Coastal Marine Science 30(1): 140–145, 2006

Distribution of some species of harpacticoid copepods in east coast of Peninsular Malaysia

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Received: 25 August 2005; Accepted: 10 November 2005

Abstract— An ecological study of benthic harpacticoid copepods in East Coast of Peninsular Malaysia was carried out in Terengganu, Pahang and Johor coasts between September 2002 and March 2005. Samples were obtained from undisturbed sediment collected using a Smith McIntyre grab of 0.0768 m^2 surface area. Twelve species of meiobenthic harpacticoid copepods belonging to eight families and ten genera were identified. They were big in size and the body shape indicated their living mode as burrower or epibenthos. The density of the harpacticoid copepods was less in Terengganu and Johor compared to Pahang coast. Kruskal-Wallis analysis showed a significant different in density of these harpacticoid copepods among stations and coasts ($p<0.05$).

Key words: Harpacticoid, Malaysia, South China Sea

Introduction

In marine sediment, harpacticoid copepods represent the second most abundant meiofaunal taxon after nematodes. They are primarily benthic; a few are planktonic or live in association with other organisms. To date, the Order may already reach over 3,000 species belonging to 460 genera and 50 families (Huys and Boxshall 1991, Bodin 1997). They are small, predominantly less than 1 mm long (Thistle 1980). Harpacticoida can be found living in sediment particles interstices (mesosammic), burrowing in the sediment (endosammic) or living on the sediment surface (episammic) (Huys et al. 1996).

Harpacticoida are known to be short in their generation time. They are also widely known for their sensitivity to the environmental disturbance in their habitat (Hicks and Coull 1983, Coull and Chandler 1992). Due to the frequent epibenthic occurrence, harpacticoids are preferred prey for small demersal fishes, carnivore crustacean and polychaetes. In sandy tidal flats, particularly where small annelids and other prey are rare, harpacticoids play a decisive nutritional role for fishes (Gee 1987).

Study of harpacticoid copepods in the Malaysian coast of the South China Sea is still few. Most of the studies so far concentrated on the ecology of meiobenthos. Habitats chosen were mangrove forest (e.g. Sasekumar 1994, Huys and Gee 1996, Gee and Somerfield 1997, Zaleha et al. 2003), subtidal and coral reefs (e.g. Shabdin and Zainuddin 1990, Zaleha et al. 2001). Species number of harpacticoid copepods found in the previous study reached to 40 species in the west coast of Peninsular Malaysia (Zaleha 2002) and 25 at Redang Island (Zaleha et al. 2001). The most important families were Ectinosomatidae, Canuellidae, Longipedidae, Harpacticidae, Diosaccidae and Ameiridae.

This study aimed to determine the spatial distribution of dominant harpacticoid copepods in the coast of Malaysian South China Sea. The information will be useful for the coastal management planners and fisheries department as well as for the activities of biodiversity conservation.

Materials and Methods

Study area

The study area covered coastal water of Terengganu, Pahang and Johor. Transects were laid 5 km from the shoreline perpendicular to the open sea starting from selected area In Terengganu coast, samples were taken from Kuala Besut to Dungun water whereas in Pahang from Kuantan New Port to Endau water and in Johor from Kuala Mersing to Teluk Penawar. Seven transects separated 15 km apart were established in Pahang, six in Terengganu and Johor. Each transect had four stations situated at every 15 km started at 5 km from the coastal line toward the open sea (Fig. 1). Samplings in Terengganu, Pahang and Johor were carried out during September 2002 to April 2003, October 2003 to April 2004 and September 2004 to March 2005, respectively.

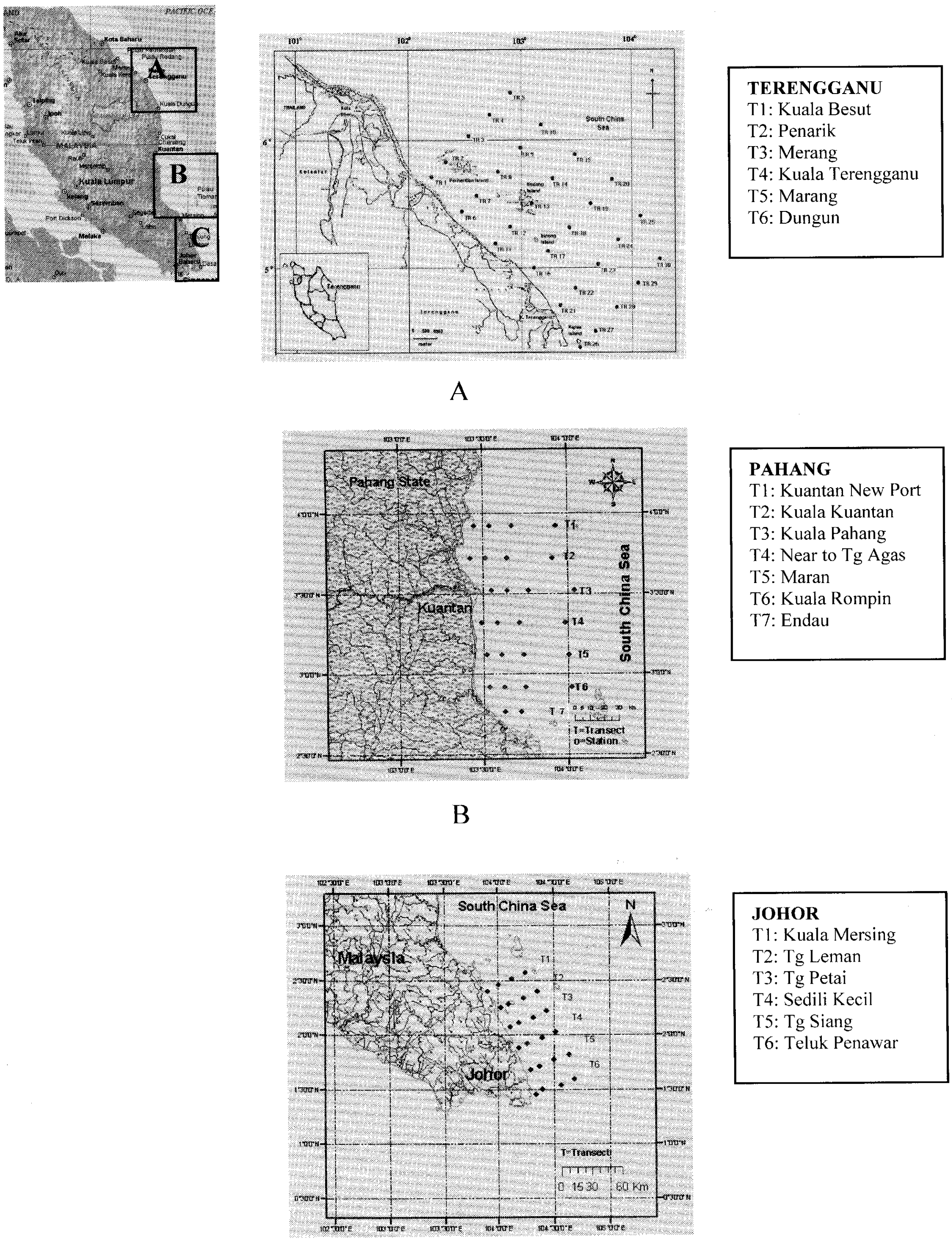

Fig. 1. Location of the study area in the East Coast of Peninsular Malaysia. A; Terengganu, B; Pahang, C; Johor.

Field sampling

Sediment samples were obtained using a Smith McIntyre grab with the area of $0.0768\,m^2$. The sediment was transferred to a tray and five replicate cores (34 mm in diameter) of sediment were randomly taken from the sediment surface (modified from McIntyre and Warwick (1984)). The core sample was then put into bottle and fixed with 10% neutralize formalin with Rose Bengal stain and brought to the laboratory for further analyses.

Laboratory analysis

In the laboratory, the sediment was put into 500 ml beaker and decanted with filtered seawater before sieving it through meshes of 500 μm and 62 μm opening. The fauna retained in the 500 μm sieve were considered as macrobenthos and on the lower as meiobenthos.

Table 1. Summary of setal formula of harpacticoid species found in the present study.

Species	Endopod			Expod		
	P2	P3	P4	P2	P3	P4
Brianola stebleri Monad, 1972	1.1.122	1.1.112	1.0.112	0.1.121	0.1.121	0.0.121
Cletodes sp.	1.112	1.123	1.122	0.1.223	0.1.223	0.1.223
Stenhelia clavus Boeck, 1865	0.2.121	1.1.122	1.1.121	0.1.123	0.1.123	0.1222
Stenhelia sp.	1.1.121	1.1.321	1.1.221	1.1.223	1.1.223	1.1.223
Amphiascus cinctus Sars, 1905	modified	1.2.321	1.1.221	1.1.223	1.1.323	1.1.323
Rhyncolagena levantia Por, 1964	1.1.221	1.1.221	1.1.221	1.1.223	1.1.123	1.1.123
Halectinosoma brunneum Lang, 1944	1.1.223	1.1.223	1.1.232	1.1.221	1.1.221	1.1.221
Paralaophonte octavia Lang, 1944	0.220	0.123	0.121	0.1.223	0.1.223	0.1.123
Parastenhelia hornelli Thompson & T.Scott, 1903	1.1.121	1.1.221	1.1.221	0.1.123	0.1.223	0.1.323
Parastenhelia sp.	1.1.121	1.1.221	1.1.221	0.1.123	0.1.223	0.1.323
Phyllopodosyllus borutzkyi T.Scott, 1906	0.3	1.3	1.3	1.0.022	1.0.022	1.1.222
Dactylopusia crassipes Lang, 1936	1.2.221	1.2.321	1.2.221	1.1.223	1.1.323	1.1.323

Harpacticoid copepods were sorted out from the benthos samples using a small loop into cavity blocks. Specimens morphologically 'look alike' were placed together in one cavity block. Samples were then preserved in 70% ethanol. Due to the need of dissection of specimen, only specimen with at least 20 individuals in a block was processed for further identification.

Each harpacticoid copepod specimen was transferred into 50% glycerol for dissection. Firstly whole body was examined and photographed using Motic image camera attached to the compound microscope. Then dissection of specimen was carried out under a dissecting microscope. To dissect, a pair of finest insect needles was used to separate 1st to 5th pair of legs and mouth parts (Coull 1977). All the dissected parts were mounted in CMCP-9 on slide under a separate cover slip. Identification of species was done referring to the keys derived from Lang (1948, 1965), Wells (1978) and compilation of Bodin (1997). All copepod samples were sorted and the adults were enumerated after identification of the species.

The density was calculated for each replicated samples and further quantified for the mean density for the station in each transect. The mean density for each station was test using Kruskal–Wallis nonparametric test to determine the relationship of mean density among the stations and coasts in East Coast of Peninsular Malaysia.

Results

Some harpacticoid species of the East Coast of Peninsular Malaysia

Twelve harpacticoid species from 10 genera were identified in this study. The species found were from eight families; Canuellidae, Cletodidae, Diosaccidae, Ectinosomatidae, Laophontidae, Parastenheliidae, Tetragonicipitidae and Thalestridae. Species identification was based on the morphological features of leg 1, leg 5 as well as the setal formula of setae distributed on the endopod and exopod of leg 2 (P2), leg 3 (P3) and leg 4 (P4). Table 1 summarized the setal formula observed for each species identified in the present study.

All species listed were big in size (larger than 200 μm). The body shape recorded from microscopic observation indicates that their mode of living was burrower or epibenthos (Table 2).

Density of the harpacticoid species in East Coast of Peninsular Malaysia

Overall, Pahang coast showed the highest mean density of harpacticoid copepods that ranged between 120$\pm$1.6 ind. 10 cm^{-2} (mean$\pm$SD) to 232$\pm$2.9 ind. 10 cm^{-2} compared to Terengganu (62$\pm$1.4 to 169$\pm$33.4 ind. 10 cm^{-2}) and Johor (61.8$\pm$1.9 to 97$\pm$4.1 ind. 10 cm^{-2}) coasts (Fig. 2). There was a significant difference ($p<0.05$) in the mean density among coasts.

In Terengganu coast, the density decreased at the third station in transects 2 (Penarik water), 4 (Kuala Terengganu water) and 6 (Dungun water) (Fig. 3). Transect 3 located in Merang water however, showed the greatest increase from second (near to Redang Island) to third station and this contributed the highest mean density (445$\pm$87.2 ind. 10 cm^{-2}) in the area. The lowest mean density (22$\pm$3.6 ind. 10 cm^{-2}) was found at the last station of this transect. There was a significant difference ($p<0.05$) in the mean density among stations.

In Pahang, the highest mean density (321$\pm$2.9 ind. 10 cm^{-2}) was found at station 3 of transect 2 located near to the Kuantan water and the lowest at the first station of transect 6 (89.5$\pm$1.1 ind. 10 cm^{-2}) located between Nenasi and Endau water (Fig. 4). The density was highest at the third station in all transects. There was a significant difference in the mean density among stations ($p<0.05$).

Table 2. List of harpacticoid copepods at sampling station of present study.

Family	Species	Body Shape (Adopted from Coull 1977)
Canuellidae	*Brianola stebleri* Monad, 1972	Fusiform, elongate
Cletodidae	*Cletodes* sp.	Dorsoventrally compressed
Diosaccidae	*Stenhelia clavus* Boeck, 1865	Elongate
	Stenhelia sp.	Elongate
	Amphiascus cinctus Sars, 1905	Fusiform prehensile
	Rhyncolagena levantia Por, 1964	Elongate
Ectinosomatidae	*Halectinosoma brunneum* Lang, 1944	Fusiform
Laophontidae	*Paralaophonte octavia* Lang, 1944	Fusiform compressed
Parastenheliidae	*Parastenhelia hornelli* Thompson & T.Scott, 1903	Elongate
	Parastenhelia sp.	Elongate
Tetragonicipitidae	*Phyllopodosyllus borutzkyi* T.Scott, 1906	Fusiform, prehensile
Thalestridae	*Dactylopusia crassipes* Lang, 1936	Dorsoventrally compressed

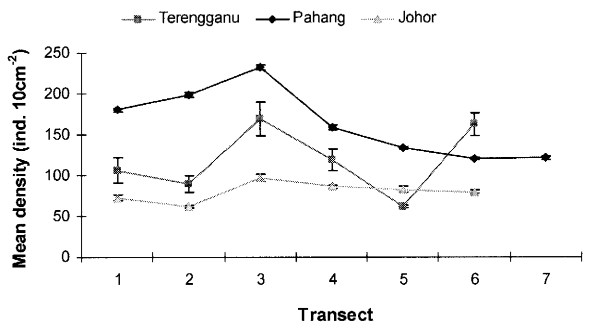

Fig. 2. Mean density (ind. 10 cm^{-2}) of harpacticoid copepods in East Coast of Peninsular Malaysia.

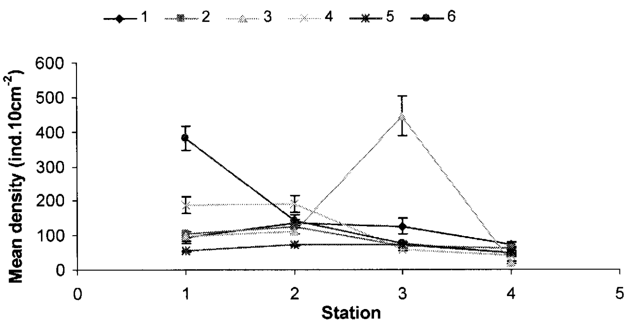

Fig. 3. Mean density (ind. 10 cm^{-2}) of harpacticoid copepods at each station for transects in Terengganu coast.

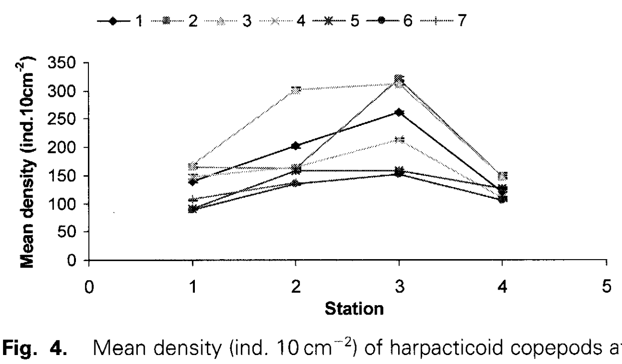

Fig. 4. Mean density (ind. 10 cm^{-2}) of harpacticoid copepods at each station for transects in Pahang coast.

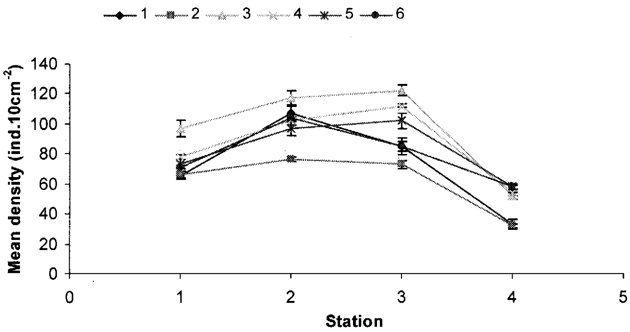

Fig. 5. Mean density (ind. 10 cm^{-2}) of harpacticoid copepods at each station for transects in Johor coast.

For Johor coast, in three transects (3,4,5), the density was highest at the third station, similar to the trend found in Pahang coast. On the other hand, in transects 1 (Kuala Mersing water) and 6 (Teluk Penawar water), the density was highest at the second station (Fig. 5). The mean density was the highest (122±3.5 ind. 10 cm^{-2}) at the third station of transect 3 located at Sedili Kecil, whereas the lowest (32±1.1 ind. 10 cm^{-2}) at the last station of transect 2, located near the Pulau Aur area. There was a significant difference in the mean density among stations ($p<0.05$).

Discussion

The species list and number found in the present study were different from those found in the intertidal zone of west coast of Peninsular Malaysia (Zaleha 2001) as well as the subtidal zone of Redang Island (Zaleha et al. 2001). This might be due to the different bottom type and microenvironment found in those study area. Zaleha (2001) studied the harpacticoids in the intertidal zone facing The Strait of Melaka. On the other hand, although the Redang Island (Zaleha et al. 2001) was located in the coastal zone of South China Sea, samples were collected in the area with a deployed subsea pipeline near Pulau Pinang area.

In this study, the density of harpacticoid copepods was found within the range reported in the previous study in Malaysia despite the limitation to the density of only 12 species. From the study of Zaleha et al. (2001) at sandy beach subtidal of Redang Island, the range of harpacticoid copepods was between 47.2 to 543 ind. 10 cm^{-2}. Idris et al. (1999) reported 40 to 976 ind. 10 cm^{-2} in Langkawi Island. However, from other tropical country, higher data compared to the present study have been reported. For example Ansari et al. (1990) reported 4716 to 5240 ind. 10 cm^{-2} in medium sand and 6555 ind. 10 cm^{-2} in course sand of Lakshadweep Island.

In general, sediment grain size is one of the primary factors affecting the abundance and species composition of meiofaunal organisms (Giere et al. 1988). Previous report showed that meiobenthic harpacticoid copepods prefer sandy sediment than muddy sediment (Coull 1970, 1985). The sediment found in Pahang was coarse sand whereas those in Terengganu and Johor were fine sand (Abd Aziz et al. 2001). This factor might contribute to the higher density of copepods in Pahang than Terengganu and Johor.

In all transects, the density of harpacticoid copepods was lower at both first and the last stations than at second and third stations. The low density in the offshore area may be due to the fine grain size of the sediment. Generally, harpacticoid are known to be sensitive to the environmental disturbance, and thus, the density was low at the first station of each transect. The environmental disturbance found in Terengganu and Pahang are fishery activities in Kuala Besut, Penarik and Marang water followed by petrochemical industry in Dungun and Kuantan New Port and aquaculture in Merang water. Meanwhile in Johor coast, the terrestrial plantation activity has attributed towards the disturbance. The less disturbance of anthropogenic activity and the stability of environment might be the possible reason for the high density of harpacticoid copepods at second and third stations. However, in areas located near to the island such as Redang, Perhentian, Kapas and Tioman Island, the density of harpacticoid species was low, although the previous report found high species richness in island ecosystem (Zaleha et al. 2001).

In conclusion, the 12 species of harpacticoid copepods reported from the east coast of Peninsular Malaysia are very important as they are able to present the trend of distribution seaward as well as along coastline from north to south of the east coast of Peninsular Malaysia. In view of their density and range of distribution, they may represent the density distribution of benthic copepods in the East Coast of Peninsular Malaysia.

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Appendix 1

Location of sampling station in East Coast of Peninsular Malaysia

1A. Terengganu coast

Station	Coordinates		Water depth (m)
	Latitude	Longitude	
TR1	5°51.7′N	102°36.2′E	10.9
TR2	5°55.6′N	102°40.1′E	21.5
TR3	6°01.2′N	102°45.9′E	33.4
TR4	6°06.8′N	102°51.6′E	39.2
TR6	5°43.7′N	102°44.1′E	8.1
TR7	5°47.6′N	102°48.2′E	24.6
TR8	5°53.2′N	102°54.0′E	39.4
TR9	5°59.0′N	102°59.7′E	39.9
TR11	5°36.4′N	102°53.1′E	15.6
TR12	5°40.4′N	102°57.0′E	27.5
TR13	5°46.0′N	103°03.3′E	21.4
TR14	5°51.7′N	103°08.6′E	46.8
TR16	5°30.8′N	103°03.3′E	15.7
TR17	5°34.6′N	103°07.2′E	20.4
TR18	5°40.4′N	103°13.0′E	50.9
TR19	5°46.0′N	103°18.8′E	46.3
TR21	5°22.2′N	103°10.6′E	15.6
TR22	5°26.1′N	103°14.7′E	35.4
TR23	5°32.0′N	103°20.5′E	53.6
TR24	5°37.6′N	103°26.3′E	50.8
TR26	5°12.2′N	103°16.2′E	14.5
TR27	5°16.0′N	103°20.2′E	32.1
TR28	5°21.8′N	103°26.0′E	41.0
TR29	5°27.6′N	103°31.8′E	58.7

1B. Pahang coast

Station	Coordinates		Water depth (m)
	Latitude	Longitude	
PH1	3°55.0′N	103°27.0′E	15.3
PH2	3°55.0′N	103°31.8′E	18.6
PH3	3°55.0′N	103°38.6′E	25.0
PH4	3°55.0′N	103°45.4′E	36.1
PH6	3°43.0′N	103°25.3′E	13.5
PH7	3°43.0′N	103°33.5′E	19.2
PH8	3°43.0′N	103°36.7′E	21.6
PH9	3°43.0′N	103°43.7′E	27.3
PH11	3°31.0′N	103°33.0′E	15.4
PH12	3°31.0′N	103°37.2′E	19.5
PH13	3°31.0′N	103°44.2′E	24.3
PH14	3°31.0′N	103°51.2′E	28.1
PH16	3°19.0′N	103°29.4′E	8.2
PH17	3°19.0′N	103°34.2′E	12.4
PH18	3°19.0′N	103°41.1′E	21.6
PH19	3°19.0′N	103°48.0′E	24.3
PH21	3°07.0′N	103°31.0′E	7.4
PH22	3°07.0′N	103°35.5′E	14.3
PH23	3°07.0′N	103°42.5′E	23.5
PH24	3°07.0′N	103°49.2′E	24.2
PH26	2°55.0′N	103°32.1′E	12.8
PH27	2°55.0′N	103°36.8′E	15.4
PH28	2°55.0′N	103°43.5′E	23.5
PH29	2°55.0′N	103°50.1′E	25.5
PH31	2°43.0′N	103°36.9′E	17.3
PH32	2°43.0′N	103°42.5′E	29.0

1C. Johor coast

Station	Coordinates		Water depth (m)
	Latitude	Longitude	
JB1	2°25.4′N	103°55.3′E	12.1
JB2	2°27.6′N	104°00.2′E	23.6
JB3	2°30.8′N	104°07.6′E	28.4
JB4	2°34.1′N	104°15.0′E	34.7
JB6	2°15.2′N	104°01.8′E	12.6
JB7	2°16.9′N	104°05.7′E	16.9
JB8	2°20.6′N	104°14.1′E	32.5
JB9	2°23.9′N	104°21.5′E	37.8
JB11	2°04.3′N	104°06.7′E	11.2
JB12	2°06.5′N	104°11.6′E	16.5
JB13	2°09.7′N	104°19.0′E	35.4
JB14	2°13.0′N	104°26.4′E	29.9
JB16	1°53.0′N	104°11.5′E	9.8
JB17	1°55.2′N	104°16.4′E	22.1
JB18	1°58.4′N	104°23.8′E	32.9
JB19	2°01.7′N	104°31.2′E	37.8
JB21	1°40.7′N	104°17.9′E	16.1
JB22	1°42.9′N	104°22.8′E	31.1
JB23	1°46.1′N	104°30.2′E	37.5
JB24	1°49.4′N	104°37.6′E	45.8
JB26	1°27.0′N	104°21.0′E	19.8
JB27	1°29.2′N	104°25.9′E	20.3
JB28	1°32.4′N	104°33.3′E	22.2
JB29	1°35.7′N	104°40.7′E	37.5