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DISTRIBUTION OF BENTHIC FORAMINIFERA IN PAHANG RIVER ESTUARY, MALAYSIA

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ABSTRACT

A study on the distribution of benthic foraminifera in surface sediment was carried out along Pahang River Estuary in the east coast of Peninsular Malaysia (South China Sea). A total of 30 sediment samples were taken from the sampling stations between latitude 3°12' and 3°47'N and longitude 103°24' and 103°43'E. A total of 22,457 individuals of foraminifera belonging to 30 families, 47 genera and 84 species were identified. The dominant species was *Amphistegina lessonii* d'Orbigny, 1826 with 4,084 individuals obtained, then followed by *Amphistegina gibbosa* d'Orbigny, 1839 (3,544 individuals) and *Asterorotalia pulchella* (d'Orbigny, 1839) (2,010 individuals). Amphisteginidae was the dominant family with 7,628 individuals (representing 33.97% of all individuals). While family with the most diverse species was Hauerinidae with 20 species. The species diversity was from 9 to 42 species. The abundance of benthic foraminifera was from 98 to 3,725 individuals. The species diversity index, H(s) was in the range of 1.41 to 2.96. A comparative analysis showed high degree of resemblance between the study area and southwestern South China Sea.

Key words: distribution, abundance, diversity, benthic foraminifera, Pahang River estuary

INTRODUCTION

Foraminifera are testate organisms, which mean that they have shells (tests). The protoplasm covers the exterior of the test. The simplest shapes are tubes or spheres. The tests are divided into chambers; more chambers are added as the cell grows. There are three basic test compositions: organic, agglutinated, and secreted calcium carbonate (Boersma, 1980). Foraminifera are aquatic organisms, found in both freshwater and marine environments. Species diversity is highest in tropical areas. Foraminifera are the most prevalent benthic organisms in deep-sea fossil records, but some are planktonic. There are many characteristics which influence foraminifera distribution, such as sediment type, food availability, oxygen levels, and hydrostatic pressure. However, species can tolerate a wide range of unfavorable conditions. Low abundance of foraminifera in benthic regions may indicate an environment under stress (Doyle, 1996).

During the last few decades the deep-water assemblages of the north-western and central parts of the South China Sea were successfully investigated. The studies of benthic foraminifera in the China Seas were presented in taxonomic monographs by Brady (1884) and Millett (1904). The first analyses of benthic foraminifera from the South China Sea focused on the shelf areas. Waller (1960) analysed surface samples along the South China coast and distinguished four assemblages related to water depth. Biswas (1976) examined the depth-related distribution of recent benthic foraminifera from the Sunda shelf. Miao and Thunell (1993, 1996) studied the recent, deep-sea benthic foraminiferal distribution patterns along two transects from the eastern and southern margins of the South China Sea. The purpose of this study was to determine the distribution of benthic foraminifera in Pahang River Estuary in the east coast of Peninsular Malaysia.

MATERIALS AND METHODS

A total of 30 sediment samples were collected from 30 sampling stations around Pahang River estuary, east coast Peninsular Malaysia. The Pahang River estuary is located at Pekan which is situated 50 km

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south of Kuantan. The location of sampling stations is between latitude 3°12' and 3°47'N and longitude 103°24' and 103°43'E (Fig. 1). All the samples were taken from the sediment surface using a Grab Sampler of Petite Ponar type. The foraminifera samples were prepared by wet filtration washings. In the laboratory, the samples were washed over three different size sieves: 500 mm, 150 mm and 0.063 mm. The specimens were picked, identified and counted. All the specimens were picked from the dried samples.

A number of systems of quantitative analysis were applied to the fauna, including the simple species diversity (number of species in each sample), abundance (specimen number in each sample), and dominance (percentage of the most abundance species in sample). The Shannon-Wiener's diversity indexes, H(s) were calculated using PAST (Palaeontological Statistics) software. The coordinate and faunal compositions are shown in Table 1. The species were identified using Scanning Electron Microscopy (SEM) and Light Microscopy

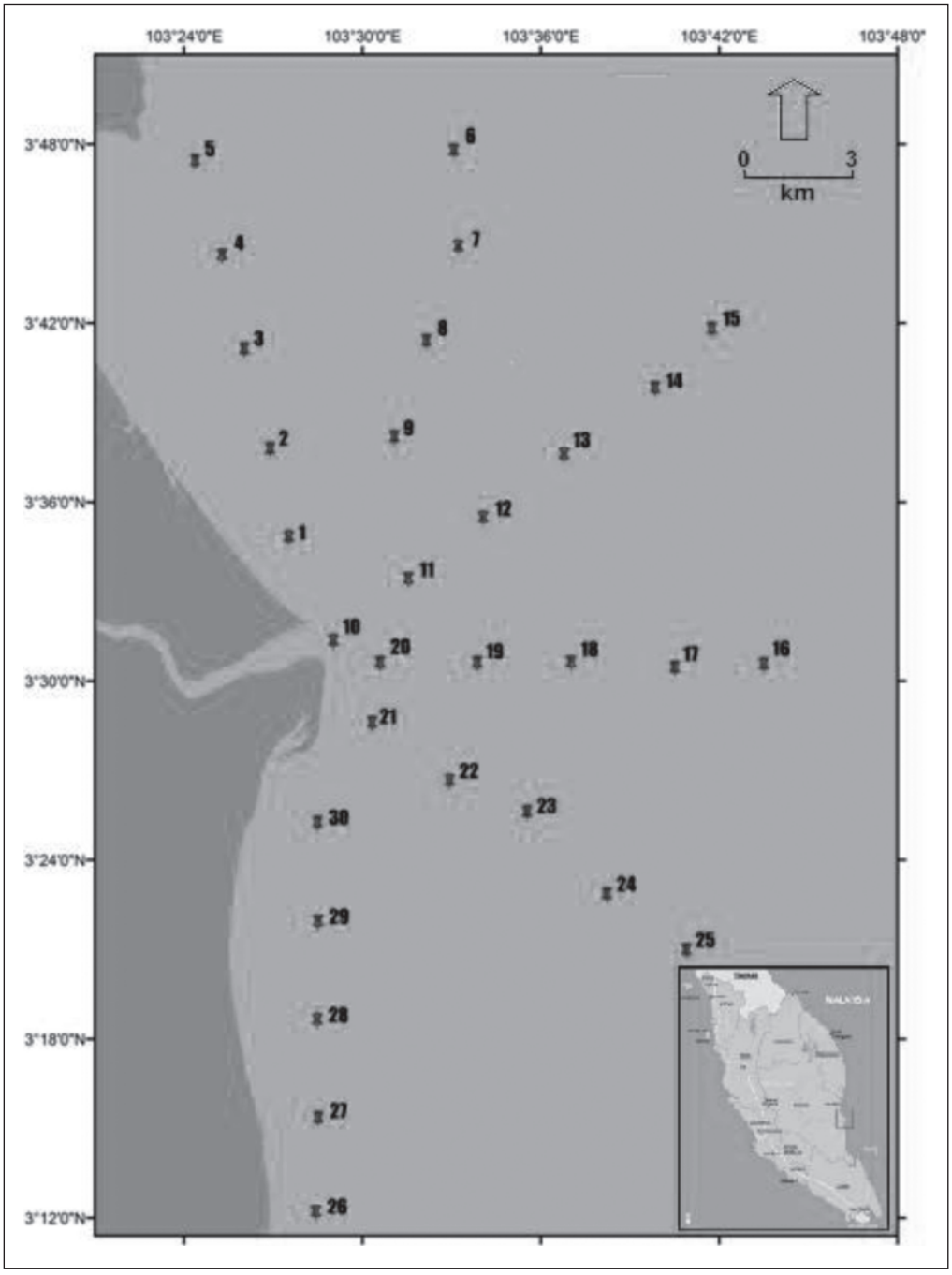

Fig. 1. Location of sampling stations

Table 1. The coordinate, no of species, no of individuals and Index of Diversity, H(s)

Station	Transect	Latitude (N)	Longitude (E)	Species	Total	H(s)	Sediment type
1	T1	03°34.762'	103°27.530'	19	126	2.74	Clayey silt
2		03°37.720'	103°26.889'	23	151	2.40	Sand
3		03°41.062'	103°26.028'	17	98	2.45	Sand
4		03°44.208'	103°25.284'	23	154	2.87	Sand
5		03°47.369'	103°24.369'	19	3725	1.53	Sandy silt
6	T2	03°47.731'	103°33.080'	30	373	2.91	Sand
7		03°44.510'	103°33.230'	16	128	2.10	Sand
8		03°41.332	103°32.156'	20	581	1.85	Sand
9		03°38.118'	103° 31.071'	27	2287	1.75	Sand
10	T3	03°31.288'	103° 29.028'	42	1738	2.75	Sand
11		03°33.354'	103° 31.546'	20	1130	1.79	Sand
12		03°35.417'	103° 34.059'	21	1735	2.06	Sand
13		03°37.533'	103°36.786'	22	544	2.12	Sand
14		03°39.755'	103°39.852'	11	99	1.69	Sand
15		03°41.742'	103°41.761'	15	482	1.57	Sand
16	T4	03°30.495'	103°43.503'	21	618	1.92	Sand
17		03°30.385'	103°40.505'	9	195	1.41	Sand
18		03°30.564'	103°37.023'	19	287	1.81	Sand
19		03°30.546'	103°33.865'	24	234	2.58	Silty sand
20		03°30.543'	103°30.600'	34	972	2.91	Silt
21	T5	03°28.534'	103°30.329'	20	220	2.26	Silty sand
22		03°26.594'	103°32.929'	19	228	2.39	Sand
23		03°25.545'	103°35.545'	33	1744	2.48	Sand
24		03°22.788'	103°38.226'	42	2424	2.41	Sand
25		03°20.918'	103°40.901'	35	1260	2.78	Sand
26	T6	03°12.137'	103°28.434'	28	287	2.96	Sand
27		03°15.289'	103°28.516'	23	126	2.83	Sand
28		03°18.589'	103°28.485'	25	207	2.89	Sand
29		03°21.872'	103°28.518'	26	186	2.95	Sand
30		03°25.189'	103°28.494'	16	118	2.47	Silty sand

(LM). The selected species from SEM micrographs are shown in Plate 1. For the identification of foraminifera, we referred to the taxonomy provided by Whittaker and Hodgkinson (1979), Loeblich and Tappan (1988), Jones (1994) and Szarek *et al.* (2006).

RESULTS AND DISCUSSION

Abundance, Dominance and Diversity of Foraminifera

A total of 84 species of 47 genera and 30 families were identified from about 22,457 individuals picked from 30 samples. The families were Lituolidae, Haplopragmoididae, Nouriidae, Trochamminidae, Textulariidae, Tubinellidae, Uvigerinidae, Bolivinidae, Amphisteginidae, Eponididae, Rosalinidae, Planulinoididae, Cibicididae, Planulinidae, Planorbulinidae, Nonionidae, Elphidiidae, Rotaliidae, Nummulitidae, Spirillinidae, Peneroplidae, Soritidae, Hauerinidae, Cribrolinoididae, Spiroloculinidae, Riveroinidae Opthalmidiidae, Lagenidae, Vaginulinidae and Ellipsolagenidae. Among these represented families in the area, Hauerinidae family had the highest specific diversity with 20 species recorded. There were from genus *Quinqueloculina, Lachlanella, Triloculina, Pyrgo, Siphonaperta, Agglutinella* and *Sigmoilopsis*. The most dominant family was Amphisteginidae with highest percentage, comprising 33.97% of all individuals. Representatives of these families are typical of infralittoral marine environments around the world. All the species recorded were benthic and tropical forms. The simple species diversity was from 9 to 42 species. The H(S) value was from 1.41 to 2.96 whereas the highest value was at the station 26 and the lowest value was at the station 17 (Table 1).

The dominant species was *Amphistegina lessonii* d'Orbigny, 1826 with 4,084 individuals obtained (18.19%), then followed by *Amphistegina gibbosa* d'Orbigny, 1839 (3,544 individuals, 15.78%) and *Asterorotalia pulchella* (d'Orbigny, 1839) (2,010 individuals, 8.95%). The abundance of foraminifera was highest at station 5 with 3,725 individuals and followed by station 24 with 2,424 individuals. While station 3 showed the lowest abundance of foraminifera with only 98 individuals.

Amphistegina lessonii d'Orbigny, 1826 can be characterized by a test flat involute trochospiral. The umbilical side is thicker than the spiral side.

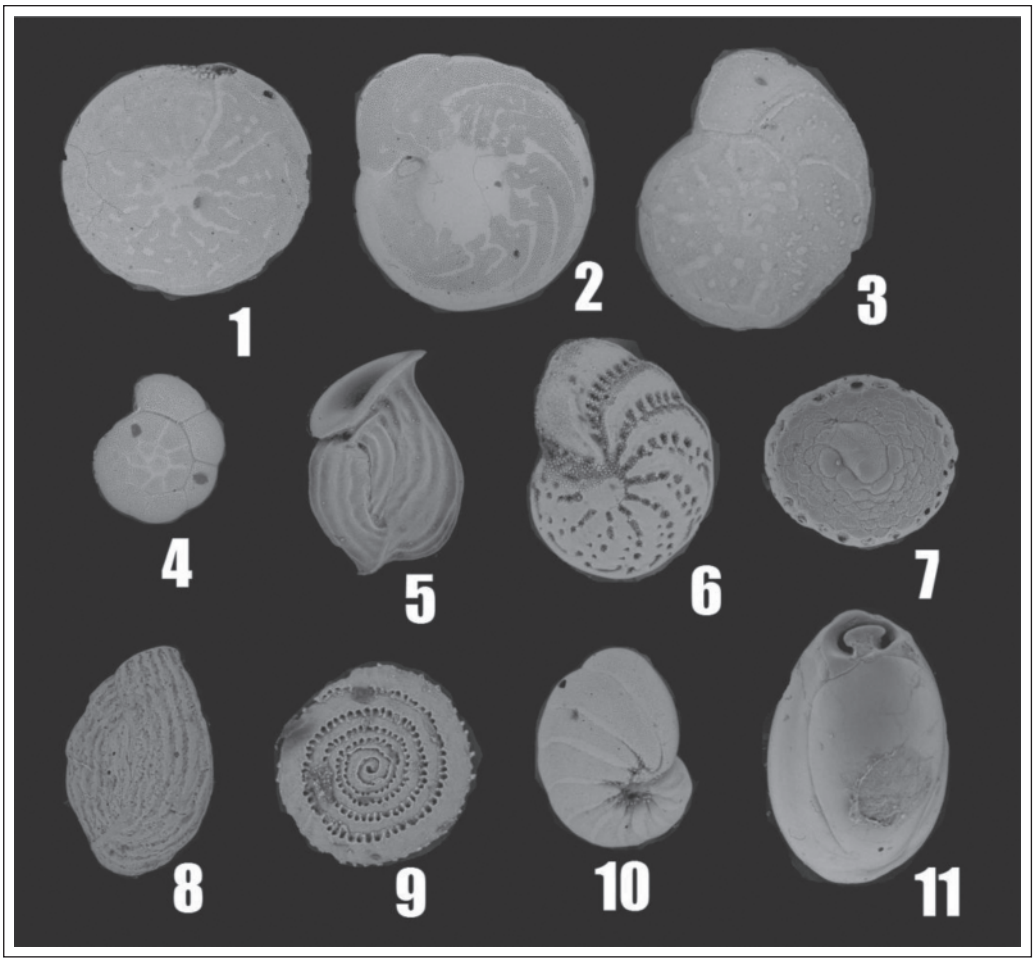

Plate 1. 1) *Amphistegina lessonni* d'Orbigny, 1826, TM-1000, x200, sample station 9; **2)** *Amphistegina gibbosa* d'Orbigny, 1839, TM-1000, x200, sample station 9; **3)** *Operculina ammoides* (Gronovius, 1781), TM-1000, x200, sample station 11; **4)** *Ammonia beccarii* (Linnaeus, 1758), TM-1000, x400, sample station 9; **5)** *Articulina pacifica* Cushman, 1944, TM-1000, x300, sample station 20; **6)** *Elphidium advenum* (Cushman, 1922), TM-1000, x300, sample station 5; **7)** *Sorites marginalis* (Lamarck, 1816), TM-1000, x250, sample station 16; **8)** *Lachlanella undulata* (d'Orbigny, 1852), TM-1000, x300, sample station 5; **9)** *Spirillina denticulata* Brady, 1844, TM-1000, x300, sample station 7; **10)** *Nonion fabum* (Fichtell & Moll, 1798), TM-1000, x400, sample station 5; **11)** *Pyrgo elongata* (d'Orbigny, 1826), TM-1000, x250, sample station 7.

The dorsal septa are radial and curving backwards at about 2/3 shell radius. While the ventral septa are sinusoidal. *Amphistegina lessonii* d'Orbigny, 1826 is the most abundant larger foraminifera in the area. It occurs in almost all samples but the highest densities have been found on sandy substrates. Compared to other species, the shell shape of *Amphistegina lessonii* d'Orbigny, 1826 is adapted to living on sandy substrates that are moves by waves (Hohenegger *et al.,* 1999). *Amphistegina lessonii* d'Orbigny, 1826 shows a very broad depth range in the Indo Pacific from 0-90 m with highest densities around 10-25 m (Hohenegger, 1996). It has been reported to have either a preference for sandy and solid substrates.

Comparison

A comparative analysis of the data collected in the present study with the adjacent area showed high degree resemblance with southwestern South China Sea (Szarek *et al.,* 2006). Of the total of 84 species obtained, 65 were found to be common to the both areas. Among these, few species were found to be widespread (*Amphistegina lessonii, Asterorotalia pulchella, Amphistegina gibbosa* and *Quinqueloculina candeiana*). These above species were also found to be reported earlier from the Togopi Formation, Sabah (Whittaker and Hodgkinson, 1979).

The observations made revealed that a large number of species were common between the study

area and southwestern South China Sea, however the dominant species was different. This could probably be due to the difference in water depth in the study area. The dominant species in the southwestern South China Sea were *Heterostegina depressa, Operculina ammonoides, Peneroplis pertusus, Nummulites venosus, Amphistegina lessonii, Sorites marginalis* and *Baggina indica.*

CONCLUSION

The recognised benthic foraminifera constituted by a total of 84 species belonging to 47 genera were identified from the study area. An analysis and comparison showed that a high degree of faunal replication between the study area and southwestern South China Sea. A total of 65 species are common to the two areas with relative abundance and distribution (*Amphistegina lessonii, Asterorotalia pulchella, Amphistegina gibbosa* and *Quinqueloculina candeiana*).

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