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ZOOPLANKTON BIOMASS AND ITS CONSTITUENTS FROM 100-0 M AND FROM NEAR SEABED TO O M AT SHALLOW STATIONS IN THE NORTHERN ARABIAN SEA DURING DECEMBER, 1973-MAY, 1974.

By

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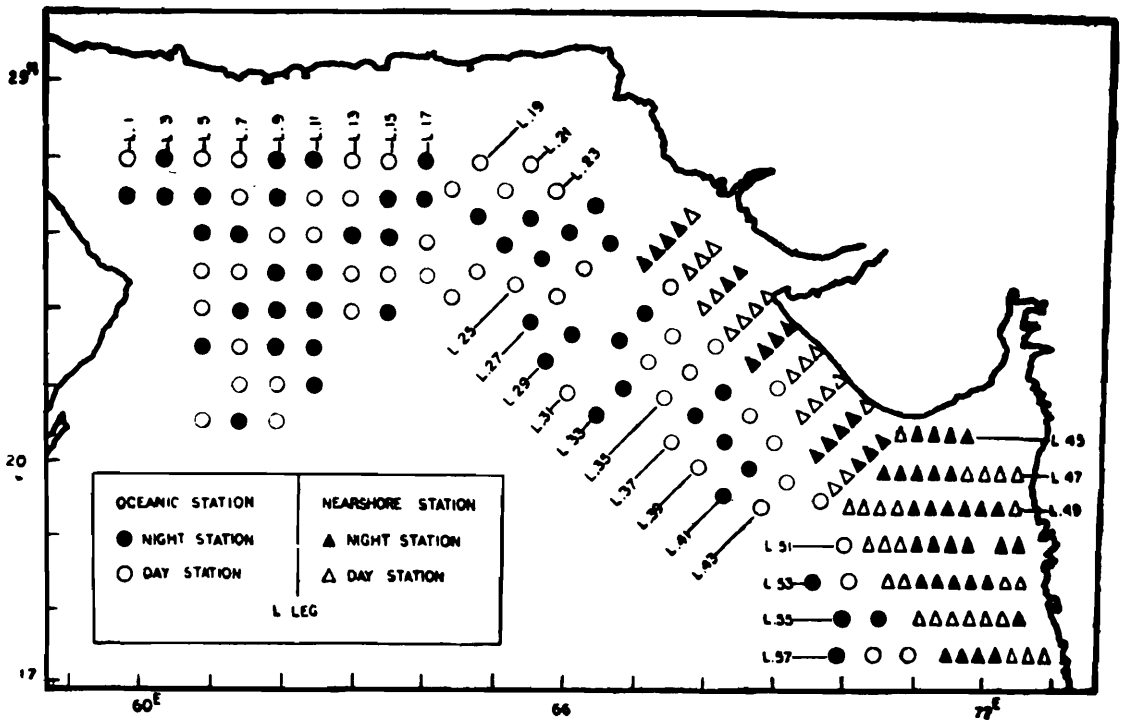
(With five Text-figures)

INTRODUCTION

It is well known that the distribution of plankton in the sea is an index of fertility not only of the water column but also of the sea bottom (Prasad, 1969). The distribution of zooplankton biomass of the inshore and offshore waters of the Arabian Sea and the Bay of Bengal upto 1965, is known in great detail. These results were based mainly on the samples of oceanographic expeditions (Sewell, 1948—John Murray Expedition; Foxton, 1957—R. R. S. Discovery; Bogorov and Vinogradov, 1961, Ponomarov and Novamor, 1962, Daniel and Premkumar, 1965—USSR R. V. Vityaz; Prasad, 1969—International Indian Ocean Expedition collections lodged at the Indian Ocean Biological Centre). Of these, Ponomorav and Novamov's (1962) work is a short account for the period of monsoon change of the Arabian Sea and Bay of Bengal and the only comprehensive account of the plankton biomass of these two regions covering all the seasons is by Prasad (1969). The grid system followed during these expeditions were wide apart and the results were based on samples collected upto 1965.

Several planktonologists have emphasized the unevenness (patchiness) in the distribution of plankton, as evidenced by the irregularity in the volumetric distribution from station to station between localities only a few miles apart during different seasons and years (Hardy and Gunther, 1935; Clarke, 1946; Hardy, 1956; Raymont, 1963). Therefore, during the Oceanographic Expedition on the I. N. S. DARSHAK in the Northern Arabian Sea from December, 1973 to May, 1974 studies were made on the standing crop (biomass) of zooplankton and variations

ZOOPLANKTON STATIONS FROM 100-0MTS IN THE OCEANIC REGION (100 STNS) AND FROM NEAR SEABED TO SURFACE FROM SHALLOW NEAR SHORE STATIONS (94 STNS).



Text-fig. 1

in the abundance of major constituents from 100-0 metres in the oceanic regions at 100 stations and from near seabed to surface at 94 shallow nearshore stations, following a close grid (Text-fig. 1). This paper summarizes these investigations.

Material and Methods

Zooplankton samples were collected with a Nansen type "standard" plankton net of 50 cms mouth diameter/225 cms total net length of bolting silk 60 meshes per linear centimetre, hauled vertically at a speed of one metre per second over a davit from 100 metres to surface at 100 oceanic stations (52 day and 48 night stations) and from near seabed to surface at 94 shallow near shore stations (46 day and 48 night stations). The total displacement volumes of samples were obtained following the technique of Foxton (1957), Daniel and Premkumar (1965). The displacement volumes have been considered to be equivalent to total biomass of the samples (Prasad, 1969). Text-fig. 1 indicates the 194 stations (100 day and 94 night stations) occupied for the collection of these samples. The values obtained for each degree square were averaged. While averaging the values in each one degree square, in a few cases displacement volumes obtained from stations established in adjoining squares were included when day or night stations were not established in that square. The mean values thus obtained are presented as the dis-

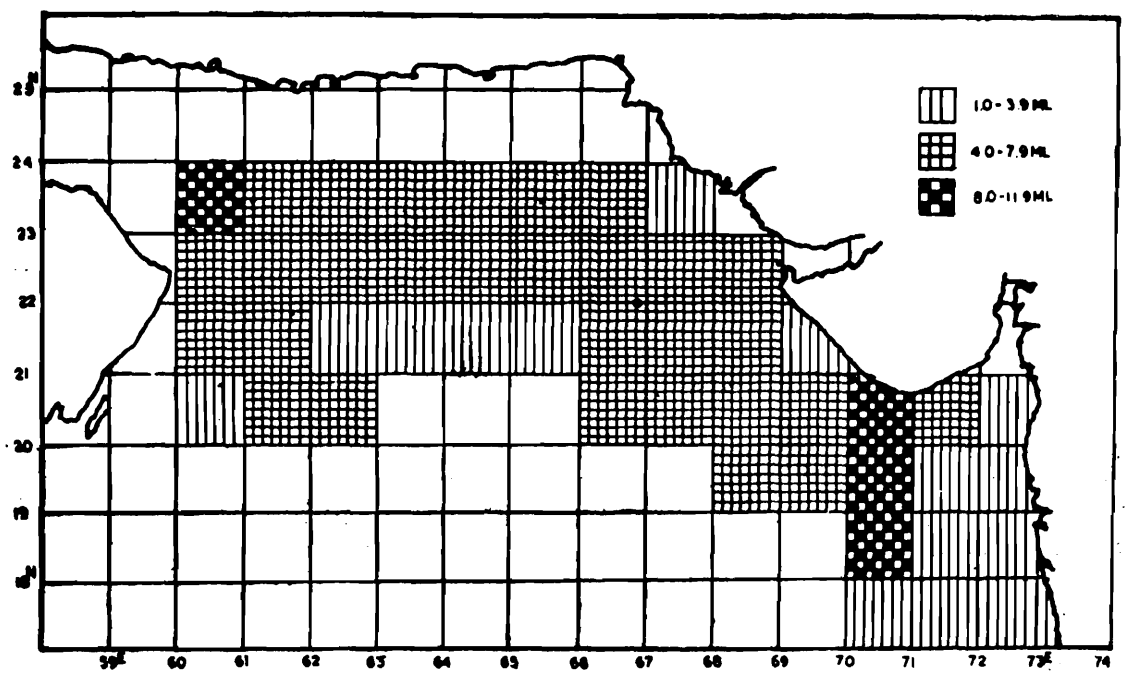
tribution of plankton biomass in generalised charts. The longitudinal and latitudinal variations of the plankton biomass were obtained by taking the averages of values between 1° increment of longitude and each 1° increment of latitude during the night and day periods. The numbers of each zooconstituent occurring in the entire plankton sample were analysed for estimating the numbers of different constituents in a haul.

OBSERVATIONS

Day and Night variations of Plankton Biomass

The distribution of zooplankton biomass as calculated from 96 night stations (48 oceanic and 48 shallow stations) and 98 day stations (52 oceanic and 46 shallow stations) in 1° squares bounded by latitudes 17° N to 24°N and longitudes 60°E to 73°E covering the sea area sampled during the oceanographic expedition on I. N. S. DARSHAK are presented in Text-figures 2 and 3. Data on date, time, latitudinal and longitudinal position, total depth of each station, depth and displacement volumes of each zooplankton haul for the 96 night and 98 day stations are presented in Tables 1 and 2. It is evident from Figures 2 and 3 and Tables 1 and 2 that zooplankton biomass from 100 metres depth in the oceanic region and from near seabed in the shallow coastal region was far more abundant during the night, ranging from 8.0 ml per vertical haul reaching peak values of 12 ml and above per vertical haul in three distinct regions: (i) off Kathiavar Peninsula, and the Gulf of Kutch'

DISTRIBUTION OF ZOOPLANKTON BIOMASS FROM 100-0 MTS (100 STNS) AND FROM NEAR SEABED TO SURFACE (94 STNS). DAY.

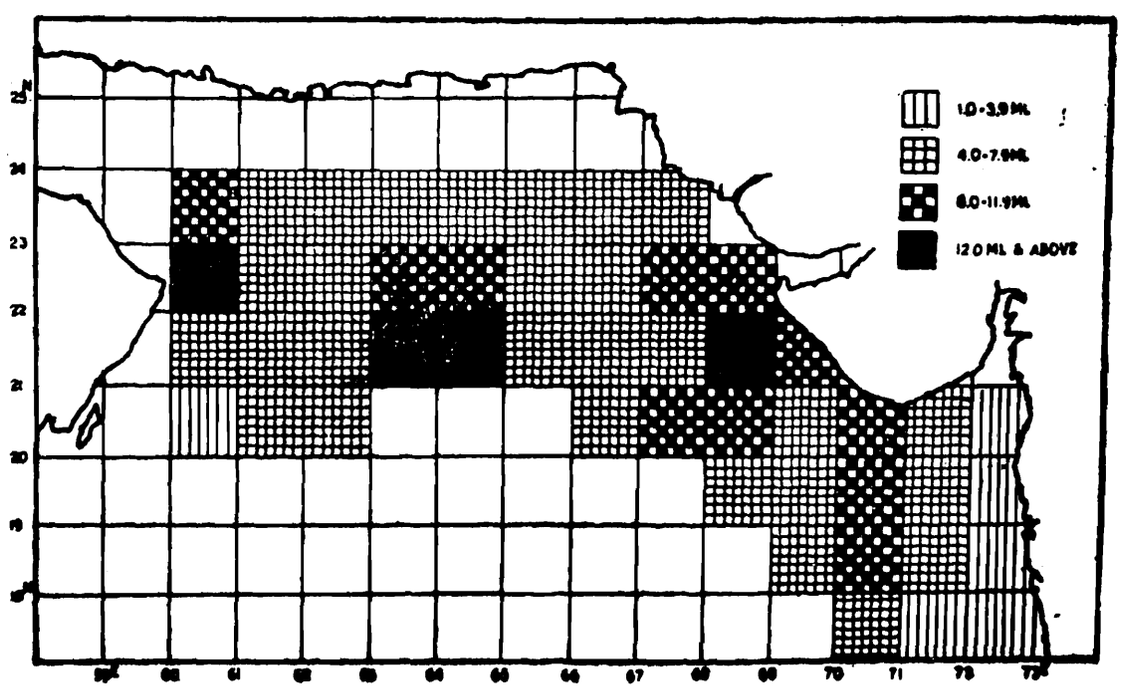


Text-fig. 2

(ii) oceanic regions in the central part of the northern Arabian sea bounded by latitudes 21°-23° North and longitudes 63°-65° East and (iii) off Ras-Al-Hadd at the mouth of Gulf of Oman. During the day, maximal biomass values of 8 to 11.9 ml per vertical haul occurred in a narrow belt in the off shore areas off the north west coast of India between 70°-71° E longitudes and off Ras-Al-Hadd in the Gulf of Oman where the night biomass values were also the same.

Low plankton biomass of 1 to 3.9 ml per haul occurred as a narrow belt between 72° E to 73°E longitudes in the inshore areas bordering the north west coast of India both during the night and day. This region of low biomass extended upto 71° E longitudes during the day. Similar low biomass values of 1 to 3.9 ml occurred during the day (i) along the central part of the Northern Arabian sea bounded by latitudes 21° to 22° North and longitudes 62° to 66° East and (ii) as three small patches: (a) at the mouth of the River Indus, (b) off Porbandar in Gujarat and (c) the offshore waters of Masira off Oman.

DISTRIBUTION OF ZOOPLANKTON BIOMASS FROM 100-0 MTS (100 STNS) AND FROM NEAR SEABED TO SURFACE (94 STNS). NIGHT



Text-fig. 3

The biomass values during the night at Masira off Oman was also very low ranging from 1 to 3.9 per haul. Areas of moderately rich plankton biomass varying from 4 to 7.9 ml per vertical haul occurred extensively in the remaining oceanic regions sampled during the Expedition both during the day and night (Figs. 2 & 3). A perusal of Tables I and II also reveal that the 27 stations (i.e. 16 night stations: 0303, 0505, 0901, 1509, 1701 , 2307, 2905, 3703, 3706, 3708, 4305, 4906, 4907, 5104, 5105, 5107,

Table 1. Showing the details of the night stations established and displacement volume in ml.

Station	Date	Time	Latitude N	Longitude E	Depth of the station	Depth of haul	Displacement volume in ml.
1	2	3	4	5	6	7	8
01.03	9.2.1974	00.25	23.30	59.46	3270	100–0	8.0
03.01	10.2	03.10	24.00	60.21	3250	100–0	5.0
03.03	9.2	19.12	23.29	60.17	3240	100–0	11.0
05.03	10.2	18.30	23.23	60.50	3250	100–0	9.0
05.05	11.2	01.16	23.00	60.50	3254	100–0	13.0
05.11	12.1	18.05	21.30	61.23	3060–3100	100–0	7.5
07.05	11.2	23.50	23.00	61.22	3250	100–0	7.0
07.09	15.1	03.00	21.59	61.23	3060	100–0	8.0
07.15	8.1	23.45	20.29	61.23	—	100–0	7.5
09.01	12.2	22.20	24.00	61.55	3244	100–0	11.0
09.03	13.2	05.35	23.29	61.55	3270	100-0	5.0
09.07	13.2	20.00	22.30	61.48	3000	100–0	9.0
09.09	14.1	21.10	21.59	61.52	0930	100–0	5.0
09.11	12.1	03.35	21.30	61.56	2160–2180	100–0	5.0
11.01	15.2	00.27	24.00	62.27	3200	100–0	4.5
11.07	14.2	03.00	22.30	62.26	2740	100–0	8.0
11.09	14.1	13.45	22.00	62.28	3160	100–0	5.0
11.11	11.1	20.05	21.31	62.24	3160–3280	100–0	5.0
11.13	10.1	03.30	21.03	62.23	3354	100–0	4.0
13.05	15.2	22.45	23.00	63.01	2840	100–0	4.0

Table 1. *Contd.*

1	2	3	4	5	6	7	8
15.03	17.2	05.08	23.27	63.32	2240	100–0	9.0
15.05	16.2	21.57	23.00	63.33	4120	100–0	8.0
15.09	14.1	00.50	21.57	63.33	2860–2900	100–0	18.0
17.01	17.2	19.38	24.00	64.05	3054	100–0	11.5
17.03	18.2	02.15	23.30	64.05	2500	100–0	4.0
21.05	08.4	21.42	23.15	64.33	3140	100–0	7.5
23.05	06.4	21.50	23.19	65.21	—	100–0	6.0
23.07	07.4	03.05	22.58	65.00	—	100–0	11.8
25.01	26.3	18.48	23.31	66.18	0237	100–0	4.5
25.03	26.3	23.10	23.10	65.57	1400	100–0	9.5
25.05	27.3	04.55	22.48	65.38	2840	100–0	3.5
27.03	25.3	03.25	23.02	66.35	0455	100–0	5.0
27.09	25.3	22.16	21.56	65.22	2800	100–0	9.0
29.02	22.3	19.37	23.19	67.30	0026	20–0	7.0
29.03	22.3	21.08	23.10	67.23	0030	25–0	5.0
29.04	22.3	22.45	23.00	67.16	0032	25–0	7.8
29.05	23.3	01.25	22.51	67.09	0097	90–0	14.5
29.11	23.3	19.46	21.43	66.00	2300	100–0	9.0
29.13	24.3	03.25	21.27	65.37	0455	100–0	5.0
31.07	20.3	19.45	22.04	67.05	1790	100–0	6.0
31.09	21.3	02.25	21.42	66.39	1870	100–0	5.0
33.01	18.1	21.00	22.39	68.29	0030	20–0	9.0
33.02	18.1	18.20	22.28	68.17	0060	40–0	9.0

Table 1. *Contd.*

1	2	3	4	5	6	7	8
33.10	18.1	22.02	21.03	46.00	2186	100–0	8.0
33.12	19.3	03.36	20.40	66.22	2320	100–0	6.0
37.01	18.1	02.00	21.53	69.08	0030	25–0	1.5
37.02	17.1	23.45	21.45	69.00	0054	50–0	9.0
37.03	17.1	21.45	21.34	68.49	0065	50–0	25.0
37.04	17.1	18.45	21.24	68.38	0100	75–0	9.0
37.06	23.2	19.52	21.03	68.13	2370	100–0	15.0
37.08	24.2	02.54	20.41	67.51	2860	100–0	10.0
39.08	26.2	01.58	20.25	68.19	2960	100–0	9.0
41.08	27.2	22.15	20.03	68.39	2540	100–0	4.5
41.10	28.2	03.12	19.42	68.18	3100	100–0	8.5
43.02	27.1	03.45	20.40	70.10	0047	30–0	7.0
43.03	27.1	01.32	20.32	69.58	0070	20–0	3.0
43.04	26.1	22.30	20.24	69.46	0065	50–0	1.0
43.05	26.1	19.07	19.53	69.12	0102	50–0	16.0
45.01	23.12.1973	01.30	20.30	71.36	0027	15–0	0.5
45.02	23.12	23.00	20.30	71.36	0025	15–0	0.5
45.03	23.12	21.00	20.30	71.21	0025	15–0	1.0
45.04	22.12	04.00	20.29	71.04	0034	20–0	1.0
45.06	25.12	23.15	20.30	70.35	0051.5	40–0	6.0
45.07	25.12	21.15	20.19	70.24	0084	70–0	8.0
45.08	25.12	18.45	20.07	70.10	0070	70–0	8.0
47.05	23.1.1974	04.30	19.56	71.34	0035	25–0	5.0

Table 1. *Contd.*

1	2	3	4	5	6	7	8
47.06	23.1	02.10	19.57	71.17	0038	20–0	3.0
47.07	23.1	23.50	19.58	71.02	0050	40–0	8.0
47.08	22.1	21.25	19.59	70.46	0075	40–0	6.5
47.09	22.1	18.00	19.58	70.25	0078	70–0	6.0
49.02	25.1	04.35	19.30	72.13	0028	20–0	1.0
49.03	25.1	02.50	19.30	71.58	0032	20–0	2.5
49.04	25.1	01.00	19.30	71.44	0046	30–0	4.0
49.05	24.1	23.10	19.30	71.29	0062	50–0	6.0
49.06	24.1	21.20	19.30	71.12	0068	50–0	13.0
49.07	24.1	18.30	19.31	70.48	0081	60–0	13.0
51.01	29.1	05.25	18.58	72.38	0024	15–0	6.0
51.02	29.1	03.08	19.00	72.23	0040	30–0	5.0
51.04	04.1	20.15	19.00	72.51	0067	50–0	33.0
51.05	04.1	23.15	19.00	71.34	0075	50–0	35.0
51.06	05.1	01.30	19.00	71.17	0080	70–0	9.0
51.07	05.1	05.05	19.00	71.01	0084	70–0	25.0
53.03	03.5	19.50	18.31	72.16	0048	40–0	1.0
53.04	03.5	22.56	18.30	71.58	0076	65–0	1.5
53.05	04.5	00.57	18.29	71.43	0084	70–0	1.5
53.06	04.5	03.07	18.27	71.28	0083.5	75–0	1.5
53.07	04.5	05.30	18.27	71.15	0086	80–0	3.0
53.13	04.5	21.52	18.30	69.40	1230	100–0	6.0
55.02	06.5	04.20	18.00	72.36	0039	35–0	4.0

Table 1. *Contd.*

1	2	3	4	5	6	7	8
55.10	06.5	21.05	18.01	70.32	1572	100–0	8.5
55.12	07.5	04.25	17.58	70.01	2830	100–0	8.5
57.04	08.5	19.40	17.30	72.18	0094.5	85–0	2.0
57.05	08.5	22.20	17.31	72.00	0101	90–0	1.5
57.06	09.5	01.00	17.31	71.44	0096	85–0	1.5
57.07	09.5	04.00	17.32	71 28	0099	90–0	2.0
57.13	09.5	09.18	17.31	70.57	—	100–0	7.5

Table - 2. Showing the details of the day stations established and displacement volume in ml.

Station	Date	Time	Latitude N	Longitude E	Depth of the station	Depth of haul	Displacement volume in ml.
1	2	3	4	5	6	7	8
01.01	9.2.1974	06.20	24.01	59.45	3240	100–0	5.0
05.01	10.2	09.32	24.00	60.51	3230	100–0	10.0
05.07	11.2	08.50	22.30	60.51	3002	100–0	11.0
05.09	15.1	07.55	21.58	60.52	2920	100–0	4.0
05.15	9.1	08.05	20.27	60.56	—	100–0	3.0
07.01	12.2	15.00	24.00	61.23	3246	100–0	4.5
07.03	12.2	07.38	23.32	61.23	3270	100–0	10.0
07.07	11.2	16.05	22.29	61.23	3130	100–0	8.0
07.11	12.1	09.40	21.30	61.23	2980	100–0	5.0
07.13	10.1	15.30	21.00	20.8	2660-2720	100–0	4.0
09.05	13.2	12.50	23.01	61.50	3140	100–0	7.5
09.13	10.1	10.00	20.59	61.55	3320	100–0	3.0
09.15	8.1	16.00	20.30	61.55	0273	100–0	6.0
11.03	14.2	16.55	23.29	62.26	3246	100–0	8.0
11.05	14.2	10.10	23.00	62.28	2720	100–0	7.5
13.01	15.2	08.30	23.59	63.00	3200	100–0	5.5
13.03	15.2	15.13	23.29	63.00	2620	100–0	3.0
13.07	16.2	06.10	22.30	63.01	4000	100–0	4.0
13.09	14.1	06.15	22.57	63.33	1640	100–0	2.0
15.01	17.2	12.31	24.00	63.33	3160	100–0	4.5

Table 2. *Contd.*

1	2	3	4	5	6	7	8
15.07	16.2	14.55	22.31	63.33	2306	100–0	6.0
17.05	18.2	08.56	23.00	64.05	1980	100–0	8.5
17.07	18.2	15.50	22.30	64.04	522	100–0	10.0
19.01	09.4	11.30	24.00	64.39	2860	100–0	5.0
19.03	09.4	17.17	23.44	64.20	2020	100–0	6.0
21.01	08.4	08.12	23.59	65.22	1600	100–0	8.0
21.03	08.4	13.52	23.39	65.00	2880	100–0	4.0
23.03	06.4	16.55	23.40	65.44	—	100–0	5.0
23.09	07.4	08.05	22.35	64.35	2320	100–0	5.5
23.11	07.4	14.06	22.20	64.17	2700	100–0	3.8
25.07	27.3	11.50	22.32	65.11	2270	100–0	3.5
27.05	25.3	09.14	22.37	66.08	1780	100–0	7.0
27.07	25.3	16.40	22.19	65.48	2560	100–0	3.5
29.01	22.3	17.50	23.29	67.42	0020	18–0	1.5
31.02	20.3	08.30	23.57	68.01	0027	20–0	3.0
31.03	20.3	10.30	22.46	67.50	0041	33–0	4.0
31.04	20.3	13.51	22.36	67.38	0094	85–0	4.5
31.05	20.3	16.02	22.25	67.27	0113	100–0	5.0
31.13	21.3	15.35	21.00	65.59	2498	100–0	4.0
33.03	18.1	16.15	22.18	68.04	0085	70–0	2.5
33.04	17.1	10.00	22.07	67.53	0100	90–0	4.5
33.06	18.3	09.00	21.46	67.31	1820	100–0	5.5
33.08	18.3	14.46	21.26	67.09	2180	100–0	4.0

Table 2. *Contd.*

1	2	3	4	5	6	7	8
35.01	18.1	06.45	22.18	68.49	0030	20–0	75
35.02	18.1	08.00	22.09	68.40	0037	25–0	.50
35.03	18.1	10.35	21.58	68.29	0064	50–0	2.0
35.04	18.1	12.30	21.49	68.18	0090	75–0	1.5
35.05	17.1	14.35	21.38	68.07	0139	100–0	3.0
35.07	22.2	15.02	21.18	67.46	1680	100–0	12.0
35.09	22.2	07.10	21.02	67.25	2414	100–0	6.0
37.10	24.2	10.10	20.16	67.28	2930	100–0	2.0
39.01	25.2	08.05	21.34	69.32	0031	20–0	1.5
39.02	25.2	10.15	21.26	64.24	0044	30–0	3.5
39.03	25.2	12.27	21.52	69.12	0070	50–0	7.0
39.04	25.2	14.28	21.04	68.59	0130	100–0	8.5
39.06	25.2	11.16	20.41	68.34	2780	100–0	5.0
39.10	26.2	09.52	20.03	67.55	3020	100–0	5.0
41.01	27.2	06.08	21.11	69.53	0028	15–0	2.5
41.02	27.2	08.20	21.04	69.45	0046	35–0	2.0
41.03	27.2	09.55	20.54	69.34	0066	50–0	2.5
41.04	27.2	11.28	20.44	69.23	0084	70–0	6.5
41.06	27.2	14.58	20.24	69.01	1348	100–0	7.0
43.01	27.1	06.50	20.54	70.20	0024	20–0	10.0
43.07	26.1	13.45	19.53	69.12	1500	100–0	8.0
43.09	26.1	08.05	19.31	68.50	2538	100–0	4.0
45.05	22.12.1973	07.45	20.29	71.04	0041	20–0	.5

Table 2. *Coutd.*

1	2	3	4	5	6	7	8
45.09	25.12	16.30	19.58	70.01	0082	70–0	20.0
45.10	25.12	13.20	19.47	69.50	0093	50–0	9.0
45.11	25.12	10.00	19.36	69.41	0128	100–0	5.0
47.01	23.1.1974	13.25	20.00	72.35	0020	20–0	1.5
47.02	23.1	11.05	19.58	72.21	0035	20–0	1.0
47.03	23.1	09.00	19.58	72.05	0035	20–0	1.0
47.04	23.1	06.45	19.55	71.51	0032	20–0	3.0
49.01	25.1	07.00	19.29	72.29	0020	10–0	1.5
49.08	24.1	16.20	19.30	70.34	0076	60–0	3.5
49.09	24.1	14.00	19.30	71.29	0080	60–0	4.0
49.10	24.1	11·25	19.30	70·04	0080	60–0	3.5
49.11	24.1	09.25	19.30	69·52	0096	70–0	6.5
51.08	05.1	07.30	19.00	71.44	0088	70–0	16.5
51.09	05.1	09.40	19.00	71·50	0098	75–0	20.0
51.10	05.1	12.40	19.00	71.01	0085.5	70–0	19.5
51.11	05.1	15.10	19.00	70.15	0273	100–0	21.5
53.01	03.5	15.17	18.30	72.42	0022	20–0	.5
53.02	03.5	17.07	30.05	72.28	0040	30–0	1.0
53.08	04.5	08.40	18.27	72.59	0087	70–0	1.5
53.09	04.5	11.55	18.28	70.44	0094.5	85–0	1.5
53.11	04.5	15.40	18.28	70.12	1230	100–0	2.0
55.03	06.5	06.17	18.00	72.20	0052	45–0	1.2
55.04	06.5	08.35	18.00	72.04	0090	80–0	2.0

Table 2. *Contd.*

1	2	3	4	5	6	7	8
55.05	06.5	10.58	18.00	71.48	0095.5	80–0	3.0
55.06	06.5	12.55	18.01	71.32	0093	80–0	2.5
55.07	06.5	14.55	18.01	71.16	0085.1	75–0	75
55.08	06.5	17.29	18.00	71.01	0089	80–0	1.5
57.01	08.5	10.05	17.30	72.59	0026	20–0	1.0
57.02	08.5	14.48	17.30	72.47	—	35–0	1.5
57.03	08.5	17.13	17.30	72.33	0079	70–0	1.5
57.09	09.5	08.45	17.31	70.57	—	100–0	1.5
57.11	09.5	16.58	17.31	70.27	—	100–0	1.5

11 day stations: 0501, 0507, 0703, 1707, 3507, 4301, 4509, 5108, 5109, 5110 and 5111) at which the zooplankton biomass was high ranging from 10.0 ml and above/vertical haul were established during the different periods of day and night. Even the twelve stations (i. e., 8 night stations: Sta. Nos. 1509, 2905, 3703, 3706, 4305, 5104; 5105, 5107, 5 day stations: 4509, 5108, 5109, 5110 and 5111) at which peak biomass values occurred were established in morning, midday, evening or night. Further, the zooplankton biomass was very poor at 5 stations (1107, 4501, 4904, 5305 and 5706) established during midnight.

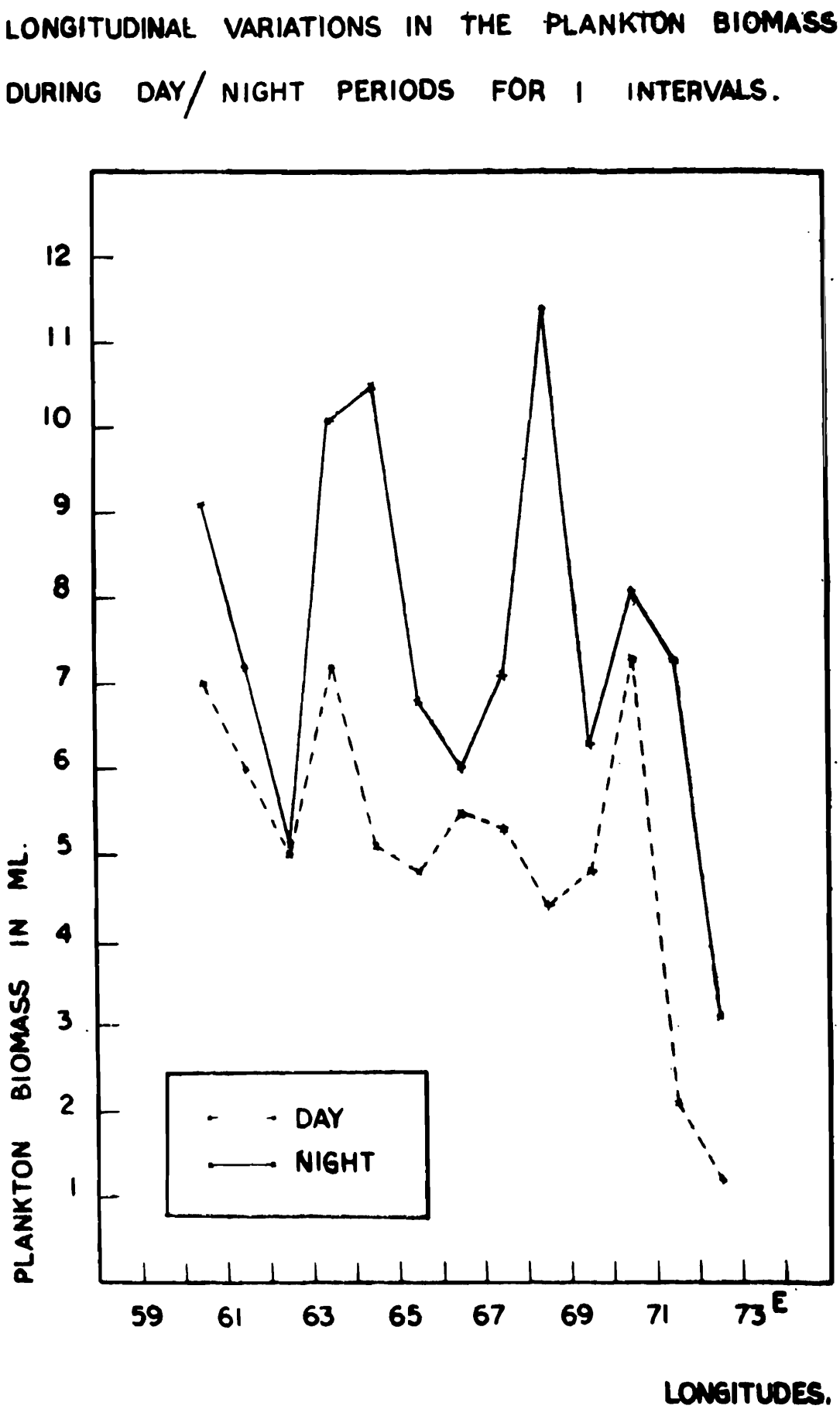
Longitudinal and Latitudinal variations of Plankton Biomass.

Text-figures 4 and 5 show longitudinal and latitudinal variations in the plankton biomass from 100 metres depth/seabed during day/night periods for 1° intervals. From Text-figure 4 it is seen that higher plankton biomass occurred during the night than during the day in all the longitudes. Very high concentrations of plankton occurred during the night between 60°-61° E, 63°-65°E and 68°-69°E longitudes. It was observed that the plankton biomass was comparatively very low during the day between longitudes 71°-73°E. In the zones between longitudes 62°-63°, 66°-67° and 70°-71° E the concentrations of plankton biomass in the night were only slightly denser than during the day.

Text-figure 5 shows that the plankton biomass during the night in all the latitudes is far denser than during the day. It is also seen that there is a peak biomass value of 10.4 ml per vertical haul during the night and 9.3 ml per vertical haul during the day in the latitudinal zone between 18°-19°N which is due to very high displacement volumes at stations 5108, 5109, 5110, 5111 during the day and 5104, 5105 and 5107 during the night on 4th and 5th January 1974. Similarly, the high value of 10.1 ml and/vertical haul during night between latitudes 19° and 20°N is due to the high biomass values of 13.1 ml/ vertical haul obtained at the night stations 4906 and 4907 on 24th January 1974.

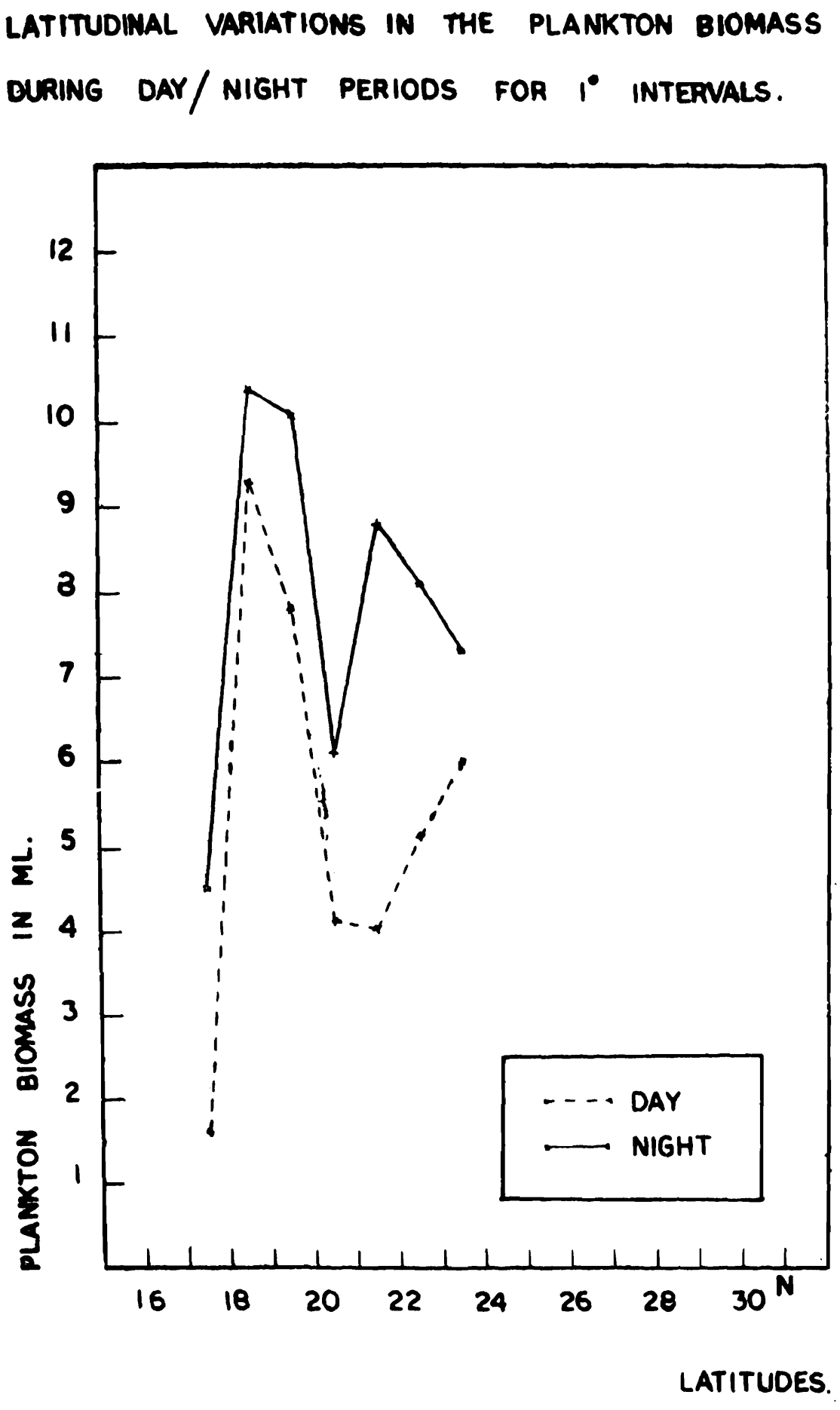
Constituents of plankton at 16 *night and* 11 *day stations with an increase in total biomass.*

Out of the 96 night and 98 day plankton stations established, it was found that at 16 night and 11 day stations, swarming of species of siphonophores, medusae, ostracods, copepods, mysids, amphipods and salps were responsible for increased total biomass value. (Data are presented in Table 3.) A perusal of Table 3 shows that the copepoda constituted mainly by species of the genera *Eucalanus*, *Rhincalanus*, *Acrocalanus* and *Clausocalanus* formed the dominant group at 11 night stations (0505, 0901, 1509, 2307, 2905, 3703, 3708, 4906, 5104, 5105, 5107) and 6 day stations (0501, 0507, 1707, 5109, 5110, 5111). In these 17 stations, the ostracods, *Cypridina dentata* (Muller) also occurred in



Text-fig. 4

high numbers. The increase in total biomass was contributed mainly by the swarming of ostracods *Cypridina dentata* at 5 night stations (0303, 1701, 3706, 4305, 4907) and 3 day stations (0703, 3507, 4301).



Text-fig. 5

At these stations the ostracods outnumbered even the copepods. Swarms of large sized salps (*Pegea confoedrata* (Forskal) *Iasis zonaria* (Pellas) *Metacalfia hexagona* (Quoy & Gaimard) occurred at 5 night stations

(4906, 4907, 5104, 5105, 5107) and 5 day stations (4509, 5108, 5109, 5110, 5111). Swarms of scyphomedusae (*Pelagia noctiluca* Peron & Lesueur), Hydromedusae (*Liriope* sp.), siphonophores [*Diphyes chamunissonis* Huxley *Lensia hotspur* Totton, *Muggiaea atlantica* Cunningham] ostracods (*Cypridina dentata*), euphausids (*Euphausia* spp.) and salps (*Metacalfina hexagona, Iasis zonaria* and *Pegea confoedrata*) occurred at 3 night stations (5104, 5105, 5107) and 4 day stations (5108, 5109, 5110 and 5111). Similarly, swarms of the same species of ostracods, euphausids, and salps and the amphipod *Hyperia* sp, the neritic siphonophore *Lensia subtiloides* Lens & Van Riemsdijk and several species of copepods (*Eucalanus* spp, *Rhincalanus* spp, *Acrocalanus* spp and *Clausocalanus* spp) occurred at stations 4906 and 4907.

At station 4907 three specimens of the siphonophore, *Ceratocymba dentata* Bigelow which is a mid-ocean species usually inhabiting the depths of the ocean, occurred. This indicates that upwelling of cold deep water probably occurred in this region during January 1974.

Remarks

A comparison of the data on zooplankton biomass from 100 metres depth in the oceanic stations and from seabed in the inshore stations obtained during this study with those of neuston biomass reported earlier by Daniel and Jothinayagam (1977) during the same expedition reveals that (i) neuston and plankton biomass are comparatively very rich at the surface extending upto 100 metres in the oceanic regions and upto the thermocline in the shallower inshore regions (Daniel and Jothinayagam, 1977), (ii) the regions where the lowest neuston biomass value of upto 3.9 ml per five minute haul occurred during the night contained the maximum plankton biomass ranging from 8.0 to 12.0 ml and above and (iii) the areas where the maximal neuston biomass ranging from 8.0 to 12.0 ml and above per five minute haul occurred during the night exhibited moderately rich zooplankton biomass. This is probably due to the reactions of the organisms constituting the neuston and plankton to different intensities of light during the night and day and to other factors such as changes in temperature, salinity, pH, oxygen tension, pressure and water mass movement in the environment which have been suggested as factors influencing the vertical movement and consequently the distribution of plankters (Raymont 1963, Banse 1964 and Daniel and Premkumar 1965). The occurrence of peak biomass values at stations established during the different periods of day and night during this study support the view that different organisms react differently to different intensities of illumination. Further, the biomass values being very poor at 5 midnight stations also support the view that certain planktonic organisms sink during midnight below 100 metres depth (Kikuchi, 1930; Banse, 1964; Daniel and Premkumar, 1965).

Table—3. Showing the total displacement volumes (ml) with the numbers of each zoological constituents occurring in each haul at 16 night and 11 day stations

S. No.	Station No.		Total volume	Siphono-phores	Medusae	Polychaets	Ostracods	Copepods	Amphipods	Euphausid	Lucifer	Mysids	Shrimps	Decapod larvae	Mollusca	Chaetognaths	Salpa	Others
1.	03.03	N	11	186	25	15	9600	2500	45	35	20	80	20	15	20	50	20	20
2.	05.01	D	10	150	18	8	5650	8600	60	80	30	75	15	5	12	85	30	15
3.	05.05	N	13	180	16	12	8650	5500	25	170	25	40	5	10	35	30	10	30
4.	05.07	D	11	135	30	—	2500	4600	30	350	30	45	—	5	10	55	35	15
5.	07.03	D	10	240	15	10	6050	4500	40	200	10	60	15	16	25	45	25	20
6.	09.01	N	11	160	35	20	1500	5700	70	300	10	80	20	10	15	60	20	25
7.	15.09	N	18	815	40	15	1600	7600	25	450	60	75	40	20	36	45	10	18
8.	17.01	N	11.5	230	20	10	6500	1800	30	250	10	35	20	15	48	30	—	30
9.	17.07	D	10	95	36	20	2500	3600	45	160	50	40	24	18	40	55	30	26
10.	23.07	N	11.8	120	50	16	1200	3000	75	200	25	60	15	10	28	36	25	10
11.	29.05	N	14.5	200	70	12	1250	6700	50	250	26	57	18	27	55	40	30	15
12.	35.07	D	12	250	35	10	7500	1700	95	160	46	50	27	15	20	35	15	20
13.	37.03	N	25	750	120	20	2700	3800	20	600	50	35	20	28	40	25	30	15
14.	37.06	N	15	560	80	16	5800	1300	65	560	55	20	35	30	20	35	10	25
15.	37.08	N	10	230	25	10	2500	4800	40	200	45	60	20	15	10	40	15	20

Table 3. *Contd.*

S. No.	Station No.		Total volume	Siphono-phores	Medusae	Polychaets	Ostracods	Copepods	Amphipods	Euphausids	Lucifer	Mysids	Shrimps	Decapod larvae	Mollusca	Chaetognaths	Salps	Others
16.	43.01	D	10	215	36	12	7600	1500	20	150	25	40	10	20	36	45	20	15
17.	43.05	N	16	850	85	10	8600	2500	150	360	20	55	10	8	20	40	80	10
18.	45.09	D	20	760	75	15	4700	1800	110	800	15	60	25	20	45	30	150	20
19.	49.06	N	13	815	40	8	1250	3050	96	560	20	50	40	15	60	40	120	15
20.	49.07	N	13	910	35	16	1500	3000	120	450	50	80	30	10	70	55	108	10
21.	51.04	N	33	1270	98	10	4700	6800	75	1200	30	60	20	36	33	40	150	25
22.	51.05	N	35	1460	148	20	1850	6500	30	950	45	70	40	30	80	60	220	16
23.	51.07	N	25	1480	120	25	1960	8500	80	1200	40	60	20	25	80	50	180	20
24.	51.08	D	16.5	1125	180	30	1600	560	75	700	80	50	36	15	120	45	150	18
25.	51.09	D	20	1540	140	20	1250	8500	90	880	75	85	60	30	70	30	200	15
26.	51.10	D	19.5	1230	128	24	1800	7000	45	560	35	90	35	20	95	48	350	10
27.	51.11	D	21.5	1850	110	30	1600	3500	80	1500	60	75	40	35	66	55	250	15

N — Night Station

D — Day Station

The results obtained on zooplankton biomass from 200 metres depth in the northern Arabian sea based on the material collected during the International Indian Ocean Expedition (Prasad, 1969) generally agree with the distribution of zooplankton biomass from 100-0 metres depth obtained during this study. Further, the results of Paulinose and Aravindkshan (1977) on the zooplankton collections from 200 metres during the same Expedition wherein the highest intensity of zooplankton was from the region in between 20°-23°N latitude and 66°-70°E longitude, link up well with the distribution of biomass from 100-0 metres and from near seabed to surface obtained during the present study.

The occurrence of areas of very rich zooplankton in the oceanic regions of the central part of the Arabian sea in the 100-0 metres depth zone observed during this study is mainly due to the siphonophores, medusae and copepods. Similarly, the rich zooplankton biomass off Ras-Al-Hadd is contributed by the swarming of ostracods and copepods. The ostracods outnumbered even the copepods at eight stations, a remarkable feature unique for the northern Arabian sea. This unique feature has also been reported earlier by Daniel and Jothinayagam (1977) while studying the neuston and by Paulinose and Aravindakshan (1977) while studying the zooplankton collection from 200-0 metres depth during the same Expedition. Further, it is of interest to note that upwelling of deep cold water occurred at station 4907 during January 1974 replenishing this region by the nutrient rich deeper waters which probably contribute to the high intensity of zooplankton biomass between 70°-71°E longitudes.

SUMMARY

During the oceanographic expedition on the I. N. S. DARSHAK in the Northern Arabian Sea from December 1973 to May 1974 studies were made on the biomass of zooplankton and variations in abundance of major constituents from 100-0 metres in the oceanic regions at 100 stations and from near seabed to surface at 94 shallow nearshore stations following a close grid system. These studies revealed that (i) the zooplankton biomass was far more abundant during the night than during the day (ii) the regions where the maximum plankton biomass occurred contained the lowest neuston biomass (iii) the regions where moderately rich zooplankton occurred contained the maximal neuston biomass (iv) peak biomass values occurred at some stations established during different parts of day and night and poor zooplankton biomass occurred at some midnight stations for which explanations are given (v) the longitudinal and latitudinal variations of biomass and zooconstituents of plankton at stations with an increased total biomass and possible

upwelling of cold deepwater due to the occurrence of a siphonophore are discussed.

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