

Heterotrophic Bacteria in the Surface Sea Water of the Indian Ocean*

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In the Antarctic Ocean, nitrate and nitrite assumed to be produced by microorganisms were found in the surface sea water, nitrite-N ranging from 0.03 to 0.17 $\mu\text{g/L}$ ^{1,2)}. The presence of nitrate and nitrite was related to the occurrence of phytoplanktons, consumers of nitrate²⁾, but nitrifying bacteria, producers of nitrate, have not been found in this area¹⁾. In the temperate and tropical regions of the Indian Ocean, nitrate and nitrite were observed to be lower by value, or none, and the decrease of nitrate and nitrite was assumed to be relative to the presence of nitrate reducers distributed in this area abundantly^{1,3,4)}.

This paper describes the determination of heterotrophic bacteria isolated from the surface sea water samples of Indian Ocean.

Samplings. Sea water samples were collected by H. Meguro at the stations in the Indian Ocean during the fifth Japanese Antarctic Research Expedition 1960-1961 (Fig. 1). After uninterrupted storage for about six months at -5°C in 25 ml-polyethylene bottles, the sea water samples were thawed and immediately served for microbiological studies.

Isolation. Microorganisms were isolated at 25°C by means of smearing 0.1 ml of sea water or its dilution by a glass stick on the sea water agar plate⁵⁾. They were grouped into cultural groups by each station with their colony appearances^{1,3,5)}, and two representatives of each group served for determination.

Determination. Determination was carried out by means of employing 75 % aged sea water in place of the distilled water in the ordinary test media⁶⁾ and sea water agar in place of the nutrient agar⁵⁾. Prevalent groups were identified with *Pseudomonas azotogena*, active nitrate reducers³⁾ (Table 1).

1. *Achromobacter aquamarinus* ZoBell et Upham, 1944

Strains : Mc-136, 129, 131, 133.

2. *Achr. stationis* ZoBell et Upham, 1944

Strains : Mc-125, 127.

In the Bergey's Manual (1957)⁷⁾, Zobell and Upham's strain was described as *Brevibacterium stationis* Breed, 1953, gram-positive, but easily destained. These strains were distinctly gram-negative and identical with the original description of *Achr. stationis* ZoBell et Upham, 1944, except nitrate reduction⁸⁾.

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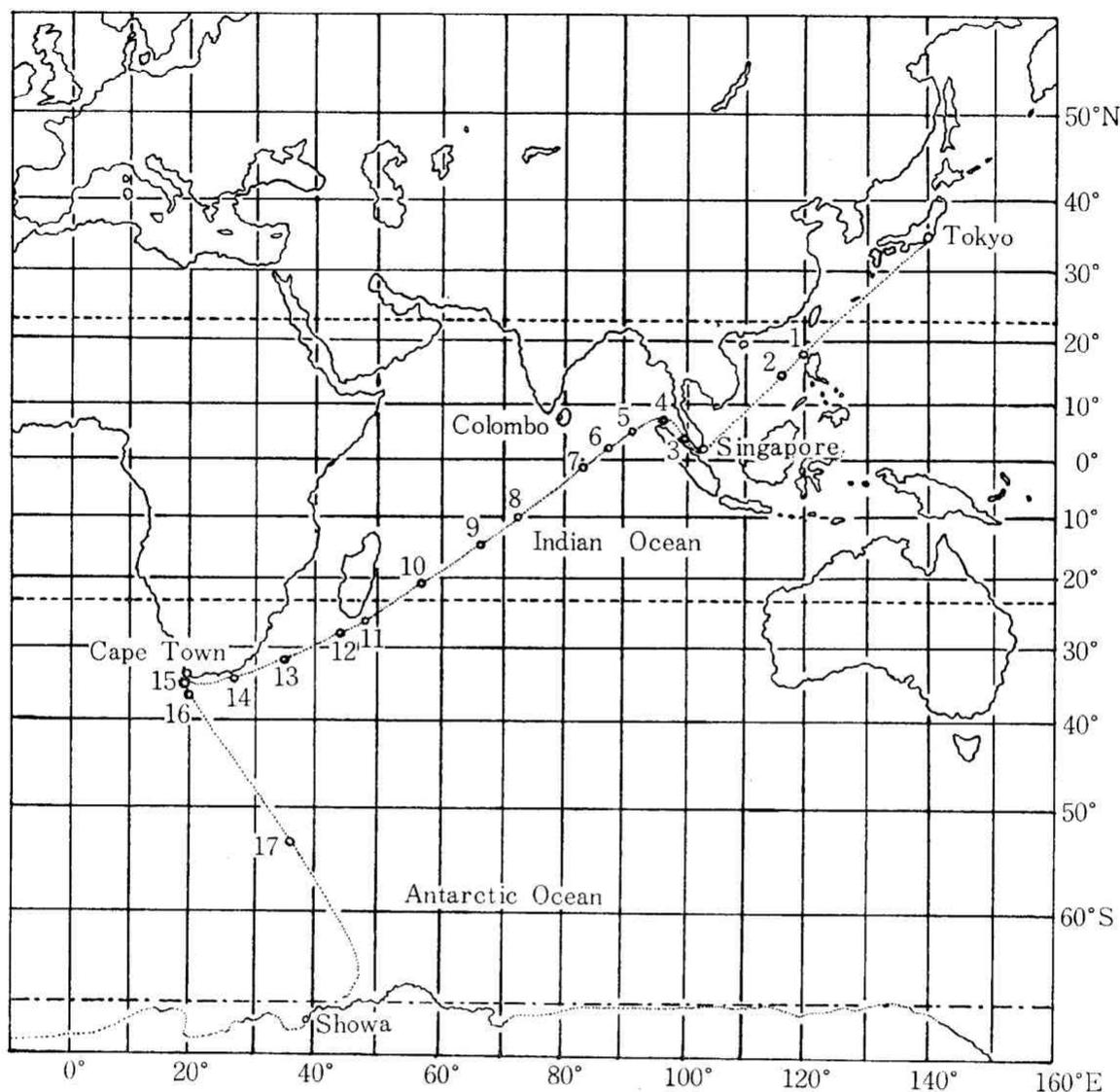


Fig. 1 Track of JARE-5 cruise and the sampling stations, 1960-61.

3. *Achr. stenohalis* ZoBell et Upham, 1944
Strains : Mc-151, 172, 174, 180.
4. *Brevibacterium maris* (Harrison 1929) Breed, 1953
Strain : Mc-274.
5. *Brev. minutiferula* (Steinhaus 1941) Breed, 1953
Strains : Mc-98, 105.
6. *Flavobacterium aestumarina* (ZoBell et Upham 1944) Brisou, 1954
Strains : Mc-201, 279, 280.
7. *Fl. balustinum* Harrison, 1929
Strain : Mc-255.
8. *Fl. diffusum* (Frankland et Frankland) Bergey et al., 1923
Strains : Mc-212, 240.

Table 1. Isolates and their origins

	Sea water samples																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
<i>Achr. aquamarinus</i>	-	+	-	-	-	-	-	-	+	-	-	+	-	+	-	-	-
<i>Achr. stationis</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Achr. stenohalis</i>	+	+	-	-	+	+	+	+	+	-	-	-	-	-	+	+	+
<i>Brev. maris</i>	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Brev. minutiferula</i>	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Fl. aestumarina</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
<i>Fl. balustinum</i> & <i>Fl. okeanokoites</i>	-	-	-	+	+	+	-	+	+	-	+	-	-	+	-	+	-
<i>Fl. diffusum</i>	+	-	-	+	-	+	+	+	-	-	+	-	+	-	+	+	-
<i>Fl. halmephilum</i> & <i>Fl. neptunium</i>	-	+	-	-	-	+	+	+	+	-	-	-	+	-	-	+	-
<i>Fl. uliginosum</i>	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-
<i>Mic. infimus</i>	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ps. azotogena</i>	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Ps. hypothermis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
<i>Ps. vadosa</i>	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Sar. litoralis</i>	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
<i>V. algosus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-
<i>V. marinopraesens</i>	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

*+ : isolated. - : not found by the methods employed for isolation.

9. *Fl. halmephilum* Elazari-Volcani, 1940
Strain : Mc-246.
10. *Fl. neptunium* ZoBell et Upham, 1944
Strains : Mc-192, 197.
11. *Fl. okeanokoites* ZoBell et Upham, 1944
Strains : Mc-269, 270.
12. *Fl. uliginosum* ZoBell et Upham, 1944
Strains : Mc-258, 259.
13. *Micrococcus infimus* ZoBell et Upham, 1944
Strain : Mc-278.
14. *Pseudomonas azotogena* ZoBell et Upham, 1944
Strains : Mc-13, 36, 59, 77, 89.

Though it was not ascertained whether these strains should produce nitrogen gas from nitrate or not, these strains were identified with *Ps. azotogena*, because of the agreement with the original description in respect of all the properties except nitrate reduction⁸⁾.

15. *Ps. hypothermis* ZoBell et Upham, 1944
Strain : Mc-264.
16. *Ps. vadosa* ZoBell et Upham, 1944
Strains : Mc-110, 112 ; 115.

Mc-115 is different from the original description and other two strains in nitrate reduction and citrate utilization, but it was identified with this species, because of its agreement with this species in respect of other properties⁸⁾.

17. *Sarcina litoralis* Poulsen, 1879

Strain : Mc-277.

18. *Vibrio alginus* ZoBell et Upham, 1944

Strain : Mc-160

19. *Vibrio marinopraesens* ZoBell et Upham, 1944

Strains : Mc-117, 124.

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SUMMARY

284 heterotrophic bacteria were isolated from 17 sea water samples of the Indian Ocean, collected during the fifth Japanese Antarctic Research Expedition 1960-1961. They were distinguished into 23 groups, 40 strains, by their colony appearances, which served for determinative studies. Identified species are as follows : *Achromobacter aquamarinus*, *Achr. stationis*, *Achr. stenohalis*, *Brevibacterium maris*, *Brev. minutiferula*, *Flavobacterium aestumarina*, *Fl. balustinum*, *Fl. diffusum*, *Fl. halmephilum*, *Fl. neptunium*, *Fl. okeanokoites*, *Fl. uliginosum*, *Micrococcus infimus*, *Pseudomonas azotogena*, *Ps. hypothermis*, *Ps. vadosa*, *Sarcina litoralis*, *Vibrio alginus*, and *Vibrio marinopraesens*. Prevalent species in the surface sea water of the Indian Ocean are *Ps. azotogena*, *Achr. stenohalis* and *Flavobacterium* spp.

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