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Marine Pollution in Hong Kong

Hong Kong, with an exploding population rising from 600,000 in 1945 to over 4 million in 1970, has had to give first priority to housing. It is not surprising that there is heavy pollution of coastal waters. Tolo Harbour, already dangerously polluted, is an area which is scheduled for a great increase in population. This preliminary study of conditions in the bay will aid planning of future sewage treatment.

Hong Kong is located at 22°N 114°E, just south of the Tropic of Cancer. Its geographic position places it under the influence of the East China Sea to the north and the Indo-Pacific region to the south, with Kuroshio and Taiwan currents being most influential. As it is on the northern boundary of the South China Sea, Hong Kong is subtropical. The Pearl River influences salinity and associated factors such as sedimentation, especially in the spring-summer rainy season, and particularly on the south-west side of the Colony.

The total land area of Hong Kong is 1,032 km^2, the majority of which (945 km^2) is the less densely populated 'New Territories' which include more than 230 small islands (Hong Kong Government, 1970). This relatively small land area, supporting 600,000 persons at the end of World War II, now holds over 4,127,800 (1970 census). Hong Kong is thus one of the most densely populated areas in the world, with as high as 165,000 persons per km^2

The human density and increase in heavy industry leads to obvious waste disposal difficulties. Sewage treatment is largely only primary; and ocean dumping of raw sewage is the norm. Ocean currents, with their high dispersal rate are given the task of removal, which is often impossible. The same is true for industrial pollutants, including slaughterhouse wastes, and dye plant effluents, with many effluents secondarily reaching the sea via original discharge into streams. The local government is becoming aware of the problem of marine pollution, albeit slowly, but they have been primarily concerned with providing housing, and it can be easily understood how priorities arose. The alarming pollution rates are thus officially being noted, with corrective action being envisaged.

We began a study of pollution levels in 1970, with emphasis on Tolo Harbour, which, with an area of approximately 20 square miles, is the second most important harbour in Hong Kong, and is also the location of the Marine Science Laboratory of the Chinese University of Hong Kong. Tolo Harbour is nearly landlocked, and thus its inner reaches have only moderate tidal flushing rates. It is at these locations that the only noteworthy towns, Shatin and Taipo, are situated.

Methods

For initial study, the water of five stations was sampled and analysed for temperature, salinity, dissolved oxygen, pH, turbidity, BOD, and coliform bacteria. The sediments were analysed for particle size, and coliform bacteria. Additional quantitative data on plankton and benthic fauna have been gathered, and are now being analysed. Temperature was taken by hand thermometer; salinity by an AO refractometer; dissolved oxygen was analysed through the Pomeroy-Kirschman Winkler modification; *p*H was taken by a TOA *p*H meter; turbidity was with a standard Secchi disc; and, BOD and coliforms were measured by standard methods (APHA, 1955). Samplers used were a 1 l. Doty sampler for water, a Rittenberg bacterial bottom sampler (Emery, 1958), and a simple ZoBell bacteriological sampler. (ZoBell, 1941; Sieburth, 1963.)

Results

The seasonal salinity range in Tolo Harbour is 17.5 per thousand to 33.0 per thousand; the temperature range of surface water is 11.6°C to 32.3°C. The wide ranges indicated here are typical of estuarine conditions. Considering only the middle of the harbour, 17.8°-31.5°C (mean 23.9°C) and 18.5 per thousand to 34.0 per thousand (mean 30.4 per thousand), for temperature and salinity values respectively, are more meaningful. Dissolved oxygen, as an example, falls to zero at the effluent of the textile dyeing factory at Shatin, at a depth of only a few feet. Secchi disc visibility varies from 1 m at Shatin to as high as 16 m in the dry season, at the mouth of Tolo Harbour.

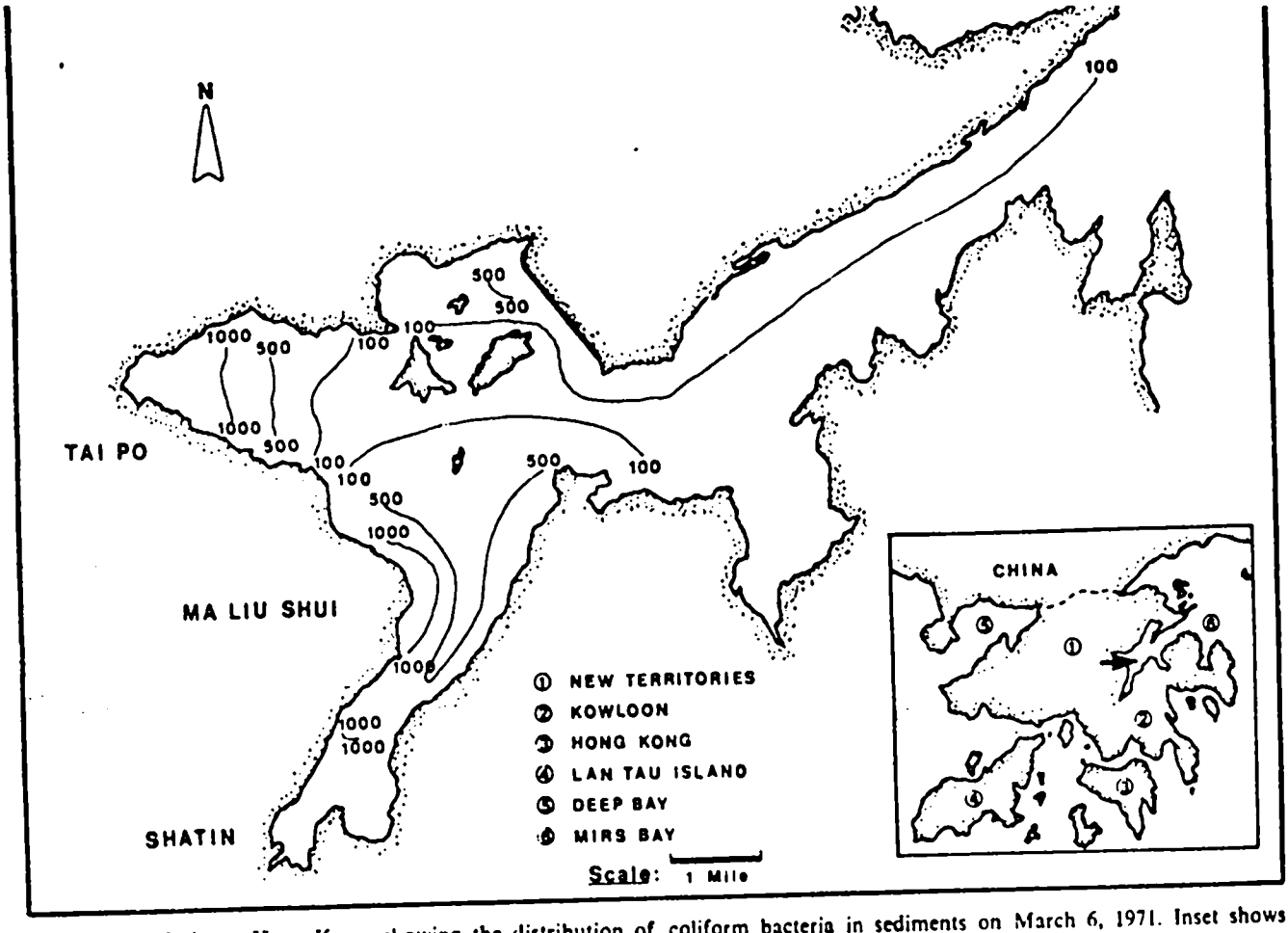

Fig. 1 Tolo Harbour, Hong Kong, showing the distribution of coliform bacteria in sediments on March 6, 1971. Inset shows Hong Kong with an arrow indicating Tolo Harbour.

Biochemical oxygen demand (BOD) is considered of prime importance in the determination of pollution levels (Thomann *et al.*, 1968). The pollution indicator depletion level of 5 ppm (WHO, 1967) has been exceeded only at Shatin and Taipo, with values of 6.4 ppm and 7.0 ppm, respectively, but this depended on tidal stage.

For coliforms, the standards of 1,000 MPN/100 ml for bathing, and 50 MPN/100 ml for seafood collection (WHO, 1967) are greatly exceeded at Shatin and Taipo. Values as high as 92,000 MPN have been found. Shatin, in particular, is heavily populated with clams. *Katelysia*, *Tapes*, and *Anomalocardia*, in particular, are collected by up to several hundred persons at a time at low tide for personal consumption or for sale to seafood restaurants. Clam tissues show an equally high MPN rate. We have made preliminary tests to the generic level for other bacterial contaminants, and have found both *Salmonella* and *Streptococcus* in the water and in clam tissues.

Preliminary nitrate and phosphate determinations as high as 25.1 μg.a./l. for the former, and 3.1 μg.a./l. for the latter, indicate sewage pollution in the Taipo and Shatin areas (Bracos-Kontos & Dugdale, 1971). The Taipo area is of particular note, for several thousand boat dwellers reside here, and they depend on tidal flushing for removal of sewage and garbage.

From thirty preliminary samples of sediments, taken in March, 1971, a map of Tolo Harbour may be drawn showing lines of equal bacterial levels in topographic fashion (Fig. 1). The areas of Taipo, Shatin, and Ma Liu Shui contain the greatest number of residents, and Ma Liu Shui is the site of the Chinese University. Later samples show a depletion of MPN levels at Ma Liu Shui, probably because of the installation of an activated sludge sewage treatment plant at the University. This plant is not yet fully operational, however.

There are plans to resettle up to 500,000 people to Shatin in the next few years, to add to its present 30,000 persons, and unless adequate sewage treatment measures are installed, the Shatin area, and indeed all of Tolo Harbour, will become even more heavily polluted. At present, the mouth of the Harbour receives cleaner water from Mirs Bay and the open ocean, and is sparsely populated, thus showing a lower MPN rate on Fig. 1. Relatively normal biotic growth is found in the outer area of Tolo Harbour, including corals and their associates, but these forms will not tolerate much greater pollution. A gradient of fauna can already be seen, though pollution is not the only factor causing such a gradient.

Finally, Tolo Harbour is the second largest harbour in Hong Kong, and even though sparsely populated as compared with Victoria Harbour in the downtown area, is heavily polluted in its inner reaches. With Goldberg and Bertine's (1971) use of gross national product per area ratio as a measure of potential national pollution, Hong Kong is at the highest level, with a value of US $2,500,000,000/year/km² (Montagu, 1971) and it is indeed living up to expectations.

Conclusions

Many areas of Hong Kong show heavy marine pollution. We have placed particular emphasis on Tolo Harbour, because of its proximity to our research facilities and due to the imminent population increase on its shores. A background study has thus begun, and is continuing. Coliform bacterial levels for swimming have been exceeded by as high as 92 times, even though persons still swim in areas such as this. The normal level considered safe for removal of seafoods has been exceeded by 1,800 times, and again, heavy use is made of seafoods, particularly clams, taken from such areas.

We can conclude from our preliminary results that Tolo Harbour is heavily polluted, especially in the Shatin and Taipo areas, and that even greater pollution levels will be found as population levels increase.

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PARLIAMENT

British Legislation on Estuary Pollution Promised

Legislation enforcing many of the recommendations made by the Royal Commission on Environmental Pollution in its report on pollution in British estuaries and coastal waters will be included in the Government's forthcoming bill to establish the Regional Water Authorities.

In a written answer in the House of Commons last month Mr Eldon Griffiths, under-secretary of state at the Department of the Environment, said that the government accepted a large majority of the commission's recommendations, and agreed that control of estuarial pollution should be part of an integrated policy for waste disposal. The government also accepts:

- that more and better chemical and biological monitoring of estuaries is needed,
- that regional water authorities must control and monitor all discharges into rivers estuaries and coastal waters,
- that river authorities should monitor critical pollutants in industrial estuaries and each estuary should be the responsibility of only one authority,
- that all discharges to sewers should be controlled, that industry should pay the full cost of disposing of its wastes, that authorities should have powers to take samples from private sewers and have the right to refuse particular constituents in effluents,
- that the government should take the lead in international arrangements to publish data on monitoring, and should make mandatory the publication of information on discharges by industry.

Mr Eldon Griffiths, quoting a letter to Sir Eric Ashby, chairman of the Royal Commission, went on to say that the government is considering introducing a system of charges to those companies that wish to empty effluent direct into rivers and estuaries. He assured Sir Eric that the government is eager to bring the new legislation into effect as soon as possible after it becomes law.

But Mr Griffiths stated that while the government was eager to clean estuaries to the point where they can support a mixed population of coarse fish, cleaning them to the stage at which migratory fish can pass at all states of the tides—one of the criteria suggested by the Royal Commission which could be used to demonstrate the health of an estuary—would be very costly indeed, 'and there might be no commensurate gain from the high level of expenditure'. The government, Mr Griffiths said, would subscribe to the second criterion 'as an ideal', but he warned that 'there could well be tasks on the freshwater rivers which are more urgent and could provide greater benefits to the community at large than achievement of the ultimate quality for estuaries'.

The Royal Commission also wanted discharges from vessels into 'controlled waters' (for example the Solent and the Wash) placed under controls. Mr Griffiths replied that the Intergovernmental Maritime Consultative Organization is to discuss this matter in 1973.

The Royal Commission also urged that it should be obligatory for planning authorities to consult the proposed regional water authorities if new developments will 'substantially' increase the effluent load on an estuary. Mr Griffiths agreed with this in principle, but pointed out that the definition of 'substantial' depends on the characteristics of the estuary as well as on the nature of the effluent. Planning authorities have already been advised to consult river authorities, Mr Griffiths said, and the Department of the Environment is considering issuing a directive making such consultation mandatory.

The Department and the Welsh Office have sent a circular to local authorities drawing their attention to