PHUKET MARINE BIOLOGICAL CENTER

Phuket, Thailand

RESEARCH BULLETIN NO. 39

THE COMMUNITY STRUCTURE, ABUNDANCE AND DISTRIBUTION OF ZOOPLANKTON AT THE EAST COAST OF PHUKET ISLAND, SOUTHERN THAILAND, ANDAMAN SEA.

by

PENSRI BOONRUANG

PUBLISHED BY THE CENTER

Phuket 1985

THE COMMUNITY STRUCTURE, ABUNDANCE AND DISTRIBUTION OF ZOOPLANKTON AT THE EAST COAST OF PHUKET ISLAND, SOUTHERN THAILAND, ANDAMAN SEA.

by PENSRI BOONRUANG

Phuket Marine Biological Center, P.O. Box 60, Phuket 83000, THAILAND

CONTENTS

ABSTRACT

A study on zooplankton in coastal water adjacent to mangrove forest was carried out in Phang-nga Bay and east coast of Phuket Island during April 1981 to April 1982. The zooplankton biomasses were recorded in term of displacement volume, wet weight, dry weight and ash free dry weight. The biomass expressed as dry weight and ash free dry weight were correspond very well. The maximum values of biomass dry weight were 32.32 and 32.10 mg./m.^{3} and biomass ash free dry weight were 11.12 and 12.00 mg./m.^{3} in January and April respectively. The conversion factor from dry weight to ash free dry weight was 0.434.

The highest density of zooplankton recorded was 1,047 specimen/m.^{3} in April. The density of zooplankton was highest during the north-east moonsoon season during January to April 1982 and the maximum abundance was found in the uppermost part of Phang-nga Bay.

The zooplankton communities were comprised of 35 different categories of animal groups. Copepods was found the most dominant group ranging from 30-45% and *Lucifer* was the second most dominant organism ranging from 7-30%. Other groups of zooplankton were also recorded. The proportion of meroplankton was higher than holoplankton at the innermost station in Phang-nga Bay. The seasonal occurrence of some important zooplankton groups were also observed in this study.

I. INTRODUCTION

Very little information is available on the coastal zooplankton communities along the west coast of Thailand, and only the International Indian Ocean expedition has sampled offshore stations from this area (Rao, 1973). The present study was undertaken to obtain information on zooplankton biomass and the composition of the coastal waters next to a mangrove area. The

related data on primary production and phytoplankton will be reported separately (Sundstrom *et al.*, in press). The near shore and offshore zooplankton along the west coast of Thailand is being treated in a parallel investigation.

The coastal area in Phang-nga bay was chosen because it is an area which gives high yields to traditional fisheries and at the same time harbours many types of aquacultural activities, such as fish cage culture as well as mussel and cockle culture. The annual primary production is high; Sundstrom *et al.* (in press) found values ranging from 106-4,487 mgc.m.$^{-2}$day^{-1}. An understanding of the community structure and the patterns of geographic and seasonal variations is important for estimation of fish production of the area. The aim of this plankton study is to characterize the zooplankton of Phang-nga Bay and thus to contribute to the understanding of the ecosystem, which has shown to be of great economic value.

II. MATERIALS AND METHODS

(a) The study area (Fig. 1)

The studied bay can be called an estuary according to the definition of Pritchard (1967) 'An estuary is a semi-enclosed coastal body of water which has a free connection with the open sea and within sea water is measurably diluted with fresh water derived from land drainage.' The bay is semi-enclosed and separated into western section and eastern section by Ko Yao Yai and Ko Yao Noi. The western section is Phang-nga bay, which belongs to Phang-nga Province; the eastern section is Ao Luk, which belongs to Krabi Province. These two sections are bordered by extensive mangrove forests. There are three rivers and many small channels along the mangrove border which discharge freshwater from land into the bay. Especially the upper part of Phang-nga Bay is diluted with freshwater from the Phang-nga river. During the rainy season, freshwater inflow to the upper part of the bay causes the salinity to vary considerably, between 9 and 22‰ at the surface and between 28 and 30.5‰ at the bottom in shallow areas where the depth of water is about 1 meter. In the more seaward areas with a depth of about 5 meters the salinity varied between 25 and 30‰ at the surface and between 31 and 32‰ and the bottom (Mok 1979). Samples were collected along the upper part of Phang-nga bay towards the sea along the eastern coastline of Phuket Island and comprised 15 stations (Fig. 1). The stations are the same as those used in the study of phytoplankton and primary production (Sundstrom *et al.*, in press).

(b) The zooplankton collection

Zooplankton samples were taken monthly in daytime at the 15 stations during April 1981 to April 1982 with a Marutoku net type B, diameter 45 cm., length 80 cm., mesh opening 330 µm. A flow meter was mounted at the center of the net's mouth for measurement of the flow of water through the net. At each station two oblique hauls were taken from the bottom to the surface at depths of 5-25 meters. The duration of each haul was 5 minutes and the speed of the boat about 1 knot. All samples were preserved by adding 1 part of neutralized concentrated formaldehyde to 9 parts of sea water with the zooplankton to obtain 4% formaldehyde.

(c) Analysis of zooplankton composition

One sample from each station was diluted to 500 ml. and agitated until it was well mixed; a subsample of 100 ml. was then separated and placed in a counting tray (modified from the Bagorov counting tray, see Wickstead, 1965). The zooplankton of each systematic category was counted, and the number multiplied by 5 to give the total number for the sample. To express the density of the zooplankton groups as the number of individual per cubic meter of water in the sample, the total number of specimens was divided by the volume of water filtered through the net as recorded by the flow meter.

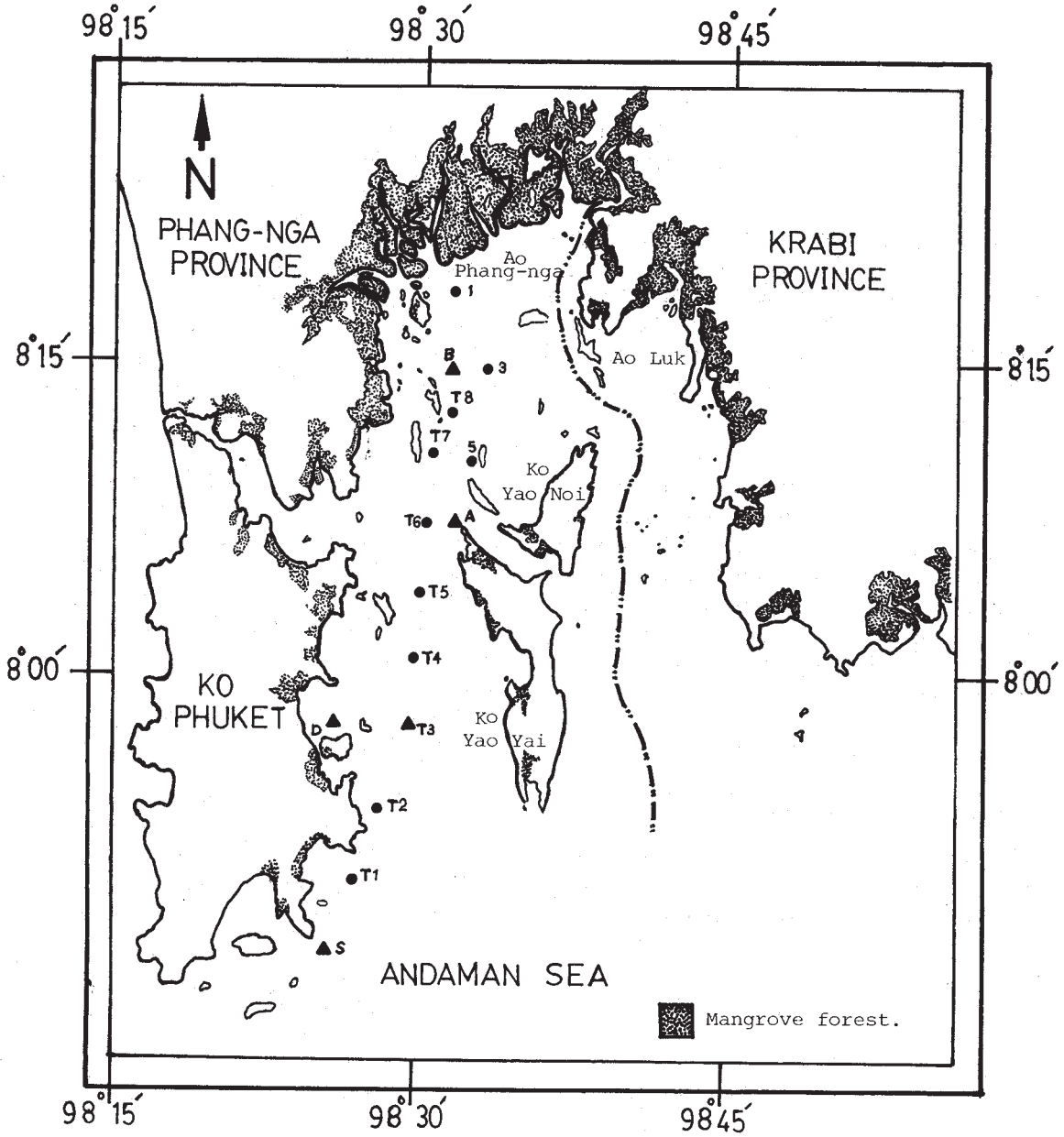

Fig. 1. Location of the sampling stations.

(d) Biomass determination

The other sample from each station was used for determination of biomass through different methods, such as displacement volume, wet weight, dry weight, and ash free dry weight. The procedures for the methods were as follows (Hernroth & Vilijamaa, 1979).

Displacement volume method. The sample was filtered with plankton net with mesh size 200 μm., which is smaller than the mesh size of the net used for towing. The plankton sample was washed with distilled water three times in order to get rid of salts and formaldehyde and the small amounts of phytoplankton and detritus. The material was left on the net for 3-4 hours to dry in the shade. Then the material was put into a graduated cylinder with water and the

volume of the plankton measured. The displacement volume of zooplankton was expressed as ml./m^3.

Estimation of dry weight. After determination of the displacement volume the material was filtered again with the same net and left to dry in the shade again. The material was weighed to obtain the wet weight and then dried in an oven at 80°C for 24 hours. The dry weight was expressed as mg./m^3.

Estimation of ash-free dry weight. After determination of the dry weight the samples were ashed in the muffle furnace at 500°C for approximately 12 hours. The material left in the jar was the ash content. The sample was allowed to cool and weighed. The ash free dry weigh is dry weigh minus ash content. The ash-free dry weight, also called organic dry weight, is expressed as mg./m^3.

III. RESULTS

(a) *Biomass and Abundance*

The zooplankton biomass was estimated with different techniques and the results were compared to show an accurate result in obtaining zooplankton biomass for this study. The zooplankton biomass values expressed in volume, dry weight and ash free dry weight were shown by monthly in Table 1.

Maximum volume of zooplankton, 0.40 ml./m.,^{3} was recorded in June and July, and the annual mean was 0.26 mg./m.^{3} The zooplankton volume is a rather poor expression of the biomass because of the highly varying water content of the different groups of animals. The biomass expressed as dry weight showed maxima of 32.32 mg./m.^{3} and 32.10 mg./m.^{3} in January and April, respectively, the annual mean being 19.68 mg./m.^{3} The biomass expressed in ash free dry weight showed maximum values 11.12 and 12.00 mg./m.^{3} in January and April 1982, respectively, with an annual mean of 8.11 mg./m.^{3} The biomasses expressed in dry weight and ash free dry weight correspond rather well. The conversion factor from dry weight to ash free dry weight was calculated, on an average it was 0.434.

The number of zooplankton organisms per m.^{3} of water in different months was also recorded (Table 1). The highest number 1,047 individuals/m.,^{3} was recorded in April 1982. The annual mean number was 682 individuals/m.^{3}

Table 1. Zooplankton Biomass. (Means of all stations.)

Month	Volume (ml./m.^{3})	Dry weight (mg./m.^{3})	Ash free dry weight (mg./m.^{3})	Conversion factor	Mean Number of Zooplankton no/m.^{3}
April 81	0.20	11.48	5.87	0.511	505
June 81	0.40	10.89	4.67	0.429	303
July 81	0.40	18.70	6.47	0.346	479
August 81	0.26	17.16	8.39	0.489	600
January 82	0.22	32.32	11.12	0.344	931
February 82	0.15	15.13	8.25	0.545	907
April 82	0.21	32.10	12.00	0.374	1,047
Mean	0.26	19.68	8.11	0.434	682
Standard deviation	0.09	9.00	2.70	0.08	279

As could be expected, there was no correlation between numbers of organism and dry weights; the variation during the year of the composition of the zooplankton (see below) shows maxima of small and large organisms which contribute in highly different ways to the dry weights and the numbers of individuals. As already stated by several authors the most informative measure of the biomass is the content of ash free dry matter (organic matter).

(b) *Distribution of zooplankton biomass*

Zooplankton volume showed much variation over the year at the 15 stations from the upper part of Phang-nga bay to the east coast of Phuket Island (Fig. 2). In general there were high volumes at the stations in Phang-nga bay and lower at the stations on the east coast of Phuket Island. Also the mangrove lined Sapam Bay (Sta. D) at the east coast showed high values.

The histograms for dry weight and ash free dry weight are shown in Figs. 3&4. The tendency to higher values at the inner stations and at Sapam Bay than at the outer stations is variable both between station and between months but shows the same general tendencies as the dry weights. The average densities for each month (Table 1) show that there were more than twice as many zooplankton organisms per $m.^3$ in April 1982 than in April 1981. The highest density of zooplankton oecurred in February and April 1982 with the maximum being 2,703 per $m.^3$ at Sta. 7 in

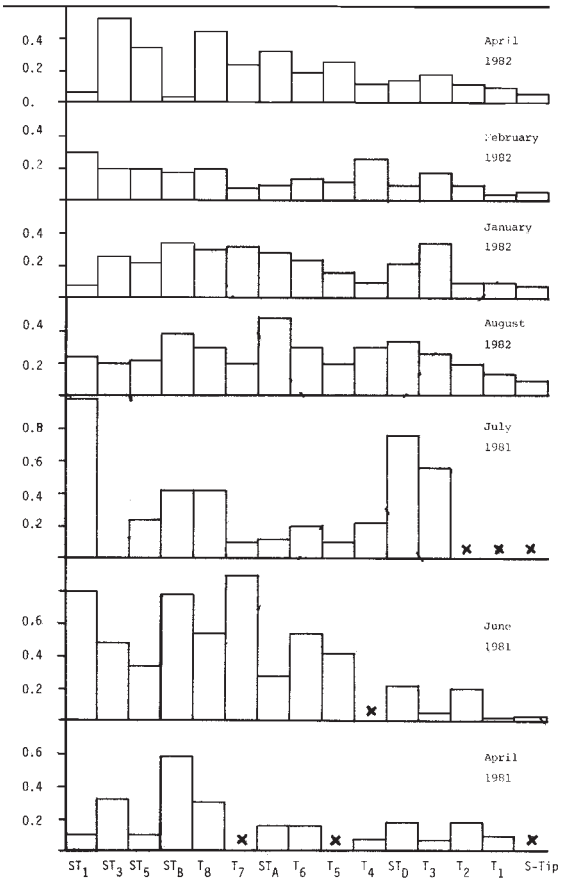

Fig. 2. Displacement Volume of Zooplankton (ml./$m.^3$)

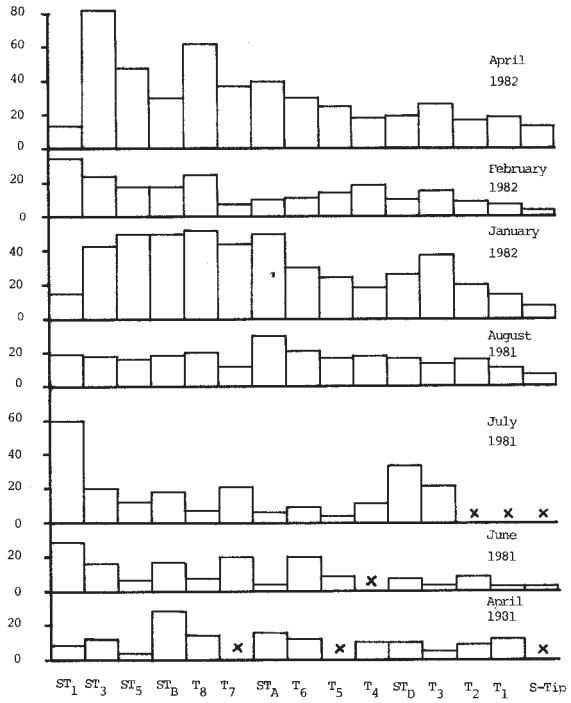

Fig. 3. Dry weight of zooplankton (mg./$m.^3$) x = no sample

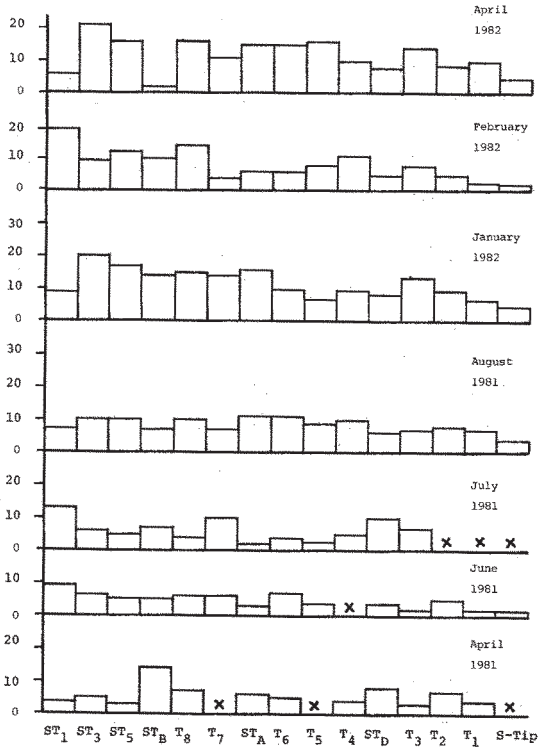

Fig. 4. Ash free dry weight of zooplankton (mg./m.^{3})
x = no sample

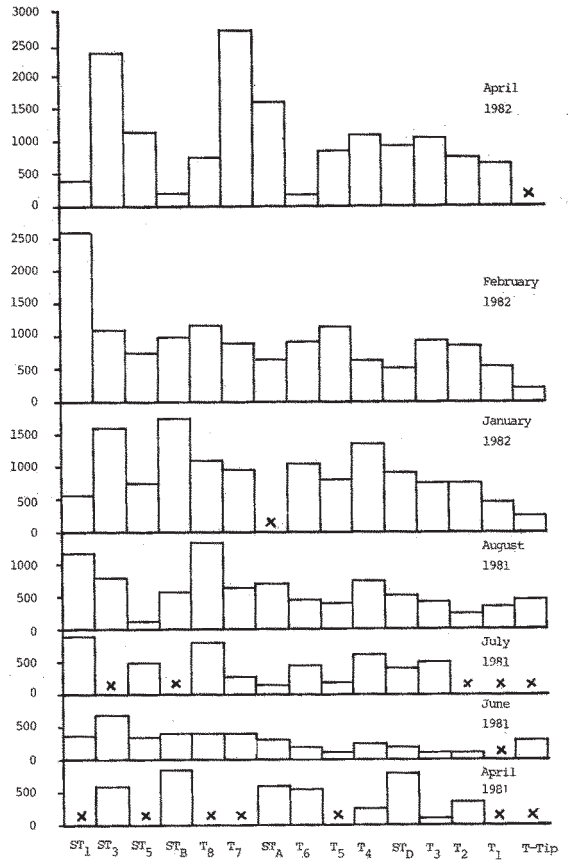

Fig. 5. Total number of zooplankton organisms per m.^{3}
x = no sample

April (Fig. 5) the densiy of the zooplankton was highest during the northeast moonsoon season during January to April and the highest numbers of organisms were found in Phang-nga Bay.

(c) *Composition of zooplankton communities*

Fig. 6 Shows the percentage of selected zooplankton categories at each station. Copepods was the dominant group in the zooplankton communities at all stations ranging from 30 to 45% in all samples. The penaeid shrimp *Lucifer* was the second most dominant form and made up 7-30% in all samples. It occurred in high number at stations in Phang-nga Bay and Sapam Bay from (Sta. 1, 3, 5, 7, 8, B and D) Chaetognatha was the third group and it constituted 3-16% of all samples. It was more abundant at the seaward stations along the east coast than in the inner part of Phang-nga Bay. Larvae of brachyurans, gastropods and bivalves were less important (1-10% each in the samples); they were most abundant in Phang-nga Bay. Larvae of shrimp and fish were obtained at all stations but they were not abundant.

The zooplankton organisms were separated into the two ecological groups, holoplankton and meroplankton (Table 2). The holoplankton was numerically abundant at all stations, and there was a slightly higher proportion of meroplankton at the innermost station in Phang-nga Bay (Fig. 7). The planktonic larvae were not identified to species, so it is not possible to state

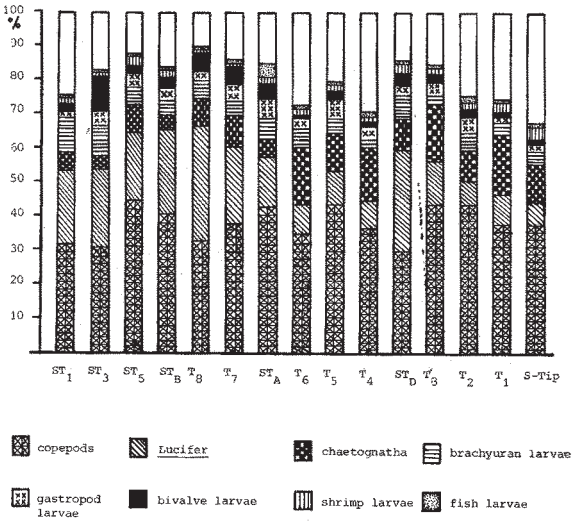

Fig. 6. Annual percentage of major groups of Zooplankton

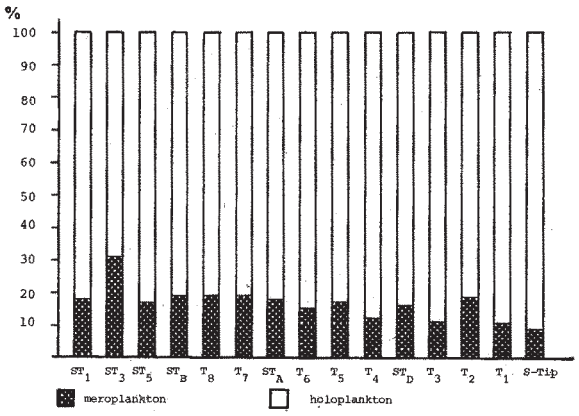

Fig. 7. Relation between holoplankton and meroplankton in percentage of total number of individual

Table 2. *List of Zooplankton Composition*

Holoplankton	*Meroplankton*
1. *Noctiluca*	24. Anthozoan larvae
2. Foraminifera	25. Polychaete larvae
3. Radiolaria	26. Cirriped larvae
4. Other protozoa	27. Phyllosoma larvae
5. Hydromedusae	28. Stomatopod larvae
6. Siphonophores	29. Anomuran larvae
7. Ctenophores	30. Brachyuran larvae
8. Ostracods	31. Gastropod larvae
9. Copepods	32. Bivalve larvae
10. Amphipods	33. Cyphonautes
11. Isopods	34. Brachiopod larvae
12. Cumaceans	35. Echinoderm larvae
13. Mysids	
14. Shrimps	
15. *Lucifer* sp	
16. *Acetes* sp	
17. Chaetognaths	
18. Larvaceans	
19. Thaliaceans	
20. Other tunicates	
21. Fish larvae	
22. Nauplius	
23. Unknowns	

whether the larvae have originated mainly from local spawnings or mainly from neighbouring areas.

(d) *Seasonal occurrence of selected groups of zooplankton*

The occurrence of some important zooplankton groups in the whole area through the year is shown in Table 3. *Noctiluca* was absent in most samples, but was very common in a few samples from February 1982. It also appeared in less number during July 1981 and January 1982 and there was no recorded in other months. Hydromedusae were present in all samples and showed highest numbers in April 1981 and February 1982. Siphonophores occurred in low number most of the year, with maxima in April 1981 and February-April 1982. Polychaete larvae were found year round, with pronounced maxima during the north-east monsoon periods (November-April) and they were especially numerous in January-April 1982. As mentioned above, the copepods were dominant throughout the study. The highest concentration was observed in April 1982 with 410.5 per m.,^{3} which was 40.8%

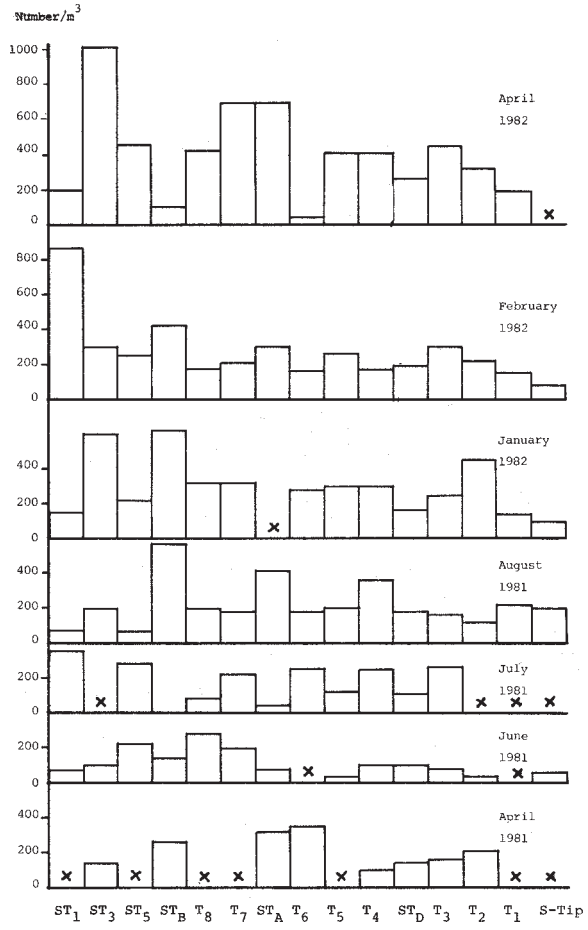

Fig. 8. Distribution of Copepods
x = no sample

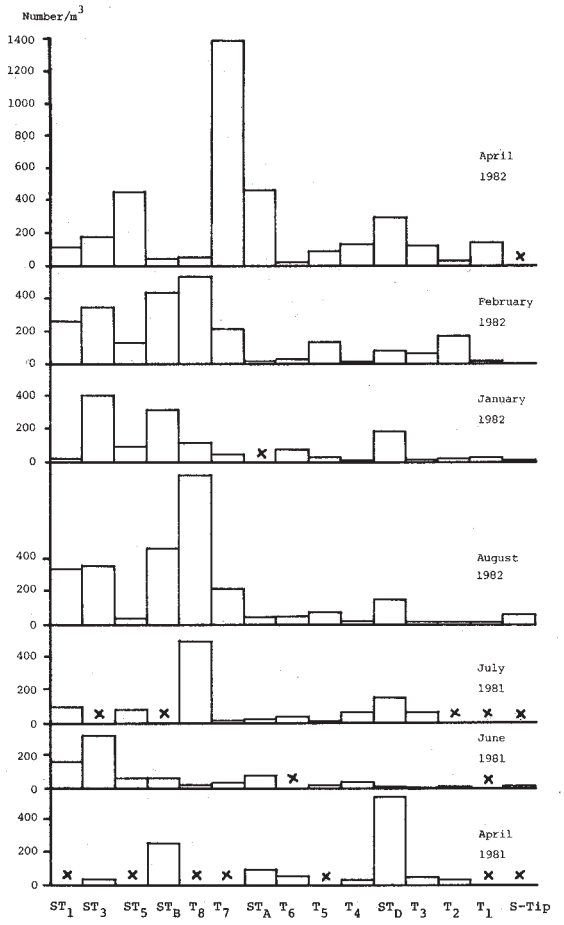

Fig. 9. Distribution of *Lucifer* sp.
x = no sample

of the specimens collected that month. Cirriped larvae occurred in great numbers in the samples from January and February 1982. Amphipods always occurred in low numbers. Shrimp larvae showed varying abundance with a maximum of 63.4 per m.^{3} in April 1981. *Lucifer* was abundant year round with a maximum of 250.9 per m.^{3} in April 1982. Stomatopod larvae were rare. Brachyuran larvae occurred year round with minimum abundance of 1.2-1.8 per m.^{3} in June-July 1981 and a pronounced maximum of 154.4 per m.^{3} in February 1982. Gastropod larvae occurred abundantly in all months with a slight peak of 40.0 per m.^{3} in April 1982. Bivalve larvae occurred in all samples but in highly fluctuating numbers; maximum and minimum abundance were observed in the same month of the two years (April 1982: 83.4 per m.^{3}; April 1981: 1.2 per m.^{3}). Chaetognaths likewise occurred year round, but with a pronounced maximum in January-April 1982. Fish larvae were found year round.

(e) *Distribution of some selected groups of zooplankton*

Figs. (8-12) show the monthly distribution patterns of some animal groups from the upper part of Phang-nga Bay to the southern tip of

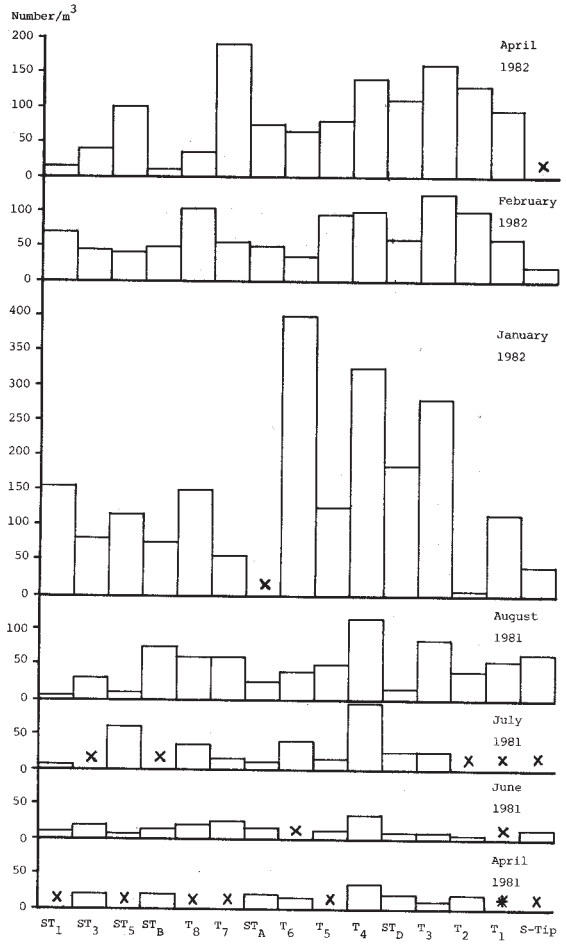

Fig. 10. Distribution of chaetognatha
x = no sample
* = specimen not found

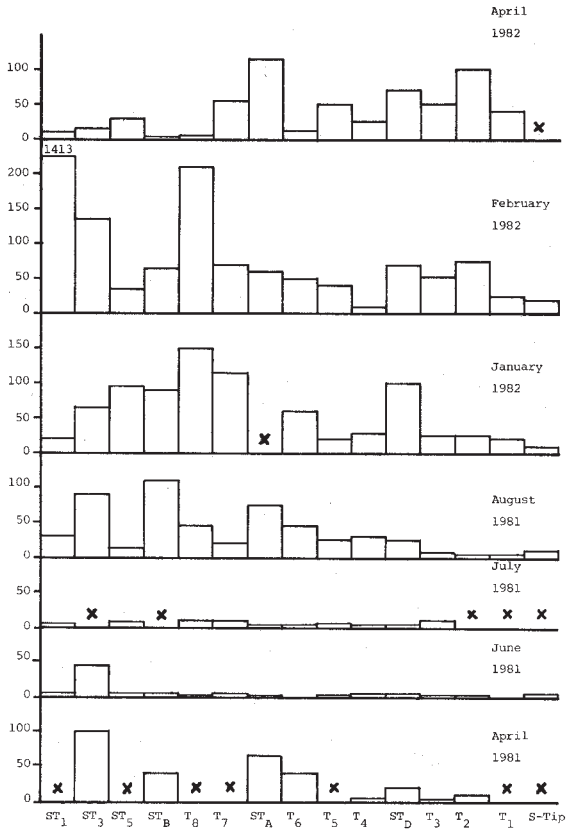

Fig. 11. Distribution of brachyuran larvae (Organism per m.3)
x = no sample

Phuket Island. Copepods (Fig. 8) were distributed throughout the whole study area with no special regional preference. *Lucifer* (Fig. 9) was clearly more abundant at the inner stations of Phang-nga Bay and at Sapam Bay than at the stations of the more open parts of the bay. The holoplanktonic chaetognatha (Fig. 10) showed a different distributional pattern with highest numbers at the outer stations. Also brachyuran and bivalve larvae (Figs. 11-12) were clearly more abundant in the inner parts of the bay than in the outer parts.

IV. DISCUSSION

The numerical abundance of zooplankton from this study corresponded very well with the biomass. The maximum biomasses recorded were 32.33 and 32.10 mg./m.^{3} of dry weight and 11.12 and 12.00 mg./m.^{3} of ash free dry weight in January and April 1982, respectively, and the maximum numerical abundances also were observed in the same months with the mean mumbers of 931 and 1,047 per m.^{3} (Table 1). Divakaran, *et al.* (1980) studied the zooplankton

Table 3. Seasonal accurrence of some selected groups of zooplankton at all stations.

Common group	April 1981		June 1981		July 1981		August 1981		January 1982		February 1982		April 1982	
	No/m.^{3}	%	No/m.^{3}	%	No/m.^{3}	%	No/m.^{3}	%	No/m.^{3}	%	No/m.^{3}	%	No/m.^{3}	%
Noctiluca sp.	–	–	0.1	–	26.7	2.9	–	–	4.6	1.0	93.3	13.3	-	-
Hydromedusae	6.7	1.7	3.9	2.7	1.0	0.2	2.1	0.4	3.7	0.4	4.5	0.6	3.0	0.5
Siphonophoes	7.5	4.8	1.1	0.5	1.0	0.3	1.6	0.5	1.3	0.3	11.6	1.6	8.4	1.1
Polychaete	13.7	2.0	2.9	0.8	7.9	1.5	4.3	0.6	22.5	2.1	18.9	1.4	17.3	1.8
Ostracods	8.7	3.2	15.3	5.1	5.2	1.0	22.1	4.1	43.2	5.8	45.6	5.7	32.8	3.2
Copepods	205.2	37.7	114.4	40.4	199.5	46.6	226.3	39.8	301.8	33.2	269.6	29.5	410.5	40.8
Cirriped	0.1	–	14.1	2.6	0.1	–	–	–	42.0	4.5	23.3	1.6	7.0	0.8
Amphipods	0.3	0.1	0.5	0.4	0.3	–	0.6	0.2	1.2	0.2	2.9	0.5	2.1	0.3
Shrimps	63.4	1.8	3.8	1.0	3.6	0.9	17.8	2.6	17.9	2,5	20.0	2.5	21.0	2.4
Lucifer sp.	140.3	26.4	61.7	12.1	105.2	17.7	186.0	21.2	101.6	9.1	158.0	15.4	250.9	20.0
Stomatopods	1.4	0.5	0.7	0.2	0.1	0.1	0.9	0.2	1.3	0.3	0.5	0.2	2.0	0.3
Brachyuran	34.8	6.0	6.9	1.8	5.2	1.2	34.8	5.1	58.2	6.2	154.4	10.7	40.7	4.4
Gastropods	18.1	4.1	18.4	7.2	19.1	4.6	21.3	3.1	27.7	2.8	33.1	3.3	40.0	2.9
Bivalve	1.2	0.2	9.8	3.3	20.1	4.7	11.1	1.8	37.9	3.4	12.5	1.4	83.4	5.5
Chaetognaths	18.9	5.6	14.7	5.8	32.5	7.3	48.5	9.0	150.4	17.8	67.1	9.0	87.8	11.9
Fish larvae	11.0	1.9	3.1	1.8	6.1	3.1	8.9	1.5	6.1	0.4	6.0	0.7	2.5	0.3

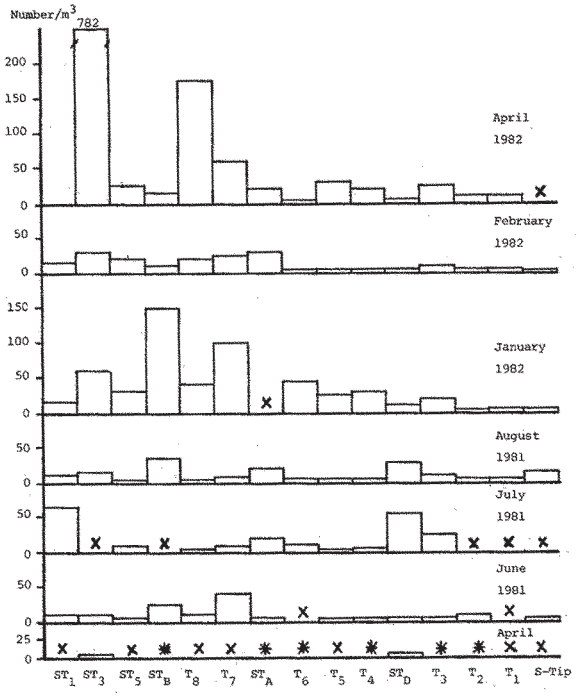

Fig. 12. Distribution of bivalve larvae
x = no sample
* = no specimen not found

of inshore waters at the south west coast of India and found the high biomass values during January and April whereas the period of high numerical abundance was August to October. The high numerical value in August was due to a bloom of cladocerans while the high biomasses in January was caused by swarms of tunicate *Oikopleura* sp. and in April by coelenterates. In this study the high dry weights and numerical abundances in January, February and April were due to increased numbers of almost all groups of animals (Table 3).

It is well known that plankton collecting with only one type of net will not sample the total zooplankton community because of the varying size of the zooplankton organisms (Unesco, 1968). However, the standard plankton collecting method used here is well suited for obtaining information about the composition of the coastal zooplankton community containing many larval forms of ecologically and economically important groups. Among the important groups which were obtained in disproportionately low numbers should be mentioned the penaeid *Acetes* and the mysids; these two groups can be collected in great number when using larval nets (Boonruang & Janekarn, 1985). It should also be mentioned that the time of collection of the plankton sample is important because many plankton organisms perform daily vertical migrations. Many quantitative plankton studies have found that plankton samples taken at night have higher biomass than day samples (Nair, *et al.*, 1978). In this study plankton collecting was made only during the daytime.

The percent composition of zooplankton abundance of some several of the major groups

of zooplankton were shown to be more abundant at the inner part of Phang-nga bay than in the more open area and only the chaetognaths group was more abundant in the outer area. The chaetognaths are holoplanktonic, and their distribution corresponds well with the observation that the meroplanktonic groups are most abundant at the inner stations in Phang-nga Bay. This indicates that the inner part of Phang-nga Bay is suitable as a nursery ground for many economically important animals because some of the main planktonic predators like chaetognaths, siphonophores and medusae are less abundant here than in the outer part of the bay.

V. CONCLUSIONS

1. The biomass of zooplankton was measured with different methods such as displacement volume, dry weight, ash free dry weight for organic carbon, and number of organism. The dry weight and ash free dry weight were correspond very well by showing their maximum values of biomass during January and April 1982. The conversion factor, dry weight to ash free dry weight for the zooplankton was 0.434.

2. The highest values of 2600-2700 No/m.^{3} were found at the inner part of Phang-nga Bay during February to April 1982. The average number of zooplankton was 682 No/m.^{3} in this studied area.

3. The zooplankton community in Phang-nga Bay comprised of copepods averaged 30-50%, *Lucifer* averaged 7-30% and chaetognatha averaged 3-16% of the total zooplankton.

4. The seasonal occurrence of the zooplankton groups appeared to be more abundance during the northeast monsoon period (November-April).

5. The distribution patterns of zooplankton groups showed more abundance in the inner parts than in the outer parts of the bay. Except copepods were distributed throughout the study area and chaetognaths occured in high numbers at the outer part of the bay.

ACKNOWLEDGMENTS

The author is grateful to Mr. Jorgen Hylleberg for supporting the equipment used in this study. I am thankful to Dr. Claus Nielsen for his comments and linguistic revision of the manuscript. I also wish to thank Mr. Vuthichai Janekarn, Miss Supatra Panrong, Miss Mukda Limpanawattanakul and Mr. Somkiat Khokiattiwong for all their helps in the field work and sorting the animal materials.

REFERENCES

Boonruang, P. & Janekarn, V., 1985. Distribution and abundance of Penaeid postlarvae in mangrove areas along the east coast of Phuket Island, Southern Thailand, Phuket Mar. Bio. Cent. Res. Bull., **36** : 22 pp.

Divakaran, O., Arunachalam, M., Nair, N.B. & Radmanabhan, K.G., 1980. Studies on the zooplankton of VIZHINJAM inshore water south-west coast of India. Mahasagar Bull. Nat. Inst. Ocean. **13**(4): 335-341.

Hernroth, L. & Viljamaa, H., 1979. Recommendations on methods for marine biological studies in the Baltic sea. Pub. Interim. Baltic Mar. Env. Comm. 12 pp.

Mok, T.K., 1979. Report on assessment of suitability of cage culture of marine fish in Phang-nga Bay. Thailand. South China Sea Fisheries. Development and Coordinating Programme Manila, Phillippines. 29 pp.

Nair, V.R., George, P. & Paulinose, V.T., 1978. Zooplankton studies in the Indian Ocean. II. From the Arabian sea during the Post-Monsoon Period. Mahasagar Bull. Nat. Inst. Ocea. **11** (1-2): 35-43.

Pritchard, D.W., 1967. Quoted from Day Y.H., 1981. The nature origin and classification of estuaries. In: Estuarine Ecology, pp. 1-6. Ed. by J.H. Day, Netherlands. A.A. Balkema Rotterdam.

Rao, T.S.S., 1973. Zooplankton studies in the Indian Ocean In: The biology of Indian Ocean, pp. 243-255. Ed. by Z. Brent & S.A. Gerlach, London: Thapman & Hall.

Sundstrom, Bo.G., Janekarn, V., Boonruang, P. & Hylleberg, J., The pelagic primary production around Phuket Island and in Phang-nga Bay. Phuket Mar, Biol. Cent. Res. Bull., (in press).

Unesco, 1968. Zooplankton Sampling. Monograph on oceanographic methodology. 174 pp.

Wickstead, J.H., 1965. An introduction to the study of tropical plankton. Hutchinson & Co., Ltd. 160 pp.

(Manuscript received June, 1985)