Preliminary Observations on the Distribution, Composition and Abundance of Zooplankton in Chignecto Bay during June and August 1978, with Emphasis on the Relationship to Tidal Cycles

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ABSTRACT

Two 16 h series of horizontal zooplankton samples taken at two stations in the mouth of Shepody Bay in June 1978, showed that a periodic fluctuation correlated with the tide was present for the zooplankton species. The copepods were the major component found in the plankton, the meroplanktonic larvae were second in numbers, while species of mysids, chaetognaths, and ctenophores were relatively abundant.

Two separate communities existed in the plankton: The first was composed of estuarine species related to the warmer, less saline water of Shepody Bay and the other group, with a larger proportion of open water forms, was associated with the colder, more saline water of Chignecto Bay.

An areal survey in Chignecto Bay in August 1978 suggested a distribution pattern for the zooplankton related to the non-tidal counterclockwise circulation pattern of the Bay.

RÉSUMÉ

En juin 1978, on a réalisé deux séries d'échantillonnage horizontaux pendant 16 heures à deux stations de l'embouchure de la baie de Shépody; l'analyse a révélé une corrélation entre la marée et une fluctuation périodique chez les espèces du zooplancton. Chez celui-ci, les copépodes sont les pluc nombreux; viennent ensuite les larves du méroplancton

et certaines espèces de mysodidés, de chétognathes et de cténophores.

Le zooplancton étudié contenait deux communautés distinctes: la première comprend des espèces estuariennes adaptées aux eaux relativement chaudes et peu salées de la baie de Shépody, tandis que la seconde, composée d'espèces vivant dans les eaux plus froides et plus salées de la baie de Chignectou, compte une plus forte proportion d'organismes adaptés à la vie en eau libre.

L'étude aéroportée de la baie de Chignecto réalisée en août 1978 faisait croire que la distribution du zooplancton était reliée au courant anti-horaire, indépendant de la marée, des eaux de cette baie.

I. INTRODUCTION

The potential development of tidal power in the upper Bay of Fundy has generated a need for base-line information on the regional, environmental nature of the Chignecto Bay system. The purpose of this study is to produce a preliminary survey of zooplankton distribution and to create a regional, summer-time reconaissance of the zooplankton potentially affected by tidal power development.

Systematic observations at two fixed geographical stations at the mouth of Shepody Bay in June 1978 (Fig. 1), examined the quantitative and qualitative nature of the zooplankton and the temporal changes in zooplankton composition over complete tidal cycles.

Cruise 78-025 on CSS Dawson in August 1978, provided an opportunity to obtain samples representative of different regions of the Bay and to form the basis for interpretations of spatial distribution.

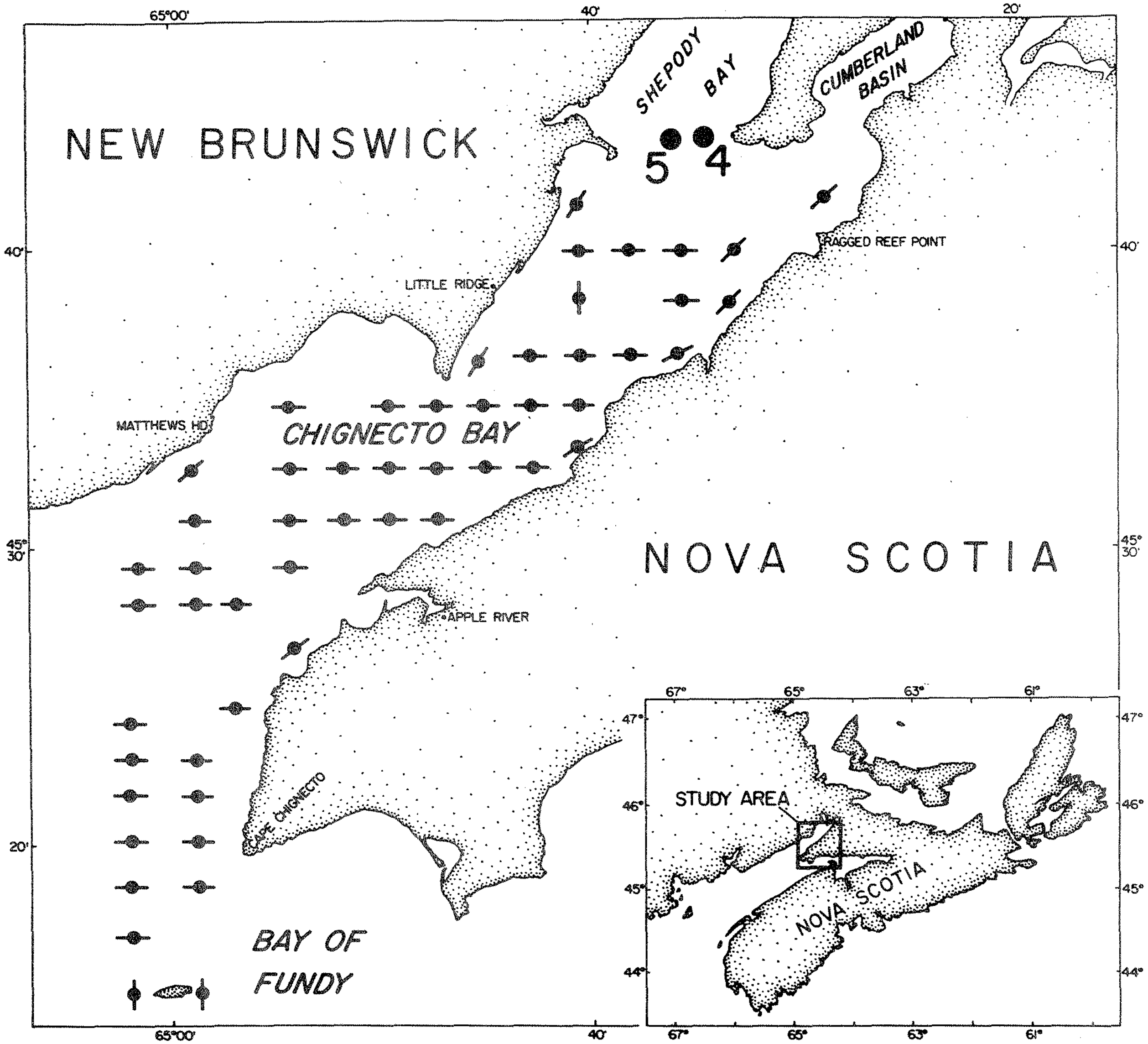

Figure 1. Map of the study area showing anchor stations occupied by the Oran II in June 1978, and the sampling tracks taken from CSS Dawson in August 1978.

II. CRUISE OF THE MFV ORAN II TO SHEPODY BAY, JUNE 20-24, 1978.

METHODS

On June 20, 1978, Station 4 off Cape Maringouin, New Brunswick, in the mouth of Shepody Bay, was occupied from 1800 h (just before low tide) until 0830 h of the 21, and Station 5 on June 23 from 1900 h to 1030 h of the 24 (Fig. 1). Zooplankton collections were made at 30 min intervals while the ship was anchored, using a 30 cm conical plankton net (246 µm mesh) placed 1-5 m below the surface for 10 min. The net was affixed to a rigid ring, with a flowmeter fitted in the centre of the mouth. The ring was attached by bridles to a towing warp, with a weight attached to the end of the towing cable to keep the net at depth. Water speed ranged between 0 and 3 knots. Samples were preserved in 5% buffered formalin-seawater solution immediately after collection.

For analysis, large zooplankton (chaetognaths, mysids, ctenophores, fish larvae, etc.) were first removed from the samples by seiving through a 1,000 µm screen and examined separately. The remaining sample (less than 1,000 µm) was then split using a Motoda splitter and fractions taken for volume, wet and dry weight, plus a numerical estimate. Estimates of species density and biomass were calculated using current meter data taken simultaneously from the opposite side of the ship. Biomass estimates and numbers of animals in each species were then converted to $\log_{10}(x+1)$, one being added to all values before transformation to eliminate the frequent zero values. To determine if a significant relationship existed between the tidal fluctuations and the zooplankton periodicity, polynomial curves were fitted for each species component and compared with the tidal curves for that time. A further comparison was made on the same graphs between species components and the levels of sunlight during the sampling interval.

RESULTS

Copepods dominated the zooplankton community, with mixtures of decapod larvae, barnacle naupli, isopods, small fish (Microgadus tomcod), polychaete larvae, harpacticoids and amphipods making up the meroplanktonic component. Dominant copepod species were: Acartia hudsonica, Eurytemora herdmani, Pseudocalanus sp. and Centropoges hamatus (some C. typicus). Neomysis americana was the only mysid present, with considerable numbers of mysid larvae also present, as were the chaetognath Sagitta elegans and the ctenophore Pleurobrachia pileus. There were also occasional pelagic polychaetes (Tomopteris sp.) and decapods (Crangon septimspinosa).

Temperature values varied from 10.0 to 14.5°C and salinity from 25.5 to 29.0°/₀₀ with distinct tide-related oscillations, (see Figs. 2 & 3). The pattern for the upper 10 m at Stations 4 and 5 consisted of cold, saline water flooding into Shepody Bay between low and high tide and on the ebb, warmer, less saline water from up the estuary flushing out into Chignecto Bay.

The biological results reflect this pattern very closely. It appears that two different communities exist in the waters sampled. The first is an estuarine related group, represented by the biomass (Fig. 4), consisting mainly of copepods and meroplanktonic larvae. This community shows a negative correlation with the tide, that is, around low tide the biomass is at peak concentration and drops off steadily to a minimum at high tide. However, as the tide turns, the concentration begins to rise

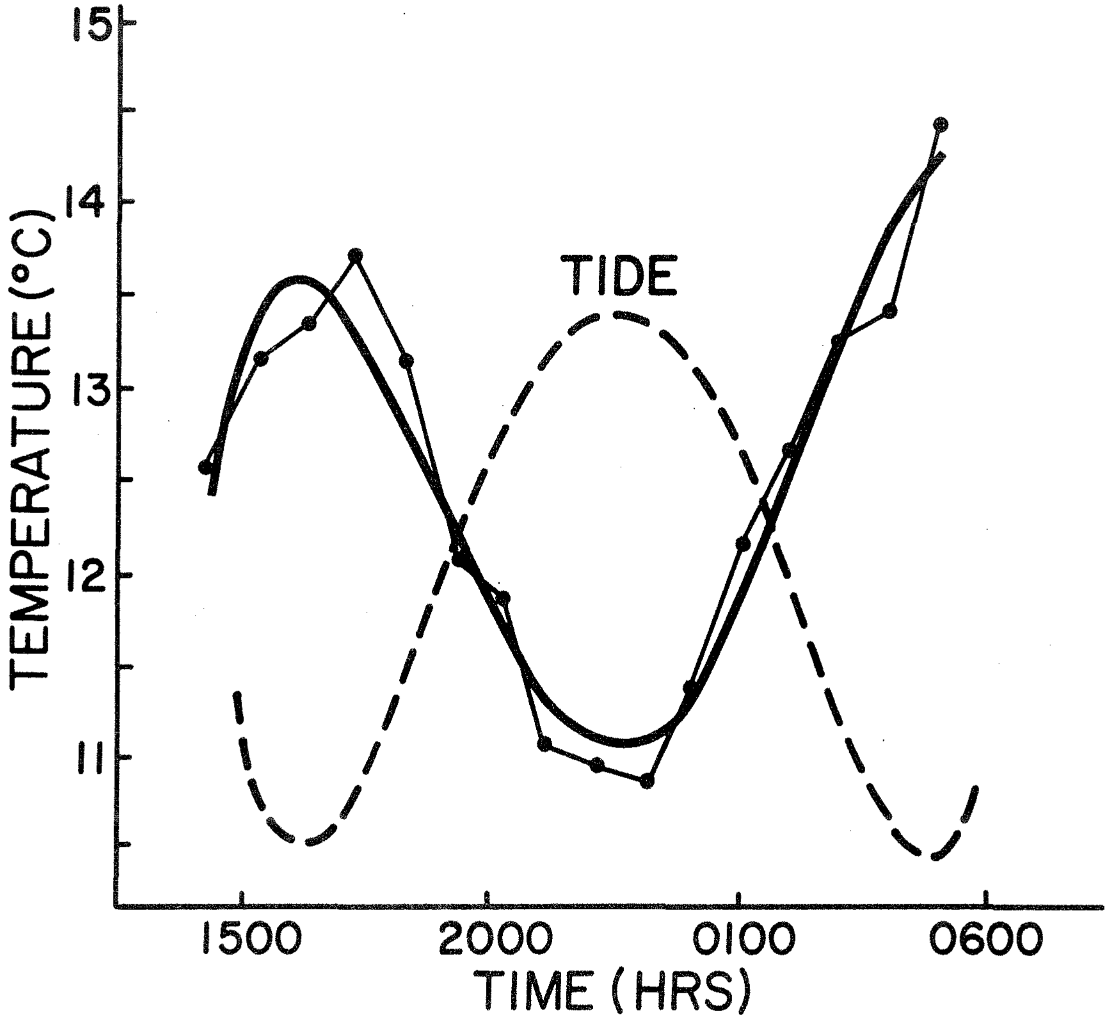

Fig. 2. Temperature (°C); Station 4, June 1978.

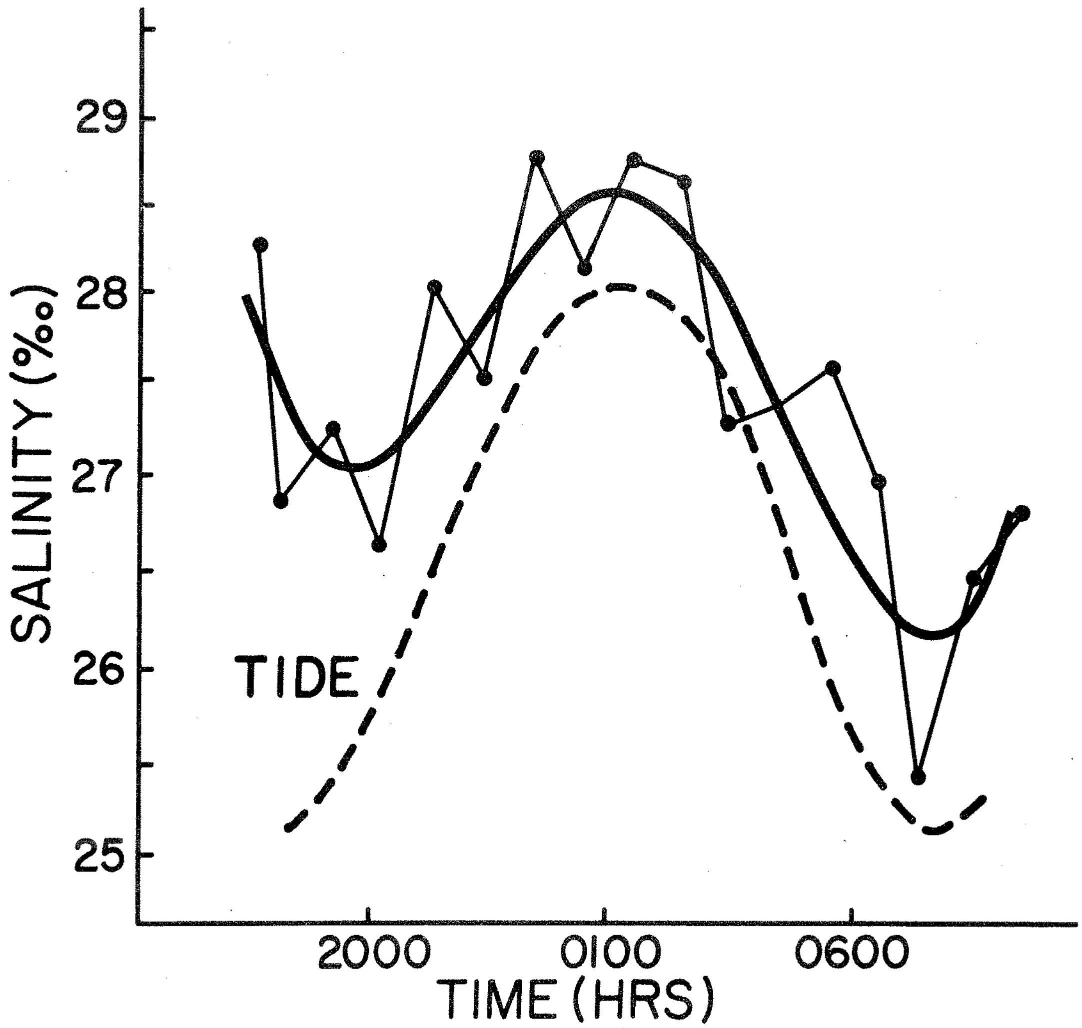

Fig. 3. Salinity (°/oo); Station 4, June 1978.

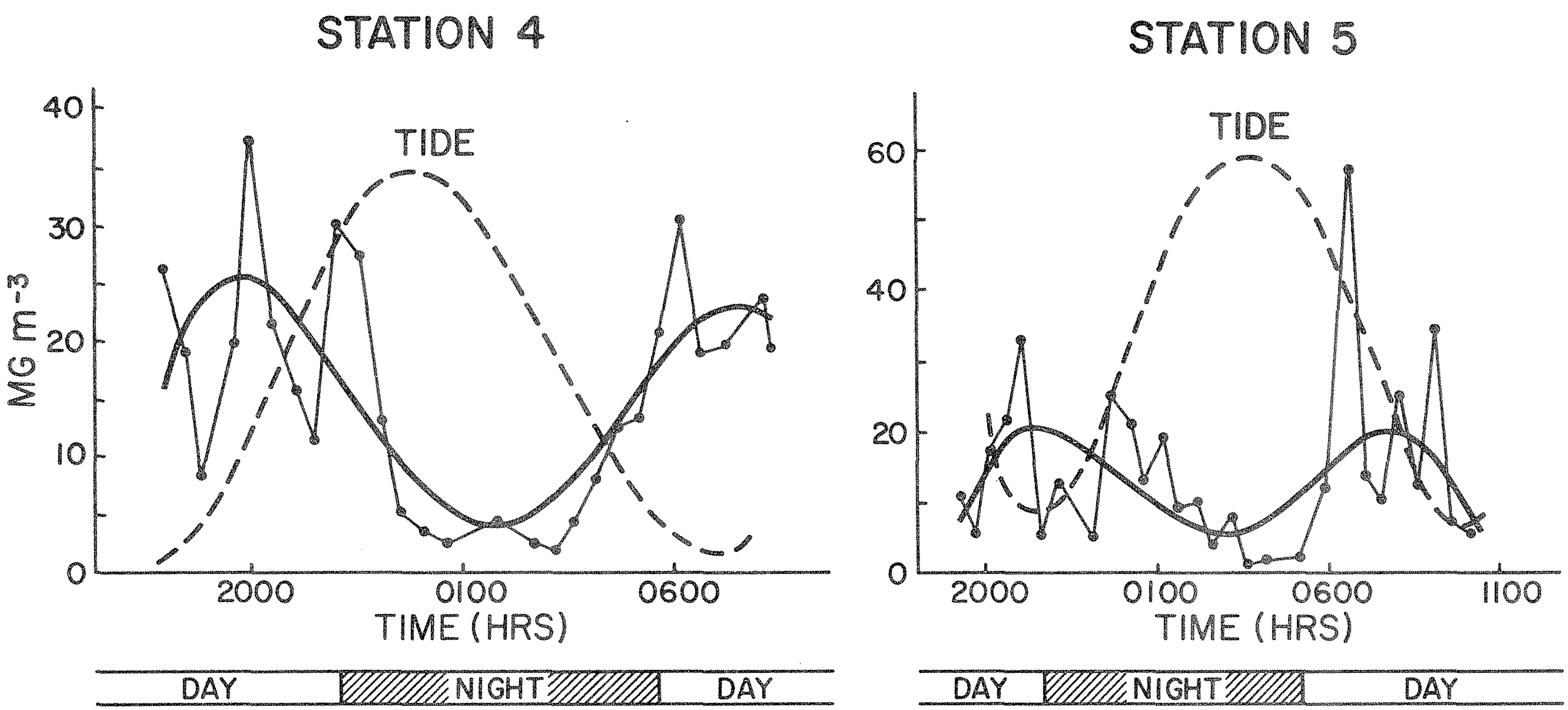

Fig. 4. Biomass (dry wt) - mg m^{-3}; Station 4, Station 5, June 1978.

again to a peak at the next low tide. This pattern is shown as well for most of the major components of the biomass: Acartia hudsonica (Fig. 5), Eurytemora herdmani (Fig. 6), Centropoges spp. (Fig. 7) and the mysid Neomysis americana (Fig. 8), as well as for the young and older mysid larvae (Figs. 9 & 10).

The second community consists of the copepod Pseudocalanus sp. (Fig. 11) and the chaetognath Sagitta elegans (Fig. 12). This community showed a positive correlation with the tide, the calculated polynomial regression lines following the same pattern with time. These species are tied to the colder, more saline water mass of Chignecto Bay, in agreement with Strong and Daborn's (1979) results which showed Pseudocalanus in Chignecto Bay and it's absence from Shepody Bay and Cumberland Basin.

Although a suspected dilution effect existed in relation to the rising tide with the first community (i.e. range of depths at mean tide between high and low water at Stations 4 and 5 is 10.2 m), this is probably not the case since the second community reached its maximum concentration at high tide when the water depth was at its maximum and the greatest potential dilution exists.

Many of the samples contained large quantities of detritus. A visual estimation of detrital abundance contained in the samples was made and the results compared to the state of the tide (Fig. 13). Maximum concentrations of detritus occur at peak velocities, almost symmetrically on flooding and ebbing tides, suggesting that these surface concentrations are related to the increased turbulence at mid-tide.

It was suspected that this increased concentration of detrital material mixed in with the plankton, might have clogged the net. However,

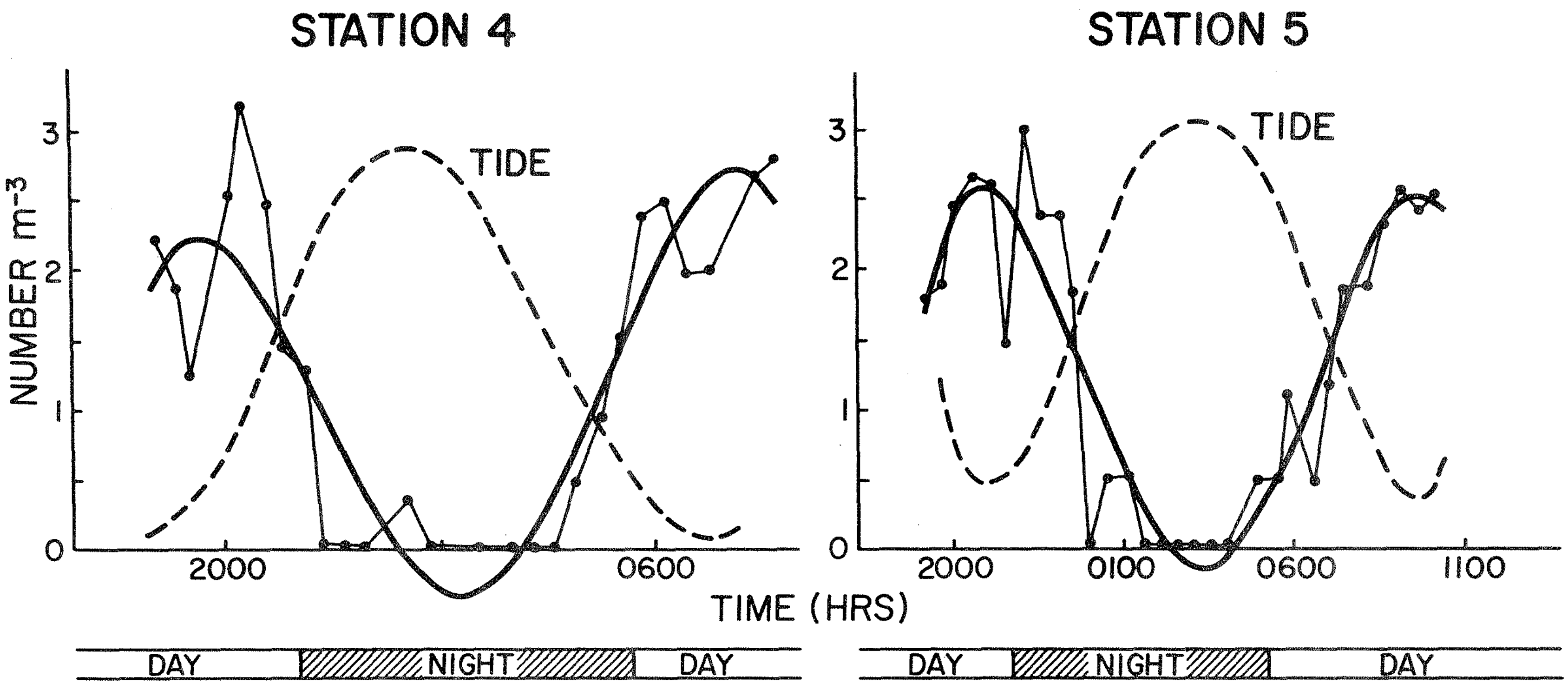

Fig. 5. Acartia hudsonica - no m^{-3}; Station 4, Station 5, June 1978.

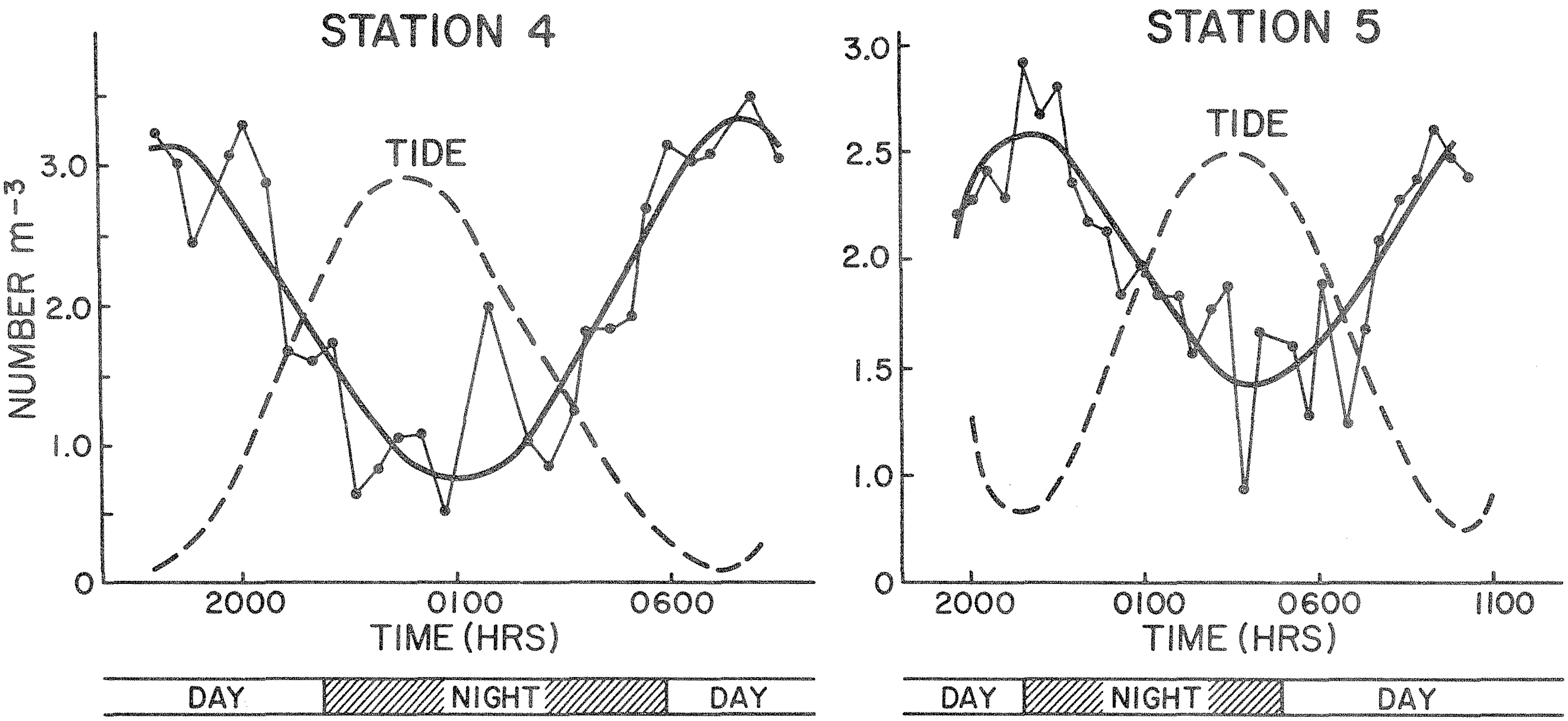

Figure 6. Eurytemora herdmani - no m^{-3}; Station 4, Station 5, June 1978.

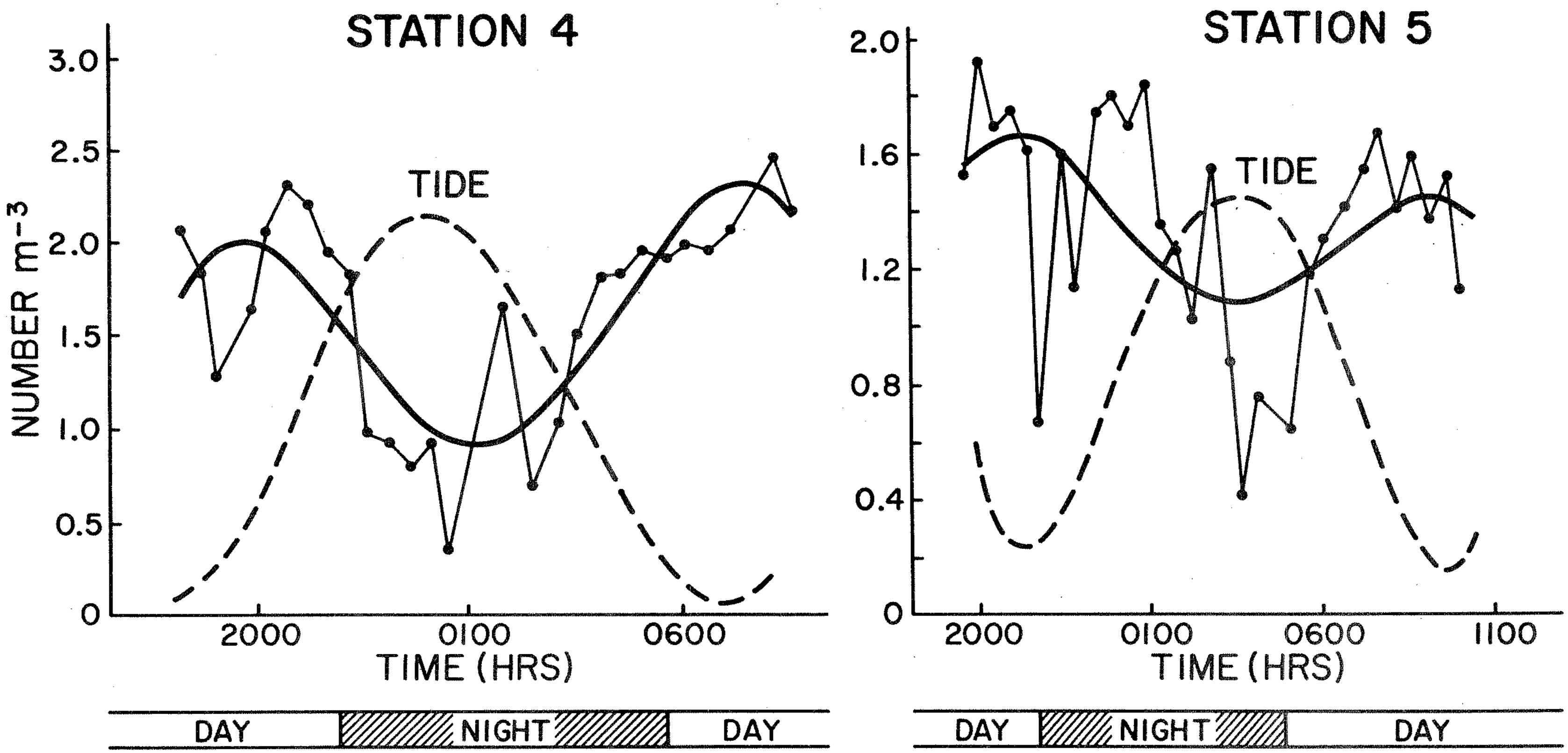

Figure 7. Centropoges hamatus/typicus - no m^{-3}; Station 4, Station 5, June 1978.

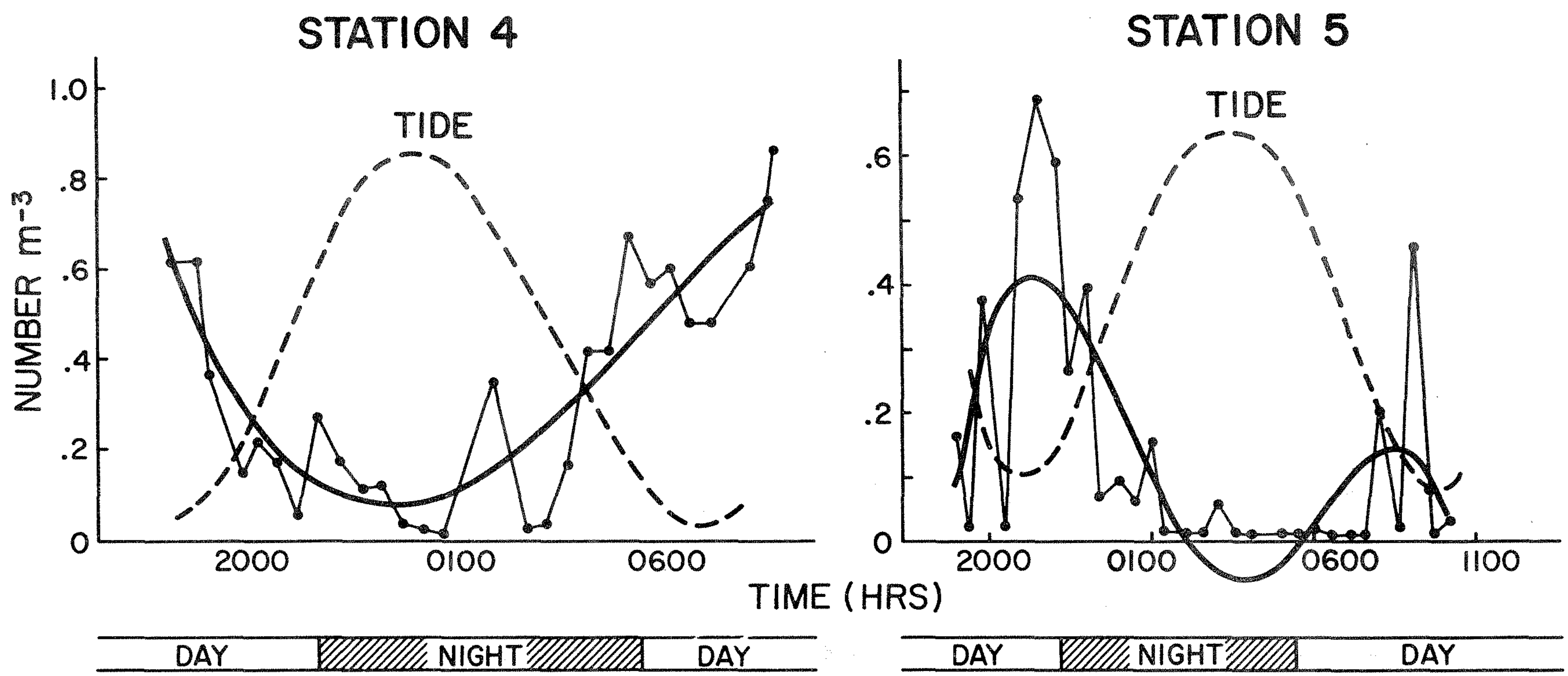

Figure 8. Neomysis americana - no m^{-3}; Station 4, Station 5, June 1978.

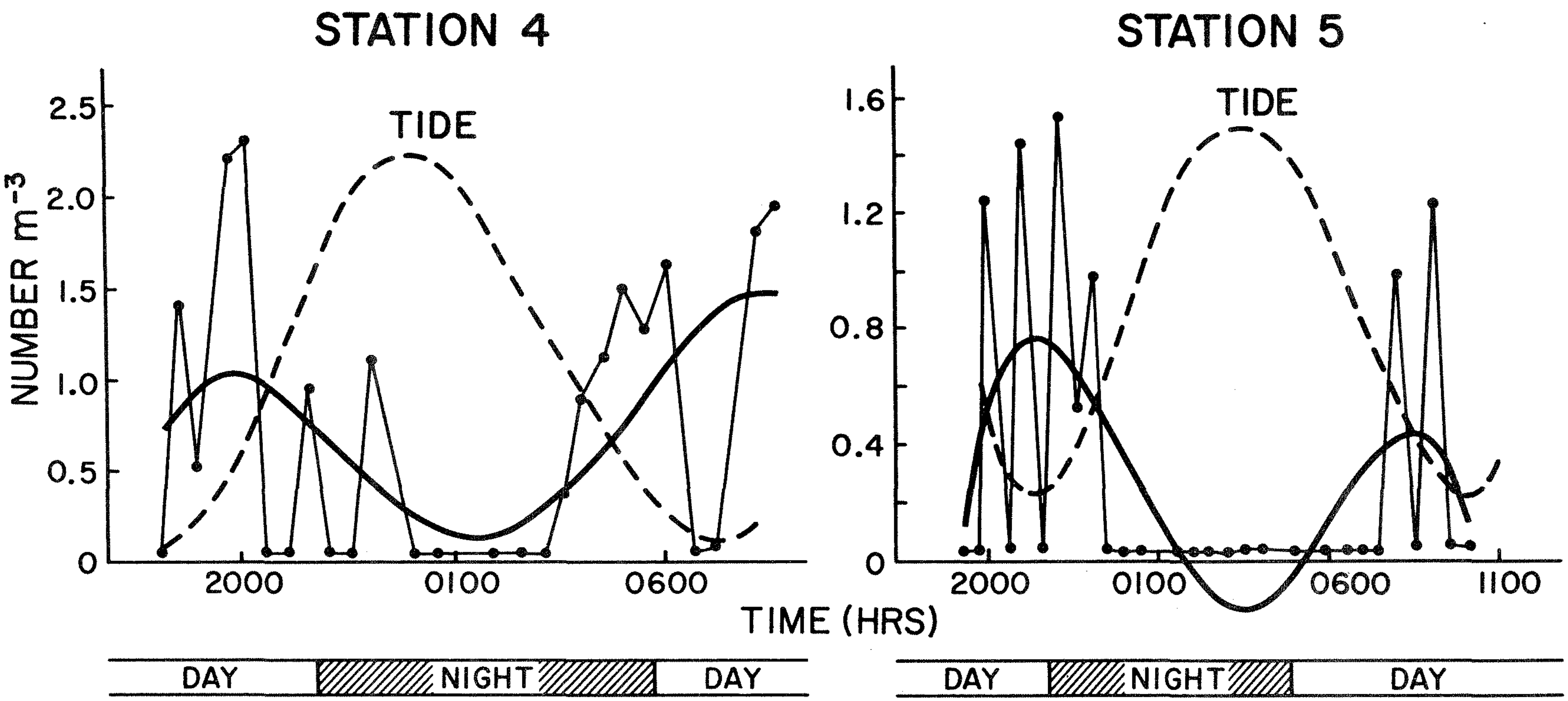

Figure 9. Early mysid larvae - no m^{-3}; Station 4, Station 5, June 1978.

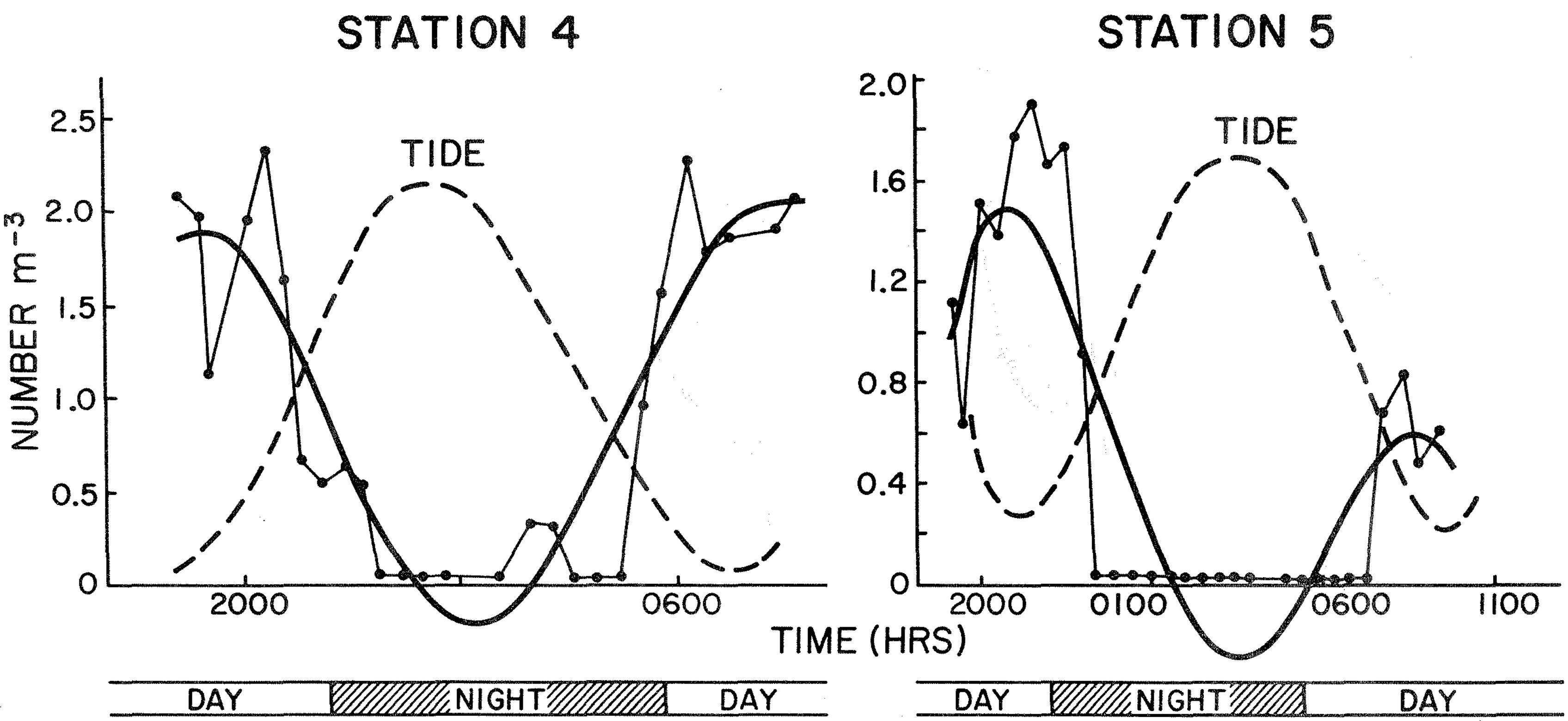

Figure 10. Mysid larvae - no m^{-3}; Station 4, Station 5, June 1978.

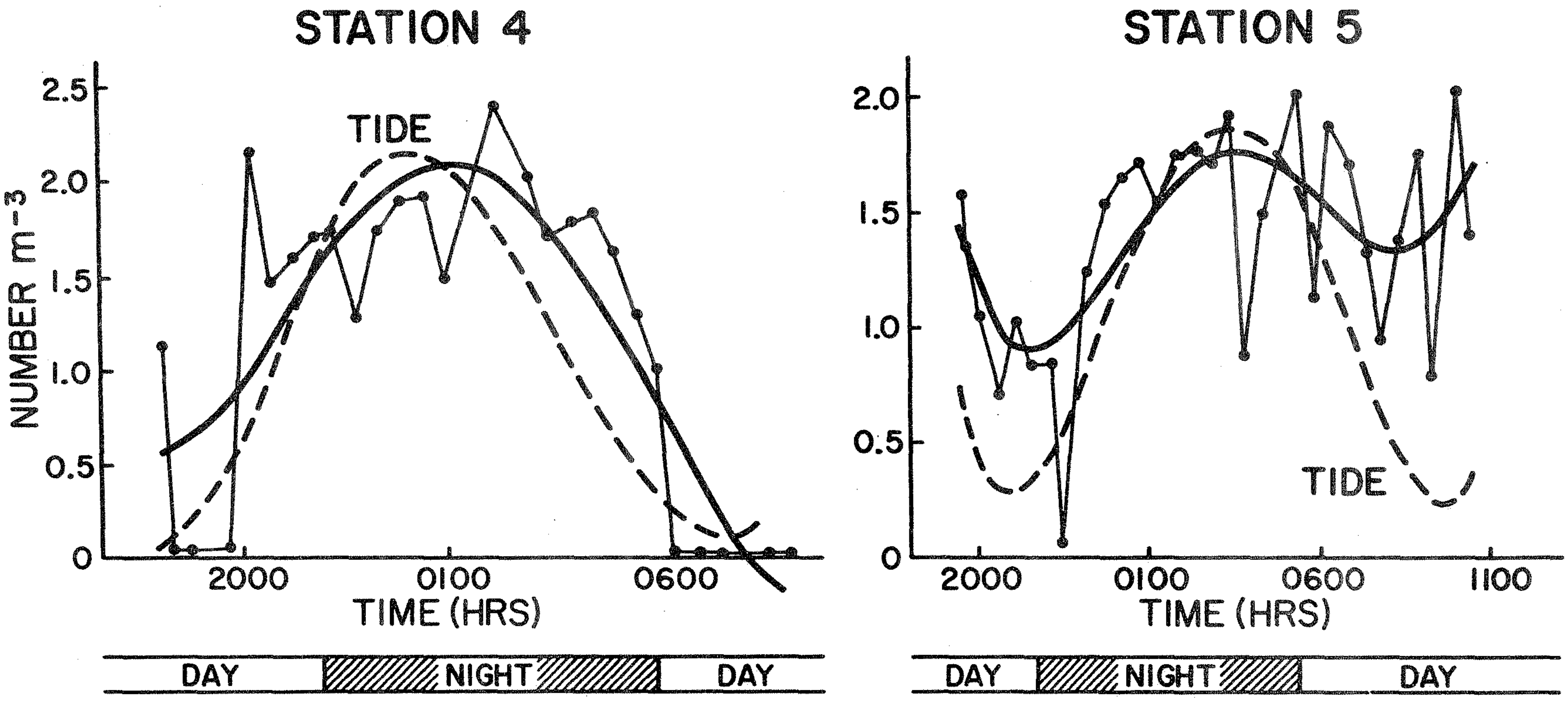

Figure 11. Pseudocalanus sp. - no m^{-3}; Station 4, Station 5, June 1978.

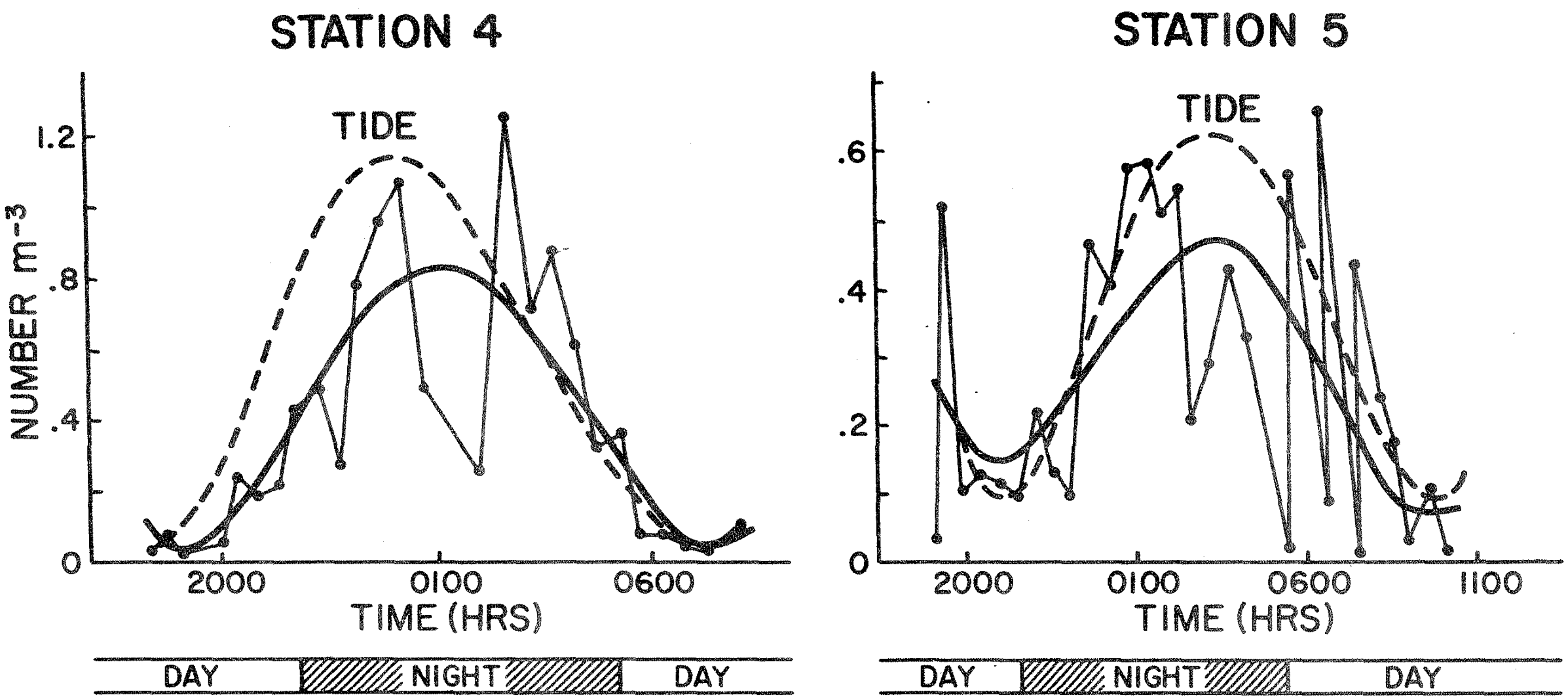

Figure 12. Sagitta elegans - no m^{-3}; Station 4, Station 5, June 1978.

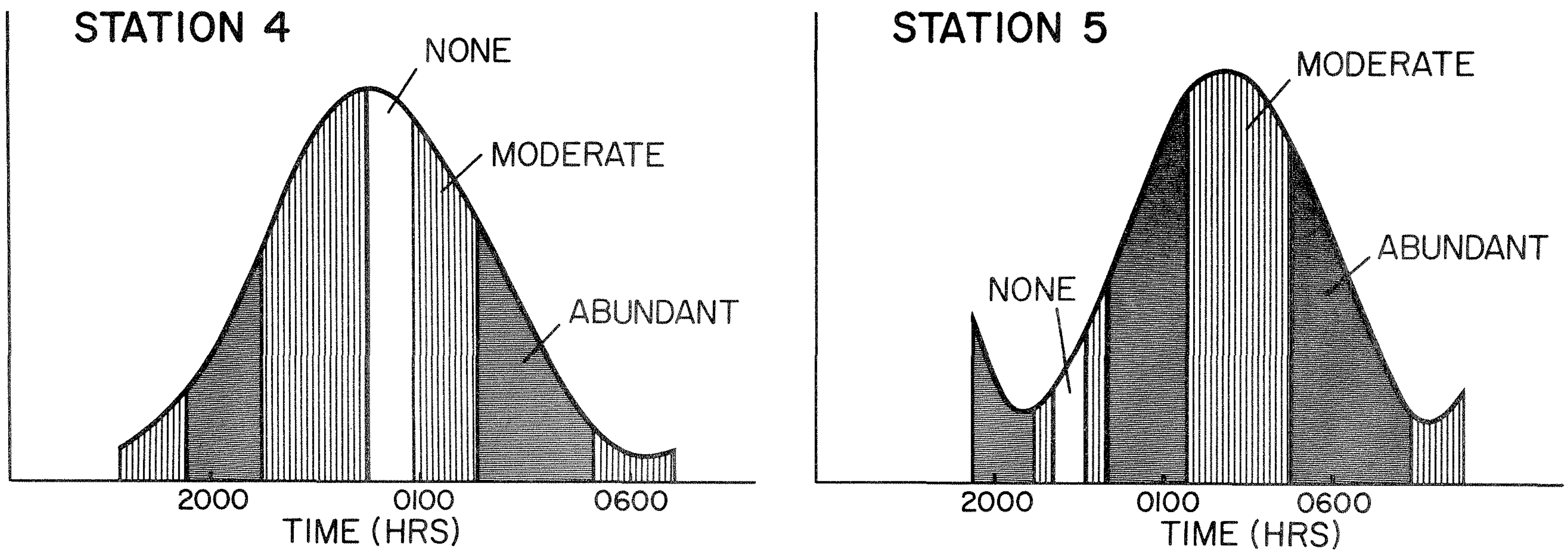

Figure 13. Estimated abundance of detritus; Station 4, Station 5, June 1978.

the clogging was monitored by using two independant measures of the flow; one inside the net by a flowmeter mounted in the centre of the mouth and one taken from the opposite side of the ship at the same depth and time using a current meter. Comparing the results from both readings, the pattern appears essentially the same, (Fig. 14). However, calculated volumes taken from the net meter, tend to lag very slightly behind those from the current meter, suggesting a small effect, but the velocities reached essentially the same maxima. The current meter values were used for the calculations because the flow meter instrument in the net was designed for high speed sampling and did not react in a linear manner at current speeds below approximately 1 knot.

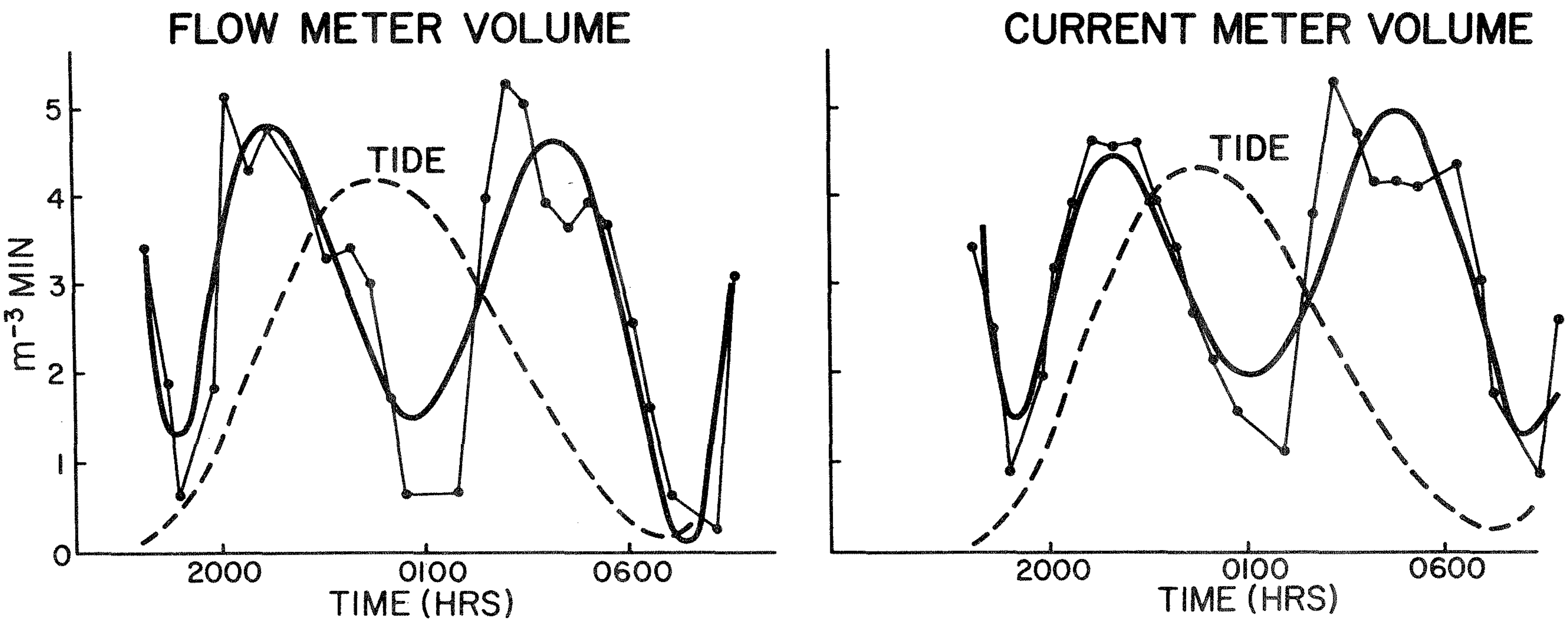

Figure 14. Flow meter volume and current meter volume; Station 4, June 1978.

III. CRUISE OF THE CSS DAWSON, 4-22 AUGUST 1978, CHIGNECTO BAY.

METHODS

During the course of seismic surveys when the ship was steaming in excess of 4 knots, a 15 cm diameter Icelandic highspeed sampler, fitted with a 308 μm mesh net, was deployed at various depths. The length of the tows varied from 15 to 30 min. Similar tows of 10 min duration were obtained when the ship steamed east or west between grab sample stations. Fifty-seven samples were obtained, covering all hours of the day and depths from the surface to about 30 m (Fig. 1).

Samples were treated as in the June study, yielding a numerical estimation of species abundance and an areal distribution of biomass.

RESULTS

The major characteristics of the zooplankton populations was the general dominance by copepods, the occasional abundance of other taxa and much variation in the total counts. The most commonly found copepod species were: *Acartia hudsonica*, *Eurytemora herdmani*, *Pseudocalanus sp.*, *Centropoges hamatus* and *C. typicus* and the occasional *Calanus fimmarchicus* and *Labidocera aestiva*. *Neomysis americana* was the most abundant mysid species, present with *Mysis stenolepis*. *Sagitta elegans* was the only chaetognath present and *Pleurobrachia pileus* the only ctenophore. Meroplanktonic larvae of barnacles, decapods, isopods, polychaetes, amphipods and gastropods were common and occasional small fish, pelagic polychaetes and the decapod *Crangon septimspinosa* were encountered. A distribution map was constructed for the biomass of the samples less than 1,000 μm

(Fig. 15). As the samples were taken from a variety of depths and times of the day and night, it becomes difficult to coordinate all samples into one instantaneous picture. Ideally, we would want samples taken from similar conditions of the tide, depth and time of day, but due to the rather opportunistic nature of the cruise, a synoptic survey was not possible.

IV. GENERAL DISCUSSION

The most striking feature of the anchor station sampling in June was the evidence of tidal periodicity. The periodic oscillation varied with different species, which suggested that they were reacting to different environmental conditions.

The question however arises as to whether the zooplankton periodicity is more closely related to the diurnal tidal cycle or solar cycles. Many authors including Wickstead (1968) have described a pattern of movement toward the surface during the darkness, followed by a withdrawal from the surface during daylight. This could explain the pattern of the chaetognaths and of Pseudocalanus, which do increase in numbers near the surface waters at night and decrease toward dawn. However the majority of the plankton components, Acartia, Eurytemora, Centropoges, Neomysis and certain meroplanktonic larvae, tend to react oppositely to this pattern, with a decrease from the surface at night and an increase during the day. As the sampling did not extend very far into the daylight hours, we cannot be certain if animals were responding to light. However the waters in these upper embayments are characterized by extremely high suspended sediment concentrations (100-2,000 mg/l) as a result of strong tidal mixing and vertical turbulence, which would make it difficult for zooplankton to

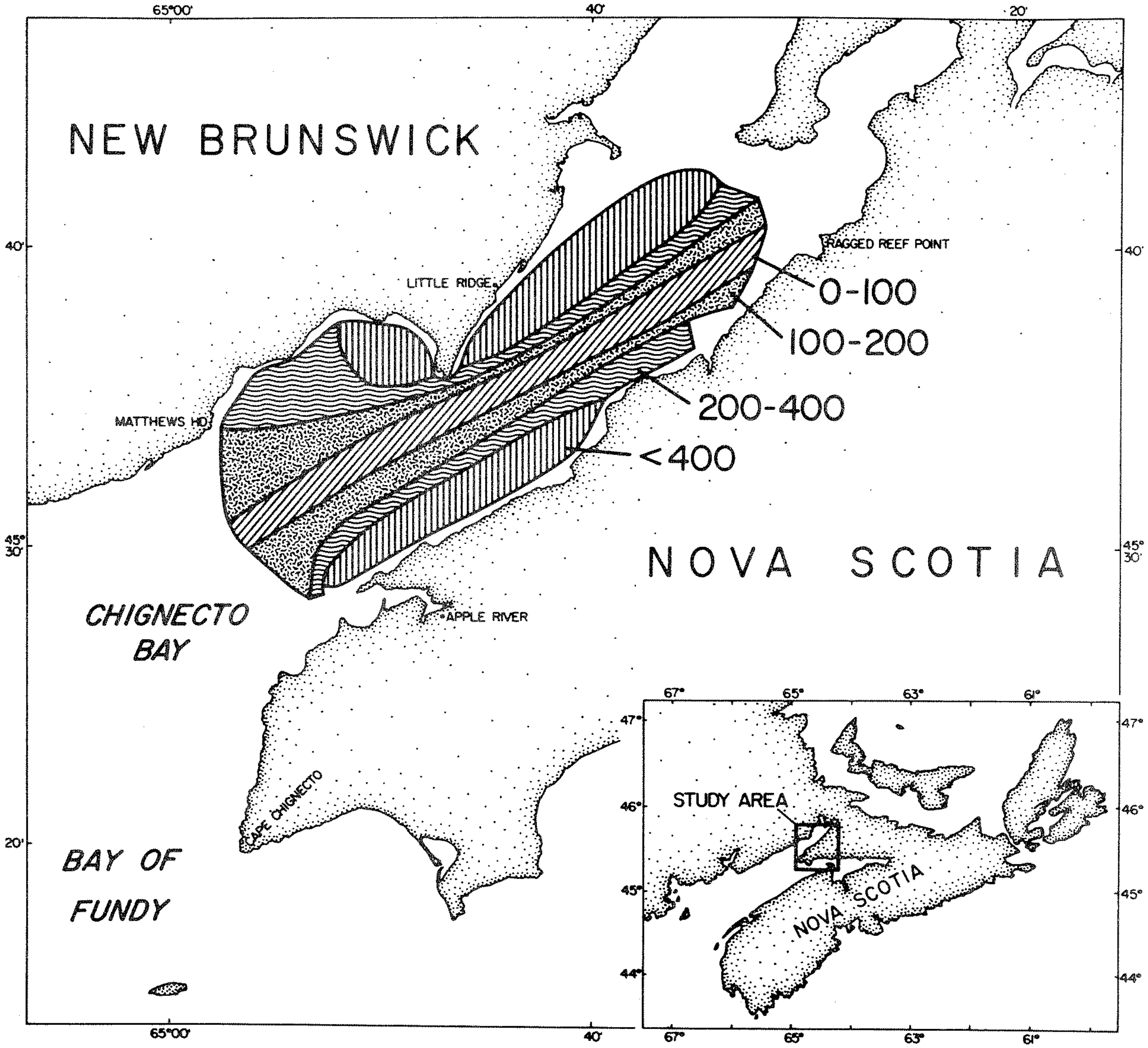

Figure 15. Distribution of biomass (less than 1000 μm), mg m^{-3}, August 1978.

maintain vertical distribution or change positions in response to light stimulus. As well, light penetration is restricted to the near surface layer (1% light level occurs at a depth of 1-2 m, N. Prouse, pers. comm. 1979). Thus, it is quite likely that sunlight has little or no effect on the periodicity of the zooplankton in this area, which is further substantiated by comparing results from Station 4 and Station 5, sampled three days apart. Although the tidal phase has shifted by almost 2 1/2 h, the times of twilight remain essentially the same. Yet the maxima and minima for the animals have also shifted by over 2 hours, apparently in response to the tidal phase shift. Based upon this evidence, it appears safe to assume that the pattern of the zooplankton variation is most strongly related to the tide at the mouth of Shepody Bay.

As in the June study, the horizontal sampling in Chignecto Bay during August proved to be of limited value in that it did not allow for possible concentrations of animals in layers or locations not included in the hauls. However, it indicated wide differences in abundance which satisfy the objectives of this preliminary survey.

Unfortunately the estimation of the abundance of these samples is subject of many sources of variability. Sameoto (1975) found this variability creates special difficulties in determining how representative local samples are of the average densities of animals present over a wider area or longer time. In addition to the variability in samples due to spatial heterogeneity in density and composition, there are strong tidal influences and vertical migrations in response to light for the zooplankton.

We might now look for some controlling factor in the distribution of the zooplankton. Ketchum and Keen (1952) discussed the circulation in the Bay of Fundy and stated that there is a net inflow of more saline water along the Nova Scotia shore, with the river water mainly escaping along the New Brunswick side. They postualted that the same exchanges may be expected for any material or organisms freely transported by the water. Strong and Daborn (1979) noted the same residual counter-clockwise gyre in Chignecto Bay. Redfield (1950) demonstrated that along the south shore of the Bay of Fundy, the mean range of the tides is somewhat greater than it is along the north shore. The difference in sea surface level would augment the tendancy for the waters to circulate in a counter-clockwise direction.

The circulation pattern is also reflected in the distributions of the zooplankton. Examination of the biomass (Fig. 15) suggests that the highest concentrations of the animals are associated with the shorelines, substantiating the premise that the distributional patterns might be related to the non-tidal cyclonic circulation pattern. The temporal investigations revealed that estuarine-related zooplankton species were associated with water masses of particular temperature and salinity at the mouth of Shepody Bay. This relationship was also maintained in Chignecto Bay. In June, they had shown a marked association with the warmer, less saline waters of Shepody Bay and in August were found predominantly in the upper estuaries. That species have their own characteristic behavioural patterns, each interacting with features of the hydrographic system of the area to produce their distinctive distribution, is implied.

In a paper on the Bay of Fundy macrozooplankton, Iles (1975) also suggests that the distribution of zooplankton species in the Bay of Fundy reflects an ecological structure of the zooplankton units related to specific hydrographic features. There appear to be distinct populations, responding closely to their physical environment, in both their distributions and periodicity.

V. ACKNOWLEDGEMENTS

I would like to especially thank Dr. R.J. Conover of the Bedford Institute of Oceanography, for providing invaluable advice and guidance in the design and implementation of this program, as well as M.A. Paranjape and Dr. D.D. Sameoto. I would also like to thank Messrs. Andy Sherin and David Brown of the Institute Computing Facilities for assistance in data presentation. I want to especially acknowledge Dr. Graham Daborn of Acadia University for collecting the August samples for this study, Mike Dadswell of St. Andrews Biological Station for assistance in identification of macrozooplankton and Dr. Carl Amos of the Atlantic Geoscience Centre, for providing sampling space on the Oran II in June, and for sharing his hydrographic data. Special thanks to Dr. D.C. Gordon Jr. of the Marine Ecology Laboratory for final review of the text.

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VII. APPENDICES

APPENDIX 1a. Organisms collected occasionally at Station 4, June 1978.

Taxon	Tide low-mid	mid-high	high-mid	mid-low
Microgadus tomcod	*		*	*
Pleurobrachia pileus		**	**	*
Crangon septimspinosa		*		*
Decapod zoea	*	***	***	***
Barnacle naupli	*	***	***	**
Tomopteris sp.		*	*	
Sagitta elegans (young)	**	***	**	**
Euphausid larvae	*	**	**	**
Amphipods			*	*
Isopods	*	**	**	
Polychaete larvae		***	***	**
Harpacticoids	*	**	**	**

* rare
** common
*** abundant

APPENDIX 1b. Organisms collected occasionally at Station 5, June 1978.

Taxon	Tide low-mid	mid-high	high-mid	mid-low
Microgadus tomcod	*	*		*
Pleurobrachia pileus	*	*	*	*
Crangon septimspinosa	*	*		
Decapod zoea	***	***	*	***
Barnacle naupli	***	***	***	***
Tomopteris sp.	*		*	
Sagitta elegans (young)	**	***	*	***
Euphausid larvae	***	***	*	***
Amphipods		*		
Isopods	*			*
Polychaete larvae	***	***	***	***
Harpacticoids	***	***		***

* rare
** common
*** abundant

APPENDIX 2a. Determination of best fit of polynomial curves to data - June 1978.

Biomass (dry wt) - Station 4

Degree of Polynomial	r	Residual Error
1	0.1113	0.0851
2	0.5548	0.0621
3	0.5983	0.0601
4*	0.7174	0.0475
5	0.7586	0.0436
6	0.7960	0.0395

Biomass (dry wt) - Station 5

Degree of Polynomial	r	Residual Error
1	0.0346	0.0154
2	0.1520	0.0156
3	0.1532	0.0162
4*	0.4551	0.0137
5	0.4911	0.0136
6	0.4920	0.0142

Neomysis - Station 4

Degree of Polynomial	r	Residual Error
1	0.4412	0.0723
2	0.8437	0.0269
3	0.8753	0.0228
4*	0.8753	0.0238
5	0.8762	0.0248
6	0.9056	0.0202

Neomysis - Station 5

Degree of Polynomial	r	Residual Error
1	0.3951	0.0385
2	0.4612	0.0372
3	0.5639	0.0335
4*	0.7264	0.0241
5	0.7325	0.0247
6	0.7389	0.0252

Mysid larvae - Station 4

Degree of Polynomial	r	Residual Error
1	0.0458	0.8311
2	0.8539	0.2350
3	0.8539	0.2452
4*	0.9043	0.1725
5	0.9056	0.1783
6	0.9086	0.1817

Mysid larvae - Station 5

Degree of Polynomial	r	Residual Error
1	0.5118	0.3479
2	0.7507	0.2134
3	0.7856	0.1944
4*	0.8790	0.1200
5	0.9054	0.0991
6	0.9126	0.0959

* represents the degree of polynomial used to fit the data.

APPENDIX 2b. Determination of best fit of polynomial curves to data - June 1979 (continued)

Early Mysid larvae - Station 4

Degree of Polynomial	r	Residual Error
1	0.1257	0.6303
2	0.4506	0.5317
3	0.4628	0.5470
4*	0.5149	0.5348
5	0.6317	0.4582
6	0.6349	0.4779

Early Mysid larvae - Station 5

Degree of Polynomial	r	Residual Error
1	0.2133	0.2482
2	0.3369	0.2391
3	0.3940	0.2366
4*	0.5822	0.1925
5	0.5846	0.1997
6	0.6177	0.1958

Acartia - Station 4

Degree of Polynomial	r	Residual Error
1	0.1020	1.2355
2	0.8120	0.4430
3	0.8131	0.4599
4*	0.9032	0.2614
5	0.9074	0.2626
6	0.9077	0.2746

Acartia - Station 5

Degree of Polynomial	r	Residual Error
1	0.1020	1.0944
2	0.7859	0.4384
3	0.6026	0.3631
4*	0.9307	0.1658
5	0.9310	0.1707
6	0.9317	0.1775

Eurytemora - Station 4

Degree of Polynomial	r	Residual Error
1	0.0700	0.9621
2	0.8559	0.2694
3	0.8624	0.2692
4*	0.9128	0.1832
5	0.9135	0.1906
6	0.9183	0.1893

Eurytemora - Station 5

Degree of Polynomial	r	Residual Error
1	0.2419	0.2185
2	0.6930	0.1251
3	0.8190	0.0823
4*	0.8749	0.0610
5	0.8759	0.0630
6	0.8875	0.0599

APPENDIX 2c. Determination of best fit of polynomial curves to data - June 1978 (continued)

Centropoges - Station 4

Degree of Polynomial	r	Residual Error
1	0.2002	0.3396
2	0.6672	0.2045
3	0.6672	0.2134
4*	0.7875	0.1527
5	0.7924	0.1567
6	0.8442	0.1271

Centropoges - Station 5

Degree of Polynomial	r	Residual Error
1	0.2177	0.1495
2	0.4267	0.1331
3	0.4388	0.1365
4*	0.4971	0.1324
5	0.6827	0.0978
6	0.6870	0.1009

Pseudocalanus - Station 4

Degree of Polynomial	r	Residual Error
1	0.2170	0.6827
2	0.8185	0.2464
3	0.8185	0.2570
4*	0.8403	0.2392
5	0.8492	0.2378
6	0.8810	0.2004

Pseudocalanus - Station 5

Degree of Polynomial	r	Residual Error
1	0.3583	0.2325
2	0.4180	0.2283
3	0.4435	0.2308
4	0.6342	0.1786
5	0.6628	0.1745
6	0.6639	0.1816

Sagitta - Station 4

Degree of Polynomial	r	Residual Error
1	0.0173	0.1359
2	0.7416	0.0637
3	0.7416	0.0665
4*	0.8183	0.0511
5	0.8240	0.0520
6	0.8246	0.0544

Sagitta - Station 5

Degree of Polynomial	r	Residual Error
1	0.0529	0.0532
2	0.5430	0.0390
3	0.5601	0.0394
4*	0.6291	0.0361
5	0.6801	0.0335
6	0.6935	0.0337

APPENDIX 2d. Determination of best fit of polynomial curves to data - June 1978 (continued)

Tide Height - Station 4

Degree of Polynomial	r	Residual Error
1	0.1652	175.7681
2	0.8752	44.0470
3	0.9183	30.7858
4*	0.9944	2.3078
5	0.9972	1.1877
6	0.9981	0.8617

Tide Height - Station 5

Degree of Polynomial	r	Residual Error
1	0.0693	145.3110
2	0.8510	41.7641
3	0.8871	33.3111
4*	0.9932	2.2172
5	0.9932	2.2964
6	0.9943	2.0120

Flow Meter Volume - Station 4

Degree of Polynomial	r	Residual Error
1	0.1572	262.3895
2	0.3342	248.9465
3	0.3369	259.2399
4	0.3890	259.4542
5	0.4996	240.3434
6	0.8624	86.2077
7*	0.8794	80.2559

Flow Meter Volume - Station 5

Degree of Polynomial	r	Residual Error
1	0.0361	285.4211
2	0.0917	293.9045
3	0.3090	278.4010
4	0.3568	279.3664
5	0.6364	198.3690
6	0.7674	143.0315
7*	0.7889	137.3950

Current Meter Volume - Station 4

Degree of Polynomial	r	Residual Error
1	0.0346	182.2895
2	0.3511	166.6822
3	0.3967	167.1695
4	0.4947	156.6520
5	0.5021	162.4889
6	0.8858	49.1068
7*	0.8931	48.5773

Current Meter Volume - Station 5

Degree of Polynomial	r	Residual Error
1	0.1356	143.9740
2	0.1364	149.2890
3	0.2995	143.8003
4	0.3895	139.3583
5	0.6636	95.7598
6	0.7094	88.6925
7*	0.7355	85.7034

APPENDIX 3. High Speed Tow Collections-Time of Collection, Depth (Corrected) and Location

00.00 - 06.00			06.00 - 12.00			12.00 - 18.00			18.00 - 24.00		
	depth(m)			depth (m)			depth (m)			depth (m)	
C18	5	L	C2	25	L	C1	21	U	C13	10	U
C19	5	L	C3	25	L	C4	14	U	C14	1	U
C20	5	L	C23	6	L	C5	14	U	C15	1	U
C21	6	L	C24	6	L	C6	20	U	C16	2	U
C22	6	L	C25	6	L	C7	34	U	C17	7	L
C28	6	L	C26	6	L	C8	14	U	C54	14	U
C29	6	L	C27	6	L	C9	13	U	C55	14	U
C30	6	L	C32	10	L	C10	1	U	C56	14	U
C31	10	L	C33	10	L	C11	13	U	C57	16	U
			C34	6	L	C12	10	U			
			C35	6	L	C40	8	L			
			C36	6	L	C41	8	L			
			C37	10	L	C43	6	L			
			C38	6	L	C44	5	L			
			C39	10	L	C51/52	20	L			
			C42	5	L	C53	20	U			
			C45	8	L						
			C46/47	17	L						
			C48	20	L						
			C49/50	17	L						

Dividing line between 'Upper'(U) and 'Lower'(L) Chignecto Bay is taken as Cape Enrage - Sand River.

No. of samples in Upper Chignecto Bay = 19
No. of samples in Lower Chignecto Bay = 35

APPENDIX 4a. Zooplankton Samples (308 μm mesh net fitted to a high speed Icelandic sampler) (August 1978)

Bottle No.	Date	Time	Lat/Long or Station	Depth (m)	Speed (kts)	Heading
C1	9 Aug.	13.57-14.27	45°41'/64°36'	21	5.2	216
C2	10 Aug.	11.18-11.33	45°33'/64°47'	25	9.9	59
C3	10 Aug.	11.46-11.56	24 - 23	25	7.2	82
C4	10 Aug.	12.46-12.56	45°34'/64°41'	14	6.7	316
C5	10 Aug.	13.55-14.05	45°36'/64°43'	14	6.8	100
C6	10 Aug.	14.51-14.56	15 - 16	20	7.2	107
C7	10 Aug.	14.51-14.57	15 - 16	34	7.2	107
C8	10 Aug.	16.07-16.17	45°37'/64°42'	14	6.9	108
C9	10 Aug.	16.49-16.59	45°37'/64°35'	13	6.9	87
C10	10 Aug.	17.51-18.01	6 - 5	1	6.7	262
C11	10 Aug.	17.51-18.01	6 - 5	13	6.7	262
C12	11 Aug.	17.43-17.53	17 - 18	10	5.5	280
C13	11 Aug.	18.46-18.55	45°42'/64°34'	10	6.3	282
C14	11 Aug.	18.02-18.12	18 - 19	1	5.2	258
C15	11 Aug.	18.21-18.31	19 - 20	1	5.8	267
C16	11 Aug.	18.54-19.04	20 - 21	2	4.0	267
C17	11 Aug.	20.48-20.58	26 - 25	7	5.7	30
C18	12 Aug.	00.49-00.59	45°33'/64°50'	5	6.0	91
C19	12 Aug.	01.36-01.46	45°33'/64°45'	5	6.3	89
C20	12 Aug.	03.21-03.31	45°31'/64°52'	5	6.7	268
C21	12 Aug.	04.51-04.25	44 - 45	6	5.0	270
C22	12 Aug.	05.10-05.20	46 - 47	6	5.0	270
C23	12 Aug.	06.00-06.10	48 - 49	6	4.5	270
C24	12 Aug.	06.53-07.03	50 - 51	6	5.0	70
C25	12 Aug.	07.37-07.48	52 - 53	6	5.0	80
C26	12 Aug.	08.20-08.30	45°38'/64°52'	6	6.2	74
C27	12 Aug.	11.12-11.22	45°30'/64°55'	6	5.1	262
C28	15 Aug.	01.50-02.00	45°16'/64°59'	6	6.5	80
C29	15 Aug.	03.16-03.26	45°15'/64°56'	6	6.5	116
C30	15 Aug.	04.05-04.16	45°16'/64°55'	6	2.6	226
C31	15 Aug.	05.01-05.11	88 - 89	10	5.4	259
C32	15 Aug.	06.03-06.13	86 - 87	10	5.1	90
C33	15 Aug.	06.54-07.04	85 - 84	10	5.2	90
C34	15 Aug.	07.57-08.07	45°21'/64°59'	6	5.6	270
C35	15 Aug.	08.46-08.56	45°20'/65°04'	6	5.7	268
C36	15 Aug.	09.34-09.44	45°21'/65°03'	6	5.8	87
C37	15 Aug.	10.15-10.25	45°22'/64°59'	10	6.9	85
C38	15 Aug.	11.13-11.23	45°24'/64°57'	6	5.8	266
C39	15 Aug.	11.59-12.06	45°24'/65°01'	10	6.8	280
C40	15 Aug.	12.52-13.03	45°25'/64°02'	8	6.4	83
C41	15 Aug.	13.48-13.58	45°24'/64°55'	8	7.0	78
C42	16 Aug.	11.21-12.01	45°32'/64°59'	5	5.1	112
C43	16 Aug.	13.08-13.39	45°31'/64°52'	6	6.2	19

APPENDIX 4a. Zooplankton Samples (308 μm mesh net fitted to a high speed Icelandic sampler) (August 1978) (continued)

Bottle No.	Date	Time	Lat/Long or Station	Depth (m)	Speed (kts)	Heading
C44	16 Aug.	14.31-15.04	45°45'/64°51'	5	4.9	206
C45	17 Aug.	09.31-10.01	45°27'/64°50'	8	5.0	13
C46	17 Aug.	11.00-11.20	45°44'/64°49'	17	5.0	156
C47						
C48	18 Aug.	09.38-10.08	45°28'/64°60'	20	5.0	201
C49	18 Aug.	10.30-11.00	45°27'/64°57'	17	5.1	35
C50						
C51	18 Aug.	12.10-12.30	45°33'/64°51'	20	5.0	-
C52						
C53	18 Aug.	12.45-13.16	45°33'/64°44'	20	5.5	22
C54	18 Aug.	20.35-20.50	45°35'/64°45'	14	5.4	299
C55	18 Aug.	21.07-21.22	45°36'/64°42'	14	5.1	121
C56	18 Aug.	21.47-22.02	45°35'/64°39'	14	5.0	343
C57	18 Aug.	22.36-22.51	45°40'/64°38'	16	5.1	91

APPENDIX 5. Organisms collected occasionally in 'Upper' Chignecto Bay - August 1978.

(numbers m^{-3}) filtered

Sample No.	Taxon							
	Small fish	Decapod zoea	Barnacle naupli	*Calanus fimmarchicus*	*Sagitta elegans*	Euphausid larvae	Polychaete larvae	Gastropod veligers
4						1.3	2.5	41.0
5					4.0			20.0
6						1.6	2.4	21.0
7							3.4	17.0
8		1.7	2.0		1.7		3.8	13.5
9				1.7	4.3			14.5
10	1.0							20.0
11					2.0			0.4
12	0.5							0.2
13								0.1
14		0.1			0.1			0.3
15		0.7	0.3			0.3		0.2
16		0.6	0.5		0.2	0.3	0.1	
53					6.2			33.0
54					9.0			58.0
55								40.0
56								31.0

APPENDIX 6. Organisms collected occasionally in 'Lower' Chignecto Bay - August 1978.

(numbers m^{-3}) filtered

Sample No.	Taxon									
	Crangon septimspinosa	Decapod zoea	Barnacle naupli	*Calanus fimmarchicus*	*Labidocera aestiva*	*Sagitta elegans*	Euphausid larvae	Isopods	Polychaete larvae	Gastrapod veligers
2		0.2		0.6	0.2	0.6	1.0	1.0		1.1
3		2.5				4.0	5.0			31.0
17			2.0			3.6				7.0
18		3.0	2.4				3.4			20.0
19		2.8	2.3			0.9	2.3			24.0
20										16.0
21	1.2		3.5	3.5						26.0
22						8.0			6.0	30.0
23			4.0						7.0	18.0
24		0.6	3.0			0.7	0.7		13.5	0.3
25			0.1				0.1		0.4	
26		1.8	0.2				0.5		0.4	0.2
27		1.7	0.3			0.4	0.9			
28		1.1	0.2	1.0	0.5	0.6	2.0			1.1
29						1.1	0.9			0.7
30		1.0	0.8		1.0	2.6	2.8	0.8		1.5
31		0.5	0.8	0.5		0.7	0.4		0.7	1.4
32		0.4	0.8			0.6	0.4		2.2	0.4
33			0.6					0.7	0.4	0.6
34		0.2					0.2	0.3		0.2
35		0.4	1.5			0.8	1.9			1.2
36										
37			0.3							
38		0.1	0.5							
39			2.5						0.1	
40			0.2				0.2			
41		0.1								
42		0.6	0.5			0.8	2.3			
43		0.3					0.4		0.1	
44		1.8					2.5			1.1
45						2.3	1.0			1.6
46/47				2.0	1.8	5.6			2.3	23.0
48						2.0				5.0