

# Studies on the Seasonal Cycle of Sea Surface Temperatures, Salinities and Phytoplankton in Puttalam Lagoon, Dutch Bay and Portugal Bay along the West Coast of Ceylon

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## Introduction

A study of the sea surface temperatures, salinities and phytoplankton was carried out at Puttalam lagoon, which is the largest lagoon in Ceylon and in the adjacent bays, Dutch Bay and Portugal Bay, for one year from June, 1960 to May, 1961. Lagoon fishing is carried out throughout the year, but most of the fishing is done during the South West Monsoon, as the sea outside is too rough for small vallams, theppams and orus to go out fishing. Surface temperatures and salinities for the Bay of Bengal have been reported by Sewell (1925), Das (1954) and Jayaraman (1954). They have made detailed studies for specific nearshore locations along the Indian coasts. La Fond (1954, 1957) had shown the relation of these data to the water masses and circulation. La Fond (1958) had also described the seasonal cycle of sea surface temperatures and salinities along the East Coast of India. Studies on the plankton of the inshore waters off Mandapam were made by Prasad (1954, 1956). Studies on plankton were also made by Chacko (1950), Ganapathi and Murthy (1953 and 1955), Ganapathy and Rao (1953), and Menon (1945).

However, no work on marine plankton had been described for Ceylon waters. It was thought worthwhile to study the seasonal cycle of sea surface temperatures, salinities and phytoplankton and their effect on fisheries production in these areas, as phytoplankton forms the food of zooplankton and the food of fishes directly or indirectly.

## Material and Methods

Surface plankton hauls were made with Kitahara's surface plankton net with an over all length of 120 cms. and diameter of 30 cms. The mesh is in conformity with the International Standard No. 13 and with the Japanese standard XX 13. Plankton hauls were made once a month from the departmental motor launches the "Seer", "Kelawalla", and "Halmessa". The speed of the boat was kept constant during the tow which was confined to 15 minutes. The plankton collected was transferred into clean bottles and preserved in 4% formalin. Temperature readings of surface water were made on the dates of collection. Salinities were obtained by determining chlorinity by Knudsen's method and reading salinity values directly from Knudsen's table. Quantitative estimations were made by counting under a binocular microscope the plankton contained in 1 c.c. samples. Different symbols were used to denote the comparative abundance of the different diatoms, dinoflagellates and Cyanophyceae.

## Sea surface temperature

The mean monthly surface temperatures at Puttalam lagoon vary from 27.6° C to 30.8° C. The peak temperatures were in April, May and June and the lowest found were in November, December

and January. The temperature range is 3.2° C. There is a gradual fall in temperature from April to September and from October to January. The lowering of the temperature from April to September is probably due to the high winds during the South-West Monsoon which causes turbulence, which results in the mixing of the surface water and subsurface cold water. The lowering of temperature from October to December can be attributed to the general cooling of the atmosphere and the onset of the North-East winds as reported by Ganapathi and Venkata Rama Sarma (1958). The surface temperatures at Dutch Bay and Portugal Bay reveal the same pattern as in Puttalam lagoon, although the temperatures are relatively lower. This is because Puttalam lagoon is further away from the sea and is rather shallow compared to Dutch Bay and Portugal Bay.

TABLE I

MONTHLY SURFACE TEMPERATURE AND SALINITY AT FOUR LOCATIONS ON PUTTALAM LAGOON FROM JUNE, 1960 TO MAY, 1961

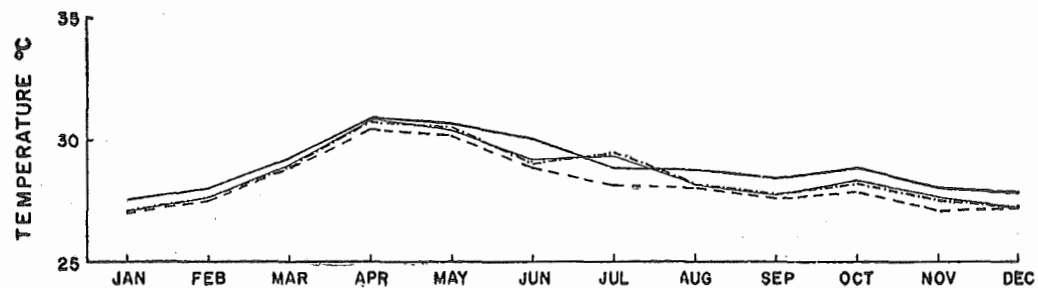
	<i>Puttalam Lagoon</i>		<i>Dutch Bay</i>		<i>Portugal Bay towards Pallugaturai</i>		<i>Portugal Bay towards Kovil Munai</i>	
	<i>Temp. (°C)</i>	<i>Sal. (‰)</i>	<i>Temp. (°C)</i>	<i>Sal. (‰)</i>	<i>Temp. (°C)</i>	<i>Sal. (‰)</i>	<i>Temp. (°C)</i>	<i>Sal. (‰)</i>
January	.. 27.6	.. 20.4	.. 27.0	.. 21.3	.. 27.1	.. 30.0	.. 27.1	.. 30.5
February	.. 28.0	.. 24.7	.. 27.5	.. 25.2	.. 27.6	.. 30.5	.. 27.6	.. 30.8
March ..	.. 29.2	.. 24.5	.. 28.8	.. 29.1	.. 28.8	.. 30.2	.. 28.6	.. 30.1
April ..	.. 30.8	.. 22.8	.. 30.4	.. 29.6	.. 30.4	.. 30.5	.. 30.6	.. 31.4
May ..	.. 30.6	.. 29.9	.. 30.2	.. 20.0	.. 30.3	.. 32.0	.. 30.4	.. 31.9
June ..	.. 30.0	.. 30.4	.. 28.9	.. 30.8	.. 29.0	.. 31.8	.. 29.2	.. 35.6
July ..	.. 28.8	.. 33.8	.. 28.2	.. 35.0	.. 29.4	.. 33.2	.. 29.2	.. 34.3
August ..	.. 28.6	.. 35.3	.. 28.0	.. 34.5	.. 28.2	.. 32.2	.. 28.3	.. 32.1
September	.. 28.2	.. 33.8	.. 27.6	.. 33.4	.. 27.7	.. 33.1	.. 27.7	.. 32.2
October ..	.. 28.4	.. 36.4	.. 27.8	.. 34.8	.. 27.8	.. 35.4	.. 27.9	.. 35.6
November	.. 28.0	.. 20.0	.. 27.4	.. 18.5	.. 27.5	.. 28.2	.. 27.6	.. 29.4
December	.. 27.8	.. 20.2	.. 27.2	.. 20.4	.. 27.2	.. 31.4	.. 27.2	.. 31.5

### Salinity

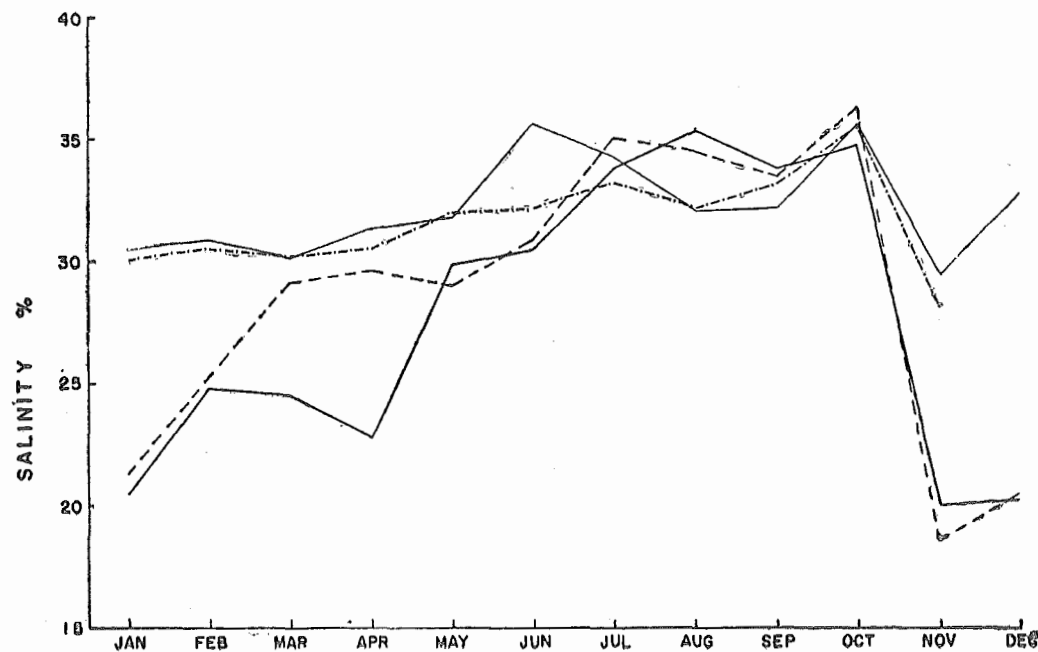
The highest salinities at Puttalam lagoon are from May to October ranging from 29.9‰ in May to 36.4‰ in October. The salinities vary from 20‰ in November to 22.8‰ in April. This shows that during the South-West Monsoon the salinity is high and low during the North-East Monsoon. Probably the salinities are relatively high from May to October due to the high evaporation that takes place during these months, as the lagoon is rather shallow not exceeding two fathoms in the deepest area and 1-2 feet in the shallowest area, and to the prevalence of high winds during the S.-W. Monsoon. Further, higher salinity waters are brought into the lagoon from the Central Indian Ocean and southern part of the Arabian Sea as the current is from South to North (Sewell 1925-32). There is a close resemblance between the temperature and salinity of waters at Mandapam described by La Fond (1958) and in the bays of the west coast of Ceylon. During the North-East Monsoon the current is reversed, i.e., from North to South (Sewell 1925-32), as a result, the salinity values are low from November to April, namely 20‰ to 24.7‰. At Dutch Bay the salinity range was similar to Puttalam lagoon except that the salinities in March and April were higher which coincides with the high temperatures reached during these months. The salinities at Portugal Bay towards Kovil Munai and Pallugaturai are comparatively higher than at Puttalam Lagoon or Dutch Bay as Portugal Bay is closer to the sea. Although there is an increase in the salinities in Portugal Bay from April to October during the South-West Monsoon the increase is not as high as in Puttalam lagoon.

Fig. 1

MONTHLY SURFACE TEMPERATURE AND SALINITY  
AT FOUR LOCATIONS ON PUTTALAM LAGOON FROM  
JUNE 1960 TO MAY 1961.



- PUTTALAM LAGOON
- - - DUTCH BAY
- · - · - PORTUGAL BAY TOWARDS PALLUGATURAI
- - - PORTUGAL BAY TOWARDS KOVIL MUNAI



## Plankton

There were sudden fluctuations in the distribution of phytoplankton but no definite conclusions can be drawn due to the short period of observation. The distribution of phytoplankton including Dinophyceae and Cyanophyceae is shown in tables 2, 3, 4 and 5. There are more than one phytoplankton maximum in a year. At Puttalam lagoon blooms of *Thalassiosira subtilis* occurred in November, *Rhizosolenia alata* in February, *Rhizosolenia imbricata* in March and May, *Chaetoceros lascinosus* in February, *Thalassionema nitzschioides* and *Thallassiothrix frauenfeldii* in May. At Dutch Bay blooms of *Coscinodiscus gigas* occurred in June, *Skeletonema costatum* in August, *Bacteriastrum varians* in July, *Chaetoceros diversus* in October, *Rhizosolenia imbricata* in February, *Rhizosolenia alata* in March, *Biddulphia mobilensis* in May, *Thallassiothrix frauenfeldii* July to September, *Rhaphoneis discoides* in September, *Asterionella japonica* May and in October, *Thalassionema nitzschioides* in April and May. Blooms at Portugal Bay towards Kovil Munai were identical with those of Dutch Bay. Blooms at Portugal Bay towards Pallugaturai were mostly identical, but blooms of *Chaetoceros pervianus* occurred in October, and *Thalassiosira subtilis* in November.

In all the 4 regions the bulk of phytoplankton occurred from May to September during the South-West Monsoon and is the cumulative effect of several species. For example the bulk of phytoplankton in May was composed of *Thalassiosira decipens*, *Thalassiosira subtilis*, *Coscinodiscus gigas*, *Rhizosolenia imbricata*, *Rhizosolenia alata*, *Rhizosolenia styliiformis*, *Bacteriastrum varians*, *Chaetoceros lorenzianus*, *Chaetoceros pervianus*, *Biddulphia sinensis*, *Biddulphia pulchella*, *Rhaphoneis discoides*, *Thalassionema nitzschioides*, *Thallassiothrix longissima*, *Thallassiothrix frauenfeldii* and *Gyrosigma balticum*. There were two outbursts of diatoms in June and in October. The June outburst consisted of several species, the dominant ones being *Skeletonema costatum*, *Coscinodiscus gigas*, *Rhizosolenia styliiformis*, *Rhizosolenia alata*, *Biddulphia sinensis*, *Thalassionema nitzschioides*, *Thallassiothrix frauenfeldii* and *Asterionella japonica*. The October outburst consisted of several species of *Chaetoceros*, *Chaetoceros lorenzianus*, *Chaetoceros pervianus*, *Chaetoceros lascinosus*, *Chaetoceros diversus*, *Thallassiothrix frauenfeldii*, *Asterionella japonica*, *Rhizosolenia imbricata*, *Rhizosolenia alata* and *Rhizosolenia styliiformis*.

Sudden outbursts of a single species were common especially *Thallassiothrix frauenfeldii*, *Chaetoceros* species and *Rhizosolenia* species. The distribution of diatoms at Puttalam lagoon is different from the other three localities. The relative abundance of plankton was small and the number of species of diatoms much less. This may be attributed to the fact that it is further away from the sea and lacks nutrient salts. In the other three areas the rivers Kal Aru and Pomparippu Aru empty and bring in nutrient salts.

Four species of Dinophyceae were found in these areas and their relative abundance is shown in the tables 2-5.

*Trichodesmium erythraeum* a blue green algae belonging to the Cyanophyceae was found in plenty in January, February, March and November. Devanesan (1942) states that *Trichodesmium* found off Krusadai in abundance forms a favourite item in the food of the Indian sprat (*Sardinella gibbosa*) and the mullet (*Mugil waigiensis*). During the year June, 1960 to May, 1961 the months in which sprats were caught in large quantities were January, February, March and November. This seems to correspond with the relative abundance of *Trichodesmium erythraeum* during these months.

From the fisheries statistics available for this period the best fishing months were from May to September which corresponded to the peak months for phytoplankton. But no conclusions can be derived as there is more intensive fishing during these months of the S.-W. Monsoon in these protected regions due to the sea being too rough for distant fishing.

Fig. 2

MAP OF PUTTALAM LAGOON, DUTCH BAY, AND PORTUGAL BAY, SHOWING LOCATIONS WHERE PLANKTON WAS COLLECTED.



TABLE II

PHYTOPLANKTON CALENDAR, PUTTLAM LAGOON, JUNE, 1960 TO MAY, 1961

Species	1960						1961												
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May							
1. <i>Melosira sulcata</i> (Ehrenberg) Kuetzing ..	R	..	—	..	—	..	F	..	F	..	—	..	—	..	F	..	R	..	R
2. <i>Stephanopyxis palmeriana</i> (Greville) Grunow ..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	R	..	—	..	—
3. <i>Sceletonema costatum</i> (Greville) Cleve ..	—	..	—	..	—	..	—	..	—	..	C	..	—	..	—	..	—	..	—
4. <i>Thalassiosira coramandeliana</i> Subr.	—	..	—	..	—	..	F	..	—	..	—	..	—	..	—	..	—	..	—
5. <i>Thalassiosira decipiens</i> (Grunow) Jorgenson ..	—	..	—	..	—	..	—	..	P	..	—	..	R	..	—	..	—	..	R
6. <i>Thalassiosira subtilis</i> (Ostenfeld) Gran ..	C	..	—	..	—	..	C	..	C	..	B	..	F	..	C	..	—	..	—
7. <i>Coscinodiscus gigas</i> Ehrenberg ..	C	..	C	..	C	..	—	..	—	..	—	..	—	..	—	..	—	..	R
8. <i>Coscinodiscus marginatus</i> Ehrenberg ..	C	..	C	..	C	..	F	..	P	..	—	..	—	..	F	..	R	..	F
9. <i>Planktoniella sol</i> (Wallich) Schutt ..	R	..	R	..	—	..	R	..	—	..	R	..	R	..	—	..	—	..	—
10. <i>Aulacodiscus orbiculatus</i> Subr. ..	—	..	—	..	—	..	R	..	R	..	—	..	—	..	—	..	—	..	R
11. <i>Corethron inerme</i> Karsten ..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	R
12. <i>Schroederella delicatula</i> (Peragallo) Pavillard ..	—	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	R
13. <i>Leptocylindricus danicus</i> Cleve ..	—	..	—	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—
14. <i>Leptocylindricus minimus</i> Gran ..	—	..	—	..	—	..	—	..	—	..	—	..	R	..	—	..	—	..	—
15. <i>Guinardia flaccida</i> (Castracane) Peragallo ..	—	..	—	..	—	..	—	..	—	..	—	..	R	..	—	..	—	..	R
16. <i>Rhizosolenia cylindrus</i> Cleve ..	R	..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	R
17. <i>Rhizosolenia styliformis</i> Brightwell ..	R	..	R	..	—	..	—	..	—	..	R	..	—	..	—	..	—	..	R
18. <i>Rhizosolenia setigera</i> Brightwell ..	R	..	—	..	—	..	—	..	R	..	—	..	—	..	—	..	—	..	R
19. <i>Rhizosolenia crassipiana</i> Schroeder ..	—	..	—	..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	R
20. <i>Rhizosolenia alata</i> Brightwell ..	R	..	R	..	C	..	C	..	—	..	C	..	F	..	B	..	R	..	R
21. <i>Rhizosolenia imbricata</i> Brightwell ..	—	..	P	..	P	..	—	..	—	..	C	..	R	..	—	..	B	..	R
22. <i>Bacteriastrum varians</i> Lauder ..	R	..	R	..	—	..	F	..	—	..	R	..	R	..	—	..	—	..	R
23. <i>Chaetoceros lorenzianus</i> Grunow ..	—	..	R	..	—	..	—	..	R	..	—	..	—	..	R	..	—	..	R
24. <i>Chaetoceros pervianus</i> Brightwell ..	—	..	—	..	P	..	—	..	F	..	—	..	R	..	—	..	—	..	—
25. <i>Chaetoceros laciniosus</i> Schutt ..	—	..	—	..	P	..	R	..	—	..	R	..	R	..	R	..	B	..	R
26. <i>Chaetoceros didymus</i> Ehrenberg ..	—	..	R	..	P	..	—	..	—	..	R	..	R	..	R	..	—	..	C
27. <i>Chaetoceros diversus</i> Cleve ..	—	..	—	..	—	..	—	..	—	..	R	..	—	..	C	..	R	..	—
28. <i>Eucampia cornuta</i> (Cleve) Grunow ..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—
29. <i>Eucampia zoodiacus</i> Ehrenberg ..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	R	..	—	..	—
30. <i>Ditylum brightwellii</i> (West) Grunow ..	C	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	R
31. <i>Triceratium favus</i> Ehrenberg ..	C	..	C	..	C	..	C	..	—	..	R	..	R	..	R	..	R	..	—
32. <i>Triceratium dubium</i> Brightwell ..	—	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—
33. <i>Triceratium alternans</i> Bailey ..	P	..	F	..	F	..	—	..	—	..	—	..	—	..	—	..	—	..	—
34. <i>Biddulphia pulchella</i> Gray ..	F	..	F	..	—	..	C	..	C	..	C	..	—	..	—	..	R	..	—
35. <i>Biddulphia sinensis</i> Greville ..	—	..	—	..	R	..	C	..	C	..	—	..	—	..	—	..	R	..	—
36. <i>Biddulphia mobilis</i> Bailey ..	R	..	F	..	R	..	R	..	—	..	—	..	R	..	—	..	—	..	—
37. <i>Rhabdonema mirificum</i> W. Smith ..	—	..	—	..	R	..	R	..	F	..	—	..	C	..	R	..	—	..	—



TABLE II—(contd.)

PHYTOPLANKTON CALENDAR, PUTTALAM LAGOON, JUNE, 1960 TO MAY, 1961

Species	1960							1961				
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
<i>Cyanophyceae</i>												
75. <i>Trichodesmium erythraeum</i> Ehrenberg ..	P	C	C	R	—	P	—	P	P	C	C	C

\* R = Rare 1—10 individuals per C.C.  
 F = Few 11—25 do.  
 C = Common 26—75 do.  
 P = Plenty 76—200 do.  
 B = Bloom = more than 200 do.

TABLE III

PHYTOPLANKTON CALENDAR, DUTCH BAY, JUNE, 1960 TO MAY, 1961

Species	1960							1961				
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
1. <i>Melosira sulcata</i> (Ehrenberg) Kuetzing ..	R	R	R	R	—	—	—	—	F	F	F	R
2. <i>Stephanopyxis palmeriana</i> (Greville) Cleve ..	R	R	R	—	—	R	—	—	—	F	F	R
3. <i>Skeletonema costatum</i> (Greville) ..	P	P	B	F	P	P	P	—	R	R	—	—
4. <i>Thalassiosira coramandeliana</i> Subr. Jorgenson ..	R	R	—	—	—	—	—	—	—	—	R	R
5. <i>Thalassiosira decipiens</i> (Grunow) ..	F	F	R	C	C	C	—	—	R	R	R	C
6. <i>Thalassiosira subtilis</i> (Ostenfeld) Gran ..	C	R	—	C	—	B	—	R	C	—	R	C
7. <i>Coscinodiscus gigas</i> Ehrenberg ..	B	B	P	C	C	C	C	F	F	F	C	C
8. <i>Coscinodiscus marginatus</i> Ehrenberg ..	C	P	P	C	R	F	F	F	C	—	—	R
9. <i>Planktoniella sol</i> (Wallich) Schutt ..	R	R	R	R	C	R	F	F	F	C	C	C
10. <i>Aulacodiscus orbiculatus</i> Subr. ..	—	—	—	—	C	—	—	R	R	—	R	—
11. <i>Corethron inerme</i> Karsten ..	—	—	—	—	—	R	R	—	—	—	—	R
12. <i>Schroederella delicatula</i> (Peragallo) Pavillard ..	—	—	R	—	—	—	—	—	—	—	—	R
13. <i>Leptocylindricus danicus</i> Cleve ..	C	R	—	—	—	—	—	R	—	—	R	R
14. <i>Leptocylindricus minimus</i> Gran ..	C	R	—	—	—	—	—	—	C	—	—	R
15. <i>Guinardia flaccida</i> (Castracane) Peragallo ..	—	R	—	—	—	—	—	—	R	F	—	—
16. <i>Rhizosolenia cylindrus</i> Cleve ..	C	R	R	R	—	—	—	—	—	—	R	R
17. <i>Rhizosolenia styliformis</i> Brightwell ..	R	R	C	R	—	—	R	C	—	—	R	R
18. <i>Rhizosolenia setigera</i> Brightwell ..	C	F	C	C	P	F	F	—	R	R	R	R
19. <i>Rhizosolenia crassipiana</i> Schroeder ..	C	F	—	—	P	C	C	F	R	R	F	F
20. <i>Rhizosolenia alata</i> Brightwell ..	P	F	—	—	P	C	C	F	R	R	F	F
21. <i>Rhizosolenia imbricata</i> Brightwell ..	R	P	P	R	P	C	C	C	R	B	—	C

PHYTOPLANKTON CYCLES IN PUTTALAM LAGOON



22.	<i>Bacteriastrium varians</i> Lauder	C	B	P	—	R	R	R	P	P	C	R	P	P
23.	<i>Chaetoceros lorenzianus</i> Grunow	R	R	—	—	P	P	—	—	—	—	—	—	P
24.	<i>Chaetoceros pervianus</i> Brightwell	—	C	C	P	—	—	C	—	—	—	—	—	P
25.	<i>Chaetoceros lascinosus</i> Schutt	C	C	C	C	C	C	—	—	—	—	—	—	P
26.	<i>Chaetoceros didymus</i> Ehrenberg	C	—	—	C	C	C	C	—	—	—	—	—	—
27.	<i>Chaetoceros diversus</i> Cleve	—	—	—	F	F	P	—	—	—	—	—	—	—
28.	<i>Eucampia cornuta</i> (Cleve) Grunow	—	R	—	R	R	R	—	—	—	—	—	—	—
29.	<i>Eucampia zoodiacus</i> Ehrenberg	—	R	—	R	—	—	—	—	—	—	—	—	—
30.	<i>Ditylum brightwellii</i> (West) Grunow	P	C	C	—	—	—	—	—	—	—	—	—	—
31.	<i>Triceratium favus</i> Ehrenberg	C	R	F	P	F	R	R	—	—	F	R	R	—
32.	<i>Triceratium dubium</i> Brightwell	R	R	—	—	—	—	—	—	—	—	—	—	—
33.	<i>Triceratium alternans</i> Bailey	C	C	C	—	—	—	—	—	—	—	—	—	—
34.	<i>Biddulphia pulchella</i> Gray	C	C	—	—	—	C	—	—	—	C	—	—	—
35.	<i>Biddulphia sinensis</i> Greville	P	R	R	R	R	R	R	R	R	R	R	R	P
36.	<i>Biddulphia mobilensis</i> Bailey	P	P	C	C	C	C	P	R	R	C	R	R	R
37.	<i>Rhabdonema mirificum</i> W. Smith	F	C	—	—	—	—	—	—	—	—	—	—	R
38.	<i>Rhabdonema arcuatum</i> Kuetz	R	—	—	—	—	—	—	—	—	—	—	—	R
39.	<i>Hemidiscus hardmannianus</i> (Greville) Mann	—	—	—	—	—	R	R	—	—	—	R	R	R
40.	<i>Licmorpha abbreviata</i> Agardh	R	F	F	—	—	—	—	—	—	—	—	—	—
41.	<i>Licmorpha littoralis</i> Misra	R	F	—	R	R	—	—	—	—	—	—	—	—
42.	<i>Climacosphenia moniligera</i> Ehrenberg	R	—	—	R	R	—	—	—	—	—	F	—	—
43.	<i>Climacosphenia elongata</i> Bailey	—	—	F	—	—	—	—	—	—	—	—	—	R
44.	<i>Fragilaria oceanica</i> Cleve	—	—	R	R	R	R	—	—	—	—	R	—	R
45.	<i>Rhaphoneis discoides</i> Subrahmanyam	P	C	C	C	C	R	R	—	—	—	C	C	C
46.	<i>Synedra closterioides</i> Grunow	R	R	—	—	—	R	R	—	—	—	—	R	R
47.	<i>Synedra formosa</i> Hantzsch	R	R	—	—	—	—	—	—	—	—	—	R	—
48.	<i>Thalassionema nitzschioides</i> Grunow	P	C	R	P	C	C	C	C	C	R	P	P	B
49.	<i>Thalassiothrix longissima</i> Cleve and Grunow	F	R	R	C	C	—	—	—	—	C	C	—	C
50.	<i>Thalassiothrix frauenfeldii</i> Grunow	P	B	B	B	P	P	P	C	R	C	C	C	B
51.	<i>Asterionella japonica</i> Cleve	P	C	—	—	—	B	R	—	—	—	—	—	B
52.	<i>Gyrosigma balticum</i> (Ehrenberg) Rabenhorst	F	—	—	—	—	C	—	—	—	C	C	C	C
53.	<i>Pleurosigma elongatum</i> W. Smith	C	F	—	—	—	R	C	—	—	—	C	F	F
54.	<i>Pleurosigma normanii</i> Ralfs	—	R	R	F	R	R	R	R	F	C	F	F	F
55.	<i>Pleurosigma angulatum</i> (Quekett) W. Smith	—	R	R	R	F	C	R	R	—	F	F	F	F
56.	<i>Pleurosigma aestuarii</i> Brébisson	R	R	R	R	R	—	—	—	—	R	R	R	F
57.	<i>Pleurosigma carinatum</i> Donkin	R	C	—	R	R	—	—	—	—	F	R	R	R
58.	<i>Diploneis weissflogii</i> (A. Schmidt) Cleve	—	—	R	R	—	—	—	—	—	—	—	—	—
59.	<i>Diploneis robustus</i> Subr.	—	—	—	R	R	R	—	—	—	—	—	—	—
60.	<i>Navicula hennedyii</i> W. Smith	—	—	R	R	R	R	—	—	—	—	—	—	—
61.	<i>Navicula longa</i> (Gregory) Ralfs	R	R	—	R	R	R	R	—	—	—	R	R	R
62.	<i>Pinnularia directa</i> Smith	—	—	—	R	R	—	—	—	—	—	—	—	—
63.	<i>Trachyneis aspera</i> Ehrenberg	—	—	—	—	—	—	R	R	R	R	—	—	R
64.	<i>Cymbella marina</i> Castracane	—	—	—	R	R	—	—	—	—	R	—	—	R
65.	<i>Bacillaria paradoxa</i> Gmelin	R	—	—	—	—	R	R	R	R	—	R	—	—

TABLE III—(contd.)

HYTOPLANKTON CALENDAR DUTCH BAY JUNE 1960 TO MAY 1961

Species	1960								1961														
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May											
66. Amphora salina Smith	R	..	—	..	—	..	R	..	R	..	R	..	—	..	—								
67. Nitzschia closterium (Ehrenberg) W. Smith	R	..	R	..	F	..	—	..	C	..	—	..	—	..	R	..	—						
68. Nitzschia longissima (Brébisson) Ralfs	R	..	R	..	R	..	R	..	F	..	F	..	F	..	—	..	R	..	R	..	R		
69. Nitzschia seriata Cleve	C	..	R	..	—	..	—	..	R	..	—	..	—	..	R	..	—	..	—	..	—		
70. Nitzschia sigma (Kuetzing) Smith	R	..	R	..	R	..	R	..	F	..	F	..	F	..	R	..	R	..	R	..	R		
<i>Dinophyceae</i>																							
71. Ceratium trichoceros Kofoid	R	..	R	..	R	..	R	..	R	..	—	..	—	..	—	..	R	..	R	..	R		
72. Ceratium massiliense Gourret	R	..	R	..	R	..	—	..	—	..	—	..	—	..	R	..	—	..	R	..	R		
73. Ceratium tripos Nitzsch	R	..	R	..	F	..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	—		
74. Peridinium sp.	R	..	R	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—	R	
<i>Cyanophyceae</i>																							
75. Trichodesmium erythraeum Ehrenberg	P	..	C	..	C	..	C	..	—	..	P	..	—	..	P	..	P	..	C	..	C	..	C

TABLE IV

PHYTOPLANKTON CALENDAR PORTUGAL BAY TOWARDS KOVIL MUNAI JUNE, 1960 TO MAY 1961

Species	1960								1961														
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May											
1. Melosira sulcata (Ehrenberg) Kuetzing	C	..	R	..	R	..	R	..	C	..	—	..	R	..	R	..	F	..	F	..	F		
2. Stephanopyxis palmeriana (Greville) Grunow	F	..	F	..	R	..	R	..	—	..	—	..	—	..	R	..	R	..	F	..	F		
3. Sceletonema costatum (Greville) Cleve	P	..	P	..	B	..	C	..	P	..	P	..	P	..	—	..	—	..	—	..	F	..	R
4. Thalassiosira coramandeliana Subr.	R	..	R	..	R	..	C	..	C	..	F	..	—	..	—	..	—	..	R	..	C	..	C
5. Thalassiosira decipiens (Grunow) Jorgenson	F	..	F	..	F	..	C	..	C	..	F	..	—	..	—	..	—	..	R	..	F	..	C
6. Thalassiosira subtilis (Ostenfeld) Gran	C	..	C	..	R	..	C	..	R	..	B	..	—	..	F	..	C	..	—	..	C	..	C
7. Coscinodiscus gigas Ehrenberg	B	..	B	..	C	..	C	..	C	..	C	..	R	..	R	..	R	..	R	..	R	..	C
8. Coscinodiscus marginatus Ehrenberg	C	..	C	..	C	..	F	..	C	..	F	..	C	..	R	..	F	..	C	..	R	..	R
9. Planktoniella sol (Wallich) Schutt.	R	..	R	..	R	..	C	..	F	..	—	..	—	..	F	..	F	..	F	..	F	..	F
10. Aulacodiscus orbiculatus Subr.	—	..	—	..	—	..	—	..	C	..	C	..	—	..	R	..	R	..	—	..	R	..	R
11. Corethron inerme Karsten	—	..	—	..	—	..	R	..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	—
12. Schroederella delicatula (Peragallo) Pavillard	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—



TABLE IV—(contd.)

## PHYTOPLANKTON CALENDAR PORTUGAL BAY TOWARDS KOVIL MUNAI JUNE, 1960 TO MAY 1961

Species	1960								1961				
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
56. <i>Pleurosigma aestuarii</i> Brébisson ..	R	R	R	F	C	—	—	—	R	R	R	F	
57. <i>Pleurosigma carinatum</i> Donkin ..	R	C	R	F	R	—	—	—	—	R	R	R	
58. <i>Diploneis weissflogii</i> (A. Schmidt) Cleve ..	—	—	—	—	—	—	—	—	—	—	—	—	
59. <i>Diploneis robustus</i> Subr. ..	—	—	R	—	R	—	—	—	—	—	—	—	
60. <i>Navicula hennedyii</i> W. Smith ..	—	—	R	R	R	—	—	—	—	—	—	—	
61. <i>Navicula longa</i> (Gregory) Ralfs ..	R	R	R	R	R	—	—	—	—	R	R	—	
62. <i>Pinnularia directa</i> Smith ..	—	—	R	R	—	—	—	—	—	—	—	—	
63. <i>Trachyneis aspera</i> Ehrenberg ..	—	—	—	—	—	—	R	R	—	—	—	R	
64. <i>Cymbella marina</i> Castracane ..	—	—	—	R	R	—	—	—	R	—	—	—	
65. <i>Bacillaria paradoxa</i> Gmelin ..	R	—	—	F	R	R	R	—	—	—	R	—	
66. <i>Amphora salina</i> Smith ..	R	R	—	R	R	R	—	—	—	R	—	—	
67. <i>Nitzschia closterium</i> (Ehrenberg) W. Smith ..	R	R	R	F	F	—	—	R	—	—	—	R	
68. <i>Nitzschia longissima</i> (Brébisson) Ralfs ..	R	R	F	F	R	R	R	F	—	R	R	R	
69. <i>Nitzschia seriata</i> Cleve ..	C	C	—	—	F	—	—	—	R	—	—	—	
70. <i>Nitzschia sigma</i> (Kuetzing) Smith ..	—	—	—	R	R	R	R	—	—	R	R	—	
<i>Dinophyceae</i>													
71. <i>Ceratium trichoceros</i> Kofoid ..	R	R	R	R	R	R	—	—	R	R	—	R	
72. <i>Ceratium massiliense</i> Gourret ..	R	R	R	R	—	—	—	—	R	—	R	R	
73. <i>Ceratium tripos</i> Nitzsch ..	R	R	F	F	R	R	R	R	—	R	R	R	
74. <i>Peridinium</i> species ..	R	R	—	—	R	—	—	—	—	—	—	R	
<i>Cyanophyceae</i>													
75. <i>Trichodesmium erythraeum</i> Ehrenberg ..	C	C	F	C	—	P	—	F	P	P	C	C	

TABLE V

## PHYTOPLANKTON CALENDAR PORTUGAL BAY TOWARDS PALLUGATURAI JUNE 1960 TO MAY 1961

Species	1960								1961				
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
1. <i>Melosira sulcata</i> (Ehrenberg) ..	F	F	C	C	C	—	R	—	R	R	F	R	
2. <i>Stephanophyxis Palmeriana</i> (Greville) Grunow ..	R	F	R	F	R	—	—	—	R	R	R	F	
3. <i>Sceletonema costatum</i> (Greville) Cleve ..	P	P	B	P	P	C	C	—	—	—	R	R	
4. <i>Thalassiosira coramandeliana</i> Subr. ..	F	R	R	F	F	F	—	—	—	R	F	C	

5.	<i>Thalassiosira decipiens</i> (Grunow) Jorgenson ..	F	..	F	..	R	..	C	..	C	..	R	..	—	..	—	..	—	..	F	..	C	..	F
6.	<i>Thalassiosira subtilis</i> (Ostenfeld) Gran ..	C	..	C	..	C	..	C	..	C	..	C	..	—	..	R	..	C	..	—	..	C	..	C
7.	<i>Coscinodiscus gigas</i> Ehrenberg ..	B	..	B	..	C	..	C	..	C	..	R	..	R	..	R	..	F	..	F	..	F	..	C
8.	<i>Coscinodiscus marginatus</i> Ehrenberg ..	P	..	P	..	C	..	C	..	C	..	R	..	C	..	R	..	R	..	C	..	F	..	R
9.	<i>Planktoniella sol</i> (Wallich) Schutt	R	..	R	..	R	..	F	..	F	..	—	..	—	..	R	..	R	..	R	..	F	..	R
10.	<i>Aulacodiscus orbiculatus</i> Subr. ..	—	..	—	..	—	..	C	..	C	..	—	..	R	..	R	..	—	..	—	..	R	..	R
11.	<i>Corethron inerme</i> Karsten ..	—	..	—	..	—	..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—
12.	<i>Schroederella delicatula</i> (Peragallo) Pavillard ..	—	..	R	..	—	..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—
13.	<i>Leptocylindricus danicus</i> Cleve ..	R	..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	R
14.	<i>Leptocylindricus minimus</i> Gran ..	F	..	—	..	—	..	R	..	—	..	R	..	—	..	F	..	F	..	R	..	—	..	—
15.	<i>Guinardia flaccida</i> (Castracane) Peragallo ..	—	..	—	..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	R	..	R
16.	<i>Rhizosolenia cylindrus</i> Cleve ..	C	..	F	..	F	..	F	..	—	..	—	..	—	..	—	..	—	..	—	..	R	..	—
17.	<i>Rhizosolenia styliformis</i> Brightwell	P	..	F	..	C	..	F	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—
18.	<i>Rhizosolenia setigera</i> Brightwell ..	C	..	R	..	R	..	R	..	F	..	F	..	F	..	F	..	C	..	—	..	—	..	—
19.	<i>Rhizosolenia crassipiana</i> Schroeder	F	..	R	..	—	..	—	..	C	..	F	..	F	..	—	..	—	..	—	..	—	..	—
20.	<i>Rhizosolenia alata</i> Brightwell ..	P	..	C	..	F	..	C	..	C	..	R	..	C	..	F	..	R	..	R	..	B	..	R
21.	<i>Rhizosolenia imbricata</i> Brightwell	R	..	C	..	P	..	C	..	P	..	C	..	F	..	R	..	R	..	B	..	R	..	C
22.	<i>Bacteriastrium varians</i> Lauder ..	R	..	B	..	P	..	—	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—
23.	<i>Chaetoceros lorenzianus</i> Grunow ..	R	..	C	..	C	..	C	..	P	..	—	..	—	..	—	..	—	..	—	..	—	..	—
24.	<i>Chaetoceros pervianus</i> Brightwell	—	..	R	..	F	..	—	..	B	..	C	..	R	..	—	..	—	..	—	..	—	..	—
25.	<i>Chaetoceros lascinosus</i> Schutt ..	F	..	R	..	F	..	P	..	B	..	—	..	—	..	—	..	—	..	—	..	—	..	—
26.	<i>Chaetoceros didymus</i> Ehrenberg ..	R	..	R	..	—	..	—	..	B	..	R	..	R	..	R	..	—	..	—	..	—	..	—
27.	<i>Chaetoceros diversus</i> Cleve ..	R	..	R	..	R	..	—	..	B	..	—	..	—	..	—	..	—	..	—	..	—	..	—
28.	<i>Eucampia cornuta</i> ..	—	..	R	..	—	..	—	..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	—
29.	<i>Eucampia zoodiacus</i> Ehrenberg ..	R	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—
30.	<i>Ditylum brightwellii</i> (West) Grunow	P	..	C	..	C	..	C	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—
31.	<i>Triceratium favus</i> Ehrenberg ..	C	..	C	..	C	..	P	..	F	..	F	..	R	..	—	..	—	..	—	..	—	..	—
32.	<i>Triceratium dubium</i> Brightwell ..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—
33.	<i>Triceratium alternans</i> Bailey ..	F	..	C	..	R	..	R	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—
34.	<i>Biddulphia pulchella</i> Gray ..	C	..	C	..	F	..	F	..	C	..	R	..	—	..	—	..	—	..	—	..	—	..	—
35.	<i>Biddulphia sinensis</i> Greville ..	P	..	C	..	R	..	P	..	R	..	R	..	R	..	R	..	R	..	R	..	R	..	R
36.	<i>Biddulphia mobilensis</i> Bailey ..	P	..	C	..	C	..	C	..	C	..	P	..	R	..	R	..	R	..	R	..	R	..	R
37.	<i>Rhabdonema mirificum</i> W. Smith ..	R	..	—	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—
38.	<i>Rhabdonema arcuatum</i> Kuetzing ..	F	..	R	..	—	..	—	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—
39.	<i>Hemidiscus hardmannianus</i> (Greville) Mann ..	F	..	R	..	—	..	—	..	R	..	R	..	—	..	—	..	—	..	—	..	R	..	F
40.	<i>Licmorpha abbreviata</i> Agardh ..	R	..	R	..	R	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—
41.	<i>Licmorpha littoralis</i> Misra ..	R	..	—	..	—	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—
42.	<i>Climacosphenia moniligera</i> Ehrenberg ..	R	..	—	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—
43.	<i>Climacosphenia elongata</i> Bailey ..	—	..	R	..	—	..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—
44.	<i>Fragilaria oceanica</i> Cleve ..	—	..	—	..	R	..	R	..	—	..	—	..	—	..	—	..	—	..	—	..	—	..	—
45.	<i>Rhaphoneis discoides</i> Subrahmanyam ..	C	..	C	..	C	..	B	..	—	..	—	..	—	..	—	..	—	..	—	..	R	..	R
46.	<i>Synedra closterioides</i> Grunow ..	C	..	R	..	C	..	P	..	C	..	R	..	—	..	—	..	—	..	—	..	R	..	R

TABLE V—(contd.)

PHYTOPLANKTON CALENDAR PORTUGAL BAY TOWARDS PALLUGATURAI JUNE, 1960 TO MAY 1961.

Species	1960								1961				
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	
47. <i>Synedra formosa</i> Hantzsch ..	—	.. C	.. R	.. R	.. R	.. —	.. —	.. —	.. —	.. —	.. R	.. R	
48. <i>Thalassionema nitzschioides</i> Grunow ..	P	.. C	.. F	.. P	.. P	.. C	.. C	.. R	.. R	.. P	.. B	.. B	
49. <i>Thalassiothrix longissima</i> Cleve and Grunow ..	C	.. C	.. F	.. F	.. F	.. —	.. —	.. —	.. R	.. C	.. C	.. C	
50. <i>Thalassiothrix frauenfeldii</i> Grunow ..	P	.. B	.. B	.. B	.. P	.. P	.. C	.. C	.. C	.. F	.. C	.. B	
51. <i>Asterionella japonica</i> Cleve ..	P	.. P	.. —	.. C	.. B	.. —	.. —	.. —	.. —	.. —	.. C	.. B	
52. <i>Gyrosigma balticum</i> (Ehrenberg) Rabenhorst. ..	F	.. F	.. —	.. —	.. R	.. —	.. —	.. —	.. F	.. C	.. C	.. C	
53. <i>Pleurosigma elongatum</i> W. Smith ..	F	.. C	.. C	.. C	.. C	.. C	.. —	.. —	.. —	.. C	.. C	.. C	
54. <i>Pleurosigma normanii</i> Ralfs ..	—	.. —	.. R	.. R	.. R	.. —	.. —	.. R	.. R	.. R	.. R	.. R	
55. <i>Pleurosigma angulatum</i> (Quekett) W. Smith ..	R	.. —	.. —	.. R	.. R	.. R	.. —	.. R	.. —	.. R	.. F	.. R	
56. <i>Pleurosigma aestuarii</i> Brébisson ..	R	.. R	.. R	.. R	.. C	.. —	.. —	.. —	.. R	.. R	.. F	.. F	
57. <i>Pleurosigma carinatum</i> Donkin ..	R	.. R	.. F	.. F	.. F	.. —	.. —	.. —	.. —	.. R	.. R	.. R	
58. <i>Diploneis weissflogii</i> (A. Schmidt) Cleve ..	—	.. —	.. R	.. R	.. —	.. —	.. —	.. —	.. —	.. —	.. —	.. —	
59. <i>Diploneis robustus</i> Subr. ..	—	.. —	.. R	.. F	.. R	.. —	.. —	.. —	.. —	.. —	.. —	.. —	
60. <i>Navicula hennedyii</i> W. Smith ..	—	.. —	.. R	.. R	.. R	.. —	.. —	.. —	.. —	.. —	.. —	.. —	
61. <i>Navicula longa</i> (Gregory) Ralfs. ..	F	.. R	.. R	.. R	.. F	.. F	.. —	.. —	.. —	.. —	.. F	.. R	
62. <i>Pinnularia directa</i> Smith ..	—	.. —	.. R	.. R	.. —	.. —	.. —	.. —	.. —	.. —	.. —	.. —	
63. <i>Trachyneis aspera</i> Ehrenberg ..	—	.. —	.. —	.. —	.. —	.. —	.. R	.. R	.. —	.. —	.. —	.. R	
64. <i>Cymbella marina</i> Castracane ..	—	.. —	.. R	.. R	.. —	.. —	.. —	.. —	.. R	.. —	.. —	.. —	
65. <i>Bacillaria paradoxa</i> Gmelin ..	C	.. R	.. —	.. F	.. F	.. R	.. R	.. —	.. —	.. —	.. R	.. —	
66. <i>Amphora salina</i> Smith ..	R	.. —	.. —	.. R	.. R	.. —	.. —	.. —	.. —	.. R	.. —	.. —	
67. <i>Nitzschia closterium</i> (Ehrenberg) W. Smith ..	F	.. R	.. R	.. R	.. F	.. —	.. —	.. R	.. —	.. —	.. —	.. R	
68. <i>Nitzschia longissima</i> (Brébisson.) Ralfs ..	F	.. R	.. F	.. C	.. R	.. R	.. R	.. R	.. —	.. R	.. R	.. R	
69. <i>Nitzschia seriata</i> Cleve ..	F	.. C	.. —	.. —	.. R	.. —	.. —	.. —	.. R	.. —	.. —	.. —	
70. <i>Nitzschia sigma</i> (Kuetzing) Smith ..	—	.. R	.. —	.. R	.. R	.. R	.. R	.. —	.. —	.. R	.. R	.. R	
<i>Dinophyceae</i>													
71. <i>Ceratium trichoceros</i> Kofoid ..	R	.. R	.. R	.. R	.. R	.. —	.. —	.. R	.. R	.. —	.. —	.. R	
72. <i>Ceratium massiliense</i> Gourret ..	R	.. R	.. —	.. R	.. R	.. —	.. —	.. —	.. R	.. —	.. R	.. R	
73. <i>Ceratium tripos</i> Nitzsch ..	R	.. R	.. —	.. —	.. F	.. R	.. —	.. —	.. —	.. —	.. —	.. —	
74. <i>Peridinium</i> species ..	R	.. R	.. R	.. —	.. R	.. —	.. —	.. —	.. —	.. —	.. —	.. —	
<i>Cyanophyceae</i>													
75. <i>Trichodesmium erythraeum</i> Ehren- berg ..	C	.. C	.. C	.. C	.. —	.. F	.. —	.. P	.. P	.. C	.. C	.. C	

## Summary

The monthly average temperatures at Puttalam Lagoon, Dutch Bay, Portugal Bay towards Kovil-munai and Portugal Bay towards Pallugaturai showed a distinct annual cycle. The peak was in April and values gradually fell till September. There was a further gradual fall in temperature from October to January. The highest temperatures in all four stations were in April.

The highest salinities in all the stations were from May to October i.e., during the South-West Monsoon. The salinities at Dutch Bay and Portugal Bay were high in March and April corresponding to the highest temperatures reached during these months.

Two maxima have been observed in phytoplankton production. A primary maximum in May-June and a secondary maximum in October. The primary and secondary maxima are due to the influx of nutrient laden waters from the rivers Kal Aru and Pomparippu Aru.

The phytoplankton producing blooms were *Rhizosolenia alata*, *Rhizosolenia imbricata*, *Chaetoceros lascinosus*, *Chaetoceros pervianus*, *Chaetoceros diversus*, *Coscinodiscus gigas*, *Thalassionema nitzschioides*, *Thalassiosira subtilis*, *Thallassiothrix frauenfeldii*, *Asterionella japonica*, *Skeletonema costatum*, *Bacteriastrium varians* and *Biddulphia sinensis*.

Sudden outbursts of a single species were common. These diatoms were species of *Chaetoceros* and *Rhizosolenia*, and *Thallassiothrix frauenfeldii*.

Wide fluctuations have been observed in the distribution of phytoplankton but no definite conclusions can be drawn as the period of observation was only one year.

## Acknowledgments

I wish to express my sincere thanks to Mr. K. J. M. S. Grero, Laboratory Assistant, for accompanying me in all the field trips and assisting me in the counting of phytoplankton and determining the salinities.

## References

- BAINBRIDGE, R., 1953. Studies on the interrelationships of zooplankton and phytoplankton. *Jour. Mar. Biol. Ass.*, U. K. 32, 385-447.
- CHACKO, P. I., 1950. Marine plankton from waters around the Krusadai Island. *Proc. Ind. Acad. Sci.* 31, p. 162-74.
- CHIDAMBARAM, K. and MUKUNDANUNNY, M. 1944. Notes on the swarming of the planktonic algae *Trichodesmium erythraeum* in the Pamban are and its effect on the fauna. *Current Science*, 13, p. 263.
- DAS, P. K., 1954. *Ind. Jour. Met. and Geophys.*, 5.
- GANAPATHY, P. N. and RAO, C. G., 1953. Observation on the seasonal variations in the phytoplankton production of the Indian coast with special reference to Waltair Coast. *Indian Science Congress Part III*, p. 184.
- GANAPATHY, P. N. and MURTHY, V. S. R., 1953. Salinity and temperature variations of the surface waters off the Visakhapatnam coast. *Memoirs in Oceanography, Andhra University Waltair*, 49 (i), 125-142.
- 1955. Preliminary observations on the hydrography and inshore plankton in the Bay of Bengal, off Visakhapatnam coast. *Indian Journal of Fisheries* Vol. 2, pp. 84-95.
- GONZALVES, E. A., 1947. Variations in the seasonal composition of the phytoplankton of Bombay Harbour. *Current Science* 16, 304-05.
- JEYARAMAN, R., 1951. Observations on the chemistry of the waters of the Bay of Bengal off Madras City during 1948-49. *Proc. Ind. Acad. Sci.* 38, 92-99.
- 1957. Salinity and temperature variations in the surface waters of the Arabian sea off the Bombay and Saurashtra coasts. *Proc. Ind. Acad.* Vol. XLV, 151-164.
- LA FOND, E. C., 1954. Seasonal cycle of surface temperatures and salinities along the East Coast of India. *Andhra University Memoirs in Oceanography* 52, Vol. II, 12-21.
- MENON, M. A. S. 1945. Observations on the seasonal distribution of the plankton of Trivandram Coast. *Proc. Ind. Acad. Sci.*, 22, Sec. B, 31-62.

- PRASAD, R. R., 1954. The characteristics of marine plankton at an inshore station in the Gulf of Mannar near Mandapam, *Indian Journal of Fisheries* I, 1-36.
- 1956. Further studies on the plankton of the inshore waters off Mandapam, *Indian Journal of Fisheries* 3, 1-42.
- PRASAD, R. R. and RAMACHANDRAN NAIR, 1960. Observations on the distribution and occurrence of diatoms in the inshore waters of the Gulf of Mannar and Palk Bay, *Indian Journal of Fisheries*, Vol. 7, 49-68.
- RAMACHANDRAN NAIR, P. V., 1959. The marine plankton diatoms of Trivandram coast, *Bull Res. Inst. Univ. Kerala* ser. C, 1-63.
- SEWELL, R. B., S., 1937. Oceans round India. From "an outline of the Field Sciences of India" *Ind. Sci. Congr. Assn.* 17-41.
- 1955. A study of the Sea Coast of Southern Arabia, *Proc. Linn. Soc. Lond.* (Session 1952-53) Part II.
- SUBBRAMANYAN, R., 1946. A systematic account of the marine plankton diatoms of the Madras Coast, *Proc. Ind. Acad. Sci.* Vol. XXIV, 85-197.
- 1958. Ecological studies of the marine phytoplankton of the West Coast of India. *Mem. Ind. Bot. Soc.*, 1. 145-151.
- 1959. Studies on the phytoplankton of the West Coast of India. *Proc. Ind. Acad. Sci.* 50B, 113-187.