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Studies on the Phytoplankton of Inshore and Offshore Waters off Colombo and some Data on the Hydrological Conditions of these Waters

By

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Malpas (1930) rendered a considerable amount of oceanographic data off the Gulf of Mannar in reporting his drift bottle experiments. Durairatnam (1963) studied the seasonal cycles of sea surface temperatures, salinities and phytoplankton in Puttalam Lagoon, Dutch Bay and Portugal Bay. Studies on the plankton of the inshore waters off Mandapam were made by Prasad (1954, 1956). Studies on the temperatures and salinities for the Bay of Bengal have been reported by Sewell (1925), Das (1954) and Jayaraman (1954). Similar studies were made by La Fond (1958) for the east coast of India. It was decided to gather phytoplankton and hydrological data on a straight course west of Colombo up to a distance of 30 miles. Three stations were selected as follows :—

Station 1 — 6° 53′N latitude 79° 42.5E longitude. Within the Continental Shelf 7 miles from shore.

Station 2 — 6° 57.5′N latitude 79° 37′E longitude. On the Continental Shelf 13 miles from shore.

Station 3 — 6° 57′N latitude 79°24′E longitude. Beyond the Continental Shelf 28 miles from shore.

The present paper gives a comparative account of the hydrological conditions and phytoplankton within the Continental Shelf and beyond the Continental Shelf. 54 water samples were taken for hydrological analysis and 18 surface tows for plankton. Tables 1 to 3.

MATERIALS AND METHODS

Water samples were collected by a Nansen Bottle at the surface and at depths of 15 meters and 30 meters and temperatures were read from the reversing thermometer. Turbidity was determined using a Secchi disc. Surface collections of plankton were made for 15 minutes using Kitahara's surface plankton net with an over-all length of 120 cms. and a diameter of 30 cms. The mesh was in conformity with the International Standard net No. 13 and with the Japanese standard XX 13. The boats used for the purpose were the Fisheries Corporation trawler " Gandara " for 4 trips and the smaller 50 ton trawlers " Canadian " and " North Star " for the other two trips respectively. The plankton collected were preserved in 4% formalin. Salinities were obtained by determining chlorinity by Knudsen's method and reading salinity values directly from Knudsen's table, the oxygen content by Winkler's method, the phosphate content by Ammonium Molybdate method by Robinson and Thomson and the volume of each haul by the displacement method.

Quantitative estimations were made by counting under a binocular microscope the plankton contained in 1 ml. samples. The results are shown in tables 4, 5 and 6. Although we are fully aware of the limitations of this paper it is being published as it is felt that it will be of value for future work.

Net Plankton Volume

The total net-plankton volume was highest at station 1 within the Continental Shelf and reasonably high on the Continental Shelf but poor beyond it. The plankton content was high from November to January. There was a slight decrease in February with a sudden increase in March.

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TABLE I

Station 1 8.6° 53'N Latitude, 97° 42.5' Longitude

STRAIGHT COURSE WEST OF COLOMBO

Date	*Time hours*	*Depth Metres*	*Turbidity Metres*	*Air Temp.*	*Water Temp.*	*Oxygen µg at P/L*	*Salinity ‰*	*Phosphates µg. at P/L*	*Net Volume of Plankton ml.*	*Condition of the Sea*
29.11.66	1600	0		29.2°C	28.6°C	492	33.30	0.025		Slight swell blue and clear water, slow breeze and slightly cloudy.
" North Star "	do.	15	22		28.6°C	.471	33.34	0.025	14.0	
		30			28.5°C	.431	33.83	0.15		
21.12.66	1545	0			28.5°C	.435	33.06	0.40		Slight swell, blue and clear water, slow breeze and clear sky
" Gandara "		15	23.2	29.1°C	28.2°C	.434	33.06	0.50	15.5	
		30			28.1°C	.432	33.84	0.50		
15. 1.67	1015	0			28.0°C	.438	33.44	0.05		Calm sea, blue and clear water, slight blowing and clear sky
" Gandara "		15	26	28.3°C	27.6°C	.434	33.44	0.05	12.8	
		30			27.4°C	.434	33.80	0.10		
1. 2.67	1545	0			27.9°C	.427	33.28	0.20		Rough sea, blue water, strong breeze and clear sky
" Gandara "		15	22	28.9°C	27.5°C	.420	33.84	0.25	10.5	
		30			27.5°C	.398	34.48	0.45		
5. 3.67	1600	0			27.95°C	.448	33.84	0.025		Slight swell, blue water, slight blowing, clear sky.
" Gandara "		15	18	30.0°C	27.9°C	.441	34.16	0.05	17.5	
		30			27.8°C	.439	34.23	0.15		
19. 4.67	1600	0			29.8°C	.431	33.99	0.025		Light swell, blue water slight blowing and clear sky
" Canadian "		15	25	31.2°C	29.8°C	.419	34.08	0.15	12.5	
		30			29.6°C	.410	34.09	0.15		

TABLE 2

Station 2. 6° 57.5′ N. Latitude—79° 37′ E. Longitude

STRAIGHT COURSE WEST OF COLOMBO

Date	*Time hrs.*	*Depth Metres*	*Turbidity Metres*	*Air Tem.*	*Water Temp.*	*Oxygen µg. at P/L*	*Salinity ‰*	*Posphates µg. at P/L*	*Net Volume ml.*	*Condition of the sea*
29.11.66	0915	0			28.6°C	.483	33.26	0.025		Slight swell, blue and clear water, slow breeze and slightly cloudy.
"North Star"		15	31	28.7°C"	28.6°C	.466	33.28	0.025	9.5	
		30			28.5°C	.447	34.04	0.15		
21.12.66	0920	0			28.2°C	.434	33.06	0.025		Slight swell, blue and clear water, slow breeze and clear sky.
"Gandara"		15	22	27.8°C	28.2°C	.431	33.43	0.025	10.2	
		30			28.15°C	.429	33.80	0.15		
15. 1.67	0915	0			27.6°C	.437	33.44	0.05		Calm sea, blue and clear water, slight blowing and clear sky.
"Gandara"		15	33	28.4°C	27.4°C	.427	33.72	0.72	8.4	
		30			27.4°C	.427	33.72	0.05		
1. 2.67	0945	0			28.0°C	.427	33.50	0.15		Rough sea, blue water, strong breeze and clear sky.
"Gandara"		15	30	28.2°C	27.4°C	.427	33.50	0.20	8.8	
		30			27.0°C	.413	34.48	0.20		
5. 3.67	0920	0			27.4°C	.441	33.87	0.025		Slight swell, blue water, slight blowing, clear sky.
"Gandara"		15	26	28.6°C	27.2°C	.440	33.94	0.05	11.5	
		30			27.1°C	.438	34.16	0.10		
19. 4.67	0930	0			29.85°C	.423	33.67	0.20		Slight swell, blue water, slight blowing and clear sky.
"Canadian"		15	27	30.7°C	29.7°C	.414	33.83	0.20	8.0	
		30			29.5°C	.410	34.15	0.25		

TABLE 3

Station 3. 6° 57′ N. Latitude—79° 24′ E. Longitude

STRAIGHT COURSE WEST OF COLOMBO

Date	Time hrs.	Depth Metres	Turbidity Metres	Air Temp.	Water Temp.	Oxygen µg. at P/L	Salinity 0/00	Phospates µg. at P/L	Net Volume of Plankton ml.	Condition of the sea
29.11.66	1300	0			28.7°C	.491	32.78	Less than .025		Slight swell, blue and clear water, slow breeze and slightly cloudy.
"North Star"		15	30.3	29.0°C	28.6°C	.483	33.14	0.025	5.8	
		30			28.5°C	.464	33.85	0.015		
21.12.66	1215	0			28.3°C	.434	33.06	0.20		Slight swell, blue and clear water, slowbreeze and clear sky.
"Gandara"		15	26	28.2°C	28.2°C	.432	33.16	0.25	6.4	
		30			28.15°C	.421	33.82	0.25		
15. 1.67	1335	0			28.2°C	.448	33.44	0.025		Calm sea, blue and clear water, slight blowing and clear sky.
"Gandara"		15	25	28.6°C	27.81°C	.445	33.80	0.025	5.2	
		30			27.5°C	.441	33.80	0.05		
1. 2. 67	1215	0			28.0°C	.435	33.50	0.025		Rough sea, blue water, strong breeze and clear sky.
"Gandara"		15	20	25.8°C	27.5°C	.431	33.50	0.30	5.8	
		30			27.2°C	.392	33.84	0.45		
5. 3.67	1210	0			27.6°C	.448	33.96	0.10		Slight swell, blue water, slight blowing and clear sky.
"Gandara"		15	24	29.2°C	27.6°C	.441	34.09	0.10	6.8	
		30		27.3°C		.430	34.76	0.15		
19. 4. 67	1230	0			29.8°C	.423	33.99	0.30		Slight swell, blue water, slight blowing and clear sky
"Canadian"		15	26	30.8°C	29.7°C	.418	34.06	0.15	4.2	
		30			29.6°C	.415	34.09	0.20		

TABLE 4

Phytoplankton Calendar—November, 1966, to April, 1967, Station I

6° 57.5′N. Latitude 79° 37′E. Longitude

DIATOMS	*November*	*December*	*January*	*February*	*March*	*April*
1. Melosira sulcate (Ehrenberg) Kuetzing ..	—	—	—	F	F	R
2. Thalassiosira decipiens (Grunow) Jorgenson ..	C	R	—	R	R	R
3. Coscinodiscus gigas (Ehrenberg) ..	C	C	—	—	R	R
4. Coscinodiscus marginatus Ehrenberg ..	C	C	C	F	—	—
5. Planktoniella sol (Wallich) Schutt ..	F	F	C	—	C	R
6. Rhizosolenia alata Brightwell ..	C	C	P	R	B	R
7. Rhizosolenia imbricata Brightwell ..	R	R	P	B	R	R
8. Rhizosolenia hebetata (Bailey) Gran ..	C	F	—	—	—	—
9. Bacteriastrum varians Lauder ..	F	R	—	—	—	—
10. Bacteriastrum hyalinum Lauder ..	R	—	—	—	—	—
11. Chaetoceros indicus Subrahmanyan ..	F	C	—	—	—	C
12. Chaetoceros pervianus Brigtwell ..	C	F	—	—	R	R
13. Chaetoceros lorenzianus Grunow ..	C	C	—	—	—	C
14. Chaetoceros *coarctatus* Lauder ..	C	R	—	—	—	R
15. Chaetoceros lascinosus Schutt ..	R	R	R	—	—	—
16. Chaetocerous diversus Cleve ..	—	—	—	—	R	R
17. Eucampia zoodiacus Ehrenberg ..	C	C	R	—	—	—
18. Ditylum brightwellii (West) Grunow ..	—	—	R	—	R	R
19. Biddulphia sinensis Greville ..	R	R	—	—	—	—
20. Biddulphia mobilensis Greville ..	—	—	R	R	R	R
21. Biddulphia pulchella Gray ..	R	—	—	—	—	R
22. Rhabdonia mirificum W. Smith ..	—	—	—	—	R	R
23. Climacosphenia elongata Bailey ..	R	—	R	—	—	R
24. Licmorpha littoralis Misra ..	—	—	—	—	—	R
25. Fragilaria oceanica Cleve ..	—	—	—	—	—	R
26. Rhaphoneis discoides Subrahmanyan ..	—	—	R	—	R	R
27. Synedra formosa Hantzsch ..	—	—	—	—	—	R
28. Thallassionema *nitzschioides* Grunow ..	C	C	R	R	C	C
29. Thallassiothrix frauenfeldii Grunow ..	B	B	C	C	R	R
30. Thallassiothrix longissima Cleve ..	—	—	R	R	C	C
31. Asterionella japonica Cleve ..	C	C	R	—	—	C
32. Pleurosigma aestuarii Brebisson ..	C	R	—	—	C	R
33. Trachynois aspera Ehrenberg ..	—	R	—	R	—	—
34. Bacillaria paradoxa Gymelin ..	R	R	—	—	—	—
35. Nitzchia longissima (Brebisson) Ralfs ..	R	R	R	R	R	R
36. Nitzchia seriata Cleve ..	R	—	—	R	—	—
Dinophyceae						
1. Ceratium massiliense Gourret ..	R	R	—	—	R	R
2. Ceratium trichocerous Kofoid ..	R	R	R	R	R	R
3. Ceratium fusus Ehrenberg ..	C	R	R	R	R	R
4. Ceratium tripos Nitzsch ..	C	R	R	R	R	R
5. Ceratium furca Ehrenberg ..	R	—	—	—	R	R
6. Peridineum depressum Bailey ..	R	—	—	—	R	—
Cyanophyceae						
1. Trichodesmium erythraeum Ehrenberg ..	P	P	P	C	C	C

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

TABLE 5

Phytoplankton Calendar—November, 1966, to April, 1967, Station 2

6° 57′ N. Latitude 79° 24′ Longitude.

DIATOMS	*November*	*December*	*January*	*February*	*March*	*April*
1. Melosira sulcata (Ehrenberg) Kuetzing ..	C	C	—	F	R	R
2. Thalassiosira decipiens (Grunow) Jorgenson ..	C	C	F	—	R	F
3. Coscinodiscus gigas (Ehrenberg) ..	F	C	C	R	—	—
4. Coscinodiscus marginatus Ehrenberg ..	—	F	F	—	R	R
5. Planktoniella sol (Wallich) Schutt ..	C	C	P	—	R	—
6. Rhizosolenia alata Brightwell ..	R	C	C	C	B	P
7. Rhizosolenia imbricata Brightwell ..	C	P	P	—	—	R
8. Rhizosolenia hebetata (Bailey) Gran ..	F	P	P	—	—	R
9. Bacteriastrum varians Lauder ..	F	C	—	—	—	—
10. Bacteriastrum hyalinum Lauder ..	R	C	—	—	R	R
11. Chaetoceros indicus Subrahmanyan ..	F	P	F	—	—	R
12. Chaetoceros pervianus Brightwell ..	C	C	—	—	—	F
13. Chaetoceros lorenzianus Grunow ..	F	P	P	—	R	R
14. Chaetoceros coarctatus Lauder ..	F	P	P	R	R	R
15. Chaetoceros lascinosus Schutt ..	R	R	R	—	—	R
16. Chaetocerous diversus Cleve ..	R	—	—	—	—	—
17. Eucampia zoodiacus Ehrenberg ..	C	C	R	R	R	R
18. Ditylum brightwellii (West) Grunow ..	—	R	R	—	—	R
19. Biddulphia sinensis Greville ..	R	F	F	—	—	—
20. Biddulphia mobilensis Greville ..	R	R	R	—	—	R
21. Biddulphia pulchella Gray ..	R	R	—	—	—	R
22. Rhabdonia mirificum W. Smith ..	—	..	—	—	—	R
23. Climacosphenia elongata Bailey ..	—	R	R	—	—	R
24. Licmorpha littoralis Misra ..	R	—	—	—	—	R
25. Fragilaria oceanica Cleve ..	—	R	R	—	—	—
26. Rhaphoneis discoides Subrahmanyan ..	R	R	R	—	—	R
27. Synedra formosa Hantzsch ..	—	—	—	—	—	R
28. Thallassionema nitzschioides Grunow ..	B	B	C	R	R	C
29. Thallassiothrix frauenfeldii Grunow ..	B	B	P	C	C	R
30. Thallassiothrix longissima Cleve ..	R	C	C	R	C	C
31. Asterionella japonica Cleve ..	C	C	C	—	—	R
32. Pleurosigma aestuarii Brebisson ..	C	F	F	—	—	R
33. Trachynois aspera Ehrenberg ..	—	—	R	—	—	—
34. Bacillaria paradoxa Gymelin ..	R	C	R	—	—	—
35. Nitzchia longissima (Brebisson) Ralfs ..	F	F	R	—	—	—
36. Nitzchia seriata Cleve ..	F	R	—	—	—	R
Dinophyceae						
1. Ceratium massiliense Gourret ..	R	R	R	R	—	R
2. Ceratium trichocerous Kofoid ..	R	R	R	R	—	R
3. Ceratium fusus Ehrenberg ..	C	C	R	R	R	R
4. Ceratium tripos Nitzsch ..	C	R	R	—	R	R
5. Ceratium furca Ehrenberg ..	R	R	—	—	—	R
6. Peridineum depressum Bailey ..	R	—	—	—	R	R
Cyanophyceae						
1. Trichodesmium erythraeum Ehrenberg ..	P	P	P	C	R	C

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

Phytoplankton

A bloom of *Thallassiothrix frauenfeldii* occurred in November and December. In the same month the common diatoms were *Thallassiothrix decipiens, Coscinodiscus gigas, Rhizosolenia alata, Chaetoceros lorenzianus, Eucampia zoodiacus, Thallassionema nitzschoides* and *Asterionella japonica. Coscinodiscus marginatus* was common in January as well. There was a bloom of *Rhizosolenia alata* in March. Most of the diatoms which occurred in November and December were not found from January to March but re-appeared in April..The following diatoms were found throughout from November to April : *Rhizosolenia alata, Rhizosolenia imbricata, Thallassionema nitzschioides, Thallassiothrix frauenfeldii* and *Nitzschia longissima.* Some of the diatoms which occurred inside the continental shelf and on the continental shelf were not found beyond the shelf. However, in the case of the Dinophyceae they were more common beyond the shelf in deeper waters. *Ceratium trichoceros* and *Ceratium depressum* were common in station three while *Ceratium furca* was common in November, December, February and March. *Ceratium fusus* and *Ceratium tripos* were common in November in station one while *Ceratium tripos* was common in November and *Ceratium fusus* in November and December in station three.

The blue green algae *Trichodesmium erythraeum* was found in abundance from November to January in station one and two but few in station three.

Sea surfaee temperature

The mean monthly surface water temperature varies from 27°C to 29.85°C. The temperature range for surface water is 2.98°C. The temperatures in November and December are between 28°C and 28.6°C. The temperature drops to below 28°C from January to March with a sudden increase to more than 29°C in April.

Salinity

The salinities were below 34‰° from November to January but above 34‰° from February to April. The lowest salinity recorded was 33.06‰° in December and the highest 34.48‰° in February. The salinity range is 1.42‰°. The same pattern prevailed at all the three stations.

Oxygen Contents

The monthly distribution of oxygen content in all the three stations from November to April does not show marked variations. The maximum oxygen content was 0.492 μg. at P/L. in November and the minimum 0.398 μg. at P/L. in February. The range of oxygen content is 0.094 μg. at P/L.

Phosphates

The phosphate content was high in station 1 in December 0.4 to 0.5 μg. at P/L. and 0.45 μg. at P/L. at a depth of 30 meters in February. The maximum phosphate content was 0.072 μg. at P/L. at a depth of 15 meters at station two in January. Apart from these the phosphate content was low. The phosphate content appears to increase with depth. At no stage was the phosphate content completely exhausted the lowest being 0.025 μg. at P/L.

SUMMARY

The monthly variations of temperature, salinity, oxygen content and phosphates in the inshore and offshore waters off Colombo have been described and discussed.

The oxygen content was quite steady during the six months and there was not much variation.

The phosphate content increased with depth and at no stage was the phosphate content completely exhausted.

TABLE 6

Phytoplankton Calendar—November, 1966, to April, 1967, Station 3

6° 53′N. Latitude 79° 42.5′E Longitude.

		November	*December*	*January*	*February*	*March*	*April*
1.	Melosira sulcata (Ehrenberg) Kuetzing . .	—	—	—	—	—	—
2.	Thalassiosira decipiens (Grunow) Jorgenson	F	F	R	—	—	R
3.	Coscinodiscus gigas (Ehrenberg) . .	F	F	R	—	—	—
4.	Coscinodiscus marginatus Ehrenberg . .	R	R	R	R	R	R
5.	Planktoniella sol (Wallich) Schutt . .	—	—	—	—	—	—
6.	Rhizosolenia alata Brightwell . .	C	C	P	R	R	C
7.	Rhizosolenia imbricata Brightwell . .	R	R	R	—	—	R
8.	Rhizosolenia hebetata (Bailey) Gran . .	R	F	—	—	—	—
9.	Bacteriastrum varians Lauder . .	—	—	—	—	—	—
10.	Bacteriastrum hyalinum Lauder . .	—	—	—	—	—	—
11.	Chaetoceros indicus Subrahmanyan . .	—	—	—	—	—	—
12.	Chaetoceros pervianus Brightwell . .	R	R	—	—	—	—
13.	Chaetoceros lorenzianus Grunow . .	—	R	R	—	—	—
14.	Chaetoceros coarctatus Lauder . .	C	C	P	R	R	F
15.	Chaetoceros lascinosus Schutt . .	—	—	—	—	—	—
16.	Chaetocerous diversus Cleve . .	C	C	C	R	R	R
17.	Eucampia zoodiacus Ehrenberg . .	F	F	F	—	—	R
18.	Ditylum brightwellii (West) Grunow . .	—	—	—	—	—	—
19.	Biddulphia sinensis Greville . .	—	—	—	—	—	—
20.	Biddulphia mobilensis Greville . .	R	R	—	—	—	—
21.	Biddulphia pulchella Gray . .	—	—	—	—	—	—
22.	Rhabdonia mirificum W. Smith . .	—	—	—	—	—	—
23.	Climacosphenia elongata Bailey . .	F	F	R	—	—	—
24.	Licmorpha littoralis Misra . .	—	—	—	—	—	—
25.	*Fragilaria oceanica* Cleve . .	F	F	F	R	R	—
26.	Rhaphoneis discoides Subrahmanyan . .	—	—	—	—	—	—
27.	Synedra formosa Hantzsch . .	—	—	—	—	—	—
28.	Thallassionema nitzschioides Grunow . .	R	R	—	—	—	—
29.	Thallassiothrix frauenfeldii Grunow . .	—	—	—	—	—	—
30.	Thallassiothrix longissima Cleve . .	C	C	F	R	R	R
31.	Asterionella japonica Cleve . .	R	R	R	—	—	—
32.	Pleurosigma aestuarii Brebisson . .	—	—	—	—	—	—
33.	Trachynois aspera Ehrenberg . .	—	—	—	—	—	—
34.	Bacillaria paradoxa Gymelin . .	—	—	—	—	—	—
35.	Nitzchia longissima (Brebisson) Ralfs	R	R	R	—	—	R
36.	Nitzchia seriata Cleve	P	P	P	—	—	R
	Dinophyceae						
1.	Ceratium massiliense Gourret . .	—	—	—	R	R	—
2.	Ceratium trichocerous Kofoid . .	R	R	—	R	R	R
3.	Ceratium fusus Ehrenberg . .	C	C	F	R	R	R
4.	Ceratium tripos Nitzsch . .	C	F	F	R	R	R
5.	Ceratium furca Ehrenberg . .	R	C	R	C	C	R
6.	Peridineum depressum Bailey . .	C	C	R	R	R	R
	Cyanophyceae						
1.	Trichodesmium erythraeum Ehrenberg . .	F	F	F	F	R	R

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

Phytoplankton was concentrated within the Continental Shelf and on the Continental Shelf but gradually diminished beyond the shelf. The Dinophyceae was found in abundance beyond the shelf. The volume of plankton is high from November to January corresponding to the maximum catch of fish from November to April. It diminishes slightly in February and reaches a peak in March and falls again in April.

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