THE SECOND ANNUAL SURVEY (1987) OF THE BENTHIC AND PELAGIC COMMUNITIES OF SINGAPORE RIVER

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ABSTRACT

A second annual survey of the soft-bottom benthic and pelagic communities of the Singapore River was carried out in November 1987. The Ekman grab, naturalist's rectangular dredge and trammel nets used yielded mainly the classes Crustacea, Polychaeta, Bivalvia and Gastropoda. Bivalvia was the largest class in terms of abundance with the family Dreissenidae dominating. A total of 45 families was collected giving an abundance of 6292 individuals. Station 6, located in the upper reaches of the river was the poorest in terms of the number of individuals sampled while station 5, located lower down the river, after station 6, was the richest. When comparing the results of the first three stations between this survey and a similar one a year earlier, the increase in the diversity and abundance was evident. Within the first three stations, a total of 31 families was obtained compared to 18 in the first survey. The abundance also increased from 231 to 587 individuals. Physico-chemical parameters remained rather similar to that of the first survey.

INTRODUCTION

Singapore River and the other rivers on the island of Singapore were relatively clean and unpolluted in 1819 when Sir Stamford Raffles first landed in Singapore. Due to the vast increase in the population from a mere 1000 in 1819 to 2.3 million in 1977 and even though sewerage facilities had been provided for the majority of the population, Singapore River and the other rivers draining into Kallang Basin became polluted. The sources of pollution were first identified in 1977/78 when a programme was initiated to remove these various sources of pollution from the catchment areas (Chiang, 1985).

There are few known hydrobiological studies carried out on the rivers of Singapore. The first survey of Singapore River was done in October 1986, prior to the completion of the cleaning-up programme. That was the first documented work on the hydrobiological conditions of Singapore River (Yip *et al.*, 1987). A second survey of the river was carried out a year later to see if the conditions in Singapore River have improved since the completion of the cleaning-up programme in June 1987.

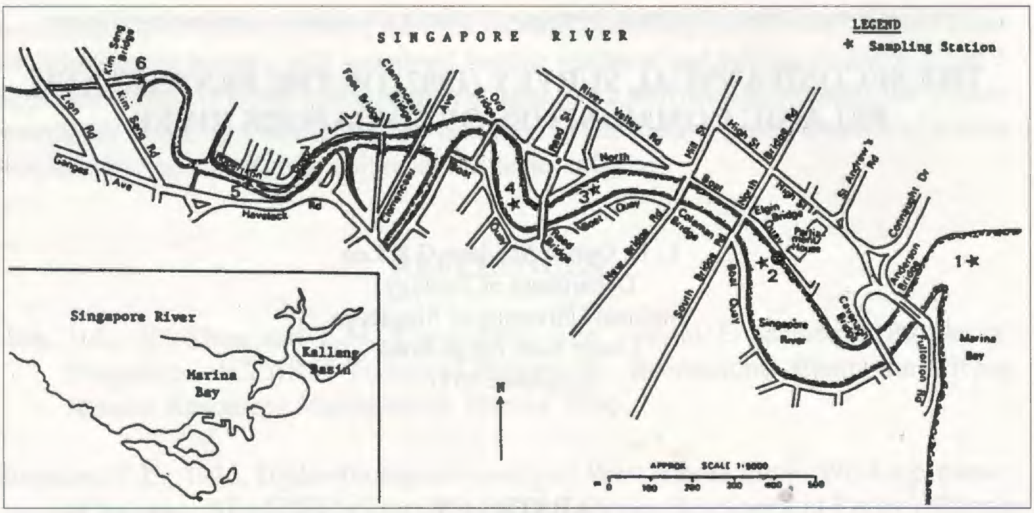

Fig. 1. Location of Singapore River (inset) and sampling stations 1 to 6.

MATERIALS AND METHODS

Six stations along the river were sampled (Fig. 1). The temperature, salinity, conductivity and dissolved oxygen content of the water were recorded at 0.5m intervals of the water column, similar to the previous survey (Yip *et al.*, 1987). In addition, three new parameters were observed in this survey: light intensity, pH and water visibility. Salinity and temperature were measured with a portable YSI Model 33 Salinity-Conductivity-Temperature meter, while the dissolved oxygen content was measured with a portable YSI Model 57 Oxygen meter. The conductivity of the water was measured using a portable pHOX 52E Conductivity meter and pH, with an Orion Research Model SA 250 pH meter. Water visibility was measured with a Secchi Disc while light intensity was measured using the LI-COR underwater light sensor. An Ekman grab (15cm x 15cm) was used to collect samples of infauna while a naturalist's rectangular dredge (75cm x 20cm opening and 50cm long polypropylene net bag with stretched mesh size of 2.5cm) was used to collect samples of epifauna. One dredge and three grab samples were taken at each of the stations. The dredge was towed for 10 minutes at 1 knot. One trammel net 30cm long and 1.5m wide, with a stretched mesh size of 4cm, was also set at each of the stations 2 and 3 for 24 hours.

RESULTS

The results of the physico-chemical parameters are shown in Fig. 2. Water temperatures remained fairly constant throughout all the stations ranging from a mean of 28.9°C at station 2 to 31.1°C at station 4. The pH of the water was slightly alkaline with a range of 7.4 to 8.2. Stations 1 and 2 had higher mean pH levels as compared to the other stations (8.13 and 8.02 respectively), while station 6 had the lowest mean alkalinity of 7.49. Dissolved oxygen content was variable over the six stations, ranging from 0.3ppm

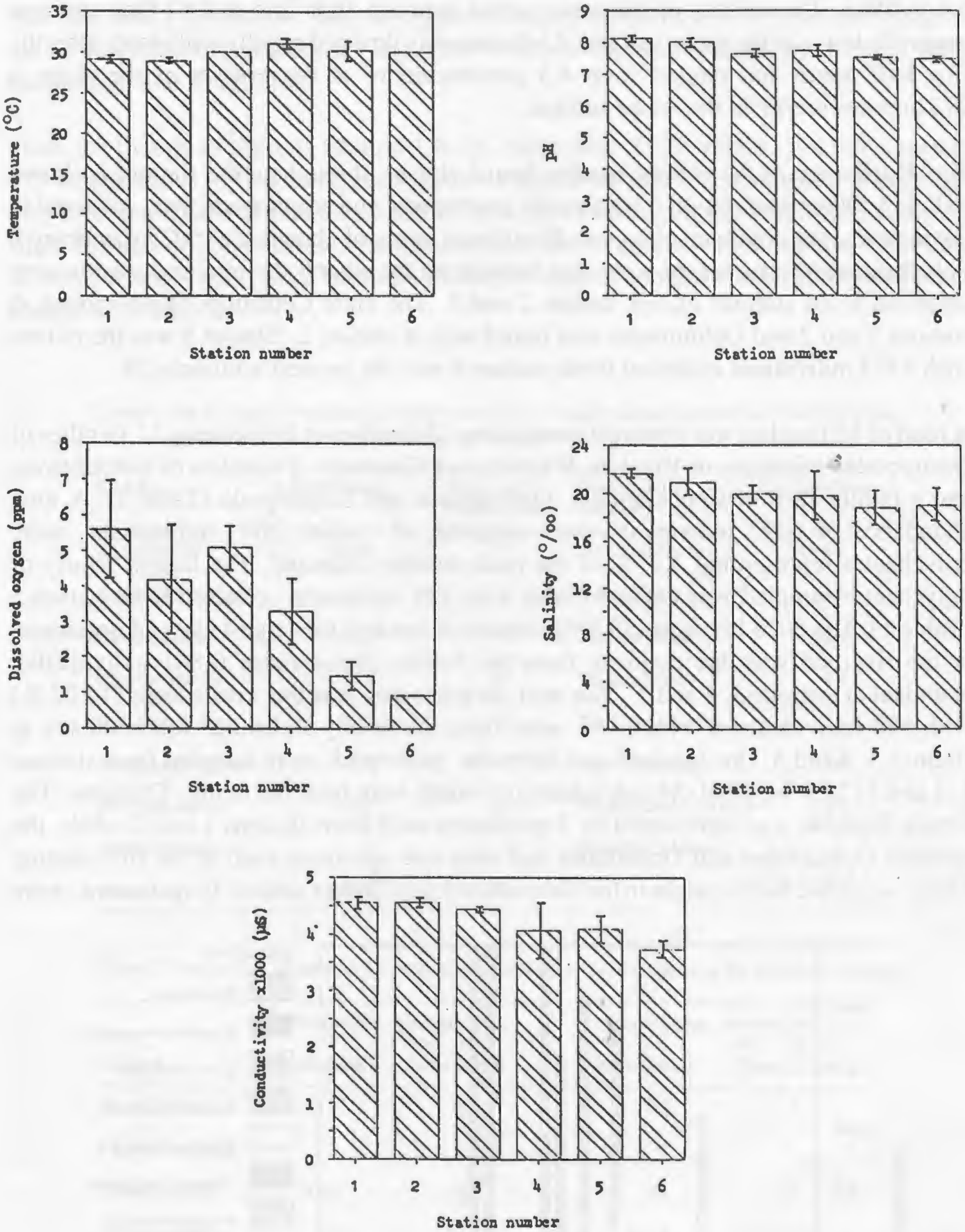

Fig. 2. The mean values of the physico-chemical parameters at the 6 sampling stations in Singapore River.

upriver to 7.0ppm at the river mouth and it also decreased with depth. Stations 5 and 6 had the lowest mean concentration of dissolved oxygen (1.47ppm and 1.11ppm respectively) while station 1 had the highest mean dissolved oxygen content of 5.6ppm. Within each station, the conductivity varied little with depth. However, the mean conductivity values decreased slightly along stations 1 to 6 ranging from 3.2×10^4µS to

4.6 x $10^4 \mu S$. The salinity of the water varied between 16.0 ‰ to 22.2 ‰ and was generally lower at the water surface. Light intensity dropped rapidly with depth after the first half metre and ranged from 4.5 μmoles/sec/m^2 at the bottom of the river to 2132μmoles/sec/m^2 at the water surface.

The distribution of the various benthic faunal classes throughout the stations is shown in Fig. 3. Other than station 6 where only gastropods and scaphopods were collected in the samples, the dominant class was Bivalvia in terms of abundance (5025 specimens). Polychaetes and crustaceans were also found at all the other 5 stations. Gastropods were collected at all stations except station 2 and 3. The class Cephalopoda was found at stations 1 and 2 and Ophiuroidea was found only at station 2. Station 5 was the richest with 4973 individuals collected while station 6 was the poorest with only 58.

A total of 45 families was obtained comprising 12 families of Polychaeta, 11 families of Gastropoda, 7 families of Bivalvia, 9 families of Crustacea, 3 families of Osteichthyes and a family each of Cephalopoda, Ophiuroidea and Scaphopoda (Table 1). A total abundance of 6292 individuals was sampled, of which 202 individuals were polychaetes representing 3.21% of the total number collected. The largest family of polychaetes sampled was Ctenodrillidae with 135 specimens collected from station 5 (Table 1). The 5025 bivalves (79.86%) obtained made it the largest class of organisms in the riverbed with the majority from the family Dreissenidae (4861 individuals), abundant at stations 3, 4 and 5. The next largest class was the crustaceans (14.02 %) with 882 individuals of which 743 were from the family Balanidae found mostly at stations 3, 4 and 5. One hundred and forty-one gastropods were sampled from stations 1, 4 and 5 (2.24 %), most (84 individuals) of which were from the family Thiaridae. The family Sepiidae was represented by 2 specimens each from stations 1 and 2, while the families Ophiactidae and Dentallidae had only one specimen each at the first station. Thirty-six of the fishes caught in the two trammel nets (from a total of 38 specimens) were

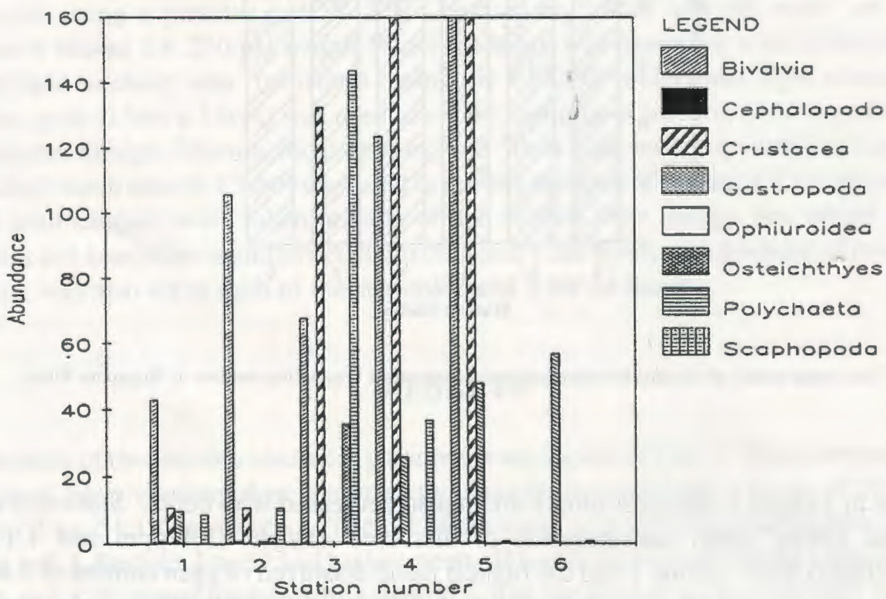

Fig. 3. Distribution of the benthic faunal classes in the 6 sampling stations.

from the family Plotosidae. They weighed between 59.06g and 158.42g and their lengths varied from 21.0cm to 26.5cm. The other two fish families caught by the nets were Lutjanidae and Mugilidae.

From the first three stations (station 1 to 3), there were 217 bivalves, 164 polychaetes, 155 crustaceans, 38 fishes, 10 gastropods, 1 ophiuroid and 1 cephalopod. Altogether they represented a total abundance of 587 individuals belonging to 31 families (Table 2). Eight families of polychaetes, 5 families of bivalves, 4 families of gastropods, 9 families of crustaceans, 3 families of fishes and 1 family each of ophiuroid and cephalopod were identified (Table 2).

Table 1. The number of families and abundances of the benthic faunal classes from the 6 sampling stations and the respective dominant families.

Class	Abundance	No. of families	Dominant family	Abundance
Bivalvia	5025	7	Dressinidae	4861
Cephalopoda	2	1	Sepiidae	1
Crustacea	882	9	Balanidae	743
Gastropoda	141	11	Thiaridae	84
Ophiuroidea	1	1	Ophiactidae	1
Osteichthyes	38	3	Plotosidae	36
Polychaeta	202	12	Ctenodrillidae	135
Scaphopoda	1	1	Dentallidae	1
Total	6292	45		

Table 2. The number of families and abundances of benthic faunal classes at the first three stations.

	Present survey		Previous survey*	
Class	Abundance	No. of families	Abundance	No. of families
Bivalvia	217	5	99	3
Cephalopoda	2	1	1	1
Crustacea	155	9	56	6
Gastropoda	10	4	2	1
Ophiuroidea	1	1	0	0
Osteichthyes	38	3	66	5
Polychaeta	164	8	7	2
Total	587	31	231	18

(*Adapted from Yip *et al.*, 1987)

Station 1 had 75 individuals belonging to 15 families while station 2 had 131 individuals in 15 families. A total of 381 individuals in 10 families were found at station 3 (Table 3).

DISCUSSION

Comparing the present results from the first three stations with those of the first survey (Yip *et al.*, 1987), there was no marked differences in the values for physico-chemical parameters (Table 5). However, the mean values of all the parameters recorded an increase in the present survey except for salinity. There was an increase of 1.4ppm in mean dissolved oxygen. This could have an impact on the biological lifeforms in the river as exemplified by the increased diversity and abundance of the aquatic fauna. The increased oxygen levels may help support a richer fauna than previously. Both the diversity and abundance of the aquatic fauna have increased. The number of families increased from 18 to 31 while the total abundance increased from 231 to 587 individuals (Table 2). There was an overall increase in the number of families when the two surveys were compared. However, the increase was most obvious at stations 1 and 2 (at station 1 the number of families increased from 9 to 15 while at station 2 from 10 to 15). An increase in total abundance of individuals was not recorded for all the three stations. While there was an increase in abundance from 35 to 131 individuals at station 2, and from 99 to 381 individuals at station 3, the abundance at station 1 dropped from 91 to 75 individuals. At the time of the present survey, it was noted that physical changes occurred at station 3 where repairs were made to the bridges spanning the river. The piling, dredging and draining works may have affected the biological communities there.

Table 3. Temporal variation of the number of families and total abundances at the first three stations.

Station number	No. of families: Present survey (1987)	No. of families: Previous survey* (1986)	Total abundance: Present survey (1987)	Total abundance: Previous survey* (1986)
1	15	9	75	91
2	15	10	131	35
3	10	9	381	99

(*Adapted from Yip *et al.*, 1987)

Table 4. The distribution of the common families in the first three stations from the two surveys

Family	Present survey Stn 1	Stn 2	Stn 3	Total abundance	Previous survey* Stn 1	Stn 2	Stn 3	Total abundance
Penaeidae	3	2	11	16	-	4	4	8
Balanidae	-	-	82	82	2	10	10	22
Grapsidae	-	1	-	1	-	1	1	3
Portunidae	1	3	-	4	-	3	-	1
Eunicidae	-	6	4	10	1	-	-	1
Plotosidae	-	-	36	36	-	5	52	57
Solenidae	12	105	-	117	8	-	-	8
Dreissenidae	-	-	60	60	65	2	23	90

(*Adapted from Yip *et al.*, 1987)

Table 5. Comparison of the mean values of the physico-chemical parameters in the first three stations between the two surveys

Physico-chemical parameters	Present survey			Previous survey*		
	Stn 1	Stn 2	Stn 3	Stn 1	Stn 2	Stn 3
Temperature (°C)	29.1	28.9	30.0	29.1	28.8	29.0
Salinity (°/oo)	21.6	20.9	20.0	21.6	22.6	20.4
Conductivity (x10^4 µS)	4.6	4.5	4.5	4.3	3.4	3.9
Dissolved oxygen (ppm)	5.6	4.2	5.1	4.1	3.4	3.0

(*Adapted from Yip *et al.*, 1987)

Of the 18 families sampled in the first survey (Yip *et al.*, 1987), 8 families were collected again in the second survey. These included the families Dreissenidae, Plotosidae, Balanidae, Penaeidae, Solenidae, Portunidae, Grapsidae and Eunicidae (Table 4). The family Solenidae increased markedly in the number of individuals from 8 individuals at station 1 in the first survey to 117 from stations 1 and 2 in this survey. The family Balanidae also increased from 22 individuals from the three stations in the previous survey, to 83 individuals all concentrated at station 3 in the present survey. Eight more specimens from the family Eunicidae were obtained from stations 2 and 3 as compared to the previous survey where only one specimen was found at the first station. For the family Penaeidae, the number of individuals increased from 8 to 15, and was especially evident at station 3 where the abundance moved from 4 to 11. These increases in abundance clearly indicate the changed nature of the river environment, enhancing a richer fauna. Station 2 however, recorded a drop in the number of individuals from 4 to 1. Three individuals from the Penaeidae family were counted where there used to be none in the first station. One more specimen of Portunidae was collected at station 3 in this survey compared to the first survey.

The other families registered a decrease in the number of specimens collected. It is of interest to note an overall decline in abundance for the family Dreissenidae, from 90 specimens in the previous study to 60 in this study, all confined to station 3. Although 65 individuals were observed at station 1 in the previous study, none were encountered here. These changes may be attributed to the same reasons stated earlier. The catfish family, Plotosidae, also decreased in number from 57 to 36, but being bottom detritus feeders, it has survived well in the riverine habitat. Catfishes have been documented to be well adapted to poorly aerated and stagnant waters. This is especially true if the bottom is muddy (Bone & Marshall, 1982). The crab family, Grapsidae, had one individual less.

On the whole, marine life within the river has improved in the 13 months since the last survey. The fauna has increased in diversity and abundance and this change may be attributed to the cleaning up campaign of the Singapore River.

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