Pertanika 13 (3), 375 - 380 (1990)

Sewage Pollution in the Coastal Waters off Port Dickson, Straits of Malacca

A.T. LAW and AZAHAR OTHMAN
Faculty of Fisheries and Marine Science
Universiti Pertanian Malaysia
43400 UPM Serdang, Selangor Darul Ehsan, Malaysia

Key words: fecal coliform bacteria, coastal waters, Port Dickson, Malaysia.

ABSTRAK

Kajian tentang taburan bakteria koliform najis dalam air pantai dan air persisiran pantai Port Dickson telah dijalankan antara bulan Ogos 1987 dan Ogos 1989. Sungguhpun ketinggian bakteria koliform najis telah dikesan dalam air pantai, tetapi bilangannya sangat rendah dalam endapan dan air persisiran yang jauhnya di antara 0.5 km hingga 5 km daripada pantai. Kajian ini menunjukkan bahawa air persisiran Port Dickson sesuai untuk tujuan rekreasi dan akuakultur.

ABSTRACT

The distribution of fecal coliform bacteria in the near-shore waters and coastal waters off Port Dickson was studied between August 1987 and August 1989. Although a significantly high level of fecal coliform bacteria was found in the near-shore waters, very low levels were detected in the sediments and in coastal waters between 0.5 km and 5 km away from the coast. The results indicate that the coastal waters off Port Dickson are suitable for recreational and aquaculture uses.

INTRODUCTION

Most of the Malaysian population is situated within a few tens of kilometers from the coast. Improper management of the coastal area development and inadequate sewage treatment systems have created problems of sewage contamination in most of the Malaysian rivers (Consumer's Association of Penang1978; Law 1980) and in some of the coastal waters (Owens 1978; Law and Azahar 1985; Law 1986; Mendia 1983). The Department of Environment (DOE) monitoring fecal coliform levels in Malaysian coastal waters, has indicated that between 35-65% of the samples contained counts higher than 500 MPN/100 ml (Mendia 1983; Tong and Law 1988) This has motivated the government to have more stringent controls for sewage discharge into the aquatic environment.

Port Dickson is one of the well known recreational beaches in Malaysia. A previous study on the fecal coliform distribution along the beaches of Port Dickson revealed that the near shore waters were contaminated by sewage effluent (Law and Azahar 1985). It was found that more than 35% of the samples contained fecal coliform counts higher than 200 MPN/ 100 ml, which exceeded the 100 MPN/100 ml level recommended for recreational waters (Grimes 1980). Since the proper measurements have been taken by the authority to minimize the level of sewage pollution and to protect beaches for public use. The present study was undertaken to continue monitoring the distribution of fecal coliform bacteria along the beaches as well as the coastal waters and sediment off Port Dickson.

MATERIALS AND METHODS

Sampling Stations

Sixteen sampling stations in three transects were established for this study and their locations are shown in *Fig. 1.* The sampling

stations covered the entire coast of Port Dickson and extended 5 km towards the sea. Stations A1, A2, A3, A4, A5 and A6 were the near-shore stations which were located at about 3 to 5 m away from shoreline at a depth of about 1 m. For each transect, stations were set at 1 km, 3 km and 5 km towards the sea except for station J which was located at about 0.5 km from the Port Dickson harbour. The stations were visisted 8 times between August, 1987 and August, 1989.

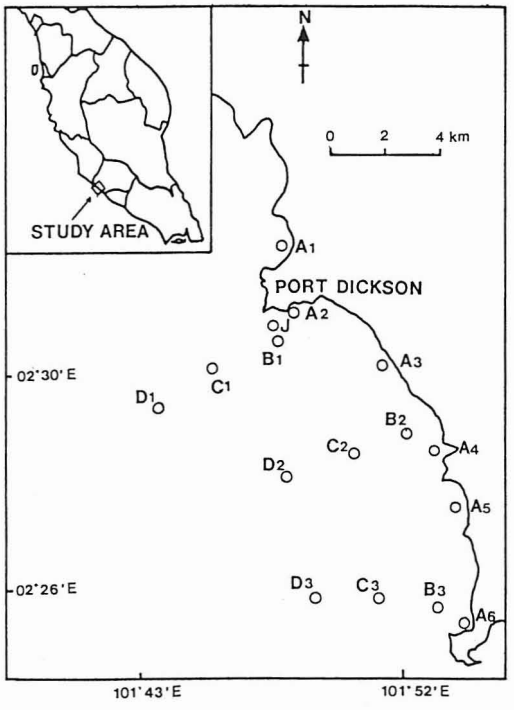

Fig. 1: Map showing the sampling stations

Collection of Samples

Water samples were taken with sterile 500 c.c. glass reagent bottles at 1 m depth below the surface of the sea water. The samples were kept cool on board with ice. The bottom sediment was taken with a Smith-McIntyre grab. Only the surface sediment (~ 3 cm) was taken for enumeration of fecal coliform. The surface sediment samples were kept cool with ice until analysis.

Fecal Coliform Enumeration

Water The five-tube most probable number method (MPN) as described in WHO (1977a) with an incubation temperature of 44.0 C was employed for the determination of fecal coliform concentrations in water. Undiluted water samples were used for the analysis except for station A2 which was diluted with 0.1% sterile saline water to 10,000 times before enumeration. Inoculation of water samples were performed at the field within six hours after sampling.

Sediment 10 g of sample wre resuspended in 100 ml sterile water saline water (0.1%) and shaken vigorously. MPN method of WHO (1977a) was used to estimate the fecal coliform content in the mixture.

RESULTS AND DISCUSSION

The fecal coliform counts in samples taken from the near-shore waters, coastal waters and coastal sediment off Port Dickson are shown in Table 1. The cumulative frequency plot of fecal coliform bacteria in the near-shore waters (from stations A1 to A6) is presented in Fig. 2, which indicates that 52% of water samples contained

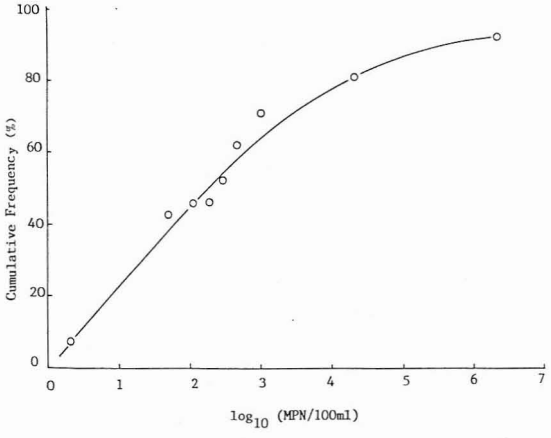

Fig. 2: Cumulative frequency of the fecal coliform distribution in the near-shore water off Port Dickson from 1986 to 1989

fecal coliform counts higher than 200 MPN/100 ml. The geometric mean of fecal colifrom counts at stations A1, A2, A3, A4, A5 and A6 were 579.4 MPN/100 ml, 3.7×10^5 MPN/100 ml, 372.6 MPN/100 ml, 19.3 MPN/100 ml, 526.4 MPN/100 ml and 103.8 MPN/100 ml, respectively. Consistently high fecal coliform counts were detected at station A2, ranging from 2×10^4 MPN/100 ml to 2×10^6 MPN/100

TABLE 1
Fecal coliform bacteria distribution in the coastal water off Port Dickson (MPN/100 ml)

Date / Station	24.8.87	28.12.87	28.3.88	20.6.88	8.1.89	25.3.89	21.5.89	22.8.89
A1	1600	-	200	1600	550	49	31	26
A2	110,000	2,000,000	20,000	20,000	20,000	70,000	700,000	40,000
A3	1600	21	330	70	920	11	< 2	27
A4	-	33	-	-	25	17	< 2	-
A5	350	900	230	540	1600	49	2	540
A6	-	49	17	240	350	33	5	33
B1	11	< 2	2	5	< 2	< 2	< 2	2
B2	5	< 2	5	< 2	2	< 2	< 2	< 2
B3	< 2	< 2	2	2	< 2	< 2	< 2	< 2
J	-*	14	< 2	-	<2	7	< 2	< 2
C1	< 2	8	< 2	< 2	< 2	< 2	< 2	< 2
C2	< 2	11	< 2	8	< 2	< 2	< 2	< 2
C3	< 2	< 2	< 2	-	< 2	< 2	< 2	< 2
D1	< 2	< 2	-	2	< 2	< 2	<2	< 2
D2	< 2	< 2	-	< 2	< 2	< 2	< 2	< 2
D3	< 2	< 2	-	< 2	< 2	< 2	< 2	< 2

* = Not determined.

ml. Station A2 was situated at the Port Dickson harbour which received waster water discharged from the town. It was found to carry the highest sewage pollution in the near-shore waters of Port Dickson. Significantly high fecal coliform counts were also detected in the vicinity of the town area, at stations A1 and A3, which were located at about 4 km north and south of the town. At station A5, the fecal coliform counts ranged between 2 MPN/100 ml and 1,600 MPN/100 ml. This station was situated in an area where most of the hotels and condominiums were located in Port Dickson. The acceptable coliform levels for bathing waters were found at stations A4 and A6 where their mean levels were below 200 MPN/100 ml. The levels of fecal coliform along the near-shore waters of Port Dickson, as obtained from the present study were similar to that reported in 1984 by Law and Azahar (1985). Efforts to clean up the Port Dickson coastal areas from sewage pollution have shown no significant improvement. It is therefore necessary that more stringent standards be enforced for the treatment and discharge of sewage effluents into the near-shore waters of Port Dickson.

Although a significant level of fecal coliform bacteria was detected in the near-shore waters of Port Dickson, very low levels were found in the coastal waters between 0.5 km and 5 km away from the coast (Table 1). More than 75% of the water samples taken from the coastal waters contained fecal coliform bacteria below detection level. The mean fecal coliform count in the coastal waters was 3 MPN/100 ml and the range was between <2 and 17 MPN/100 ml.

The distribution of fecal coliform bacteria in waters along the sampling stations of the transect, extending outwards from the harbour area, is presented in Fig. 3. It indicates that between 10^4 and 10^6 MPN/100 ml fecal coliform bacteria were detected in the near-shore waters at station A2. However, the level dropped to 10 MPN/100 ml at

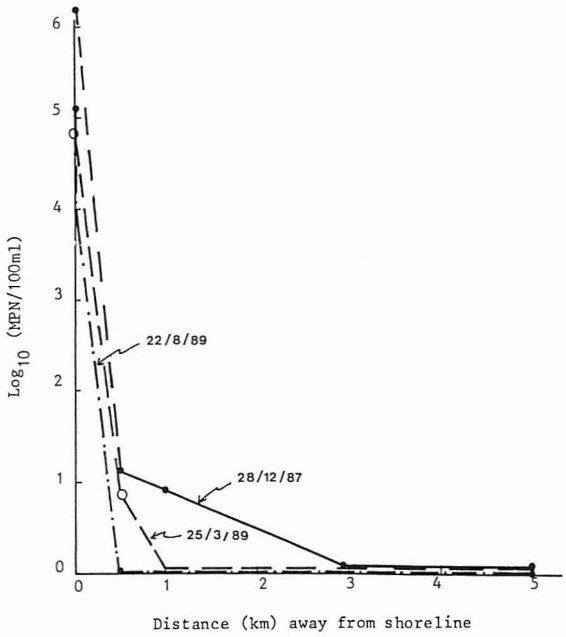

Fig. 3: Fecal coliform distribution along the transect situated near the Port Dickson harbour

0.5 km away from the coast, and was undetectable between 1 km and 5 km away from the coast. The rapid reduction of fecal coliform bacteria in the waters away from the shore is interesting. This is probably due to great degree of dilution or flushing effect in the offshore waters.

Fecal coliform content in the sediment also serves as an indicator of pollution of the overlying waters (Law 1986). Very low fecal coliform counts were recorded in the coastal sediment off Port Dickson. The mean value was 3.7 MPN/g wet sediment sample with a range of <0.2 to 17 MPN/g wet sediment. The level of fecal coliform bacteria in more than 89% of the sediment samples were undetectable. Low fecal coliform content in the sediment supports and reflects the level of low sewage pollution in the coastal waters off Port Dickson (Table 2).

DOE-UM (1986) recommend a log mean MPN of 200 fecal coliforms/100 ml as an interim standard for Malaysian recreational waters. WHO (1975, 1977b) suggests that a highly satisfactory bathing water should show fecal coliform counts consistantly less than 100 per 100 ml, and , for shellfish harvesting waters, the counts should not exceed 14 MPN/100 ml. The results of this study indicate that although the near-shore waters of Port Dickson carry some degree of sewage pollution, the sewage contamination in the coastal waters was very low and can be considered acceptable for recreational and aquaculture uses.

ACKNOWLEDGEMENTS

The authors would like to thank En. Badrul Khairi for typing the manuscript. This is an on-going project funded by IRPA (4-07-05-06).

REFERENCES

CONSUMER'S ASSOCIATION OF PENANG. 1978. The Malaysian Environment in Crisis. Penang: The Consumer's Association of Penang, 129 p.

DOE-UM. 1986. Water Quality Criteria and Standards

TABLE 2
Fecal coliform bacteria distribution in the sediment off Port Dickson (MPN/g wet sediment)

Date / Station	24.8.87	28.12.87	28.3.88	20.6.88	8.1.89	25.3.89	21.5.89	22.8.89
A1	< 0.2	< 0.2	< 0.2	<0.2	- *	< 0.2	< 0.2	< 0.2
A2	< 0.2	< 0.2	3.3	<0.2	-	0.2	< 0.2	< 0.2
A3	< 0.2	< 0.2	< 0.2	<0.2	-	< 0.2	< 0.2	< 0.2
B1	< 0.2	-	< 0.2	<0.2	-	<0.2	< 0.2	-
B2	< 0.2	17	< 0.2	<0.2	-	< 0.2	< 0.2	< 0.2
B3	< 0.2	0.2	< 0.2	<0.2	-	< 0.2	< 0.2	< 0.2

* = Not determined.

for Malaysia. Final Report, Department of Environment, Malaysia. The Consultant Group on Water Quality, Institute of Advanced Studies, University of Malaya, Kuala Lmpur. July. 1986.

GRIMES, D.J. 1980. Bacteriological Water Quality Effects of Hydraulically Dredging Contaminated Upper Mississippi River Bottom Sediment. *Appl. Environ. Microbiol* **39**: 782-789.

LAW, A.T. 1980. Sewage Pollution in Kelang River and its Estuary. *Pertanika* **3(1)**: 13-19.

LAW, A.T. 1986. Monitoring of Sewage Pollution in the Estuaries and Coastal Waters off Port Klang, Malaysia. In *Proc. Intl. Conf. Dev. Managt. Trop. Living Aquat. Resources,* ed. H.H. Chan, K.J. Ang, A.T. Law, Mohd. Ibrahim b. Hj. Mohamed and Ishak b. Hj. Omar, p. 236-241.

LAW, A.T. AND AZAHAR OTHMAN. 1985. Faecal coliform bacteria distribution in the Coastal Waters off Port Dickson. *Pertanika* **8(1)**: 131-134.

MENDIA, L. 1983. Assignment Report on Technical Cooperation to Review the Marine Water Quality Management Programme in Malaysia and the Development of the Methodology for Assessing Water Quality. WHO Report ICP/RUD/001.

OWENS, J.D. (1978): Coliform and Escherichia coli Bacteria in Seawater Around Penang Island, Malaysia. *Water Res.*, **12**: 365-370.

TONG, S.L., AND A.T. LAW. 1988. Water Quality Criteria for Coastal Zone Management. Paper presented at the *International Conference on The Marine Environment: Challanges and Opportunities.* 31 March-2 April 1988. Environment Management And Research Association of Malaysia, Kuala Lumpur, Malaysia.

WORLD HEALTH ORGANIZATION. 1975. Guides and Criteria for Recreational Quality of Beaches and Coastal Waters, Bilthoven, 28 Oct.-1 Nov. 1974, EURO 3125(1).

WORLD HEALTH ORGANIZATION. 1977a. Guidelines for Health Related Monitoring of Coastal Water Quality. Report of a Group of Experts jointly convened by WHO and UNEP, Rovinj. Yugoslavia, 23-25 February, 1977. 165 p.

WORLD HEALTH ORGANIZATION. 1977b. Health Criteria and Epidemiological Studies Related to Coastal Water Pollution. Report of a Group of Experts jointly convened by WHO and UNEP. Athens, 1-4 March 1977. ACP/CEP 209/A(2).

(Received 30 January, 1990)