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ZOOPLANKTON STUDY AT THE FLORIDA WEST COAST OTEC SITE

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September 1979

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ZOOPLANKTON STUDY AT THE FLORIDA WEST COAST OTEC SITE

Submitted to

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INTRODUCTION

This is the final report on zooplankton collected at the Tampa OTEC site in the Gulf of Mexico from June 1978 to June 1979. Presented here are analyses of the December 1978 and February, April and June 1979 samples, the June - October 1978 cruise material having been treated in our semiannual report (Hopkins et al., 1979). Averages for selected zooplankton characteristics, with the addition of biomass, for the entire 1978/79 sampling period are also presented.

METHODS

Plankton was taken with a 0.75 m diameter, 5-to-1 (length to diameter), 202 μ mesh closing net fitted with flowmeters. Collecting methods have been described in earlier reports. Samples were subdivided for analysis with a Motoda box (Motoda, 1959) and plankton in aliquots was identified, counted, and measured as detailed in the contract. Tow data for all collections subsequent to the October 1978 series are listed in Table 1.

RESULTS & DISCUSSION

Plankton Size

Analyses of samples taken subsequent to October 1978 add little to size distribution patterns established from earlier collections. and additional measuring seems unnecessary. Figures 1a-1d (see also Appendix Tables 1-20) show, typically, that peaks in samples from all depth zones are most frequently in the 0.5 - 1.9 mm range, with a small secondary maximum in the 10.0 - 19.9 mm range. The first peak consists primarily of copepods and the latter secondary one of non-copepod groups such as euphausiids, chaetognaths, and siphonophores. That size array is, of course, biased by the mesh used for collection. For instance, our data from the USF reference

station some 30 miles west of the OTEC site indicates that throughout the upper 1000 m,water-bottle plankton (30 μ gauze) smaller than 1 mm numerically exceeds net plankton (162 μ) by a factor of 10. Thus a large fraction of the population remains unsampled at the OTEC site.

Plankton Abundance

The abundance of major categories of zooplankton is given by cruise in Table 2. Again, the same general trend seen in the data set of the semiannual report is apparent. That is, total plankton and copepods decrease with depth. However, no clear pattern in seasonal and diurnal data emerges, as is emphasized by statistical analysis of copepod counts from all collections that are listed in Table 3. A t-test, for example, indicates no significant difference (t_{05}) in total copepods between day and night hauls. Further, considering copepod numbers over the year for different depth zones, peaks for 25 m night collections were in October and February,whereas maximum numbers for day collections at the same depth were for June and October. The 0-200 m zone produced peaks in June and August 1978, while maxima in the 200-800 m and 800-1000 m zones were in December 1978 and February 1979. Such variability might conceivably result from a difference in the seasonal cycles at those depth zones. It is more likely, however, that most of the variance is a function of micro- and mesoscale patchiness combined with lack of sample replication. Additionally, as Park (1975,1976) demonstrated in his plankton survey of the Texas shelf, seasonality is less pronounced on the outer, deeper stations on the shelf close to the slope than in nearshore environments of the Gulf.

Taxonomic Composition

The principal genera of the best 4 collections are essentially the same as in pre-December 1978 samples (Table 4). In the shallowest catches, 25 m

and 0-200 m, genera exceeding 10% of copepod numbers in one sample or another were the calanoids Clausocalanus, Paracalanus, and Temora, and the cyclopoids Oncaea, Oithona, and Farranula. In the 200-800 and 800-1000 m zones, the important genera were Eucalanus, Oncaea, Conaea and Pleuromamma. As in the pre-December 1978 series, calanoids were usually most abundant, cyclopoids next, and harpacticoids contributed relatively few numbers. Also, the genera predominant here, at least in shallow layers, are those most numerous in Park's collections from Texas outer shelf stations and from the USF east central Gulf reference station (though in terms of biomass at the latter location rather than numbers). Further, the genera prevalent in the deeper zones, Eucalanus and Pleuromamma in particular, are also comparably important at deeper horizons at the reference station (see Table 5). Concerning copepod taxa, the number of types identified in collections from most OTEC cruises tended to decrease with depth (Table 4), the fewest taxa usually occurring in the 800-1000 m samples.

Zooplankton Biomass

Displacement volumes were obtained for all OTEC samples from the Tampa site, and the results are listed in Tables 6 and 7. In general, mean night biomass was greater than for day collections, though the difference was not statistically significant (t_{05}). As at the USF reference station and as others have found elsewhere in temperate-tropical oceanic areas (e.g., see Vinogradov, 1968; Deevey and Brooks, 1971), biomass falls off exponentially with depth. For example, biomass in the 0-200 m zone (0.062 ml/m^3) averaged appromimately an order of magnitude more than in the 800-1000 m layer (0.007 ml/m^3). Our dry weight data from the USF reference station also show a reduction factor of 10 for comparable depth zones (3.40 mg/m^3 vs 0.31 mg/m^3).

OTEC collection mass integrated over the 1000 m water column sampled averages 21.9 ml/m^3. This is quite close to the value Deevey and Brooks (1971) found for the Sargasso Sea off Bermuda (20.2 ml/m^3), a location with warm temperate-subtropical characteristics. The OTEC value times a conversion factor of 0.1 yields an approximate dry weight of 2.19 mg/m^2, whereas biomass at the USF reference station is estimated at 1.2 mg/m^2, or roughly half that at the OTEC site. It is uncertain at present whether this represents true standing crop differences between the two locations or is more a function of variations in assay technique (dry weight vs. displacement volume measurements). Requisite, then, are some comparative data on the primary production of the two locations as well as additional zooplankton biomass analysis.

Annual Means for 1978-79

In Table 7 are mean annual values for various zooplankton parameters. While diurnal and seasonal patterns remain unclear, most of the depth trends based on averaging over the year are valid and similar to the findings of many other studies (e.g., Vinogradov, 1968; Deevey and Brooks, 1971, 1977; Roe, 1974). Predictably, total zooplankton numbers and biomass and copepod numbers decrease exponentially with depth. Also, percentage calculations show that the % of both copepods and calanoids increase with depth. Small copepods, (e.g., *Clausocalanus*, *Oncaea*, *Oithona* and *Farranula*) are the principal taxa in the 0-200 m zone, whereas the cyclopoid *Conaea* and the larger calanoids *Eucalanus*, *Pleuromamma*, and *Rhincalanus* are most prevalent in the 200-800 and 800-1000 m zones. As evidenced by numerical rank changes among top genera (Table 4) from one cruise to the next, catch variability is great. That is apparent as well in the range of the coefficient of variation values (79% to 91%) for copepod numbers which is seen in Table 7.

Again, this variability, while in part the result of sampling and analysis error, mainly stems from micro-mesoscale patchiness.

Trends of plankton populations at the OTEC site could be better substantiated statistically by either more intensive sampling on each cruise through replication or by sampling regularly over a long period (years) using the present strategy. However, if the pelagic food web is to be investigated in a meaningful way, sampling should at least be augmented by water-bottle collections and by discrete depth travels. The bottle will collect the small zooplankton poorly sampled by OTEC 162 μ mesh nets; the midwater trawls will collect macroplankton and micronekton which avoid the smaller OTEC nets. This winter, through shiptime awarded by the State of Florida (Florida Institute of Oceanography), we plan to sample the Tampa OTEC site with an array of gear (bottles, nets, trawls) to more thoroughly assess the pelagic ecosystem in the upper 1000 m. Also, some of the large plankton from these collections (e. g., euphausiids, sergestid and caridean shrimps, larger copepods) will be examined for their gut contents to begin to establish links in the food web of the east central Gulf.

Figures 1-a, b, c, and d. Abundance of plankton in each size class as listed below. Numbers within or above each frequency of the histograms designate the percentage of the copepod fraction. When numbers do not occur, copepods were not present in that size class. Depth zones and sampling times (EST) are given for each sample. Note changes in scale along the Y-axis.

Size Classes

Size Class	Actual Size Range (mm)
1	<0.5
2	0.5 - 0.9
3	1.0 - 1.9
4	2.0 - 2.9
5	3.0 - 3.9
6	4.0 - 4.9
7	5.0 - 5.9
8	6.0 - 6.9
9	7.0 - 7.9
10	8.0 - 8.9
11	9.0 - 9.9
12	10.0 - 10.9
13	20.0 - 29.9
14	30.0 - 39.9
15	40.0 - 49.9
16	>50.0

Figure 1-a.

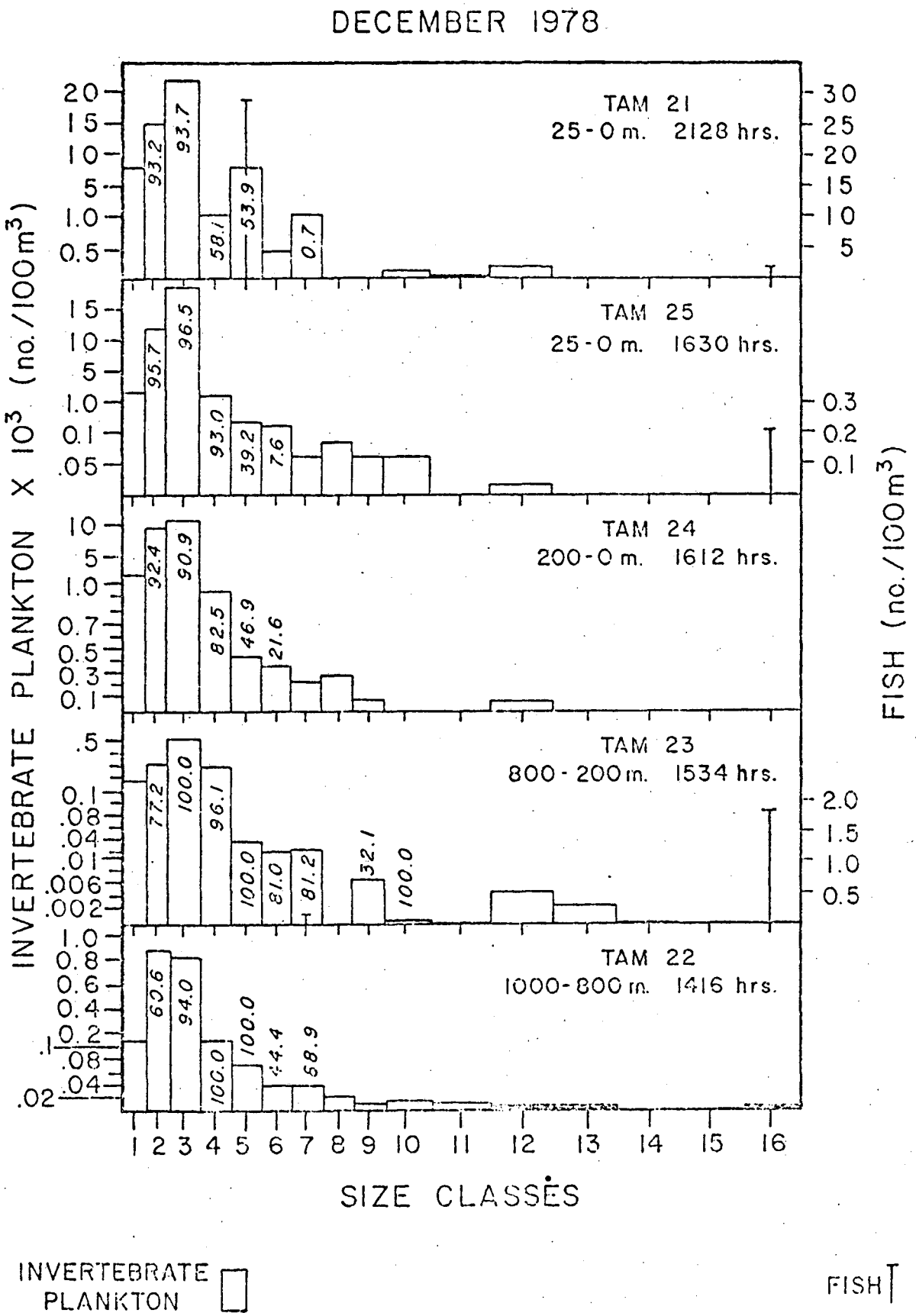

DECEMBER 1978
TAM 21
25-0 m. 2128 hrs.
TAM 25
25-0 m. 1630 hrs.
TAM 24
200-0 m. 1612 hrs.
TAM 23
800-200 m. 1534 hrs.
TAM 22
1000-800 m. 1416 hrs.
INVERTEBRATE PLANKTON X 10³ (no./100m³)
FISH (no./100m³)
SIZE CLASSES
INVERTEBRATE PLANKTON
FISH

Figure 1-b.

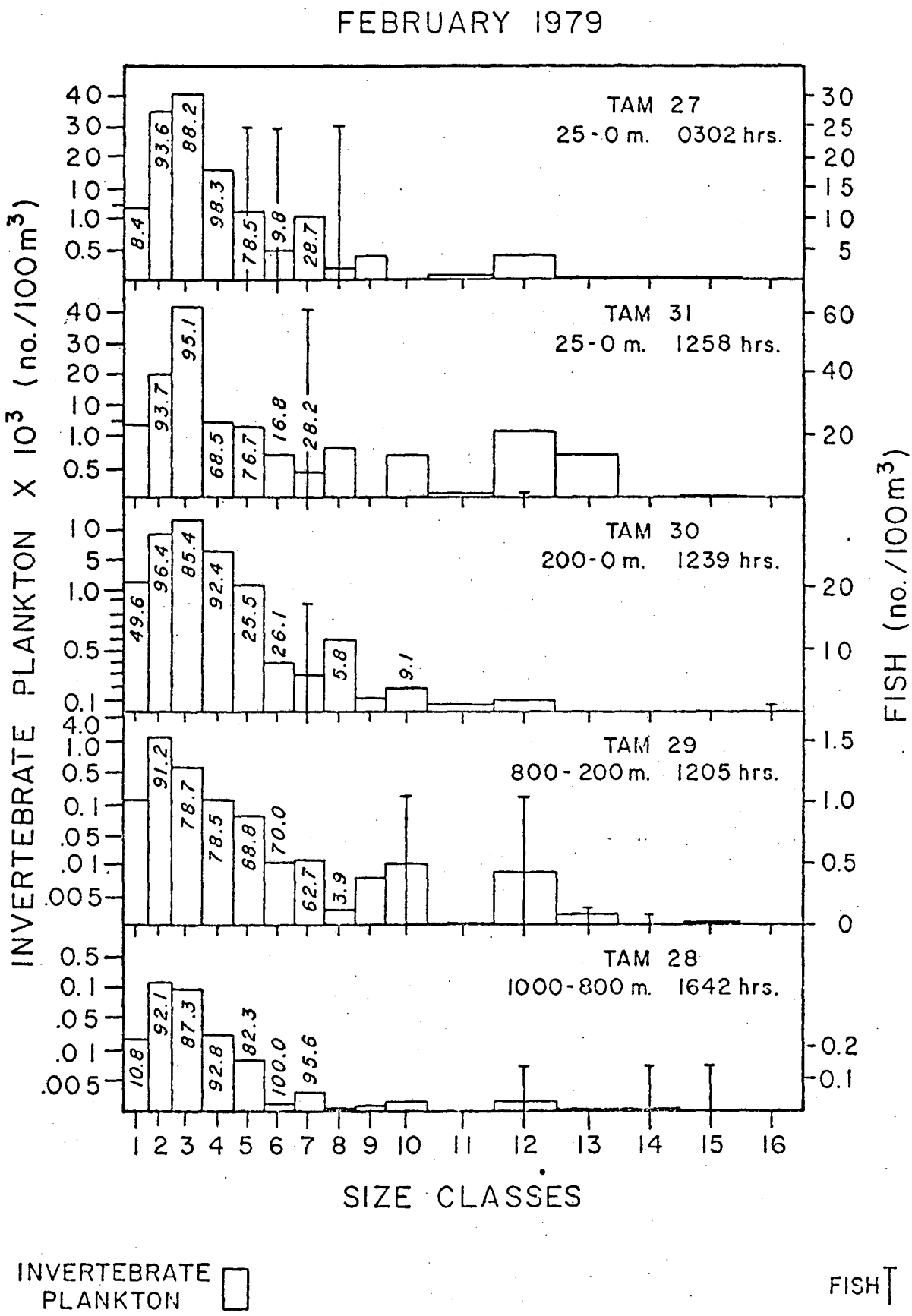
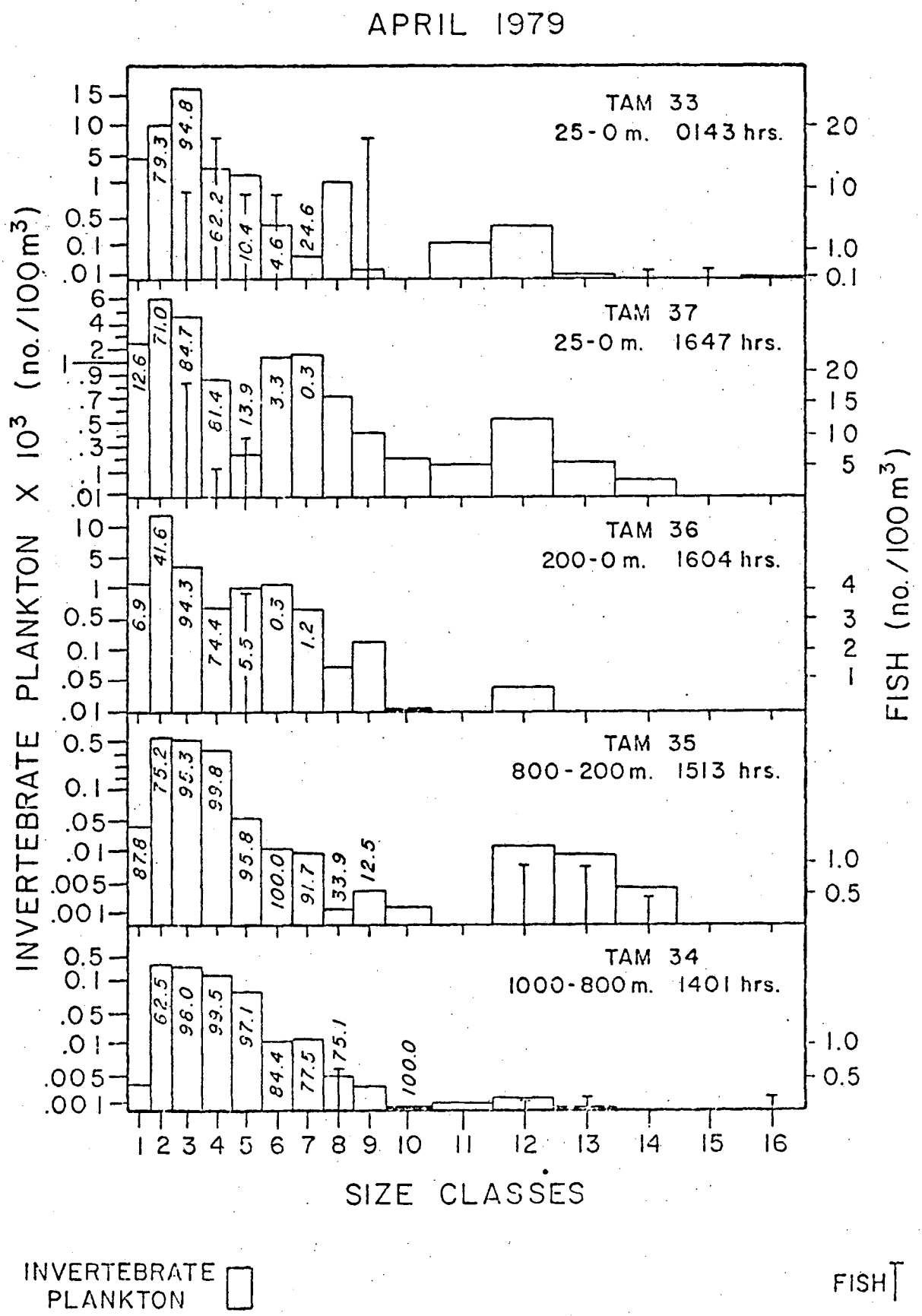

FEBRUARY 1979
TAM 27
25-0 m. 0302 hrs.
TAM 31
25-0 m. 1258 hrs.
TAM 30
200-0 m. 1239 hrs.
TAM 29
800-200 m. 1205 hrs.
TAM 28
1000-800 m. 1642 hrs.
INVERTEBRATE PLANKTON X 10³ (no./100m³)
FISH (no./100m³)
SIZE CLASSES
INVERTEBRATE PLANKTON
FISH

Figure 1-c.


APRIL 1979
TAM 33
25-0 m. 0143 hrs.
TAM 37
25-0 m. 1647 hrs.
TAM 36
200-0 m. 1604 hrs.
TAM 35
800-200 m. 1513 hrs.
TAM 34
1000-800 m. 1401 hrs.
INVERTEBRATE PLANKTON X 10³ (no./100m³)
FISH (no./100m³)
SIZE CLASSES
INVERTEBRATE PLANKTON
FISH

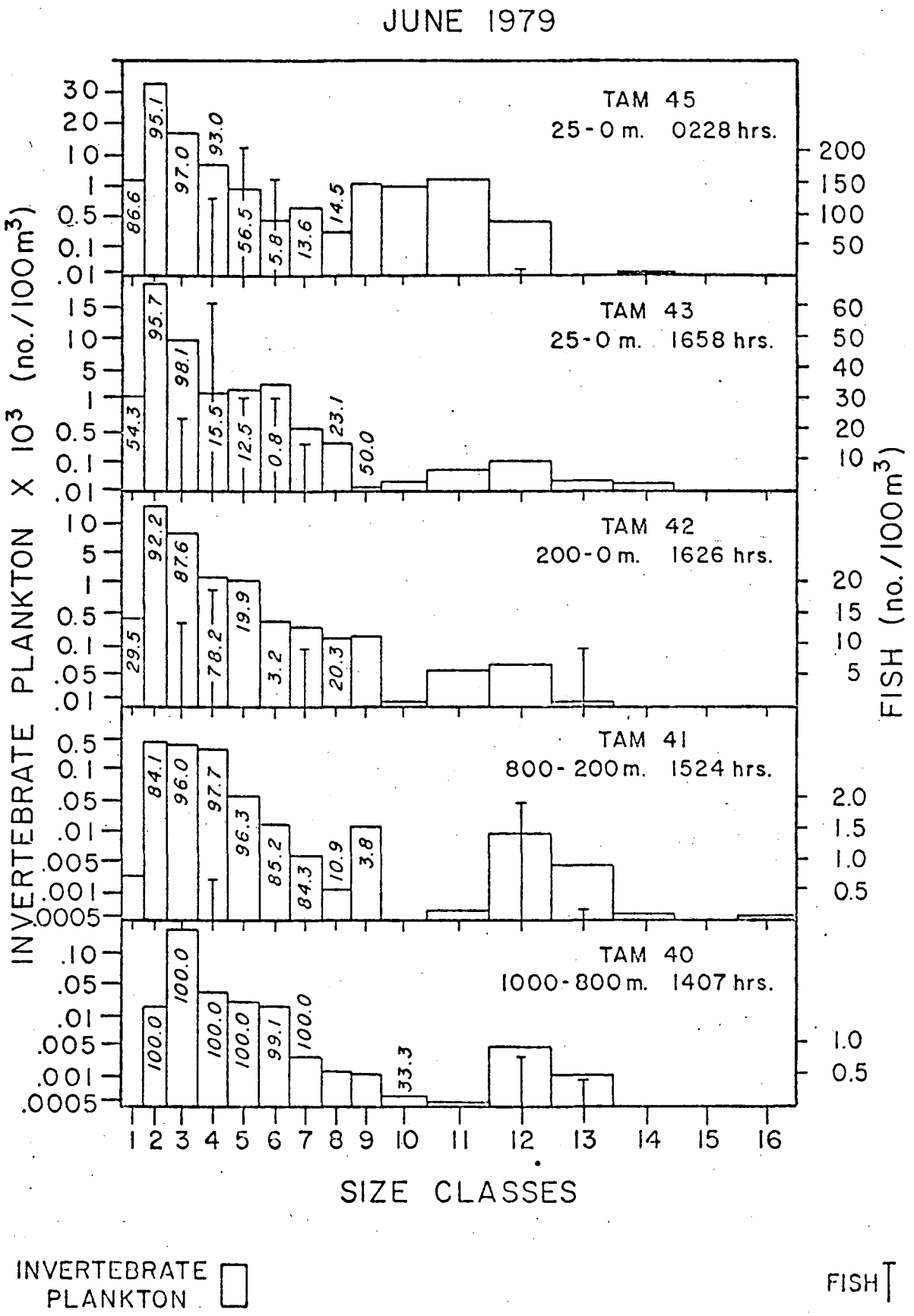

JUNE 1979
TAM 45
25-0 m. 0228 hrs.
TAM 43
25-0 m. 1658 hrs.
TAM 42
200-0 m. 1626 hrs.
TAM 41
800-200 m. 1524 hrs.
TAM 40
1000-800 m. 1407 hrs.
INVERTEBRATE PLANKTON X 10³ (no./100m³)
FISH (no./100m³)
SIZE CLASSES
INVERTEBRATE PLANKTON
FISH

Table 1. Collection data[1] for December 1978 - June 1979 tows at the Tampa OTEC site.

Cruise	Night 25 m	Day 25 m	Day		
			0-200 m	200-800 m	800-1000 m
1978 December	TAM 21 (2128 hrs)	TAM 25 (1630 hrs)	TAM 24 (1612 hrs)	TAM 23 (1534 hrs)	TAM 22 (1416 hrs)
1979 February	TAM 27 (0302 hrs)	TAM 31 1258 hrs)	TAM 30 (1239 hrs)	TAM 29 (1205 hrs)	TAM 28 (1642 hrs)
1979 April	TAM 33 (0143 hrs)	TAM 37 (1647 hrs)	TAM 36 (1604 hrs)	TAM 35 (1513 hrs)	TAM 34 (1401 hrs)
1979 June	TAM 45 (0228 hrs)	TAM 43 (1658 hrs)	TAM 42 (1626 hrs)	TAM 41 (1524 hrs)	TAM 40 (1407 hrs)

[1] 0-1000 m samples TAM 20, 26, 32, and 44 were sent directly to Lawrence Berkeley Laboratory and were not analyzed at USF.

Table 2 Plankton abundance (numbers/100 m^3)

Sample #	Copepods (% of total)	Non-Copepod Crustaceans	Other Invertebrates	Fish	Total Plankton
		December 1978 Cruise			
TAM 21[a]	36795 (74)	1141	11965	30.25	49931
TAM 25[b]	31401 (88)	518	3811	0.21	35729
TAM 23[c]	1121 (83)	68	162	1.79	1352
TAM 24[d]	19411 (80)	705	4075	-----	24191
TAM 22[e]	1585 (72)	273	343	-----	2201
		February 1979 Cruise			
TAM 27[a]	88352 (85)	2761	12594	74.85	103783
TAM 31[b]	64729 (81)	2645	12425	61.37	79860
TAM 29[c]	1918 (81)	269	184	2.69	2376
TAM 30[d]	25583 (81)	1593	4508	18.00	31702
TAM 28[e]	341 (84)	37	28	0.42	407
		April 1979 Cruise			
TAM 33[a]	25869 (67)	3366	9452	66.45	38754
TAM 37[b]	9368 (48)	1846	8298	33.04	19545
TAM 36[c]	9106 (43)	7274	4774	3.88	21157
TAM 35[d]	1458 (87)	82	138	2.20	1680
TAM 34[e]	925 (85)	16	142	1.13	1084
		June 1979 Cruise			
TAM 45[a]	56815 (87)	6087	2652	512.66	65553
TAM 43[b]	29188 (78)	2723	5553	164.53	37463
TAM 42[c]	21064 (80)	1108	4000	50.01	26171
TAM 41[d]	1289 (90)	30	117	2.89	1436
TAM 40[e]	262 (96)	3	7	1.20	272

a 25-0 m night
b 25-0 m day
c 200-0 m day
d 800-200 m day
e 1000-800 m day

Table 3. Copepod numerical abundance (individuals/100 m^3) in all 1978-79 OTEC collections.

Cruise	Night 25 m	Day 25 m	Day		
			0-200 m	200-800 m	800-1000 m
1978 June	38370	80302	27897	2306	207
August	41237	28534	23237	1410	233
October	94661	89859	15022	687	ND
December	36795	31401	1121	19412	1585
1979 February	88352	64729	1918	25583	341
April	25869	9368	9106	1458	925
June	56815	29188	21064	1289	262

Table 4. Copepods: taxonomic composition and dominant genera

Sample #	Dominant Genera (% of total copepods)		% Composition by Order		Number of taxa*
	December 1978 Cruise				
TAM 21	Clausocalanus	28.9	Calanoids	65.6	43
	Oithona	12.3	Cyclopoids	34.4	
	Oncaea	10.0	Harpacticoids	0.0	
	Euchaeta	3.7			
	Nannocalanus	3.1			
TAM 22	Oncaea	19.0	Calanoids	58.1	50
	Conaea	8.5	Cyclopoids	38.0	
	Oithona	8.4	Harpacticoids	3.4	
	Lucicutia	6.9			
	Eucalanus	5.0			
TAM 23	Eucalanus	15.9	Calanoids	67.9	51
	Oncaea	14.8	Cyclopoids	31.2	
	Conaea	11.6	Harpacticoids	0.5	
	Pleuromamma	4.6			
	Rhincalanus	4.6			
TAM 24	Oithona	30.1	Cyclopoids	51.5	45
	Clausocalanus	18.3	Calanoids	48.1	
	Oncaea	10.0	Harpacticoids	0.2	
	Corycaeus	8.9			
	Euchaeta	4.9			
TAM 25	Clausocalanus	44.9	Calanoids	68.7	35
	Oithona	19.2	Cyclopoids	28.7	
	Euchaeta	7.7	Harpacticoids	0.6	
	Oncaea	3.8			
	Farranula	3.3			

* Represents number of species identified plus genera not identified to species level.

a 25-0 m night
b 25-0 m day
c 200-0 m day
d 800-200 m day
e 1000-800 m day

Table 4 cont'd.

Sample #	Dominant Genera (% of total copepods)		% Composition by Order		Number of taxa*
	February 1979 Cruise				
TAM 27	Clausocalanus	26.7	Calanoids	69.6	61
	Oithona	15.4	Cyclopoids	26.9	
	Paracalanus	11.5	Harpacticoids	0.5	
	Oncaea	9.6			
	Nannocalanus	6.0			
TAM 28	Conaea	34.3	Cyclopoids	51.2	46
	Oncaea	11.3	Calanoids	40.0	
	Eucalanus	5.4	Harpacticoids	0.9	
	Oithona	3.9			
	Lucicutia	2.6			
TAM 29	Oncaea	16.9	Calanoids	56.6	73
	Conaea	15.3	Cyclopoids	38.4	
	Pleuromamma	11.1	Harpacticoids	0.6	
	Oithona	5.1			
	Clausocalanus	4.1			
TAM 30	Clausocalanus	28.0	Calanoids	66.3	57
	Oncaea	14.6	Cyclopoids	29.3	
	Oithona	13.5	Harpacticoids	0.2	
	Lucicutia	3.6			
	Euchaeta	2.8			
TAM 31	Clausocalanus	45.5	Calanoids	82.2	51
	Oithona	7.8	Cyclopoids	15.1	
	Euchaeta	7.5	Harpacticoids	0.7	
	Oncaea	5.8			
	Eucalanus	4.7			

* Represents number of species identified plus genera not identified to species level.

a 25-0 m night
b 25-0 m day
c 200-0 m day
d 800-200 m day
e 1000-800 m day

Table 4 cont'd.

Sample #	Dominant Genera (% of total copepods)		% Composition by Order		Number of taxa*
	April 1979 Cruise				
TAM 33	Clausocalanus	45.4	Calanoids	75.2	62
	Oncaea	14.5	Cyclopoids	24.2	
	Temora	6.9	Harpacticoids	0.5	
	Oithona	3.8			
	Farranula	3.5			
TAM 34	Eucalanus	11.9	Calanoids	75.6	56
	Oncaea	9.3	Cyclopoids	21.3	
	Conaea	6.2	Harpacticoids	0.0	
	Lucicutia	3.3			
	Pleuromamma	2.9			
TAM 35	Oncaea	22.1	Calanoids	62.3	61
	Eucalanus	16.4	Cyclopoids	36.7	
	Conaea	7.9	Harpacticoids	0.1	
	Pleuromamma	6.5			
	Oithona	5.4			
TAM 36	Clausocalanus	42.3	Calanoids	80.4	63
	Oncaea	6.7	Cyclopoids	16.5	
	Oithona	4.1	Harpacticoids	1.2	
	Undinula	3.9			
	Scolecithix	2.9			
TAM 37	Clausocalanus	34.1	Calanoids	65.1	50
	Oncaea	11.8	Cyclopoids	34.4	
	Oithona	11.6	Harpacticoids	0.0	
	Corycaeus	7.8			
	Calocalanus	6.2			

* Represents number of species identified plus genera not identified to species level.

a 25-0 m night
b 25-0 m day
c 200-0 m day
d 800-200 m day
e 1000-800 m day

Table 4 cont'd.

Sample #	Dominant Genera (% of total copepods)		% Composition by Order		Number of taxa*
	June 1979 Cruise				
TAM 40	Oncaea	28.6	Calanoids	61.9	30
	Eucalanus	22.6	Cyclopoids	35.7	
	Pleuromamma	17.3	Harpacticoids	0.0	
	Rhincalanus	6.0			
	Conaea	4.8			
TAM 41	Eucalanus	22.3	Calanoids	60.5	63
	Oncaea	19.8	Cyclopoids	35.7	
	Conaea	12.6	Harpacticoids	0.2	
	Pleuromamma	7.7			
	Clausocalanus	4.8			
TAM 42	Clausocalanus	21.9	Calanoids	62.3	57
	Oncaea	21.2	Cyclopoids	37.0	
	Oithona	7.0	Harpacticoids	0.5	
	Farranula	6.2			
	Temora	5.7			
TAM 43	Oncaea	20.3	Calanoids	48.3	42
	Clausocalanus	18.7	Cyclopoids	43.0	
	Temora	14.9	Harpacticoids	0.5	
	Farranula	10.4			
	Oithona	7.0			
TAM 45	Temora	26.8	Calanoids	75.7	53
	Farranula	11.9	Cyclopoids	23.6	
	Clausocalanus	10.7	Harpacticoids	0.5	
	Oncaea	8.9			
	Undinula	6.8			

* Represents number of species identified plus genera not identified to species level.

a 25-0 m night
b 25-0 m day
c 200-0 m day
d 800-200 m day
e 1000-800 m day

Table 5. Principal genera (biomass > 5%) of various depth zones in the upper 1000 m based on 162 μ mesh net collections at 27°N 86°W (USF std. ref. station) in the eastern Gulf of Mexico.

Depth Zone (m)	Day	Night
S-30	Farranula Undinula Clausocalanus	Farranula Undinula Clausocalanus Euphausia
30-100	Nannocalanus Euchaeta	Pleuromamma Stylocheiron Clausocalanus Euchaeta
100-200	Lucicutia Oncaea Conchoecinae[1] Pleuromamma	Nematoscelis Stylocheiron Euphausia Pleuromamma
200-500	Pleuromamma Euphausia	Pleuromamma Eucalanus
500-800	Pleuromamma Eucalanus	Pleuromamma Eucalanus Rhincalanus
800-1000	Eucalanus Valdiviella	Eucalanus

[1]Mostly Conchoecia but may include biomass from other closely related genera.

Table 6. Displacement volumes (ml/m^3) for all 1978-79 OTEC collections.

Cruise	Night 25 m	Day 25 m	Day		
			0-200 m	200-800 m	800-1000 m
1978 June	0.0727	0.1156	0.0506	0.0189	0.0114
August	0.0329	0.0805	0.0505	0.0125	0.0026
October	0.2196	0.1132	0.0426	0.0056	ND
December	0.0704	0.0891	0.0522	0.0134	0.0118
1979 February	0.3159	0.0205	0.0736	0.0110	0.0015
April	0.2560	0.1679	0.0631	0.0130	0.0097
June	0.2713	0.1337	0.0795	0.0134	0.0058

Table 7. Annual 1978-79 values for important plankton characteristics of samples from the Tampa OTEC site.

	Night 25 m	Day 25 m	Day		
			0-200 m	200-800 m	800-1000 m
Biomass (ml/m^3)	0.177	0.103	0.059	0.013	0.007
Total Copepods (No./100 m^3)	54586	47626	14195	7449	592
Coeff. Var. Copepod Nos.	91	90	89	79	84
Total Plankton (No./100 m^3)	72800	62454	20926	9180	740
% Copepods	74	73	71	83	87
Calanoids (% Copepods)	57.9	61.2	56.6	59.5	65.9
Cyclopoids (% Copepods)	40.8	31.0	39.5	38.8	30.6
Harpacticoids (% Copepods)	0.9	1.1	0.7	0.4	1.1
Clausocalanus (% Copepods)	21.4	31.6	23.7	1.3	<1.0
Oncaea (% Copepods)	22.6	12.8	16.1	20.7	12.3
Oithona (% Copepods)	8.4	13.2	14.6	4.0	2.7
Farranula (% Copepods)	1.7	5.1	5.0	<1.0	-----
Eucalanus (% Copepods)	<1.0	<1.0	<1.0	17.5	23.8
Conaea (% Copepods)	-----	-----	-----	8.1	13.3
Pleuromamma (% Copepods)	<1.0	-----	<1.0	5.6	3.4
Rhincalanus (% Copepods)	<1.0	-----	<1.0	2.2	4.6

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Appendix Table 1. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 21 Date: 12/17/78 Time: 2128 Depth: 25 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	-	-	7829.73	7829.23	-
2	14766.14	317.81	755.31	15839.26	-
3	20759.89	267.25	1131.49	22158.63	-
4	816.19	151.68	438.19	1406.06	-
5	445.41	303.37	78.01	826.79	28.89
6	-	28.90	412.34	441.24	-
7	7.22	-	1053.73	1060.95	-
8	-	-	-	-	-
9	-	-	-	-	-
10	-	-	132.90	132.90	-
11	-	7.22	-	7.22	-
12	-	65.00	132.90	197.90	-
13	-	-	-	-	-
14	-	-	-	-	-
15	-	-	-	-	-
16	-	-	-	-	1.36
Totals	36794.85	1141.23	11964.60	49900.68	30.25

* Refers to Table in text.

Appendix Table 2. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 22 Date: 12/18/78 Time: 1416 Depth: 1000-800 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	-	-	160.25	160.25	-
2	535.60	223.97	124.27	883.84	-
3	756.57	47.99	-	804.56	-
4	173.65	-	-	173.65	-
5	69.03	-	-	69.03	-
6	16.73	-	20.92	37.65	-
7	33.47	-	4.18	37.65	-
8	-	0.26	16.74	17.00	-
9	-	-	4.18	4.18	-
10	-	-	8.37	8.37	-
11	-	-	4.18	4.18	-
12	-	0.26	-	0.26	-
13	-	0.26	-	0.26	-
14	-	-	-	-	-
15	-	-	-	-	-
16	-	0.26	-	0.26	-
Totals	1585.05	273.00	343.09	2201.14	-

* Refers to Table in text.

Appendix Table 3. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 23 Date: 12/18/78 Time: 1534 Depth: 800-200 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	-	16.53	101.35	117.88	-
2	275.58	38.66	42.88	357.12	-
3	502.86	-	-	502.86	-
4	271.19	11.04	-	282.23	-
5	33.93	-	-	33.93	-
6	16.60	-	3.90	20.50	-
7	17.55	-	3.90	21.45	0.22
8	-	-	-	-	-
9	1.95	0.22	3.90	6.07	-
10	0.98	-	-	0.98	-
11	-	0.45	-	0.45	-
12	-	0.44	3.90	4.34	-
13	-	0.22	1.95	2.17	-
14	-	0.22	-	0.22	-
15	-	-	-	-	-
16	-	-	-	-	1.57
Totals	1120.64	67.78	161.78	1350.20	1.79

* Refers to Table in text.

Appendix Table 4. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 24 Date: 12/18/78 Time: 1612 Depth: 200-0 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	-	-	1732.64	1732.64	-
2	8785.89	628.35	95.20	9509.44	-
3	9564.45	19.04	932.96	10516.45	-
4	780.30	38.08	126.94	945.32	-
5	204.69	-	231.86	436.55	-
6	76.17	-	276.38	352.55	-
7	-	19.04	193.88	212.92	-
8	-	-	290.82	290.82	-
9	-	-	96.94	96.94	-
10	-	-	-	-	-
11	-	-	-	-	-
12	-	-	96.94	96.94	-
13	-	-	-	-	-
14	-	-	-	-	-
15	-	-	-	-	-
16	-	-	-	-	-
Totals	19411.50	704.51	4074.56	24190.57	-

* Refers to Table in text.

Appendix Table 5. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 25 Date: 12/18/78 Time: 1630 Depth: 25 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	-	-	2217.43	2217.43	-
2	11277.27	132.79	371.79	11781.85	-
3	18176.23	79.67	570.93	18826.83	-
4	1778.94	79.66	53.11	1911.71	-
5	141.64	159.34	60.49	361.47	-
6	26.56	39.84	281.79	348.19	-
7	-	-	60.49	60.49	-
8	-	26.56	60.49	87.05	-
9	-	-	60.49	60.49	-
10	-	-	60.49	60.49	-
11	-	-	-	-	-
12	-	-	13.28	13.28	-
13	-	-	-	-	-
14	-	-	-	-	-
15	-	-	-	-	-
16	-	-	-	-	0.21
Totals	31400.64	517.86	-	-	0.21

* Refers to Table in text.

Appendix Table 6. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 27 Date: 02/14/79 Time: 0302 Depth: 25 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	399.26	354.90	3992.59	4746.65	-
2	32820.38	1109.06	1119.14	35048.58	-
3	36996.20	216.26	4758.35	41970.81	-
4	15882.54	54.07	224.58	15151.19	-
5	1661.51	199.63	256.23	2117.37	24.95
6	49.91	24.95	435.83	510.69	24.95
7	542.64	231.71	1117.04	1891.39	-
8	-	24.95	243.51	268.46	24.95
9	-	188.92	275.03	463.95	-
10	-	-	-	-	-
11	-	99.82	-	99.82	-
12	-	267.26	169.74	427.00	-
13	-	-	1.17	1.17	-
14	-	-	0.40	0.40	-
15	-	-	0.20	0.20	-
16	-	-	-	-	-
Totals	88352.44	2761.53	12593.81	103707.78	74.85

* Refers to Table in text.

Appendix Table 7. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 28 Date: 02/14/79 Time: 1642 Depth: 1000-800 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	2.96	-	24.46	27.42	-
2	187.67	16.31	-	203.78	-
3	114.28	16.38	0.28	130.94	-
4	25.50	2.97	-	27.47	-
5	6.87	-	1.48	8.35	-
6	1.96	-	-	1.96	-
7	3.07	-	0.14	3.21	-
8	-	-	0.28	0.28	-
9	-	0.28	0.28	0.56	-
10	-	0.56	0.56	1.12	-
11	-	-	-	-	-
12	-	0.56	0.56	1.12	0.14
13	-	0.14	-	0.14	-
14	-	0.14	-	0.14	0.14
15	-	-	-	-	0.14
16	-	-	-	-	-
Totals	341.31	37.34	38.04	406.69	0.42

* Refers to Table in text.

Appendix Table 8. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 29 Date: 02/15/79 Time: 1205 Depth: 800-200 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	-	-	118.70	118.70	-
2	1229.23	109.51	9.16	1347.90	-
3	453.83	109.51	13.36	576.70	-
4	143.76	32.44	4.60	183.09	-
5	72.93	2.30	6.89	82.12	-
6	8.03	2.29	1.15	11.47	-
7	10.46	2.30	4.73	17.49	-
8	0.14	1.15	2.29	3.58	-
9	-	3.45	4.58	8.03	-
10	-	4.59	8.16	12.75	1.15
11	-	0.14	-	0.14	-
12	-	0.84	8.17	9.01	1.12
13	-	0.28	2.29	2.57	0.28
14	-	-	-	-	0.14
15	-	-	0.14	0.14	-
16	-	-	-	-	-
Totals	1918.38	268.80	184.22	2373.69	2.69

* Refers to Table in text.

Appendix Table 9. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 30 Date: 02/15/79 Time: 1239 Depth: 200-0 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	956.37	418.70	662.92	2037.99	-
2	8676.47	-	323.97	9000.44	-
3	9570.25	947.90	687.90	11206.05	-
4	5908.43	34.90	450.72	6394.05	-
5	314.09	69.79	847.72	1231.60	-
6	104.69	52.35	244.30	401.34	-
7	-	34.90	289.33	324.23	17.45
8	34.90	-	564.82	599.72	-
9	-	-	104.70	104.70	-
10	17.45	-	174.50	191.95	-
11	-	-	69.80	69.80	-
12	-	34.89	87.25	122.14	-
13	-	-	-	-	-
14	-	-	-	-	-
15	-	-	-	-	-
16	-	-	-	-	-
Totals	25582.65	1593.43	4507.93	31684.01	18.00

* Refers to Table in text.

Appendix Table 10. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 31 Date: 02/15/79 Time: 1258 Depth: 25 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	-	488.22	3254.24	3742.96	-
2	19163.50	1139.19	158.99	20461.68	-
3	39989.70	650.97	1431.50	42072.26	-
4	2808.61	91.69	1197.23	4097.53	-
5	2523.04	30.57	736.00	3289.61	-
6	122.06	61.13	544.60	727.79	-
7	122.06	-	310.88	432.94	61.13
8	-	61.13	837.27	898.40	-
9	-	-	-	-	-
10	-	-	784.48	784.48	-
11	-	122.26	30.57	152.83	-
12	-	-	2353.67	2353.67	0.24
13	-	-	784.48	784.48	-
14	-	-	-	-	-
15	-	-	0.48	0.48	-
16	-	-	-	-	-
Totals	64729.06	2645.16	12424.89	79799.11	61.37

* Refers to Table in text.

Appendix Table 11. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 33 Date: 04/29/79 Time: 0143 Depth: 25 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	-	1518.91	3392.59	4911.50	-
2	8203.71	1602.46	534.89	10341.06	-
3	15519.72	18.82	831.98	16370.52	9.41
4	1920.00	47.05	1122.10	3089.15	18.82
5	188.24	37.64	1577.45	1803.33	9.41
6	18.82	28.23	366.50	413.55	9.41
7	18.82	9.41	48.19	76.42	-
8	-	28.23	1039.08	1067.31	-
9	-	18.82	28.23	47.05	18.82
10	-	18.82	-	18.82	-
11	-	-	178.83	178.83	-
12	-	28.23	330.74	358.97	-
13	-	9.71	-	9.71	-
14	-	-	-	-	0.29
15	-	-	-	-	0.29
16	-	-	1.17	1.17	-
Totals	25869.31	3366.33	9451.75	38.687.39	66.45

* Refers to Table in text.

Appendix Table 12. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 34 Date: 04/29/79 Time: 1401 Depth: 1000-800 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	-	-	0.35	0.35	-
2	220.57	4.52	127.91	353.00	-
3	340.43	7.11	-	347.54	-
4	252.71	-	1.29	254.00	-
5	85.45	1.29	1.30	88.04	-
6	10.52	0.65	1.29	12.46	-
7	11.15	-	3.23	14.38	-
8	3.88	-	1.29	5.17	0.65
9	-	-	3.24	3.24	-
10	0.16	-	-	0.16	-
11	-	0.65	0.65	1.30	-
12	-	1.62	1.29	2.91	0.16
13	-	0.32	0.16	0.48	0.16
14	-	0.16	0.16	-	-
15	-	-	-	-	-
16	-	-	-	-	0.16
Totals	924.87	16.32	142.16	1083.35	1.13

* Refers to Table in text.

Appendix Table 13. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 35 Date: 04/29/79 Time: 1513 Depth: 800-200 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	41.47	4.35	1.73	47.55	-
2	410.06	26.13	108.86	545.05	-
3	506.84	23.95	0.86	531.65	-
4	415.18	-	0.86	416.04	-
5	59.54	-	2.59	62.13	-
6	13.81	-	-	13.81	-
7	9.50	0.86	-	10.36	-
8	0.44	-	0.86	1.30	-
9	0.86	-	6.05	6.91	-
10	-	-	3.46	3.46	-
11	-	-	-	-	-
12	-	26.99	11.24	38.23	0.88
13	-	0.22	1.08	1.30	0.88
14	-	-	0.43	0.43	0.44
15	-	-	-	-	-
16	-	-	-	-	-
Totals	1457.70	82.50	138.02	1678.22	2.20

* Refers to Table in text.

Appendix Table 14. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 36 Date: 04/29/79 Time: 1604 Depth: 200-0 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	103.55	201.20	1185.29	1490.04	-
2	5000.60	7006.57	20.71	12027.88	-
3	3422.94	27.18	179.08	3629.20	-
4	504.81	15.49	158.57	678.87	-
5	62.13	3.88	1065.92	1131.93	3.88
6	3.88	7.81	1269.11	1280.80	-
7	7.76	-	636.33	644.09	-
8	-	7.77	-	7.77	-
9	-	3.88	218.73	222.61	-
10	-	-	3.99	3.99	-
11	-	-	-	-	-
12	-	-	35.92	35.92	-
13	-	-	-	-	-
14	-	-	-	-	-
15	-	-	-	-	-
16	-	-	-	-	-
Totals	9105.67	7273.78	4773.65	21153.10	3.88

* Refers to Table in text.

Appendix Table 15. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 37 Date: 04/29/79 Time: 1647 Depth: 25 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	320.94	743.40	1480.14	2544.48	-
2	4353.37	872.87	908.18	6134.42	-
3	3912.12	54.65	653.72	4620.49	18.88
4	695.25	67.61	91.25	854.11	4.72
5	34.61	57.65	155.76	248.02	9.44
6	47.20	26.97	1365.65	1439.82	-
7	4.72	-	1470.28	1475.00	-
8	-	6.41	700.13	706.54	-
9	-	-	438.96	438.96	-
10	-	-	205.32	205.32	-
11	-	11.33	141.60	152.93	-
12	-	4.72	521.56	526.28	-
13	-	-	160.48	160.48	-
14	-	-	4.72	4.72	-
15	-	-	-	-	-
16	-	-	-	-	-
Totals	9368.21	1845.61	8297.75	19511.57	33.04

* Refers to Table in text.

Appendix Table 16. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 40 Date: 06/28/79 Time: 1407 Depth: 1000-800 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	-	-	-	-	-
2	27.14	-	-	27.14	-
3	144.46	-	-	144.46	-
4	37.44	-	-	37.44	-
5	28.68	-	-	28.68	-
6	21.00	0.20	-	21.20	-
7	3.00	-	-	3.00	-
8	-	1.60	-	1.60	-
9	-	0.20	1.20	1.40	-
10	0.20	0.20	0.20	0.60	-
11	-	-	0.40	0.40	-
12	-	0.40	4.40	4.80	0.80
13	-	-	1.00	1.00	0.40
14	-	-	-	-	-
15	-	-	-	-	-
16	-	-	-	-	-
Totals	261.92	2.60	7.20	271.72	1.20

* Refers to Table in text.

Appendix Table 17. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 41 Date: 06/28/79 Time: 1524 Depth: 800-200 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	-	-	3.62	3.62	-
2	393.59	13.04	61.59	468.22	-
3	445.86	2.90	15.93	464.69	-
4	370.35	8.70	-	379.05	0.72
5	55.70	0.72	1.44	57.86	-
6	16.66	-	2.89	19.55	-
7	5.79	0.72	-	6.51	-
8	0.18	-	1.45	1.65	-
9	0.72	0.18	18.11	19.01	-
10	-	-	-	-	-
11	-	0.72	-	0.72	-
12	-	2.17	6.88	9.05	1.99
13	-	0.36	4.35	4.71	0.18
14	-	0.36	0.18	0.54	-
15	-	-	-	-	-
16	-	-	0.36	0.36	-
Totals	1288.85	29.87	116.80	1435.52	2.89

* Refers to Table in text.

Appendix Table 18. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 42 Date: 06/28/79 Time: 1626 Depth: 200-0 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	133.33	39.09	279.79	452.21	-
2	12028.96	613.04	407.57	13049.57	-
3	7439.69	105.45	947.42	8492.56	13.64
4	1138.32	18.18	299.11	1455.61	18.19
5	264.13	163.63	898.48	1326.24	-
6	13.65	54.54	364.20	432.39	-
7	-	9.09	355.11	364.20	9.09
8	45.45	81.82	96.46	223.73	-
9	-	4.55	222.55	227.10	-
10	-	9.09	-	9.09	-
11	-	-	60.10	60.10	-
12	-	9.09	60.10	69.19	-
13	-	-	9.09	9.09	9.09
14	-	-	-	-	-
15	-	-	-	-	-
16	-	-	-	-	-
Totals	21063.53	1107.57	3999.98	26171.08	50.01

* Refers to Table in text.

Appendix Table 19. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 43 Date: 06/28/79 Time: 1658 Depth: 25 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	697.02	-	11.52	1284.32	-
2	18282.82	501.80	321.52	19106.14	-
3	9599.26	-	183.99	9783.25	23.86
4	271.46	837.43	641.22	1750.11	62.52
5	230.34	632.11	978.96	1841.41	31.26
6	24.69	652.83	2355.88	3033.40	31.26
7	-	32.90	527.25	560.15	15.63
8	74.04	-	246.30	320.34	-
9	8.23	8.23	-	16.46	-
10	-	-	34.22	34.22	-
11	-	16.46	61.12	77.58	-
12	-	24.68	141.78	166.46	-
13	-	16.45	18.43	34.88	-
14	-	-	30.56	30.56	-
15	-	-	-	-	-
16	-	-	-	-	-
Totals	29187.86	2722.89	5552.75	37463.50	164.53

* Refers to Table in text.

Appendix Table 20. Zooplankton Size Distribution (numbers/100 m^3)

Tow #: TAM 45 Date: 06/29/79 Time: 0228 Depth: 25 m
Net Characteristics: 5:1, 3/4 m, 202 μm mesh

Size Class*	Copepods	Non-Copepod Crustaceans	Other Invertebrates	Total Invertebrates	Fish
1	1776.60	198.45	75.40	2050.45	-
2	31430.30	1401.56	223.84	33055.70	-
3	17319.16	37.22	492.88	17849.26	-
4	5577.57	135.28	286.81	5999.66	138.41
5	545.75	293.40	126.17	965.32	207.80
6	24.81	192.79	209.38	427.98	158.18
7	90.97	231.81	344.38	667.16	-
8	49.42	281.26	10.34	341.02	-
9	-	821.42	248.00	1069.42	-
10	-	966.70	91.38	1058.08	-
11	-	1525.91	163.13	1698.04	-
12	-	-	371.65	371.65	8.27
13	-	-	-	-	-
14	-	-	8.27	8.27	-
15	-	-	-	-	-
16	-	-	-	-	-
Totals	56814.58	6086.80	2651.63	65553.01	512.66

* Refers to Table in text.

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