13. McMurrich, J.P.: "The Winter Plankton in the Neighbourhood of St. Andrews, N.B. 1914 - 15". Contributions to Can. Bio. 1915 - 16.

14. "Report of the Scientific Results of the Voyage of H.M.S. Challenger": Chemistry, Vol. I.

15. Vernon "Variation in Plants and Animals."

16. Ostenfeld, C. "Biddulphia sinensis in the North Sea Waters", Internat. Review ges. Hydrob. u. Hydrogr. II, 1909.

17. Heinzerling, Otto: "Der Bau der Diatomzelle". Bibliotheca Botanica, 1908.

18. Miquel, P.: "De la Culture artificielle des Diatomées", Le Diatomiste, 1. 1890 - 93.