A PRELIMINARY SURVEY OF THE BENTHIC COMMUNITIES OF WEST JOHORE STRAIT

Grace S. Y. Lim and Lyndon Gan
Department of Zoology
National University of Singapore
Lower Kent Ridge Road
Singapore 0511

ABSTRACT

The West Johore Strait is the western portion of the stretch of water separating Singapore from West Malaysia. This two-day survey represents the first study of the benthic community in the West Johore Strait. A total of 41 families from six phyla (Mollusca, Annelida, Coelenterata, Echinodermata, Hemichordata and Chordata) were recorded. The innermost part, although with more stagnant bottom conditions, still supported benthic epifauna and infauna. The two stations around the central part of the strait supported relatively richer epifauna than infauna, with the bottom community dominated by a single species of starfish and brittlestars respectively. Towards the entrance of the strait where conditions were more exposed, little epifauna was recorded.

INTRODUCTION

The Strait of Johore separates Singapore from West Malaysia and is divided into the western and eastern sections by a causeway which links the two countries. The West Johore Strait is approximately 24km long (area of approximately 36km^2), with an average width of about 1.5km (Fig. 1). The narrowest point occurs at Putri Narrows (0.6km wide). The entrance to the West Johore Strait (West Reach) is shallow (5-10m depth), but deepens to about 15m in the central portion and reaches a maximum depth of about 20m at Town Reach (Lim, 1984). Four main rivers drain into the strait on the Johore (Malaysian) side (Sungei (=river) Skudai, S. Melayu, S. Perepat and S. Pendas) while only two rivers (Sungei Buloh and S. Buloh Kechil) drain into it from Singapore. Five major rivers in Singapore that used to drain into the strait (Krangi, Sarimbun, Murai, Poyan and Tengah) have been dammed and converted into reservoirs (Chia *et al.*, 1988).

In general, there is little socio-economic activity in this section of the strait. On the coast of Singapore, the area east of the causeway is part of a residential town and gives way to timber-based industrial estate of the Krangi and the Krangi reservoir (Chia *et al.*, 1988). To the east of the Krangi reservoir near Sungei Buloh, is a shrimp farming area, followed by narrow coastal mangrove belts at Lim Chu Kang, camping grounds and former agriculture land. The coastal waters off Lim Chu Kang has been designated for future netcage culture. The coastal area from Sarimbun reservoir to Sungei Tengah is a military restricted area. Located in this stretch are military installations and the 5 river-converted reservoirs. These have little environmental impacts. The shipping traffic is light in the West Johore Strait, as its topography allows only barges and small ships to pass. On the Johore side, most of the stretch of coastline consist of tidal mudflats and mangroves.

In the past, two biological investigations have been conducted in the area. These included detailed hydrological studies by Lim (1984) and Gonzales (1976). The study by Gonzales (1976) also included plankton and nekton. This present study is the first survey of the benthic communities of the West Johore Strait using dredge and grab sampling methods. Physical parameters at the time of sampling were also recorded.

MATERIALS AND METHODS

A survey was conducted on the 11th and 12th May 1987, within the intermonsoon period (April/May). A total of four stations, all within the Singapore boundary, was selected (Fig. 1). Sampling was carried out during slack current at high tide.

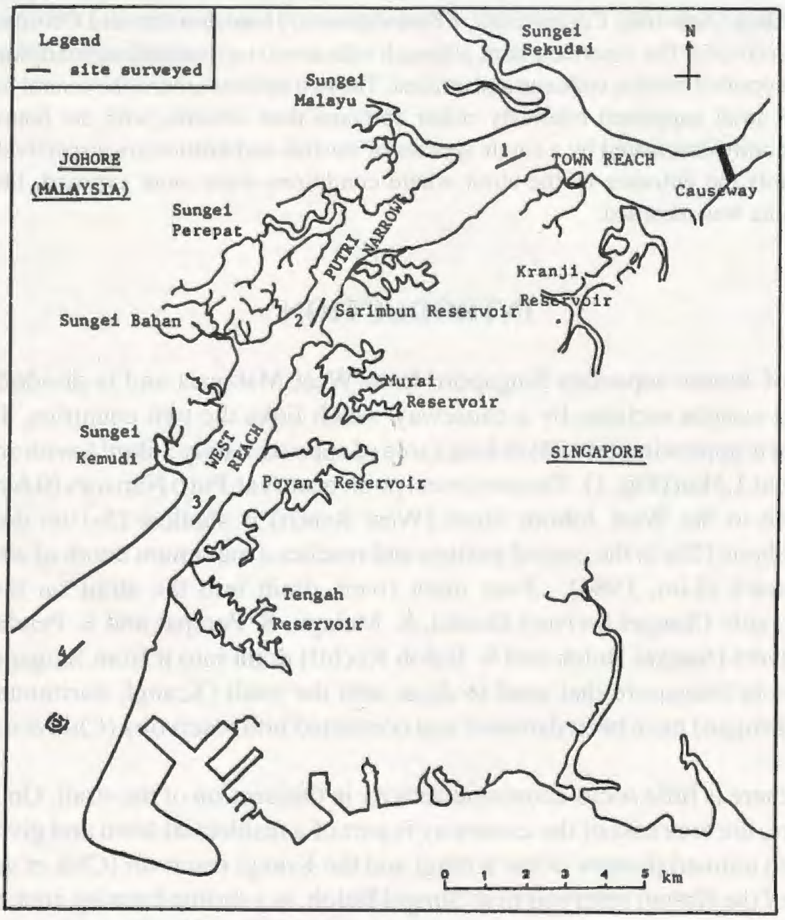


Fig. 1. Map of West Johore Strait showing survey stations

At each station, physical parameters of water visibility, temperature, salinity, conductivity, dissolved oxygen content and pH were recorded. With the exception of visibility and pH, which were taken only at the surface, all other physical parameters were recorded at 50cm intervals from the surface to the bottom. No readings were taken for Station 4 due to a heavy downpour which caused fluctuations of the water parameters. Salinity and temperature were measured using a portable YSI Model 33 Salinity-Temperature meter, conductivity with a pHOX 52E Conductivity meter, dissolved oxygen with a portable YSI Model 57 Oxygen meter, pH with a handheld electronic meter and visibility with a Secchi disc.

At each station, three grab samples were taken using an Ekman grab of gape 15cm x 15cm. For analysis, the three samples collected at each station were pooled. Only one dredge sample was obtained for each station, using a naturalist rectangular dredge with an opening of 75cm x 20cm and a 50cm polypropylene net bag (stretched mesh size 2.5cm). This was towed at 1 knot for 10 minutes. Materials brought up were sorted through 1mm and 2mm mesh-sized sieves for the grab and 5mm and 7mm mesh-sized sieves for the dredge. Specimens collected were preserved in 10% formalin or 70% alcohol. The bottom substrate dredged up at each station was also noted.

RESULTS

The visibility of the water in the strait was generally poor, (ranging from 0.6m to 1.5m) but improved from the inner-most station (station 1) to the outer-most station (station 3, Table 1). The pH of surface water in the strait was relatively high, with the highest alkalinity recorded at station 3 (10.0) and lowest at station 1 (8.1). From Fig. 2a, surface temperature was highest at station 1 and lowest at station 3. While temperature dropped with increasing depth for stations 1 and 2, it remained constant at station 3. The dissolved oxygen content at surface water was highest at station 1 (13.2ppm), followed by station 2 (10.8ppm) and station 3 (5.9ppm). The D.O. content at stations 1 and 2 dropped with increasing depth, while that for station 3 remained relatively constant (Fig. 2b). The salinity was overall lowest at station 1, followed by station 3 and highest at station 2 (Fig. 2c). With respect to depth, an increase in salinity with depth was recorded for stations 1 and 2. Conductivity increased from stations 1 to 3 and also with increasing depth at all stations (Fig. 2d). The bottom substrate was muddy at stations 1 and 3 but pebbly at station 2 and sandy at station 4 (Table 1).

Table 1. Visibility, pH and substrate condition of sampling stations in West Johore Straits.

Parameter	1	2	3	4
Visibility (m)	0.6	0.9	1.5	-*
pH	8.1	7.9	10.0	-*
Substrate	muddy	rocky	muddy	sandy

* no readings were taken

From both the dredge and grab samples, a total of 41 families from six phyla were recorded (Tables 2 and 3). These phyla were Mollusca, Annelida, Coelenterata, Echinodermata, Hemichordata and Chordata.

The specimens collected using the grab consisted of animals from two phyla, Mollusca and Annelida (Table 2). Of the phylum Mollusca, there were five families of bivalves (Class Bivalvia), five families of gastropods (Class Gastropoda) and one family of

Fig. 2a Vertical variation of temperature in West Johore Strait.

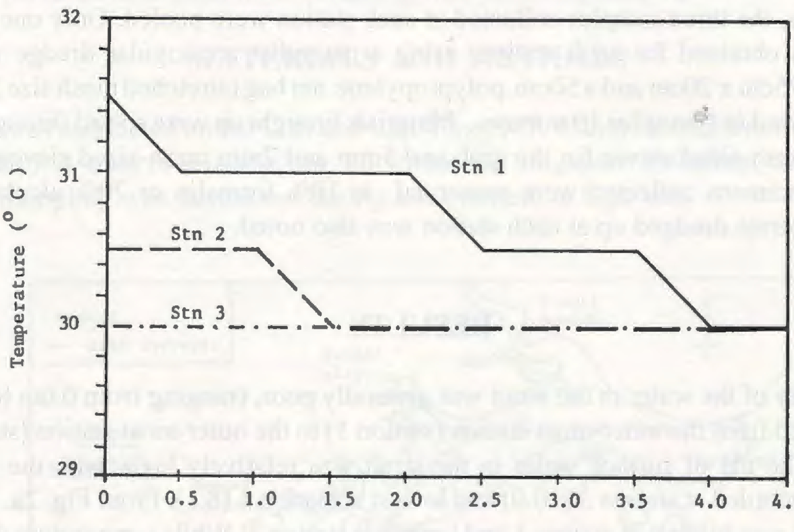


Fig. 2b Vertical variation of dissolved oxygen in West Johore Strait.

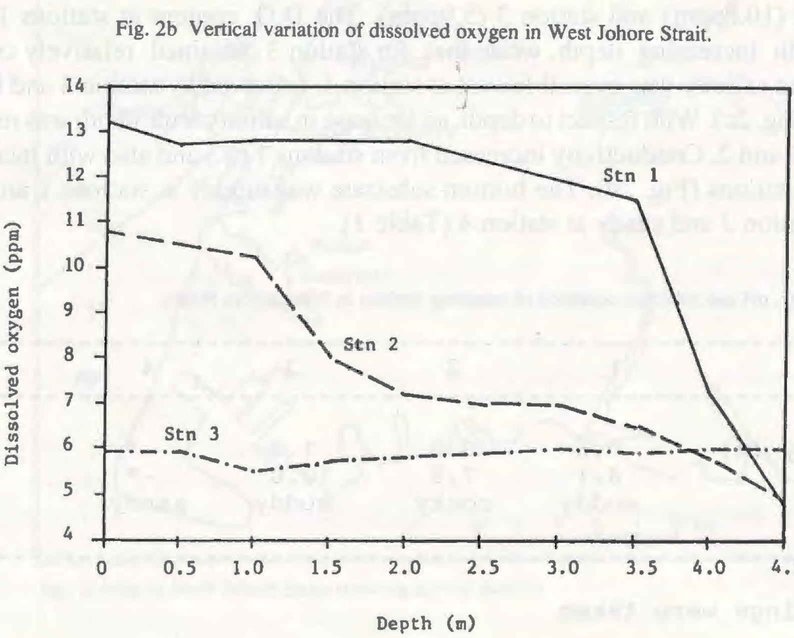


Fig. 2c Vertical of salinity in West Johore Strait.

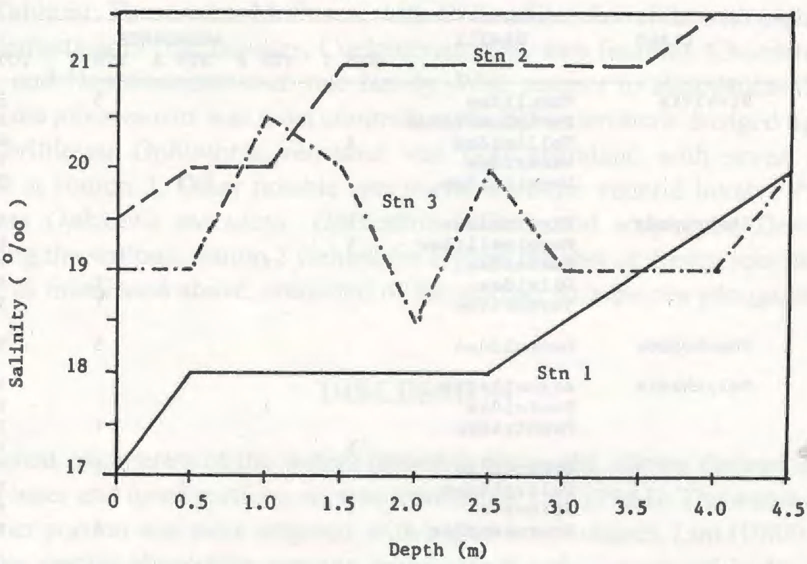
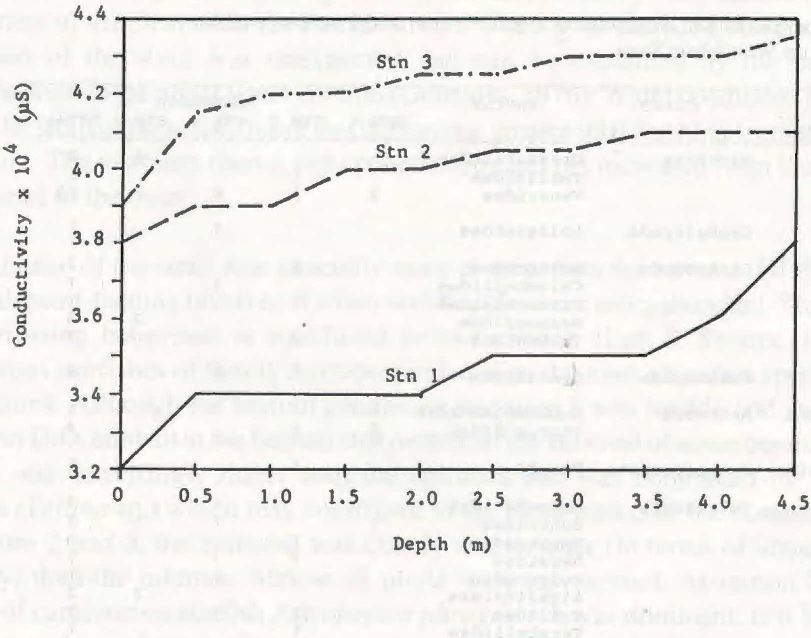


Fig. 2d Vertical variation of conductivity in West Johore Strait.



scaphopods (Class Scaphopoda). The phylum Annelida was represented by seven families from the class Polychaeta. The number of animals from the pooled grab samples was generally low, the most abundant being the bivalves, with a total of 17 specimens. Of these, the genera *Nucula, Tellina* and *Diplodonta* were more common. The worms (Polychaeta) were the next abundant group, with a total of eight specimens. The single genera of scaphopods *(Dentalium* sp.) was also common. The site from which most specimens collected was station 4, followed by station 1.

Table 2. Composition and distribution of specimens collected using the grab (infauna) in the West Johore Strait.

PHYLUM	CLASS	FAMILY	ABUNDANCE STN 1	STN 2	STN 3	STN 4	TOTAL
Mollusca	Bivalvia	Nuculidae				5	5
		Periplomatidae		1			1
		Tellinidae	4				4
		Veneridae		1			1
		Ungulinidae			3		3
	Gastropoda	?Epitonidae	1				1
		Marginellidae	1				1
		Muricidae		1			1
		Olividae				1	1
		Terebridae				1	1
	Scaphopoda	Dentalidae				5	5
Annelida	Polychaeta	Arabellidae			1		1
		Eunicidae		1			1
		Nephtyidae				1	1
			1				1
		Orbiniidae				1	1
		Pilargiidae			1		1
		Spionidae	1				1
		Sternaspidae				1	1
		18 families	11	4	5	15	35

Table 3. Composition and distribution of specimens from dredge samples (epifauna) in the West Johore Strait.

PHYLUM	CLASS	FAMILY	ABUNDANCE STN 1	STN 2	STN 3	STN 4	TOTAL
Mollusca	Bivalvia	Crassatelidae				2	2
		Tellinidae		1			1
		Veneridae	2	3	6	1	12
	Cephalopoda	Loliginidae			1		1
	Gastropoda	Acteonidae		2			2
		Columbellidae			1		1
		Fissurellidae		1			1
		Nassariidae				3	3
		Turbinidae		2			2
	Scaphopoda	Dentalidae			6		6
Coelenterata	Anthozoa	Kophobelemnidae	1				1
		Pteroeididae	2	2			4
Hemichordata	Enteropneusta	Fam #1		1			1
Annelida	Polychaeta	Aphroditidae			1		1
		Eunicidae	1		1	1	3
		Nephtyidae		1			1
		Nereidae		1			1
		Polynoidae			1		1
		Sigalionidae				2	2
		Syllidae		2			2
		Terebellidae		1			1
Echinodermata	Asteroidea	Astropectinidae		105			105
					4		4
		Goniasteridae		3			3
	Ophiuroidea	Ophiuridae			1		1
		Ophiactidae		2	4		6
		Ophiotrichidae			22		22
Chordata	Osteichthyes	Cynoglossidae				1	1
		Gobiidae			1		1
		28 families	6	128	49	10	193

The specimens collected using the dredge were more varied, with 28 families from six phyla (Table 3). These were Mollusca, with 10 families, Annelida with eight families, Echinodermata with five families, Coelenterata with two families, Chordata with two families and Hemichordata with one family. With respect to abundance, the starfish *Astropecten phragmorus* was most common, with 105 individuals dredged up at station 2. The brittlestar *Ophiothrix purpurea* was next abundant, with seven specimens collected at station 3. Other notable specimens were the venerid bivalve *Paphia* sp., brittlestars *Ophiactis maculosa, Ophiothrix ciliaris* and scaphopod *Dentalium* sp. Comparing the stations, station 2 yielded the highest number of dredge specimens. Most of these, as mentioned above, consisted of the starfish *Astropecten phragmorus*.

DISCUSSION

The physical parameters of the waters recorded during the survey showed differences between inner and outer portions, as was reported by Lim (1984). The water conditions in the inner portion was more stagnant, with higher temperatures. Lim (1984) attributed this to the greater absorptive capacity which characterises enclosed bodies of water. Vertical stratification of temperature, dissolved oxygen and salinity was also recorded. The bottom D.O. content at the two innermost stations was low. This can be expected since water exchange and mixing have been restricted by the causeway and the narrowness of the channel at the Putri Narrows. The higher surface D.O. content in the inner part of the strait was unexpected, but can be explained by the presence of phytoplankton in the upper water column (Gonzales, 1976). Water conditions in the outer part of the strait experienced more mixing having greater tidal flushing from the Strait of Singapore. The visibility (hence light penetration) and pH increased from the inner part of the strait to the outer.

The epifauna of the strait was generally more diverse than the infauna. Of the infauna, mobile deposit-feeding bivalves (*Tellina* and *Nucula)* were most abundant. Their feeding and burrowing behaviour is significant in bioturbation (Lee & Swartz, 1980). The carnivorous starfishes of family Astropectinidae were the most abundant species among the epifauna. Although the bottom conditions at station 1 was muddy and stagnant, the minimum D.O. content at the bottom still permitted the survival of some benthic life. The infauna was surprisingly richer than the epifauna and was dominated by burrowing bivalves *(Tellina* sp.) which may contribute to the bioturbation of the bottom substrate. At stations 2 and 3, the epifauna was clearly much richer (in terms of abundance and diversity) than the infauna. Almost all phyla were represented. At station 2, a single species of carnivorous starfish *Astropecten phragmorus* was dominant. It is likely to be the main predator of this rocky substrate community. The brittlestars were the dominant predator at station 3, of which the family Ophiotrichidae was more abundant. The infauna at stations 2 and 3 were considerably poorer with the record of only four and five specimens respectively. At the outer-most station (station 4), the epifauna seemed poorer than the infauna. Greater protection afforded by burrowing into the sandy substrate than living at the surface of the bottom could explain this observation. The fauna consisted mainly of sandy-bottom dwellers, of which the filter-feeding bivalve *Nucula* sp. and scaphopods *Dentalium* sp. were dominant.

In summary, the innermost part of the strait (station 1), although with more stagnant water conditions at the bottom, still supported benthic epifauna and infauna. Stations 2 and 3 supported relatively richer epifauna than infauna, with starfishes dominating the bottom community at station 2 and brittlestars at station 3. The more exposed location of station 4 expectedly supported little epifauna, but better infauna.

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