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ZOOPLANKTON STUDY AT THE MOBILE OTEC SITE IN THE NORTHERN GULF OF MEXICO

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INTRODUCTION

Certain oceanographic data are required to meet the needs of OTEC design engineers and environmental assessment groups. This report brings together the results from a year of zooplankton sampling, which was designed to provide data on the zooplankton community within the water column at OTEC site 29°N 88°W (Mobile) in the northern Gulf of Mexico.

Five cruises were made to the Mobile OTEC site aboard the R/V Virginia Key. Cruise dates were:

17-20 November 1977
27 February - 2 March 1978
9-17 June 1978
15-24 August 1978
21 October - 3 November 1978

METHODS

A metered 0.75m diameter, 202 mesh, closing plankton net and a Niskin double-trip mechanism was used to make each tow. This system allowed samples to be taken at pre-determined depths without contamination from net deployment or retrieval. The depth of each tow was determined by methods of triangulation using the angle and length of the ship's wire during the tow. Volume of water filtered by the net during each tow was calculated from digital flow meter counts.

Zooplankton samples were collected either with the net being towed from a ship which was underway or vertical hauls were made from a drifting ship. Power for vertical hauls was provided by the ship's winch. Vertical hauls often became oblique hauls depending upon weather and current conditions that often caused the ship to drift during the actual sampling time.

In the laboratory, samples were split with a Folsom Plankton Sample Splitter. A countable split contained approximately 200 to 600 copepods. Under a dissecting microscope, the zooplankton was separated into taxonomic groups. Copepods were identified, if possible, to species and all other plankters to either class or family. All individuals in the final split were counted, measured and preserved for future reference. The portion of each sample that was not included in the analysis was returned to its proper container and retained for future analysis.

ZOOPLANKTON ABUNDANCE

Table 1 shows that the zooplankton densities ranged from a high of $4017.2m^{-3}$ in the June 1978 surface water to a low of $1.9m^{-3}$ in the 1000m

Table 1

Zooplankton Abundance
(numbers m^{-3})

Sample	Date	Time (EST)	Depth (tow type)	Copepods	Other Invertebrates	Fish	Totals
1	17 Nov 77	2100	1000m (H)	1.5	0.4	-	1.9
2	18 Nov 77	0524	80m (H)	116.8	41.6	-	158.4
3	18 Nov 77	2050	20m (H)	422.4	204.0	1.6	628.0
4	19 Nov 77	0800	20m (H)	328.7	138.6	1.0	468.3
5	19 Nov 77	0935	100m (H)	71.7	34.9	0.6	107.2
7	19 Nov 77	1130	1000m-0m (O)	24.2	12.1	-	36.3
8	19 Nov 77	1540	1000m-0m (O)	12.0	6.9	-	18.9
9	27 Feb 78	1324	1000m-0m (O)	281.9	196.3	-	478.2
10	27 Feb 78	1500	1000m-900m (O)	9.6	5.1	-	14.7
12	1 Mar 78	0030	80m-0m (O)	924.3	514.0	2.0	1440.3
13	2 Mar 78	0130	200m-0m (O)	523.7	334.1	1.5	857.8
15	2 Mar 78	0930	200m-0m (O)	1025.6	483.4	1.6	1510.6
18	14 Jun 78	2320	25m (H)	2474.3	1537.5	5.4	4017.2
19	15 Jun 78	1040	1000m-800m (O)	9.2	2.7	-	11.9
20	15 Jun 78	1215	800m-200m (O)	85.0	17.5	0.2	102.7

Table 1 (continued)

Sample	Date	Time (EST)	Depth (tow type)	Copepods	Other Invertebrates	Fish	Totals
21	15 Jun 78	1300	200m-0m (0)	1255.6	629.9	5.3	1890.8
22	15 Jun 78	1345	25m (H)	824.1	225.5	-	1049.6
24	22 Aug 78	0215	25m (H)	567.3	1594.8*	-	1962.1
25	22 Aug 78	1100	1000m-800m (H)	5.5	2.2	-	7.7
26	22 Aug 78	1215	800m-200m (0)	52.5	10.1	0.2	62.8
27	22 Aug 78	1315	200m-0m (0)	388.1	294.3	2.9	685.3
28	22 Aug 78	1330	25m (H)	327.9	808.2**	2.4	1138.5
30	31 Oct 78	2140	25m (H)	793.0	542.2	3.3	1338.5
31	31 Oct 78	1000	800m-200m (0)	46.0	12.6	0.3	58.9
32	31 Oct 78	1130	200m-0m (0)	232.8	180.1***	1.1	414.0
33	31 Oct 78	1150	25m (H)	654.4	724.6****	1.7	1380.7

(H) Horizontal Tow

(0) Oblique Haul

* large dinoflagellate bloom (81% pyrocystis)

** large dinoflagellate bloom (69% pyrocystis)

*** large dinoflagellate bloom (39% pyrocystis)

**** (68% Pyrocystis and Echinoderm larvae)

November sample. Surface catches (0-25m) yielded the greatest zooplankton densities throughout the sampling period ($4017.2m^{-3}$ to $468m^{-3}$) and the lowest densities were recorded from the deeper mesopelagic populations ($11.6m^{-3}$ to $1.9m^{-3}$).

Vertical Distribution

Within the data there is evidence that a surface to 1000m zooplankton density gradient was present throughout the sampling period. Figure 1 shows an order of magnitude difference in zooplankton abundance between surface waters and the 200m - 800m depth, while another order of magnitude difference occur between the 200m - 800m and the 800m - 1000m strata.

Diurnal Migrations

Determining the variations among zooplankton population densities at a location over time is somewhat confused because of the changes in zooplankton patchiness caused by vertical diurnal migrations of individuals and by horizontal currents. No attempts were made to insure sampling within the same horizontally moving water mass. The assumption must be made that during each cruise, the occupation time at each station was sufficiently short enough so that all cruise samples were taken from a similarly characterized water column.

The phenomenon of vertical diurnal migration among species of the zooplankton community is evidenced in Figure 1. Zooplankton densities in night surface waters far exceed those found in day surface samples and they also exceed zooplankton densities of day samples from deeper water strata.

Data from day and night surface (20m - 25m) net tows taken during the November 1977, June 1978, August 1978 and October 1978 cruises demonstrate, through copepod taxonomic analysis, the extent of diurnal zooplankton migration (Table 2). Oncaea, Clausocalanus, Lucicutia and Temora in the aforementioned surface (25m) sample sets show a marked increase in the evening, while other genera (e.g.: Calocalanus) occur in greater densities during the day than the evening. The data presented in this report is inconclusive concerning vertical diel movement among the zooplankton at this OTEC site. This contractor has a special project in progress which should produce more conclusive data on vertical diurnal migrations at the Mobile site.

SEASONAL VARIATIONS

Conclusions about seasonal variations among the Mobile OTEC zooplankton using data presented in this report should be made with a certain amount of caution. The bimonthly sampling included no sample replications, therefore, some of the apparent variations among samples may be due to sampling error

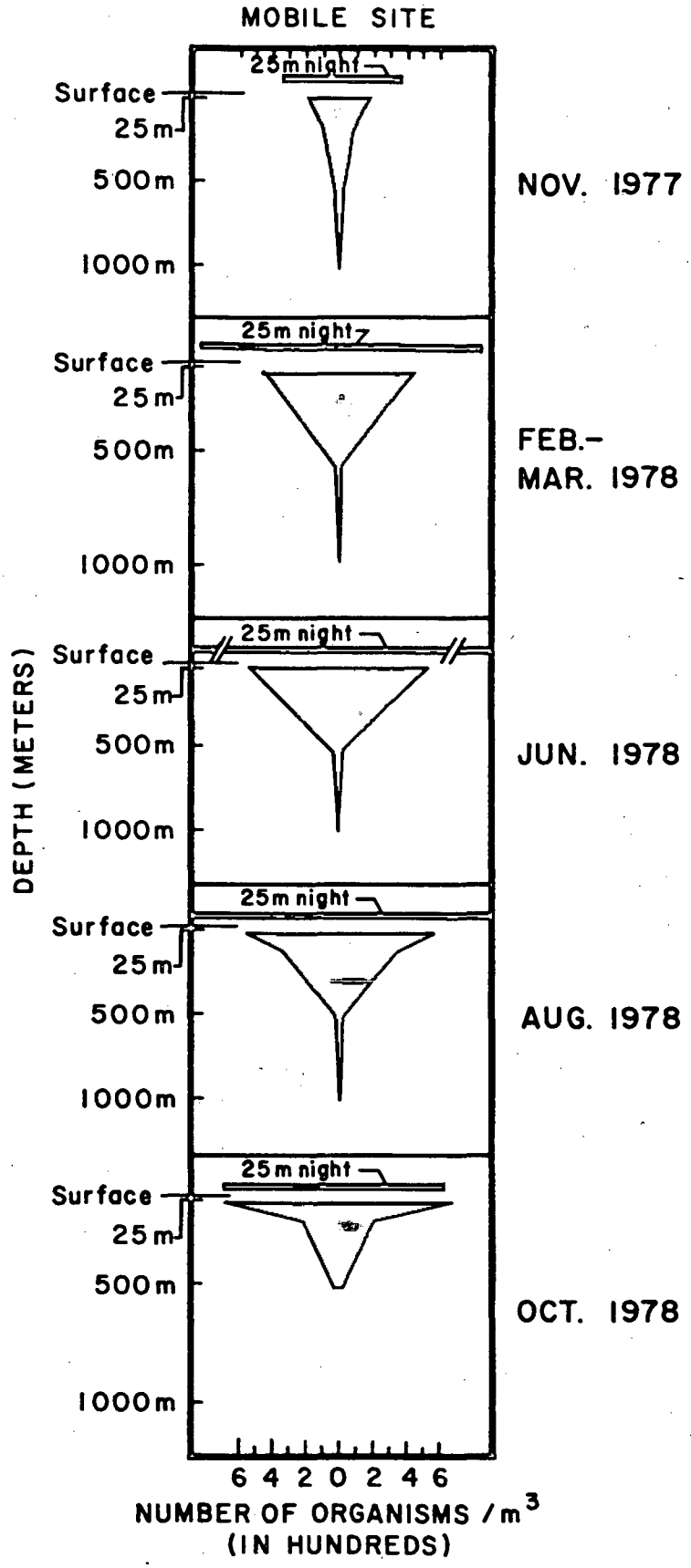


Fig. 1. Zooplankton Vertical Distribution

Table 2

Ranked Dominant Copepod Genera

Sample	Genera	Individuals m^{-3}	Percent of Copepod Population	Total Genera in Sample
Sample #1	Oncaea	0.46	30.7	25
17 Nov	Conaea	0.15	10.0	
1000m (H)	Rhincalanus	0.08	5.3	
2100	Oithona	0.04	2.7	
	Monacilla	0.04	2.7	
	Temora	0.04	2.7	
	Valdiviella	0.03	2.0	
	Lucicutia	0.03	2.0	
	Mormonilla	0.03	2.0	
Sample #2	Oithona	19.4	16.6	24
18 Nov	Oncaea	11.3	9.7	
80m (H)	Clausocalanus	8.8	7.5	
0524	Paracalanus	6.4	5.5	
	Farranula	5.7	4.9	
	Lucicutia	4.2	3.6	
	Corycaeus	3.9	3.4	
Sample #3	Oncaea	99.5	23.6	22
18 Nov	Paracalanus	76.6	18.1	
20m (H)	Oithona	65.2	15.4	
2050	Clausocalanus	54.6	12.9	
	Euchaeta	17.9	4.2	
Sample #4	Clausacalanus	63.1	19.2	21
19 Nov	Paracalanus	54.5	16.6	
20m (H)	Oncaea	40.1	12.2	
0800	Oithona	36.3	11.0	
	Calocalanus	22.9	7.0	
	Euchaeta	16.2	4.9	
	Temora	15.3	4.6	
	Farranula	15.3	4.6	
Sample #5	Oncaea	17.8	24.7	21
19 Nov	Oithona	15.1	21.0	
100m (H)	Lucicutia	4.1	5.7	
0935	Haloptilus	3.7	5.1	
	Pleuromamma	2.6	3.7	
	Euchaeta	1.8	2.5	

Table 2 (continued)

Sample	Genera	Individuals m^{-3}	Percent of Copepod Population	Total Genera in Sample
Sample #7	Oncaea	5.1	21.1	27
19 Nov	Oithona	2.9	12.0	
1000m-0m	Paracalanus	2.0	8.3	
(0)	Clausocalanus	1.6	6.6	
1130	Calocalanus	1.1	4.5	
	Farranula	0.7	2.9	
	Pleuromamma	0.6	2.5	
Sample #8	Oncaea	3.1	25.8	33
19 Nov	Clausocalanus	1.0	8.3	
1000m-0m	Paracalanus	0.7	5.8	
(0)	Oithona	0.6	5.0	
1540	Pleuromamma	0.5	4.1	
	Farranula	0.5	4.1	
	Eucalanus	0.5	4.1	
	Lucicutia	0.4	3.3	
Sample #9	Paracalanus	47.9	16.9	24
27 Feb	Eucalanus	42.2	15.0	
1000m-0m	Oithona	32.0	11.4	
(0)	Oncaea	22.8	8.1	
1324	Clausocalanus	19.1	6.8	
	Mecynocera	9.1	3.2	
	Conaea	5.7	2.0	
	Lucicutia	4.6	1.6	
Sample #10	Oncaea	1.8	18.8	26
27 Feb	Pleuromamma	1.4	14.6	
1000m-900m	Eucalanus	1.2	12.5	
(1)	Calocalanus	1.0	10.4	
1500	Conaea	0.6	6.3	
	Lucicutia	0.6	6.3	
	Oithona	0.4	4.2	
Sample #12	Eucalanus	173.3	18.7	27
1 Mar	Oithona	153.4	16.6	
80m-0m	Clausocalanus	137.5	14.9	
(0)	Oncaea	91.7	9.9	
0300	Paracalanus	79.7	8.6	
Sample #13	Oithona	99.2	18.9	27
2 Mar	Oncaea	77.3	14.8	
200m-0m	Eucalanus	45.2	8.6	
(0)	Paracalanus	43.8	8.4	
0130	Clausocalanus	33.6	6.4	
	Lucicutia	23.3	4.4	

Table 2 (continued)

Sample	Genera	Individuals m^{-3}	Percent of Copepod Population	Total Genera in Sample
Sample #15	Eucalanus	217.8	21.2	26
2 Mar	Oncaea	157.4	15.3	
200m-0m	Oithona	151.1	14.7	
(0)	Paracalanus	119.3	11.6	
0930	Clausocalanus	77.9	7.6	
	Lucicutia	71.6	7.0	
Sample #18	Oncaea	686.9	27.8	19
14 Jun	Oithona	359.8	14.6	
25m (H)	Corycaeus	354.4	14.3	
2320	Temora	245.3	9.9	
	Paracalanus	174.5	7.6	
	Clausocalanus	141.8	5.7	
Sample #19	Conaea	2.4	26.2	19
15 Jun	Oithona	1.4	15.3	
1000m-800m	Oncaea	0.96	10.5	
(0)	Eucalanus	0.96	10.5	
1040	Mormonilla	0.5	5.4	
Sample #20	Oithona	34.5	40.5	23
15 Jun	Eucalanus	8.7	10.3	
800m-200m	Conaea	6.0	7.2	
(0)	Oncaea	4.5	5.3	
1215	Mormonilla	4.4	5.2	
Sample #21	Oithona	300.0	23.9	25
15 Jun	Oncaea	283.9	22.6	
200m-0m	Temora	117.9	9.4	
(0)	Corycaeus	88.4	7.0	
1300	Paracalanus	88.4	7.0	
	Clausocalanus	64.3	5.1	
Sample #22	Oncaea	336.2	40.8	15
15 Jun	Oithona	164.0	19.9	
25m (H)	Temora	73.8	9.0	
1345	Corycaeus	69.7	8.5	
	Calocalanus	61.5	7.5	
Sample #24	Oncaea	143.8	25.7	26
22 Aug	Oithona	104.4	18.4	
25m (H)	Clausocalanus	40.9	7.2	
0215	Corycaeus	28.8	5.0	
	Mecynocera	25.7	4.5	
	Calocalanus	24.2	4.3	
	Lucicutia	21.2	3.7	
	Macrostella	21.2	3.7	

Table 2 (continued)

Sample	Genera	Individuals m^{-3}	Percent of Cropped Population	Total Genera in Sample
Sample #25	Conaea	1.1	19.4	23
22 Aug	Oncaea	0.8	15.6	
1000m-800m	Oithona	0.5	9.5	
(0)	Eucalanus	0.5	9.5	
1100	Mormonilla	0.4	7.7	
Sample #26	Oithona	13.4	25.9	23
22 Aug	Conaea	6.4	12.4	
800m-200m	Mormonilla	6.2	12.0	
(0)	Eucalanus	4.4	9.0	
1215	Oncaea	4.0	7.6	
Sample #27	Oithona	98.3	25.4	19
22 Aug	Oncaea	77.8	20.1	
200m-0m	Clausocalanus	30.8	8.0	
(0)	Farranula	30.8	7.9	
1315	Calocalanus	27.9	7.2	
Sample #28	Oithona	158.7	48.4	12
22 Aug	Calocalanus	70.0	21.4	
25m (H)	Corycaeus	29.2	8.9	
1330	Paracalanus	14.0	4.3	
	Macrostella	7.0	2.1	
	Oncaea	7.0	2.1	
Sample #30	Clausocalanus	260.7	33.3	32
31 Oct.	Oncaea	160.1	20.4	
25m (H)	Farranula	108.9	13.9	
2140	Temora	52.8	6.8	
	Calocalanus	44.6	5.7	
	Lucicutia	23.1	2.9	
Sample #31	Oncaea	11.9	26.7	33
31 Oct	Conaea	4.6	10.4	
800m-200m	Eucalanus	4.4	9.8	
(0)	Corycaeus	2.5	5.9	
1000	Clausocalanus	2.4	5.4	
	Oithona	1.7	3.9	
Sample #32	Oithona	41.9	17.9	28
31 Oct	Oncaea	35.5	15.2	
200m-0m	Clausocalanus	26.4	11.3	
(0)	Farranula	12.6	5.4	
1130	Corycaeus	12.0	5.1	
	Lucicutia	11.5	4.9	
	Calocalanus	10.3	4.4	

Table 2 (continued)

Sample	Genera	Individuals m^{-3}	Percent of Copepod Population	Total Genera in Sample
Sample #33	Clausocalanus	208.0	31.8	17
31 Oct	Oncaea	114.2	17.4	
25m (H)	Farranula	66.5	10.2	
1150	Calocalanus	39.2	6.0	
	Oithona	37.5	5.7	
	Paracalanus	30.7	4.7	
	Corycaeus	29.0	4.4	

(H) Horizontal Tow
(O) Oblique Haul

or patchiness rather than seasonal trends. Relationships between zooplankton density fluctuations and changes in temperature, salinity and currents cannot be made in this report. These physical data were measured by other OTEC contractors and included in separate reports.

A classical seasonal pattern often observed in tropical zooplankton communities, of a summer maximum and a winter depletion is seen in Figure 2, with the maximum coming in June and the lowest values occurring in November. This seasonal trend is mostly observed in night 25m samples and to a lesser degree among the data from other depths. Data from day 25m samples is sketchy because of missing data points.

During June and August (Table 2) it appears that fewer copopod genera compose a greater proportion of the total copepod population than occurred in other months. This same relationship may as well occur in other major invertebrate and fish groups, but generic identifications among these groups were not consistantly made, therefore, such relationships are not shown in these data.

TAXONOMIC COMPOSITION

Copepods are the prominent group of invertebrates in marine zooplankton. In this series of collections copepod numerical importance in the zooplankton ranged from a high of 83% in the 200m - 800m August sample to lows of 28.7% and 28.8% in August surface samples. A dinoflagellate bloom was occurring at the time that August surface samples were collected which counted for the low copepod percentage values. If the unusually high dinoflagellate densities are eliminated from samples 24, 28 and 33, the low copepod percentages of 28.7, 28.8 and 46.3 are raised to 67.9, 67.8 and 78.2, respectively (Table 1). These revised copepod percentages are more comparable to values in other samples of this series.

Greatest copepod densities occurred in surface waters (0m - 25m) but they composed a larger percentage of the total zooplankton in 200m - 800m depths (Table 1). In the 800m - 1000m water, copepods again were less abundant than at the surface or the 200m - 800m depths but constituted a large portion of total zooplankton.

Cyclopoids were represented in the list of dominant copepod genera by Oncaea, Oithona, Corycaeus, Farranula and Conaea (Table 2). Cyclopoids were the dominant group of copepods with Oncaea being the most abundant copepod genus in the study. Oncaea, Oithona and Corycaeus were present throughout the entire water column. Farranula was found in water above 200m with Conaea replacing it in the water below 200m.

Fourteen genera of calanoid copepods are listed among the numerically dominant genera (Table 2). Clausocalanus, Paracalanus, Lucicutia and Calocalanus are genera which occur in abundance in collections above 200m.

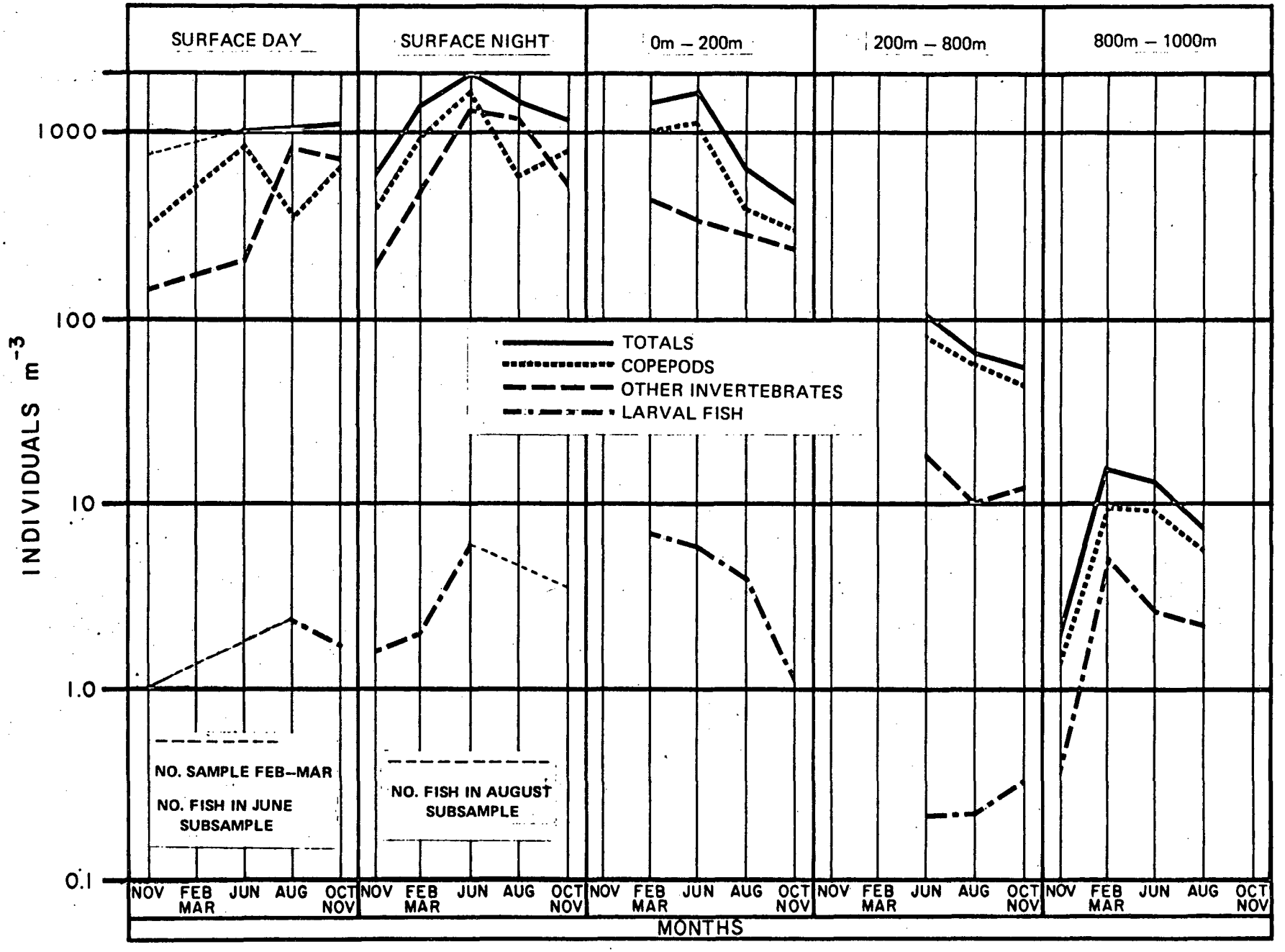


Fig. 2. Zooplankton Seasonal Variability

From samples taken below 200m, Eucalanus, Pleuromamma, Rhincalanus and Mormonilla become prevalent.

Macrostella was the only abundant harpacticoid copepod genus. Table 2 shows Macrostella abundant only in 25m August samples. It is possible that the collecting net may not effectively sample the Macrostella population. Since it is a slender copepod Macrostella could have escaped through the mesh of the 202 u net during sampling. Other harpacticoid genera (i.e. Microstella) are noticeably absent from the list of dominant genera for possibly the same reasons.

SIZE DISTRIBUTION

At the Mobile OTEC site, size classes two and three contained the majority of individual zooplankters (Figure 3). This occurred because of the dominance of copepods within the samples (Table 1). Among the non-copepod invertebrates there were two major size groups. Size class one (<0.5mm) contained Thecostomata, Foraminifera, Radiolaria and larval groups which were small but occurred in large numbers. The second group contained the largest of the zooplankters (size class 5 through 13) and include euphausiids, decapods, salps and siphonophores.

Zooplankton taken in the water column above 200m have 65% to 90% of their individuals in classes two and three. Zooplankton in water below 200m contains a greater percentage of larger individuals than occurs in the near surface waters. Even the copepods in water below 200m are larger than their surface counterparts, however, their densities are much lower.

The size range of zooplankton included in this study was apparently determined by the sampling efficiency of the net. Sufficient sampling of microplankton (<1mm) and micronekton (<2cm) must involve the use of additional sampling gear and procedures.

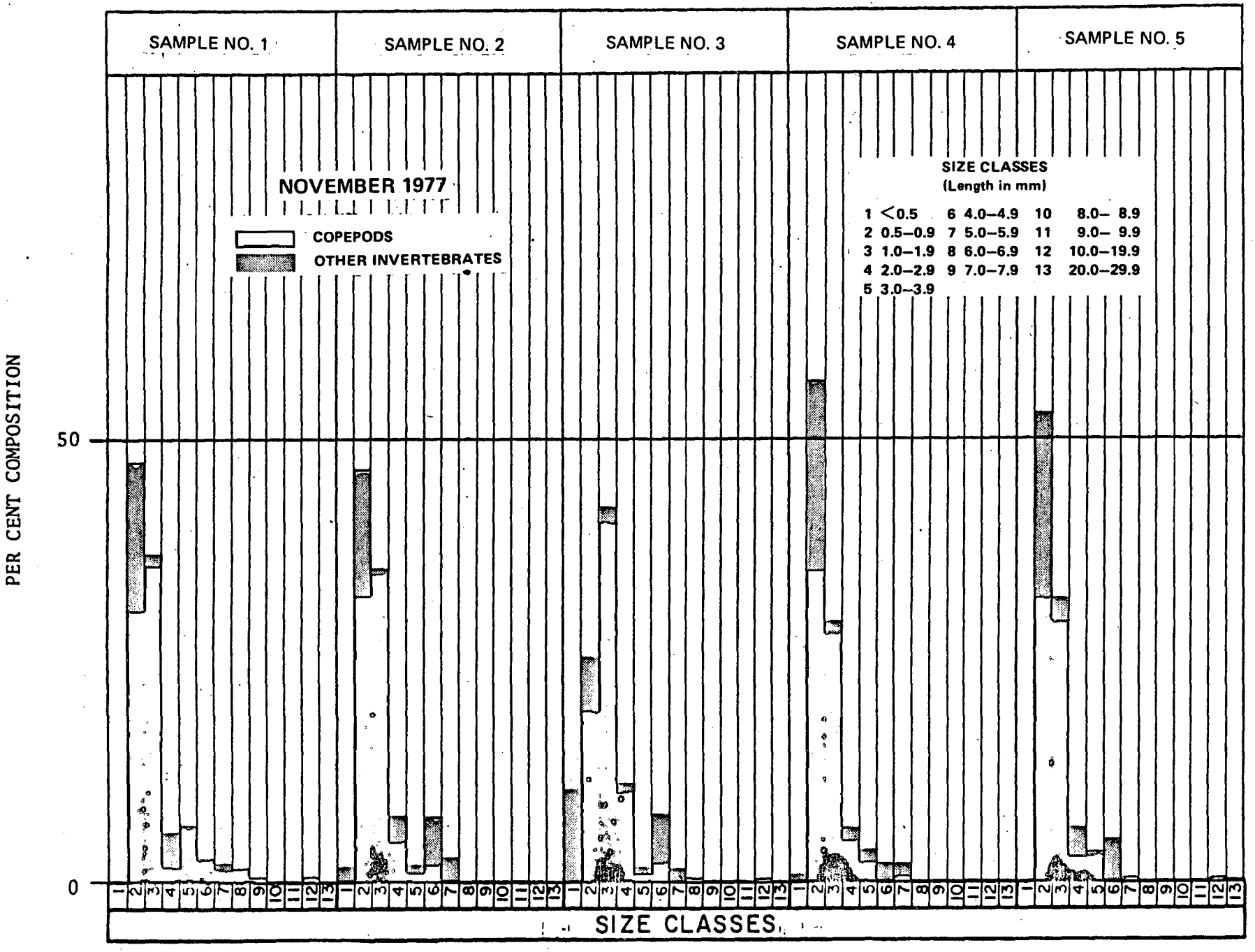


Fig. 3. Zooplankton Size Distribution

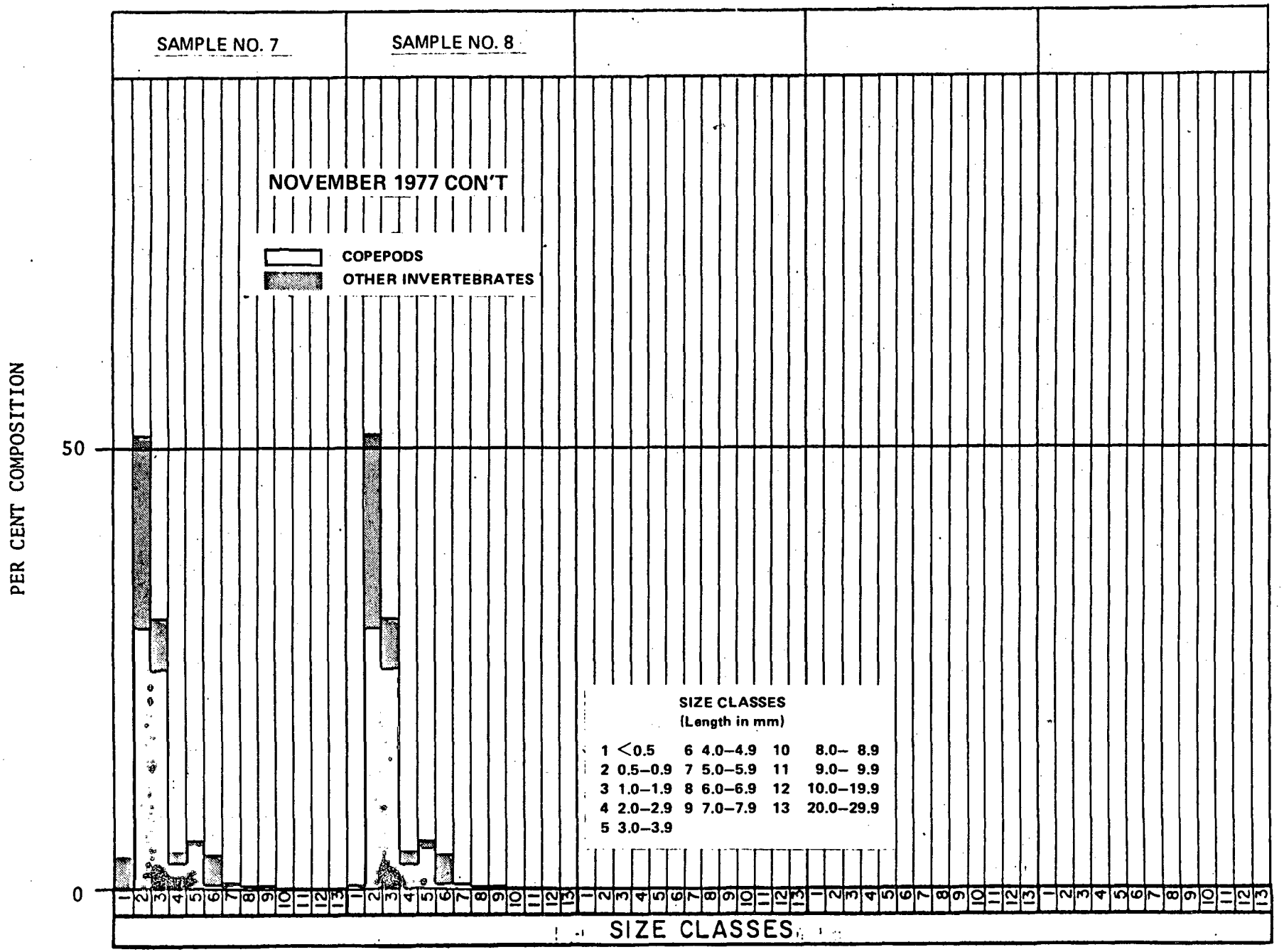
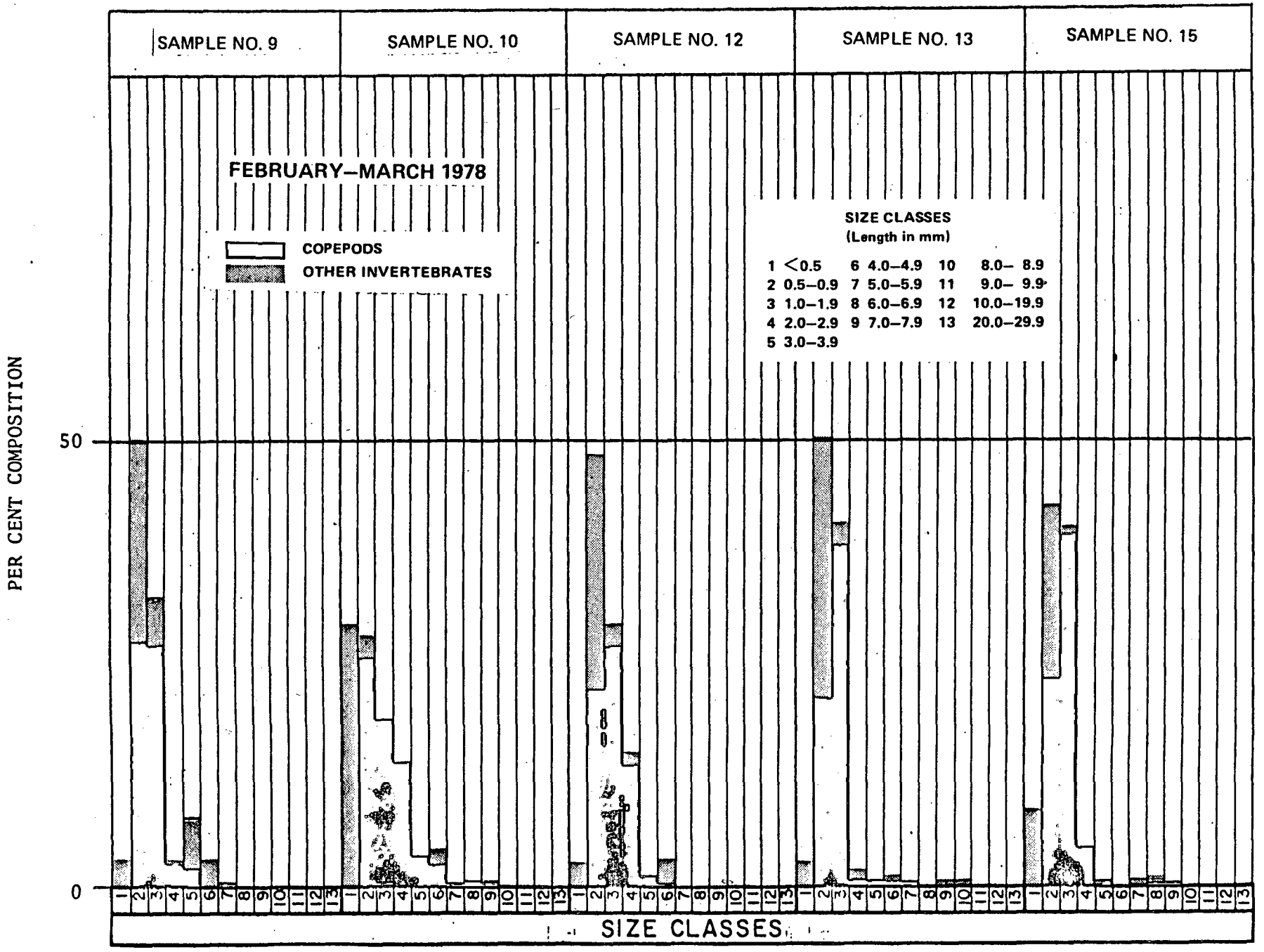


Fig. 3. (continued)



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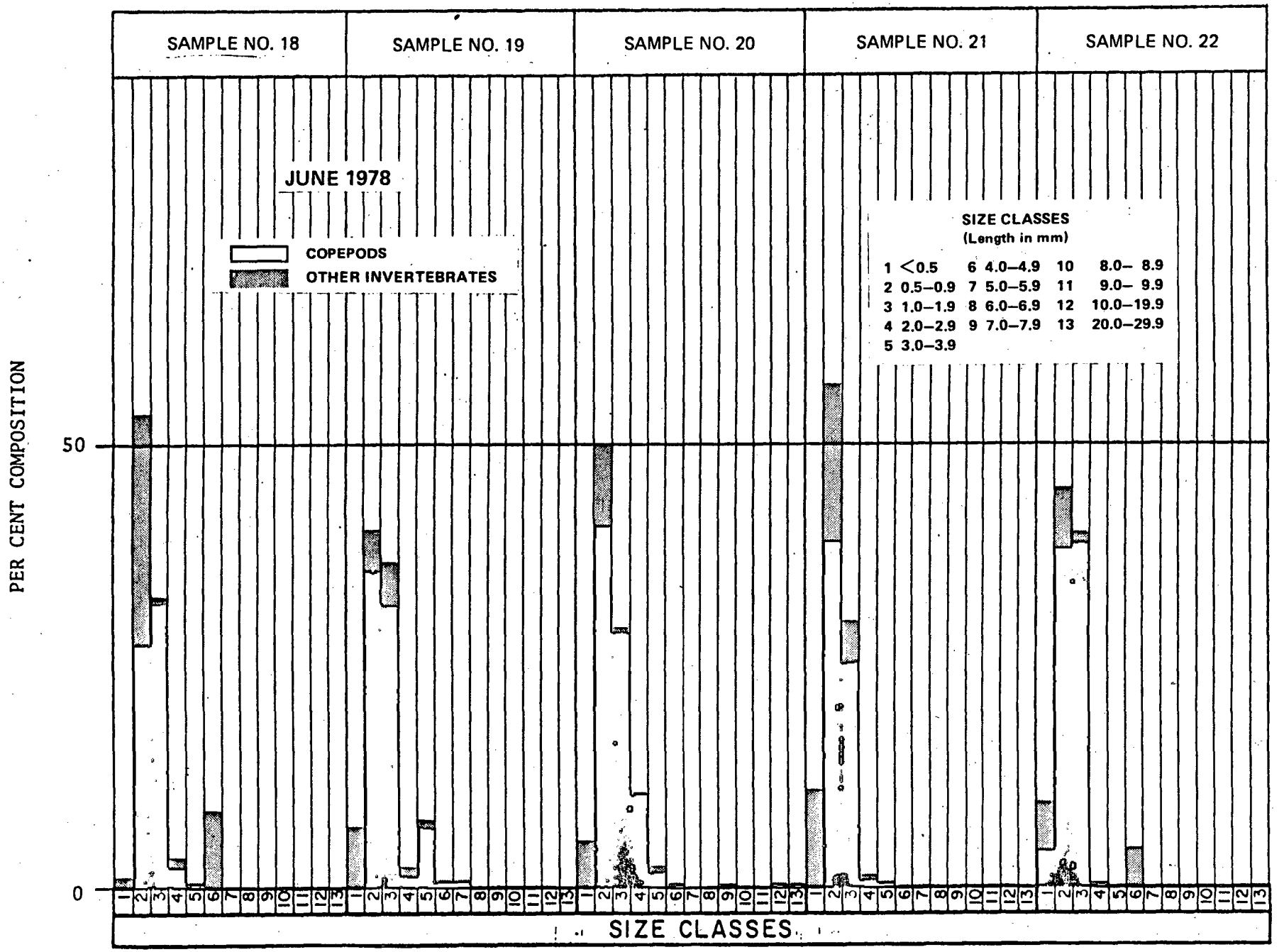

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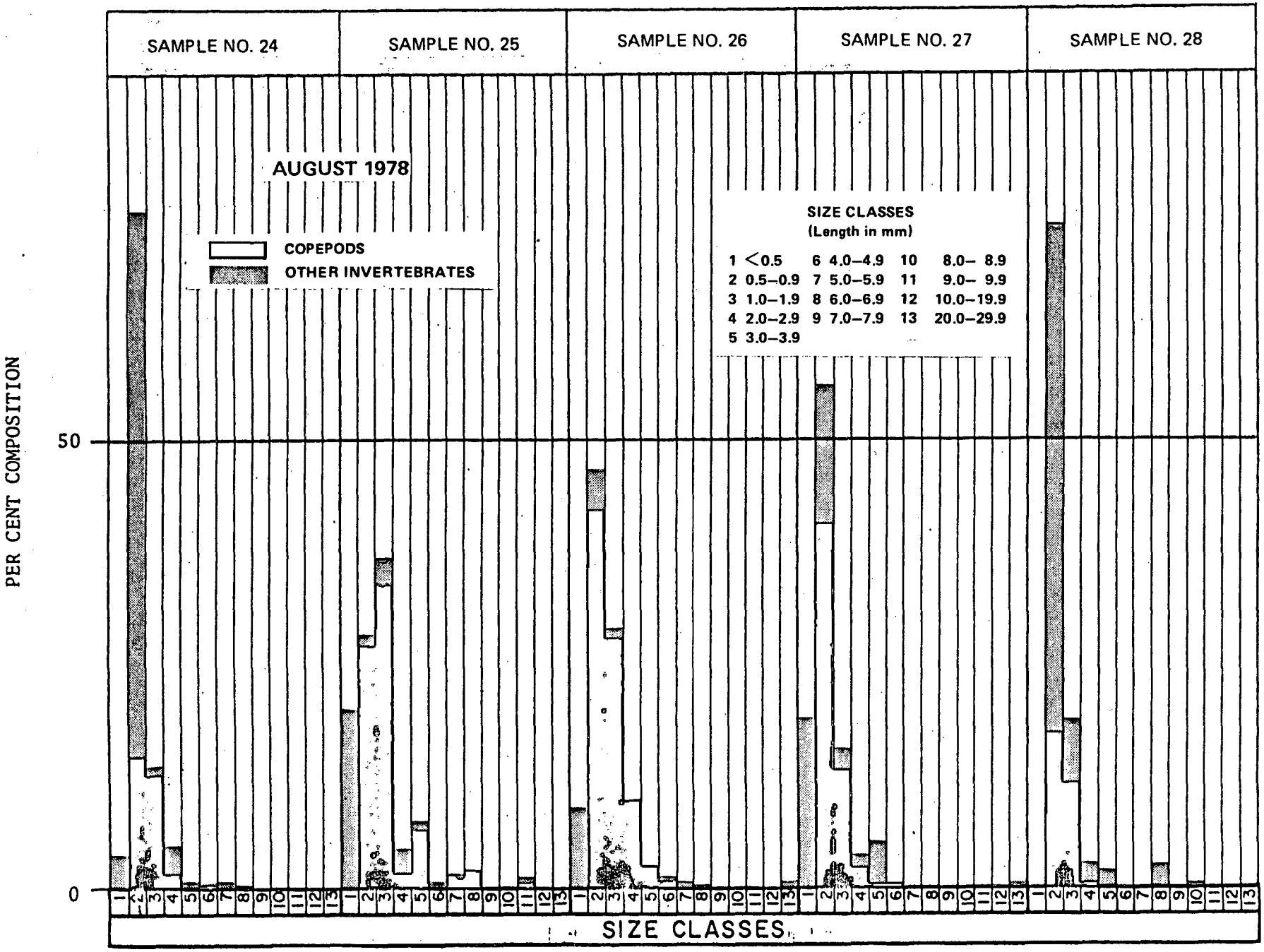

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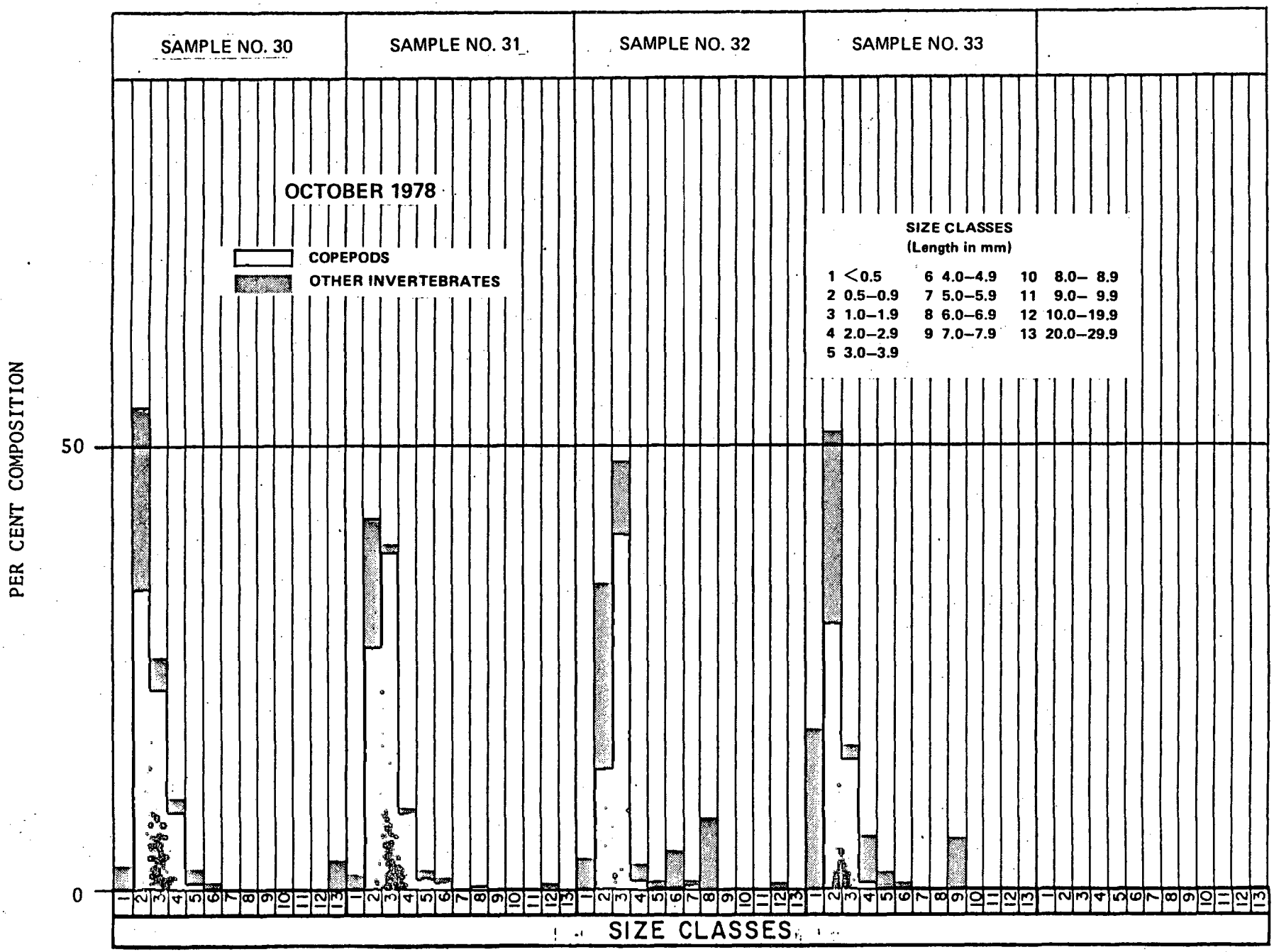


Fig. 3. (continued)

APPENDIX A

Zooplankton Size Distribution
(Numbers m^{-3})

Date Time (EST) Tow Depth (Type)		17 Nov 1977 2100 1000m (H) Sample #1			18 Nov 1977 0524 80m (H) Sample #2			18 Nov 1977 2050 20m (H) Sample #3		
Size Classes	mm	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals
1	< 0.5	-	-	-	-	2.11	2.11	-	64.42	64.42
2	0.5-0.9	0.583	0.322	0.905	51.15	22.91	74.06	119.05	38.4	157.45
3	1.0-1.9	0.684	0.004	0.688	56.06	0.35	56.41	261.72	7.35	269.07
4	2.0-2.9	0.030	0.067	0.097	6.36	5.29	11.65	25.29	43.22	68.51
5	3.0-3.9	0.097	0.004	0.101	1.06	1.06	2.12	2.45	5.71	8.16
6	4.0-4.9	0.004	0.036	0.040	2.11	9.52	11.63	12.23	36.69	48.92
7	5.0-5.9	0.022	0.013	0.035	-	0.35	0.35	-	8.97	8.97
8	6.0-6.9	0.026	-	0.026	-	-	-	1.63	-	1.63
9	7.0-7.9	0.004	-	0.004	-	-	-	-	-	-
10	8.0-8.9	-	-	-	-	-	-	-	-	-
11	9.0-9.9	-	-	-	-	-	-	-	-	-
12	10.0-19.9	0.004	-	0.004	-	-	-	-	0.82	0.82
13	20.0-29.9	-	-	-	-	-	-	-	-	-

APPENDIX A (continued)

19 Nov 1977 0800 20m (H) Sample #4			19 Nov 1977 0935 100m (H) Sample #5			19 Nov 1977 1130 1000m-0m (0) Sample #7			19 Nov 1977 1540 1000m-0m (0) Sample #8		
Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals
-	2.9	2.9	-	-	-	-	-	-	-	0.6	0.6
164.3	103.2	267.5	34.2	23.4	57.6	13.7	7.3	21.0	5.6	4.2	9.8
133.8	3.8	137.6	31.4	2.9	34.3	8.4	1.3	9.7	4.7	1.1	5.8
21.0	6.7	27.7	3.0	3.3	6.3	0.9	0.9	1.8	0.5	0.3	0.8
8.6	6.7	15.3	3.0	0.4	3.4	0.2	0.4	0.6	0.9	0.1	1.0
-	8.6	8.6	-	4.9	4.9	0.9	1.9	2.8	0.1	0.6	0.7
1.0	7.6	8.6	-	0.4	0.4	-	0.3	0.3	0.03	0.1	0.13
-	-	-	-	-	-	0.1	-	0.1	0.03	-	0.03
-	-	-	-	-	-	-	-	-	0.03	-	0.03
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	0.2	0.2	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX A (continued)

27 Feb 1978 1324 1000m-0m (0) Sample #9			27 Feb 1979 1500 1000m-900m (0) Sample #10			1 Mar 1978 0030 80m-0m (0) Sample #12			2 Mar 1979 0130 200m-0m (0) Sample #13		
Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals
-	13.7	13.7	-	4.32	4.32	-	31.9	31.9	-	20.4	20.4
132.1	109.6	241.7	3.79	0.35	4.14	316.8	390.5	707.3	179.4	255.3	434.7
130.1	26.3	156.4	2.75	-	2.75	394.4	35.9	430.3	334.0	18.3	352.3
10.3	3.4	13.7	2.07	-	2.07	199.2	19.9	219.1	2.9	7.3	10.2
9.1	28.5	37.6	0.47	-	0.47	10.0	2.0	12.0	2.9	-	2.9
-	13.7	13.7	0.34	0.30	0.64	4.0	35.9	39.9	1.5	19.0	20.5
-	1.0	1.0	0.04	-	0.4	-	-	-	2.9	-	2.9
-	-	-	0.09	-	0.09	-	-	-	-	-	-
-	-	-	-	0.09	0.09	-	-	-	-	11.7	11.7
-	-	-	-	-	-	-	-	-	-	1.5	1.5
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-

APPENDIX A (continued)

2 Mar 1978 0930 200m-0m (0) Sample #15			14 June 1978 2320 25m (H) Sample #18			15 June 1978 1040 1000m-800m (0) Sample #19			15 June 1978 1215 800m-200m (0) Sample #20		
Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals
-	130.4	130.4	-	27.2	27.2	-	0.8	0.8	-	5.2	5.2
353.0	298.9	651.9	1106.4	1052.5	2158.9	4.23	0.54	4.77	42.2	9.0	51.2
605.8	12.7	618.5	1297.3	10.8	1308.1	3.71	0.59	4.3	30.1	0.2	30.3
65.2	-	65.2	70.6	54.4	125.0	0.12	0.1	0.22	11.3	0.2	11.5
-	11.1	11.1	-	10.9	10.9	0.83	0.07	0.9	1.4	0.8	2.2
-	-	-	-	365.5	365.5	0.03	0.03	0.06	-	0.2	0.2
-	14.3	14.3	-	-	-	0.1	0.5	0.6	-	-	-
1.6	15.9	17.5	-	-	-	0.1	-	0.1	-	-	-
-	1.6	1.6	-	-	-	0.03	-	0.03	-	0.2	0.2
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	1.5	1.5
-	-	-	-	-	-	-	-	-	-	0.2	0.2

APPENDIX A (continued)

15 Jun 1978 1300 200m-0m (0) Sample #21			15 Jun 1978 1345 25m (H) Sample #22			22 Aug 1978 0215 25m (H) Sample #24			22 Aug 1978 1100 1000m-800m (0) Sample #25		
Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals
-	211.8	211.8	4.1	94.3	98.4	-	68.1	68.1	-	1.5	1.5
753.2	338.0	1091.2	405.9	69.7	475.6	290.6	1216.3	1496.3	2.05	0.14	2.19
489.4	77.5	566.9	414.1	12.3	426.4	246.2	15.1	261.3	2.61	0.24	2.85
10.4	7.9	18.3	-	4.1	4.1	22.5	68.1	90.6	0.1	0.2	0.3
2.6	-	2.6	-	-	-	6.0	4.5	10.5	0.50	0.06	0.56
-	-	-	-	45.1	45.1	-	19.7	19.7	-	0.02	0.02
-	-	-	-	-	-	-	12.1	12.1	0.06	0.02	0.08
-	-	-	-	-	-	-	1.5	1.5	0.12	-	0.12
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	0.02	-	0.02
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-

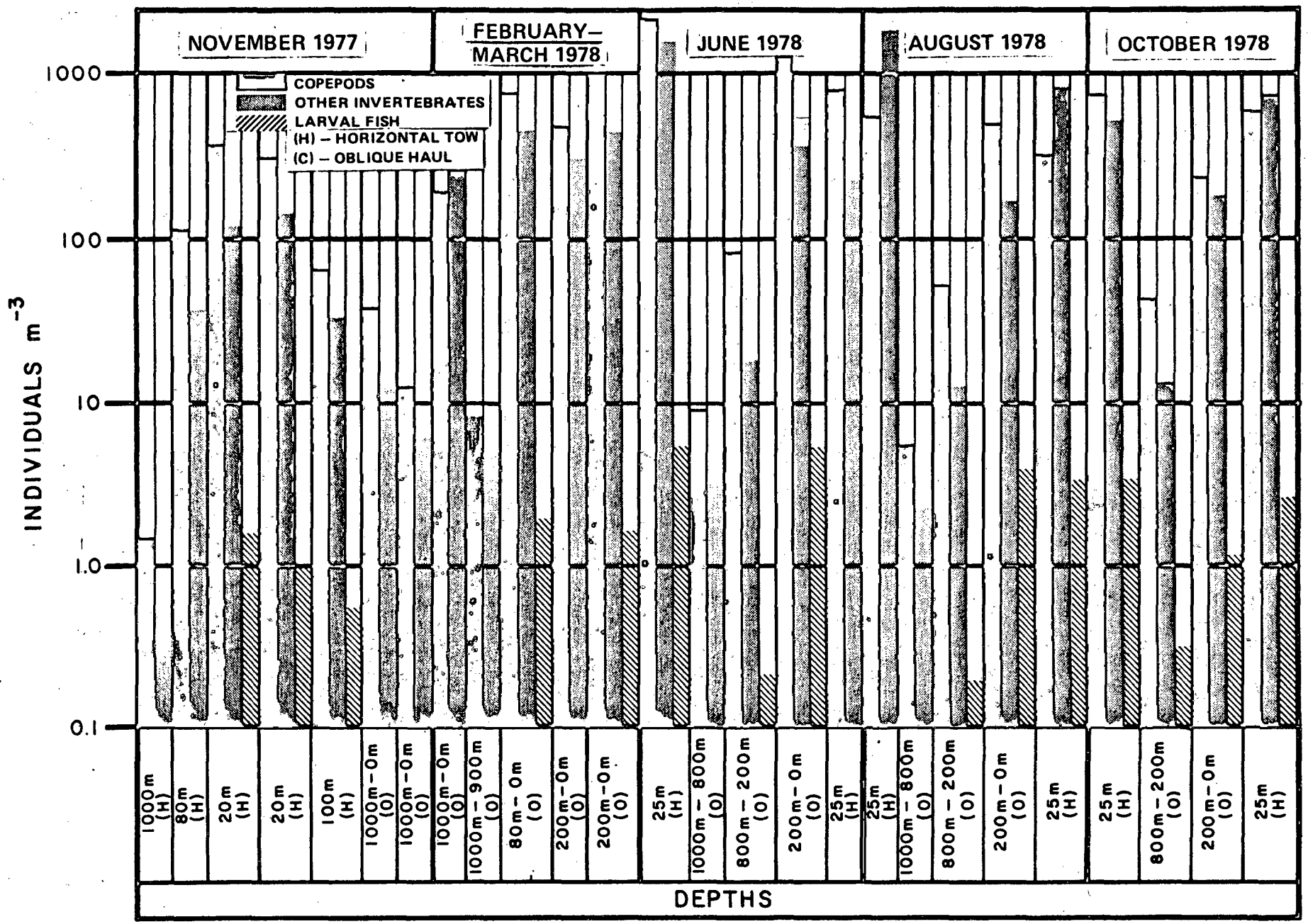
APPENDIX A (continued)

22 Aug 1978 1215 800m-200m (0) Sample #26			22 Aug 1978 1315 200m-0m (0) Sample #27			22 Aug 1978 1330 25m (H) Sample #28			31 Oct 1978 2140 25m (H) Sample #30		
Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals
-	5.5	5.5	-	128.0	128.0	-	-	-	-	28.5	28.5
27.0	2.8	29.8	279.3	113.2	392.5	197.2	665.4	862.6	463.0	276.1	739.1
17.8	0.4	18.2	91.2	13.3	104.5	129.5	81.6	211.1	311.3	45.2	356.5
6.1	-	6.1	13.2	8.8	22.0	1.2	25.7	26.9	11.8	128.8	140.6
1.2	-	1.2	1.5	32.4	33.9	-	19.8	19.8	8.5	15.0	23.5
0.4	0.2	0.6	2.9	-	2.9	-	-	-	-	8.4	8.4
-	0.2	0.2	-	-	-	-	-	-	-	-	-
-	1.0	1.0	-	-	-	-	25.7	25.7	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	1.2	1.2	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	1.5	1.5	-	-	-	-	43.5	43.5
-	0.2	0.2	-	-	-	-	-	-	-	-	-

APPENDIX A (continued)

31 Oct 1978 1000 800m-200m (0) Sample #31			31 Oct 1978 1130 200m-0m (0) Sample #32			31 Oct 1978 1150 25m (H) Sample #33		
Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals	Copepod	Non-Copepod	Totals
-	0.8	0.8	-	13.2	13.2	-	248.9	248.9
16.3	8.8	25.1	57.6	88.0	145.6	443.1	288.2	731.3
22.9	0.4	23.3	168.8	33.8	202.6	204.5	17.0	221.5
5.3	0.1	5.4	4.1	6.2	10.3	6.8	69.9	76.7
0.7	0.3	1.0	0.6	2.3	2.9	-	23.9	23.9
0.2	0.3	0.5	0.6	1.2	1.8	-	3.4	3.4
-	-	-	1.1	1.7	2.8	-	-	-
0.6	-	0.6	-	33.7	33.7	-	-	-
-	-	-	-	-	-	-	75.0	75.0
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	2.2	2.2	-	1.1	1.1	-	-	-
-	-	-	-	-	-	-	-	-

APPENDIX B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FEBRUARY–MARCH 1978
JUNE 1978
AUGUST 1978
OCTOBER 1978
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OTHER INVERTEBRATES
LARVAL FISH
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(C) – OBLIQUE HAUL
INDIVIDUALS m-3
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100
10
1.0
0.1
1000m (H)
80m (H)
20m (H)
20m (H)
100m (H)
1000m–0m (O)
1000m–0m (O)
1000m–0m (O)
1000m–900m (O)
80m–0m (O)
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200m–0m (O)
25m (H)
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25m (H)
DEPTHS

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