

**PRELIMINARY STUDY ON THE DISTRIBUTION OF THE AEROBIC  
HETEROTROPHIC BACTERIA AND THE MICROBIAL  
INDICATORS IN JAKARTA BAY**

by

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**ABSTRACT**

The distribution of heterotrophic bacteria and microbial indicators in the Jakarta Bay were studied. Higher frequency of occurrences of the total coliform were observed in water samples collected near rivermouths or in the vicinity of islands. Lower frequency of occurrences of total coliform were obtained from samples collected from the far northern side of the Bay. The isolated strains belong to the genera *Achromobacter*, *Vibrio*, *Flavobacteria*, *Micrococcus* and coliforms. *Micrococcus* and coliforms were mostly obtained from samples collected at stations which are suspected to be highly influenced by human activities. The presence of *Vibrio parahaemolyticus-like* organisms were also determined. Occurrences of the genera varied unpredictably but were mostly within the six genera mentioned.

**INTRODUCTION**

Many investigations on marine bacteria and other micro-organisms had been conducted due to the important role played by these organisms in the transformation of matter in the sea. The most important functions of microorganisms have to do with the modification of organic matter, its formation and mineralization as well (ZOBELL 1963). BENECKE (as quoted by ZOBELL 1963) indicated that bacteria are widely distributed in the sea, although relatively less abundant than in soil or fresh water. The largest bacterial populations generally occur in near shore waters contaminated by land-borne pollutants (ZOBELL 1963; RAO & BURNISON 1976). The pollutants will increase nutrient load in the sea which could act as a protection against effects of salinity and temperature resulting in the survival of bacterial strains that would otherwise die off (CARNEY *et al* 1975).

Although many works have been done on marine bacteria in parts of the world, only very little is known of the Indonesian marine bacteria. Indonesia is an archipelago consisting of thousands of islands. Two third of the territory is covered by sea water. Therefore marine research ought to

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receive more attention. The effects of marine bacteria are closely related to several aspects, e.g. the productivity of the sea, problems of sanitary significants, seafood pollution, and others which presently should be handled seriously in Indonesia.

The Jakarta Bay was chosen for this study because of the high degree of pollution that occurs in its waters. Several rivers discharge their water into the Bay, dumping domestic and industrial wastes from various urbans, particularly from Jakarta with her 5 million population. The objective of this study is, therefore, to obtain a preliminary bacteriological evaluation as a part of the coming larger study of ecology of the microorganisms of the Jakarta Bay.

MATERIAL AND METHODS

**Location of study sites**

Water samples were collected at a depth of about 0.5 m. They were taken at approximately 4 week intervals from 6 stations in the Jakarta Bay from July to December 1975 (Fig. 1). In November 1975, one cruise was made which covered a larger area (Fig. 5) with 15 stations.

**Enumeration of aerobic heterotrophic bacteria and halotolerant bacteria**

Water samples were diluted with sterile sea water. Series dilution of  $10^{-2}$  to  $10^{-4}$  were made of water samples and then plated. (0.1 ml) in triplicates on E 2216 agar for the enumeration of heterotrophic bacteria and E 2216 agar with 0.05% NaCl and tapwater for halotolerant bacteria (RHEINHEIMER 1966). For identification and determination of aerobic heterotrophic bacteria, the taxonomic scheme of SHEWAN *et al* (1960) was employed.

**Enumeration of microbial indicator organisms**

Standard methods were employed for enumeration and isolation of *Escherichia coli*, (AMERICAN PUBLIC HEALTH ASSOCIATION 1965; SAYLER *et al* 1975). Three dilutions, five tube replications of lactose broth in a standard of most probable number (M.P.N.) series were used to estimate total coliforms per 100 ml water sample. Sample volumes or diluted sample volumes in ten fold strengths (for suspected heavy polluted samples) of 10.0, 1.0 and 0.1 ml were inoculated into separate lactose broth tubes. After incubation at 35° C for 24 to 48 hours, positive tubes were confirmed by transferring it to brilliant green lactose bile broth and incubated at 35°C for 48 hours. Tubes showing acid and gas production were recorded in the

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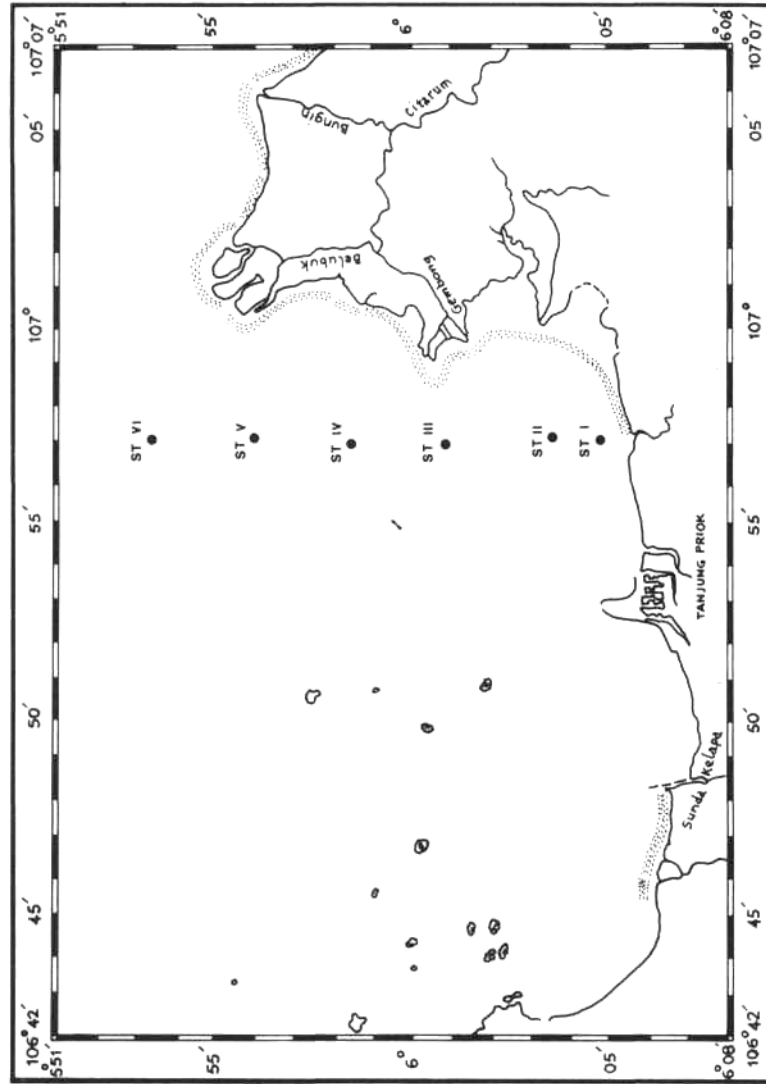


Figure 1. Location of the sampling sites.

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M.P.N. index as confirmed for total coli. Isolation of *Escherichia coli* was also done following standard methods.

**Presence of V.P.L.O. (*Vibrio parahaemolyticus*-like organisms)**

The presence of VPLO were determined by plating water samples on TCBS plates. Greenish, typical *V. parahaemolyticus*-like colonies were then streaked into salt starch agar containing 3% NaCl, 0.4% starch and 2 units penicillin per ml medium, incubated at 30°C for 28-48 hours. The colonies which hydrolised starch were picked up and inoculated in tripti ease broth. For further determination the scheme of BAROSS & LISTON(1970) was employed.

**Isolation of pathogenic bacteria from sediment and fresh marine product in 1974.**

Sediment suspensions and marine product suspensions were respectively incubated at 37°C in Enterobacteriaceae enrichment broth for 24 hours. Cultures were then streaked on Salmonella-Shigella agar. Suspected colonies were further tested for *Salmonella* and *Shigella* by employing the A.P.I. system.

RESULTS AND DISCUSSION

In general, water samples collected from all sampling sites exhibit high bacterial counts. Figures 2 and 3 present the comparison of temporal distribution of aerobic heterotrophic bacteria and the halotolerant bacteria in Jakarta Bay. The figures expressed the total viable counts of bacteria per ml X 10<sup>-4</sup> in the periods of July-December 1975.

The total viable population of the aerobic heterotrophic bacteria in the water was found to vary between 16 X 10<sup>4</sup> per ml and 270 X 10<sup>4</sup> per ml. The halotolerants varied between 14 X 10<sup>4</sup> per ml and 108 X 10<sup>4</sup> per ml. Higher counts of aerobic heterotrophic bacteria were obtained from water samples collected at stations which were not far away from the shore. Those were stations which were suspected to have more influence from the rivers Gembong and Blubuk, carrying domestic waste and industrial waste which could act as growth supporting organic matter and micronutrients (SAYLER *et al* 1975). Investigations of RAO & BURNISON (1976) also noted that the inshore biomass maximum could be expected to provide substracts for subsequent heterotrophic growth. It is then understandable that the highest count were recorded from stations I, II, III, IV.

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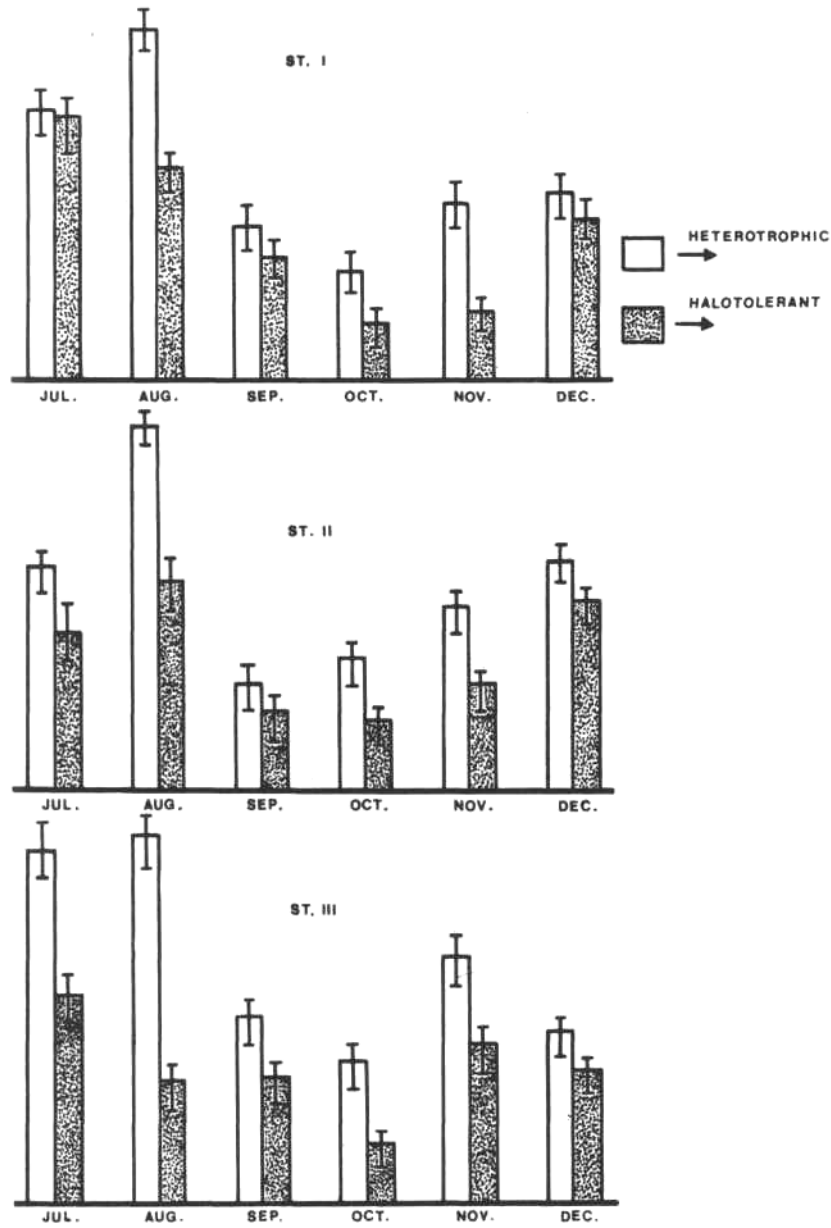


Figure 2. Comparison of the temporal distribution of heterotrophic bacteria in Jakarta Bay.

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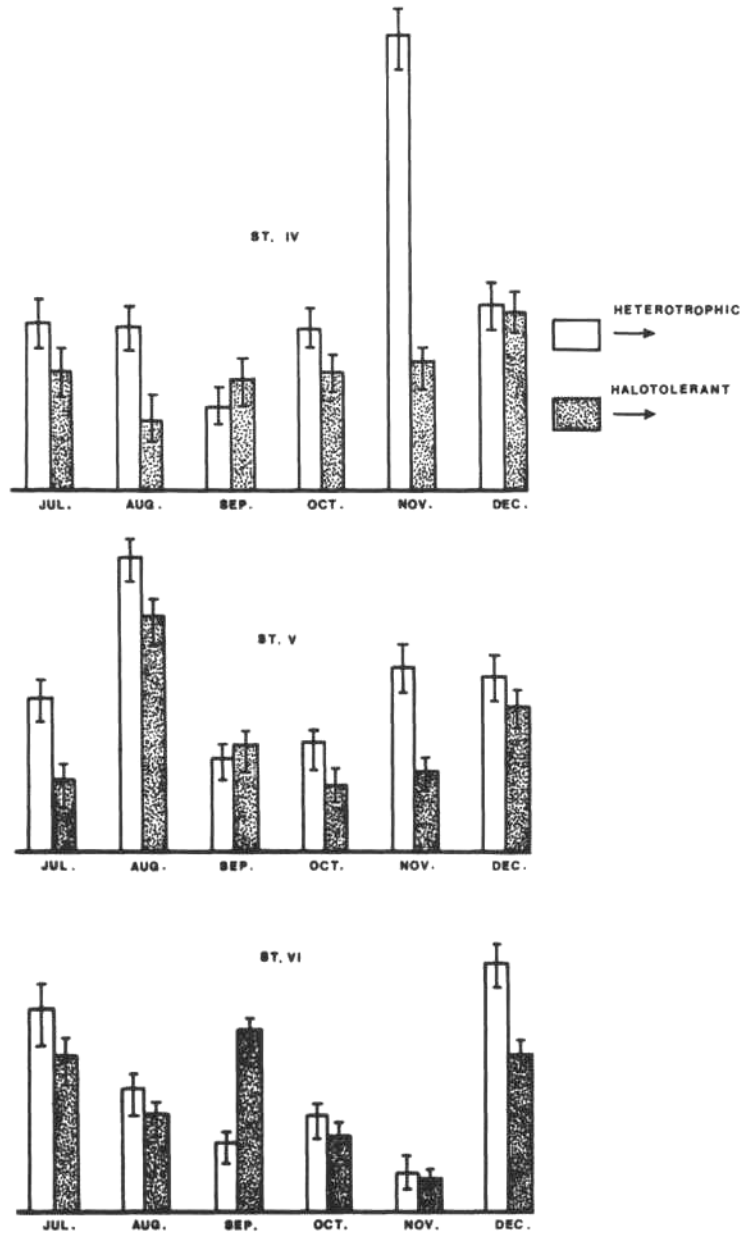


Figure 3. Comparison of the temporal distribution of heterotrophic bacteria in Jakarta Bay.

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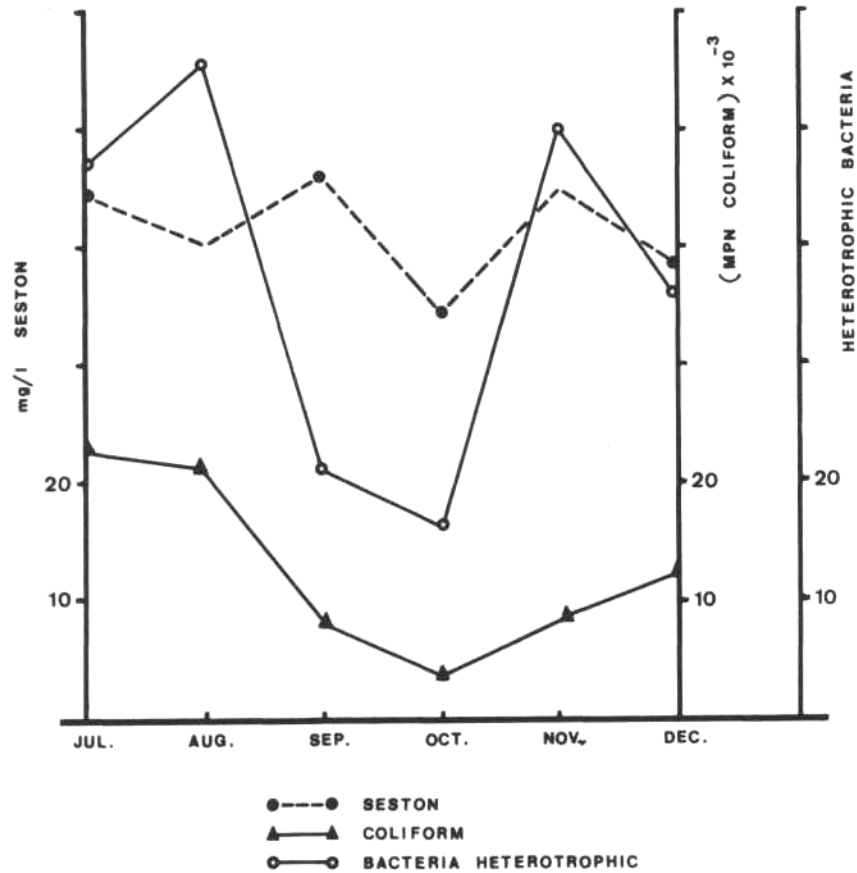


Figure 4. Fluctuation of total viable count of heterotrophic bacteria x 10<sup>-4</sup>, mg/L. Seston and M.P.N. Coliform x 10<sup>-3</sup> through July - December.

The total halotolerant counts obtained could be interpreted as reflecting input from land origin microorganisms. This land origin microorganisms could adapt themselves living in the sea as noted by WEYLAND (quoted by RHEINHEIMER 1966). The halotolerants appeared at all six stations during the study. Based on those results, it could probably be interpreted that those stations were influenced by extra aquatic source microorganisms although the strength of the influence varied from one station to another. This is expressed by the abundance of the halotolerants and the coliforms

In general, the abundance of halotolerants were found less than the aerobic heterotrophs. Higher counts of halotolerants were recorded from

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stations I, II and V, which were suspected to be influenced by the rivers Citarum and Blubuk. This condition could be observed clearly in July and August.

Generally the total counts of bacteria of both aerobic heterotrophic and halotolerant bacteria followed a same pattern, showing a rise in July and August and a decrease in October and November in most stations an increased was observed again in November-December. The pattern show sporadic variations at certain stations diverting from the pattern as exhibited as stations III and VI.

Figure 3 shows the fluctuations of total counts of bacteria, aerobic heterotrophs, seston and coliforms through July-December 1975. Seston data were obtained from Mr. ANUGERAH NONTJI, of the National Institute of Oceanology. The peak of the total counts of the aerobic heterotrophs was found in August which decreased in September and began to increase again in October-November then went down again in December. Seston had a minimum in October. It is interesting to note that there was a significant correlation between seston and the aerobic heterotrophs at the level of 5% and also a significant correlation between the aerobic heterotrophs and the coliforms at the level of 5%.

This significant correlation between seston and aerobic heterotrophs which is exhibited in this study is probably due to the ability of the seston being a potential mechanism of transporting bacteria from water to sediment and vice versa (SAYLER *et al* 1975). Bacteria occur only to a very limited extent floating free in water, most of them being attached to plankton organism (ZOBELL, 1974).

TABLE I. M.P.N. of coliforms from samples collected at six stations through July - December 1965

Month	Stations					
	I	II	III	IV	V	VI
July	$29 \times 10^3$	$11 \times 10^4$	$29 \times 10^2$	$11 \times 10^2$	$11 \times 10^2$	$11 \times 10^2$
August	$93 \times 10^2$	$15 \times 10^2$	$23 \times 10^2$	$3.6 \times 10^2$	$46 \times 10$	$46 \times 10$
September	$23 \times 10^3$	$23 \times 10^2$	$24 \times 10^2$	$36 \times 10$	$24 \times 10$	$43 \times 10$
October	$93 \times 10^2$	$15 \times 10^3$	$15 \times 10$	$11 \times 10$	$75 \times 10$	$24 \times 10$
November	$23 \times 10^3$	$24 \times 10^3$	$11 \times 10^2$	$24 \times 10$	$11 \times 10^2$	$46 \times 10$
December	$20 \times 10^3$	$44 \times 10^3$	$24 \times 10^2$	$23 \times 10^2$	$46 \times 10$	$15 \times 10$

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Table I shows the M.P.N. of coliforms from six stations studied. The count has a minimum of  $11 \times 10$  coliforms in 100 ml water sample and a maximum of  $11 \times 10^4$  coliforms per 100 ml water sample. The highest count was recorded from station II in July and the minimum was obtained from station VI in October. Higher counts were recorded from stations I, II, III, and IV. This M.P.N. seemed to follow the same pattern of fluctuation as the aerobic heterotrophs'. This result showed that a high degree of pollution exist in the vicinity of those four stations.

The most common genera of bacteria that occurred in water samples were *Pseudomonas*, *Vibrio*, *Achromobacter*, *Flavobacteria*, *Micrococcus*, and coliforms. *Micrococcus* and coliforms appeared predominantly in samples collected from stations which are not so far from the shore. In general *Pseudomonas* were always found more than 20% from the isolated strains and *Vibrio* could reach more than 15% from the isolated strains.

Figure 5 presents the distribution of M.P.N. coliforms observed in November 1975. The counts were between  $110 \times 10^4$  and  $23 \times 10$ . Stations situated near rivermouths were more polluted as expressed by the presence of high coliforms counts.

Stations located further away from shore had minimum counts as was predicted. Higher counts could also be found in water samples collected at stations located in the vicinity of islands. Those heavily polluted stations were due to the influences of human activities which inhabit those small islands.

TABLE II Positive result of pathogenic bacteria from samples of sediment and fresh marine product around the area of Jakarta Bay. 1973 – 1974.

Bacteria isolated	Kinds of samples					
	Sediment		Fish		Shell fish	
	Total	no. of. pos	total	no. of. pos	total	no. of. pos
<i>Clostridium</i>	600	6.63%	62	3.22%	49	0
<i>Vibrio parahaemolyticus</i>	40	15 %	196	9.67%	254	13.38%
<i>Salmonella</i>	15	6.66%	68	4.41%	300	52.33%
<i>Shigella</i>	–	–	68	5.88%	300	6.33%

*Vibrio parahaemolyticus* was detected at stations I and IV.

The presence of potential pathogenic bacteria from samples collected at Jakarta Bay (Table II) were detected during a short study in 1974 (THAYIB *et al* 1974; THAYIB & SUHADI 1975). *Clostridium*, *Vibrio parahaemolyticus*,

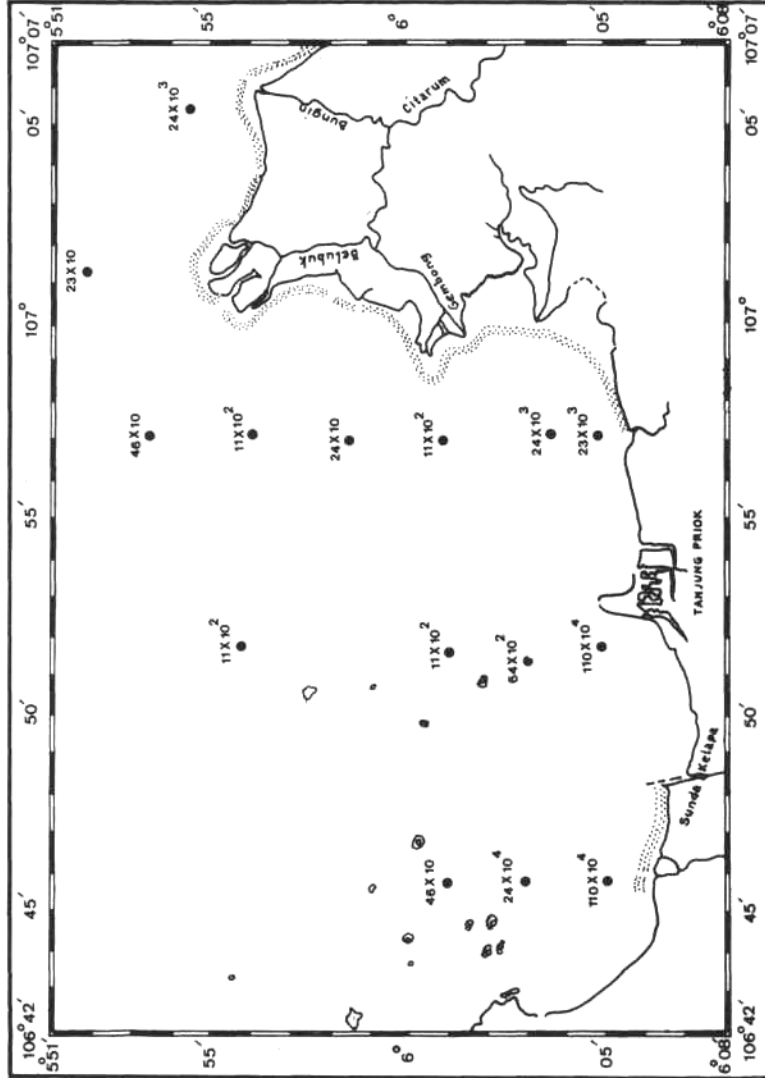


Figure 5. M.P.N. Coliforms, November 1975.

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*Salmonella*, and *Shigella* were found associated with sediment, fish and shellfish. *Salmonella* was found in higher percentage in shellfish (60%) and *V. parahaemolyticus* was found in more than 9% of the investigated fish.

The incidence of potential pathogens could be transmitted to human by sea products obtained from sewage area (COLWELL & LISTON 1962). Therefore more attention should be paid to pollution problems by conducting more research in this field, which probably could help solve problems and prevent or minimize pollution before water borne diseases break out seriously.

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