

A SURVEY OF THE SOFT-BOTTOM BENTHIC FAUNA OF PULAU TEKONG

Daphne S.L. Chung and Beverly P.L. Goh
Department of Zoology
National University of Singapore
Lower Kent Ridge Road
Singapore 0511

ABSTRACT

A preliminary survey of the soft-bottom benthic fauna carried out at seven stations around Pulau Tekong in March 1987 revealed 1604 specimens from 94 families, representing five phyla: Mollusca (32 families), Echinodermata (9 families), Coelenterata (5 families), Arthropoda (26 families) and Annelida (22 families). The family with the highest number of individuals observed was Ophiactidae, with 616 specimens. Similarity indices of families observed between stations were low. The total number of families obtained in this study is high compared to studies on other nearshore sites such as East Johore Strait and Bedok.

INTRODUCTION

The island of Pulau Tekong is situated off the northeastern coast of mainland Singapore (1° 24'N, 104° 3'E). It is flanked by the Malaysian state of Johore in the north, mainland Singapore in the south, and a smaller island, P. Tekong Kechil in the east. The river, Sungei Johore empties into the East Johore Strait northwest of P. Tekong (Fig. 1). The waters in the south experience heavy sea traffic while the northern waters have palisade fishing traps ("kelongs"). Pulau Tekong was inhabited until 1986, when the Ministry of Defence of Singapore acquired the island for military purposes. Extensive land reclamation by the Port of Singapore Authority was carried out on the southern foreshore of the island between 1981 and 1985, increasing the area of the island by some 540ha (Chia *et al.*, 1988).

The few previous studies carried out in Singapore on soft-bottom benthic communities of coastal habitats covered the East Johore Strait (Lee, 1973) and Bedok (Chou & Khoo, 1990). These two areas are situated off the northeastern and southeastern shores of Singapore mainland respectively. No such investigations have yet been carried out at P. Tekong. This paper presents the results obtained from the first soft-bottom benthic survey at P. Tekong carried out in March 1987. It deals mainly with the distribution and abundance of the benthic macrofauna (identified to family level) obtained from stations located round the island.

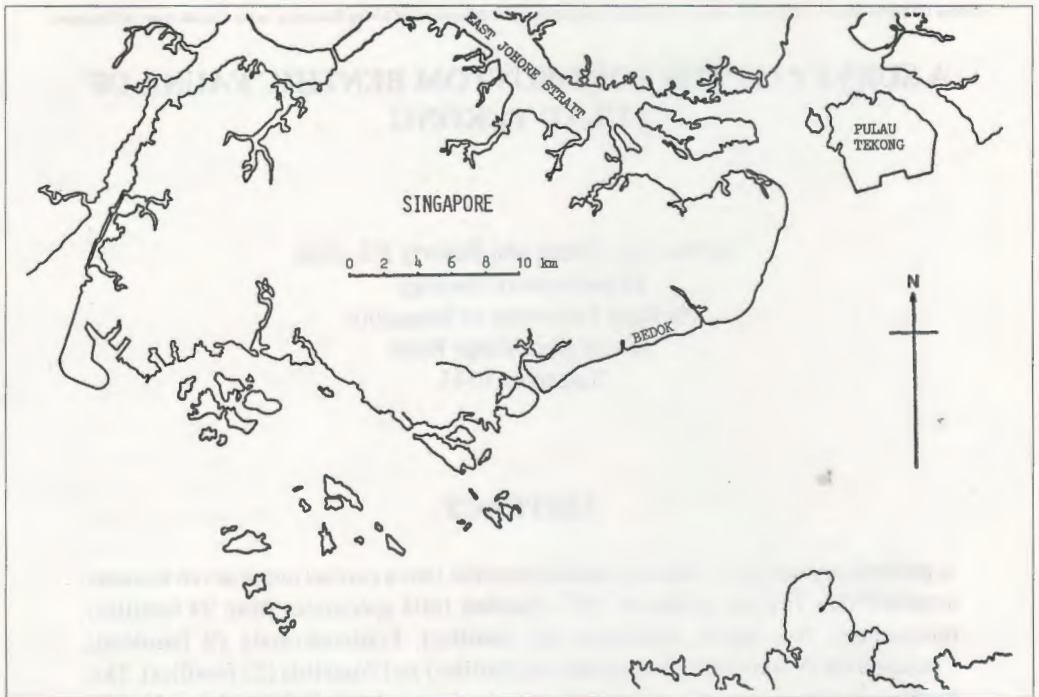


Fig. 1. Map of Singapore showing location of Pulau Tekong.

MATERIALS AND METHODS

Seven survey stations were established for sampling (Fig. 2). The sampling methods were based on those described by Dartnall and Jones (1986), but with modifications. One dredge sample was obtained at each station to study benthic epifauna. A naturalist's rectangular dredge with an opening of 75cm by 20cm and a 50cm long polypropylene net bag with stretched mesh size of 2.5cm was towed along the seabed at a speed of one knot for a period of 10 minutes. The contents were sorted using 5.0mm and 7.5mm mesh sized sieves.

In addition, three grab samples using an Ekman grab (15cm by 15cm) were taken at each station to sample benthic infauna. The grab samples were stained with Bengal rose in 10% formalin and sorted through 1mm and 2mm mesh sized sieves. All specimens were preserved in 10% formalin on the day of collection and, with the exception of the polychaetes, transferred to 70% alcohol 24 hours later. Identification of the specimens was carried out to the family level and data recorded on the computer programme, dBase III PLUS. A BENTHI programme (Bainbridge, 1988) was used to analyse the data and Morisita's Similarity Index (modified by Horn, 1966) was used to compare the similarity of families occurring between stations (Morisita, 1959).

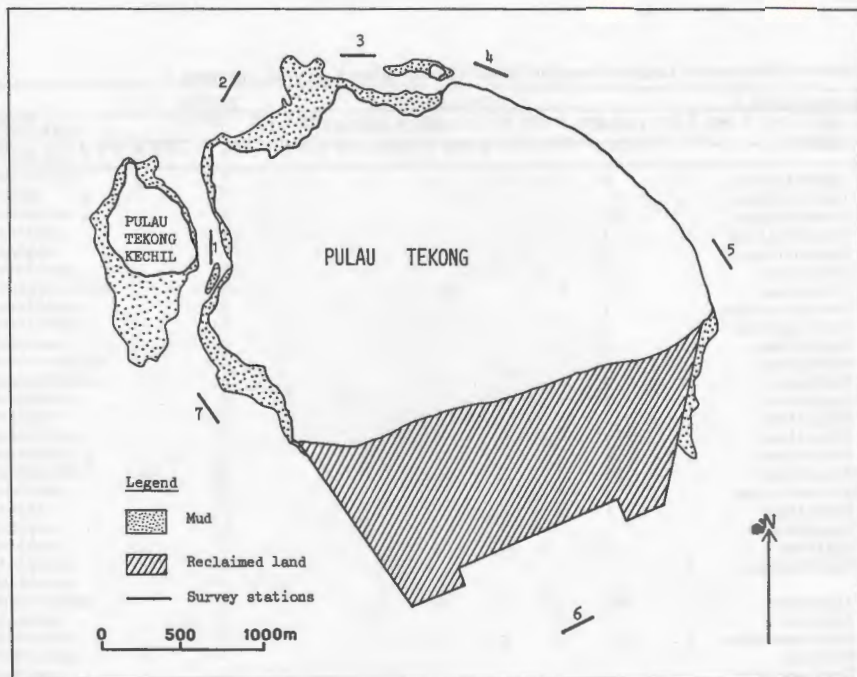


Fig. 2. Survey stations at Pulau Tekong.

RESULTS

A large variety of benthic organisms representing a total of 94 families including three unidentified crustacean families resulted from the sampling. The abundance of organisms found was high, with a total of 1604 specimens obtained (Table 1). The family with the highest number of individuals observed was Ophiactidae (phylum Echinodermata), with a total of 616 specimens. This was followed by the crustacean family, Porcellanidae, which had a total abundance of 169 individuals. The five phyla, placed in a descending order of abundance, are Echinodermata (780), Arthropoda (304), Mollusca (330), Annelida (112) and Coelenterata (13) (Figs. 3 and 4).

Station 1

The Ekman grab was ineffective and could not be deployed here because of the sandy-rocky substratum. The single dredge tow yielded a total of 918 specimens from 32 families with Ophiactidae and Porcellanidae dominating in terms of abundance. The Ophiactidae formed 65.4% and Porcellanidae, 9.9% of the individuals at station 1. Two unidentified crustacean families, each represented by one specimen, were recorded. Eighty-six specimens (9.4% of the total abundance at this station) from the family Cucumaridae (phylum Echinodermata) were observed. This family was not recorded from any of the other stations. The family Alpheidae was significantly represented in terms of numbers with 40 identified specimens making up 4.4% of the total number of individuals obtained at this station (Fig. 5a).

Table 1. Abundance of the various families found in Pualu Tekong (after Koh *et al.*, in press.)

PHYLUM	FAMILY	FAMILY TOTAL	DREDGE SAMPLES							GRAB SAMPLES								
			STN 1	STN 2	STN 3	STN 4	STN 5	STN 6	STN 7	STN 2	STN 3	STN 4	STN 5	STN 6	STN 7			
Annelida	Aphroditidae	8	1		1				1		4				1			1
	Capitellidae	1											1					
	Cirratulidae	6							2				1			1	1	1
	Ctenodrilidae	1														1		
	Dinophilidae	2												2				
	Eunicidae	5	2													2		1
	Glyceriidae	5								3					2			
	Heterospionidae	1															1	
	Lumbrineridae	2				1											1	
	Maldanidae	1												1				
	Nephtyidae	3												1			1	2
	Nereidae	2				2												
	Onuphidae	2															2	
	Opheliidae	2														2		
	Orbinidae	35	8			4							7				14	2
	Pisionidae	4												2			2	
	Polynoidae	20												20				
	Protodrilidae	1																
	Sabellidae	1			1													
	Spionidae	3														1		
Syllidae	6	2			3								1					
Terebellidae	1														1			
Arthropoda	Alpheidae	62	40	2	11	9												
	Atylidae	1																1
	Carditameridae	12														7	3	2
	Ceinidae	1											1					
	Chthamallidae	4				4												
	Colomastigidae	1												1	1			
	Dexaminidae	1											1					
	Dorippidae	1					1											
	Family 1 (Crustacea)	2	1		1													
	Family 2 (Crustacea)	1				1												
	Family 3 (Crustacea)	1	1															
	Galatheididae	1	1															
	Jaeropsidae	1				1												
	Leucosiidae	7		1		2	2	2										
	Lysianassidae	2														1		
	Majidae	6	1	2		1	1											1
	Paguridae	14	4	3		3	2	2										
	Palaemonidae	2	1		1													
	Penaeidae	9	5				1	3										
	Ploustidae	2													2			
	Porcellanidae	169	91	12	57	8	1											
	Portunidae	4	1			1	1											
	Sicyonidae	1										1						
	Squillidae	2										1						
	Stenopodidae	2			2										1			
	Xanthidae	7	2		4	1												
	Coelenterata	Alcyoniidae	1		1													
Cepheidae		1		1														
Pennatulidae		4		1						3								
Pteroisididae		1								1								
Virgulariidae		4		4														
Echinodermata	Amphiuridae	64	18	4	4	3			29	1		2			3			
	Astropectinidae	1		1														
	Cucumariidae	86	86															
	Goniasteridae	2		2														
	Ophiactidae	616	600	13		2									1			
	Ophiocomidae	1	1															
	Ophiotrichidae	75	10	46	5	8				5					1			
	Ophiuridae	1			1													
	Phylloporidae	2	2															

(cont.)

Table 1. (Cont.)

PHYLUM	FAMILY	FAMILY TOTAL	DREDGE SAMPLES							GRAB SAMPLES																
			STN 1	STN 2	STN 3	STN 4	STN 5	STN 6	STN 7	STN 2	STN 3	STN 4	STN 5	STN 6	STN 7											
Mollusca	Acteonidae	2																							2	
	Acydoniidae	1																								1
	Arcoideae	9					8					1														1
	Buccinidae	4	1									2														1
	Cardiidae	1					1																			1
	Chamidae	6		5				1																		
	Corbulidae	3																								
	Crassatellidae	58				4	50				2	1		1												2
	Cyathidae	14	2		7	1	4																			1
	Dentaliidae	2									1															1
	Donacidae	4		4																						
	Fasciolaridae	1	1																							
	Isogonomidae	5			5																					
	Muricidae	5	1		1			1	1				1													
	Mytilidae	14	7				7																			
	Nassariidae	9	2				2	1			2															
	Naticidae	1									1															
	Nuculanidae	18									1	1												1	10	5
	Nuculidae	50									3														46	
	Olividae	2																								
	Ostreidae	2										2														
	Ovulidae	1					1					1														
	Patellidae	6					5																	1		
	Pectinidae	6						6																		
	Psammobidae	4																								
	Solenidae	8										3														2
	Tellinidae	16						1	6	3	3												1		1	3
	Terebridae	1																						1		
	Trochidae	7		5	1			1																		
	Turbinidae	2		1																				1		
Veneridae	52		11	2			6	10	17	3															1	
Volutidae	3																						1	2		
Total		1604	918	110	109	125	39	81	25	43	11	25	90	21	7											

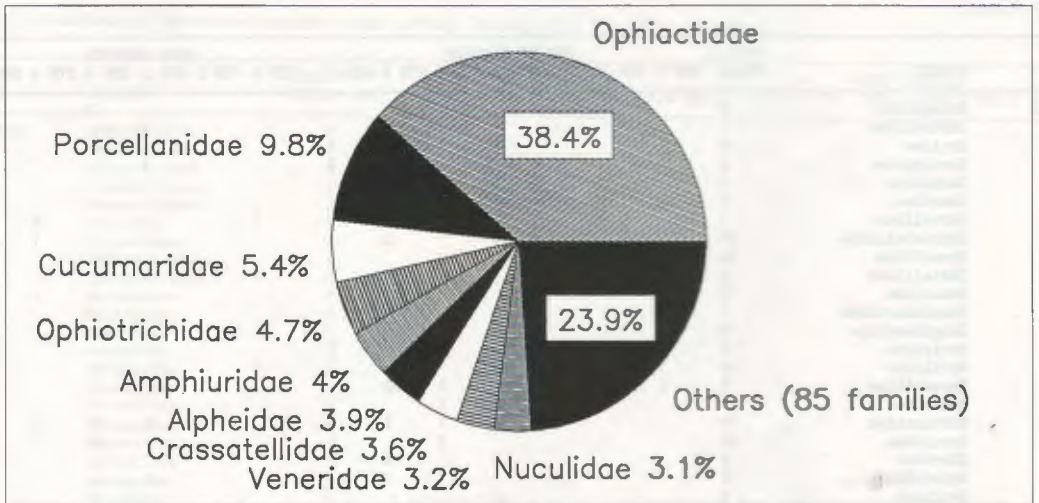


Fig. 3. Family composition of the benthic community around Pulau Tekong (based on abundance).

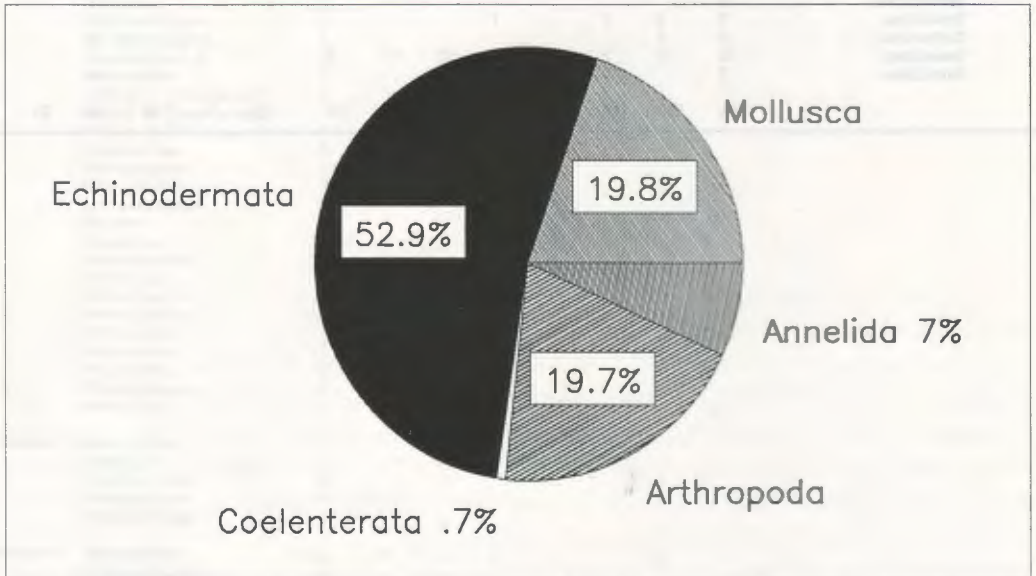


Fig. 4. Phylum composition of the benthic community around Pulau Tekong (based on abundance).

Station 2

Station 2 showed a reduction in both the number of families and abundance (Fig. 5b). A total of 20 families represented by 110 specimens was obtained. The family Ophiotrichidae was dominant in terms of abundance, with 46 specimens making up 30.1% of the total number of individuals at this station. Only 12 specimens of Porcellanidae and 13 specimens of Ophiactidae were recorded. The largest number of polychaetes was found at this station, with the family Polynoidae dominating, totalling 46.5% of the entire polychaete fauna recorded in this study.

Station 3

At station 3, the phylum that dominated in terms of abundance was Arthropoda (class Crustacea) (Fig. 5c). The family Porcellanidae was the most abundant, with individuals making up 47.5% of the total at this station. This was followed by the family Alpheidae representing 9.2% of the total. The family Ophiactidae was not recorded. However, other ophiuroids were present making up 8.3% of the total abundance of 120 specimens.

Station 4

Crassatellidae was the most abundant molluscan family at station 4, making up 33.3% of the total number of individuals here (Fig. 5d). The number of polychaetes recorded here (4.7% of the total at this station) was the lowest of all the stations. A total of 35 families with 150 individuals was recorded.

Station 5

The bivalve family Nuculidae made up 38% of the total number of individuals collected at station 5. A total of 29 families was obtained, but no echinoderms were encountered (Fig. 5e).

Station 6

The single ophiuroid family recorded at this station, Amphiuridae, was dominant here, representing 28.4% of the total number of individuals at this station. The total number of bivalves was the highest recorded between all stations, but only five gastropods were found. A total of 102 specimens was collected (Fig. 5f).

Station 7

Station 7 yielded the lowest number of individuals, with a total abundance of 32 from 18 families. The most abundant family recorded was Ophiotrichidae (phylum Echinodermata), while the family Psammobiidae (phylum Mollusca) was found only at this station (Fig. 5g).

Morisita's Similarity Indices at family level calculated between stations is given in Table 2. The indices were generally low, ranging from 0.016 between stations 1 and 7, to 0.543 between stations 2 and 7.

Table 2. Morisita's Similarity Indices between stations at Pulau Tekong.

	STN 1	STN 2	STN 3	STN 4	STN 5	STN 6	STN 7
STN 1	1.000	0.287	0.156	0.051	0.068	0.035	0.016
STN 2	0.287	1.000	0.315	0.175	0.126	0.098	0.543
STN 3	0.156	0.315	1.000	0.110	0.392	0.088	0.059
STN 4	0.051	0.175	0.110	1.000	0.074	0.164	0.267
STN 5	0.068	0.126	0.392	0.074	1.000	0.305	0.294
STN 6	0.035	0.098	0.088	0.164	0.305	1.000	0.305
STN 7	0.016	0.543	0.059	0.267	0.294	0.305	1.000

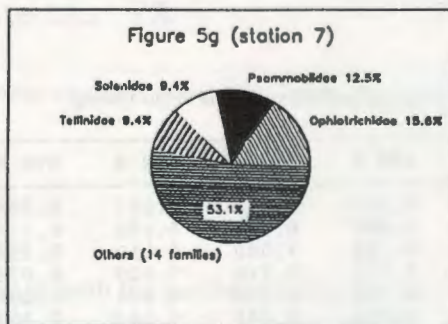
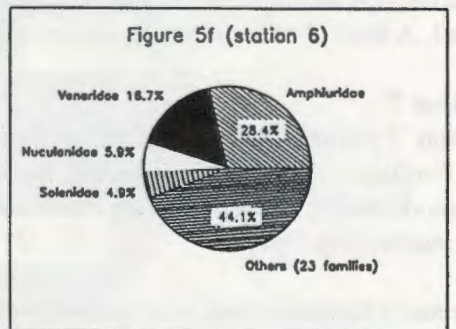
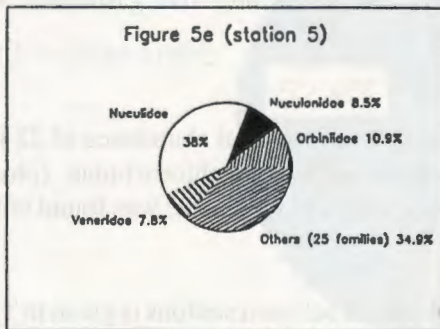
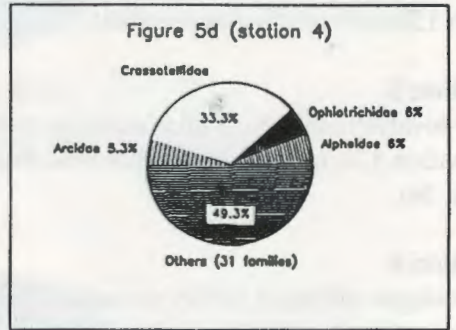
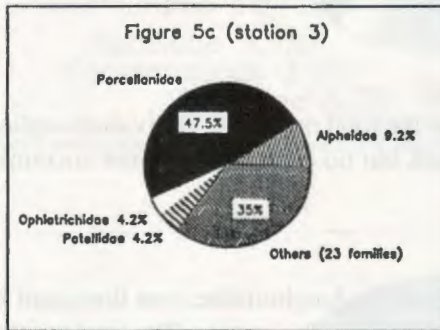
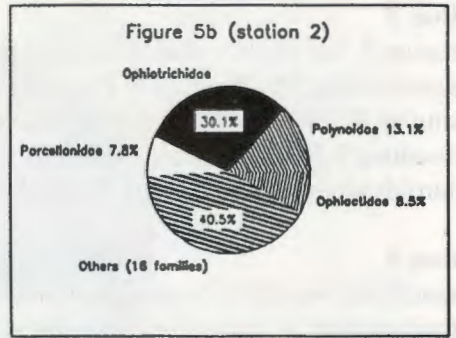
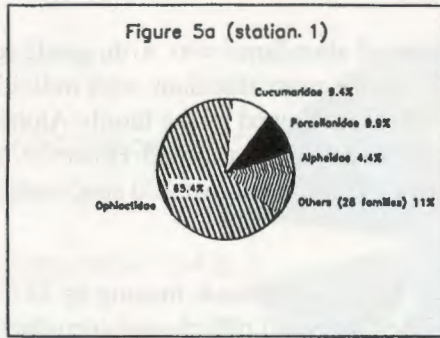


Fig. 5. Family composition of the benthic communities at the individual stations.

DISCUSSION

The similarity indices at family level computed in this study show no apparent similarity between all stations, indicating that the fauna found at P. Tekong is highly varied. Reclamation of the southern foreshore of the island between 1981 and 1985 may have changed the faunal composition of stations 5, 6 and 7. Unfortunately, no biological surveys of the benthic fauna were carried out at P. Tekong prior to the reclamation, and comparisons of changes in family diversity cannot be made.

Large concentrations of ophiuroids have been documented at Plymouth, England, and attributed to the abundance of food in the form of suspended material from tidal streams (Vevers, 1952). These dense populations are not seasonal but are believed to remain constant throughout the year. The large aggregations of ophiuroids encountered here, especially at station 1 could be due to the rivers in the vicinity of the island bringing in suspended food materials, and making conditions highly suitable for large populations of ophiuroids to thrive. Tidal current patterns of the East Johore Strait and adjacent waters documented by Lim (1983) show that strong tidal currents bring water from the East Johore Strait, Johore River and Sungei (= river) Belungkor down towards P. Tekong during ebb tide. These tidal currents also possibly circulate nutrients and enhance gaseous exchange.

The total absence of ophiuroids dredged up from station 5 could be due to a sampling error, or a bottom substratum unsuitable to echinoderms. However, no studies were carried out on the bottom substratum of all the stations, and dredge samples were not replicated. More detailed studies will have to be carried out to investigate this further.

The 94 families obtained from this survey of P. Tekong is high compared to similar studies carried out at other nearshore sites. Lee's study of the East Johore Strait (1973) yielded a total of 76 families, with 51 families obtained from dredge samples of surface fauna, and 26 infaunal families from grab samples. In this study, 69 epifaunal families and 46 infaunal species were observed.

In a study at Bedok (Chou & Khoo, 1990), 54 macrobenthic families were identified, the majority of which were crustaceans. The sampling methods employed at Bedok were different in that a total of four surveys covering six stations were carried out periodically for four years, and benthic fauna was sampled at each station using only two parallel 10-minute tows of the naturalist's dredge. Dredge samples here yielded a total of 69 families, relatively higher than the number of families obtained at Bedok.

In conclusion, this study shows that the macrobenthic fauna at Pulau Tekong is varied and diverse. This may be due to the location of P. Tekong, where tidal currents not only bring in nutrients from the East Johore Strait, Sungei Belungkor and the Johore River and circulate them, but also enhance gaseous exchange, making conditions suitable for a rich diversity of bottom fauna.

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