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The amount of hydrocarbon bacteria in the Great Wall Bay and its adjacent area

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Abstract During the summer of Antarctic in 1993/1994, the species and amount of hydrocarbon bacteria of the Great Wall Bay and its adjacent sea area have been studied. *Flavobacterium*, *Pseudomonas*, *Kurthia* and *Actinetobacter* have been identified. The number of them varied from 3 cell/L to 1100 cell/L. The number in the inner bay is larger than that out of it. The dispersing is a very important way of the changing of hydrocarbon bacteria.

Key words Great Wall Bay, Antarctica, hydrocarbon bacteria.

1 Introduction

The pollution of the petroleum hydrocarbon is extraordinary in the Antarctic sea area. On Jan. 19th, 1989, the luxurious pleasure boat "Bahia Paraso" of Argentina dashed on the rocks at the Aner Island of the Antarctic Peninsula (Li *et al.* 1992; Kennicutt *et al.* 1991) at least leaked 1.5×10^5 gallon fuel oil and lube oil. Not long after it, a Peru oil tanker sunk near the King George Island and the adjacent area was polluted; in addition, investigative ships sometimes leaked oil, and the waste oil which was used to warm persons inputted into the sea inevitably. So people has paid more attention to the oil pollution of this areas. Ocean has the ability to self-purify the oil pollution. During the removing period of ocean petrolatum hydrocarbon, hydrocarbon bacteria play an important role in catabolizing the petroleum hydrocarbon. And it is also the essential indicate organism of the pollution of the ocean petroleum hydrocarbon. There are many research reports on microbe in the Antarctic sea area (Chen and Song 1992; Chen *et al.* 1992). But the hydrocarbon bacteria have not attracted our much attention. Thus, we studied the dispersing and changing of the hydrocarbon bacteria monthly during the summer of Antarctica from Dec. 1993 to Mar. 1994, and want to get some information about the hydrocarbon bacteria in Antarctica.

2 The general situation of the research area

The studied area includes the whole Great Wall Bay, a part of the Maxwell Bay and the Ardely Bay (Fig. 1 shows the fixed research stations and investigative stations.)

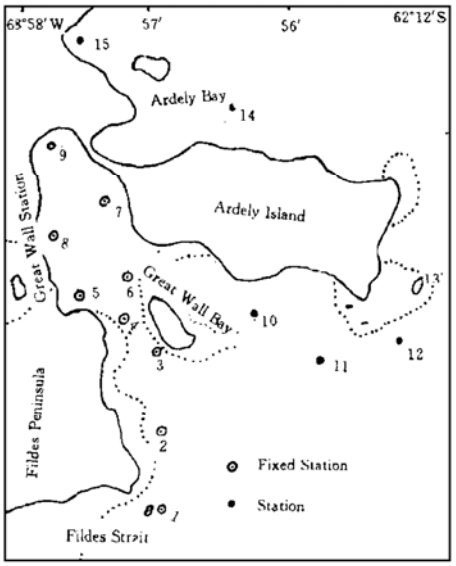

Fig. 1. The research area and the sampling stations.

The Fildes Peninsula is of Sub-Antarctic ocean climatically and the weather is warm and wet according to other Antarctic area. It has much cloud in the whole year, high humidity, lots of rain and more snowstorm. At Great Wall Station, the average temperature is −4.5 ℃, and the average precipitation is 414.9 mm yearly and the maximum is in March, the minimum is from June to August. The highest air temperature is 11.7 ℃ in summer, and the lowest is −26.6 ℃ in winter. The temperature changes very quick. During several hours, it can change more than ten centigrade degree. The air temperature and humidity are both suitable for the organisms to live in summer. The wind speed is fast in the area and average wind velocity is 17 – 18 m/s. The average atmospheric pressure is 987.0 hPa yearly. When it is influenced by the cyclone, it can be lower than 940 hPa which is usual to the atmospheric pressure of the center of the hurricane.

The inner Great Wall Bay is long-shape and about 3 km^2. The mouth of the bay is divided into two waterways by the Gulangyu Island. There is a stone dike between the Ardely Island and the Fildes Peninsula, where the rubber ships can go through smoothly during the ebb tide. When the tide is coming in, sea water of the Ardely Bay can go into the Great Wall Bay through the waterways. Besides this, more of the sea water of the Great Wall Bay goes through its mouth to exchange with the water of the Maxwell Bay. The outside sea water moves from the bottom of bay to the inner. While the inside water moves to the outside from the surface layer. By this way, the inner Great Wall Bay can eliminate the pollution.

3 Material and method

On Dec. 13th, 1993, Jan. 7th, 1994 and Feb. 3th, 1994, the measurement was carried out at the 9 fixed research stations and water samples were used to analyze the hydrocarbon bacteria. On Dec. 13th, 1993, samples were collected from Nos. 10, 11, 12, 13, 14 and 15 stations. For the continuous storm and high wave, samples were collected only from Nos. 1 – 9 fixed stations and Nos. 10 – 11 stations on Jan. 7th, 1994. On Feb. 3th, 1994, samples were from Nos. 1 – 9 fixed stations and ships returned for the high wave.

The sea water of surface layer (0.5 m) was collected by bacteria sampler. Then samples were analyzed about the amount of hydrocarbon bacteria by Try-Tube Method in the

laboratory. After being purificated in disc, the hydrocarbon bacteria were brought to China to identify.

The culture medium of hydrocarbon bacteria is followed: NH_4Cl 2 g; K_2HPO_4 0.7 g; KH_2PO_4 0.3 g; flitted sea water 1 L; diesel oil 0.5 ml; pH 7.8; 8P, 15 min.

4 Results and analysis

4.1 The species of the hydrocarbon bacteria

By primary identity, four genera of hydrocarbon bacteria occur in the sea area researched. They are *Flavobacterium*, *Pseudomonas*, *Kurthia* and *Actinetobacter*. Table 1 shows their main physiological characters.

Table 1. The main physiological characters of the hydrocarbon bacteria

Genus	Gram stain	H-L culture	Indole	Mythyl red test	Voges-proskuauer	Gelatin hydrolysis	Catalase	Oxidase	Cysts formed	Flagellar arrangement
Flavobacterium	−	−	−	−	/	−	+	−	−	Peritrichous
Actinetobacter	−	+	−	/	/	−	+	−	/	Peritrichous
Pseudomonas	−	−	−	−	+		+	+	/	Monotrichous
Kurthia	+	+	−	−	/	−	+	−	/	Peritrichous

4.2 The amount dispersion of the hydrocarbon bacteria

Table 2 and Table 3 show the results.

Table 2. The number of hydrocarbon bacteria in the Great Wall Bay and its adjacent area

Number	Environment situation	Result/(cell·L^{-1})		
		Dec. 13,1993	Jan. 7,1994	Feb. 3,1994
1	Near the Two Peaks Island	210	6	1100
2	Near the Jiuquan River, 400 m	1100	6	1100
3	The mouth of inner bay	>1100	11	>1100
4	The mouth of inner bay	53	16	>1100
5	Near oil treasury	290	11	>1100
6	Near the Gulangyu Island	1100	16	>1100
7	Near the Ardely Island	53	20	>1100
8	Near Great Wall Station	>1100	15	>1100
9	Habitat of seals	>1100	20	>1100
10	The mouth of inner bay	1100	3	
11	Outside of the Ardely Island	36	3	
12	Outside of the Ardely Island	42		
13	Outside of the Ardely Island	1100		
14	Outside of the Ardely Island	210		
15	Outside the dock of Chile Station, about 300 m	460		

Table 3. The change of numbers of hydrocarbon bacteria in the research area (cell/L)

Sea area	Number of station	Dec. 1993	Jan. 1994	Feb. 1994	Means
Inner bay*	5,6,7,8,9	>728.6	16.4	>1100	>615
Mouth of inner bay	3,4	>578.5	13.5	>1100	>564
Outside sea area	1,2,10,11,12,13,14	532.25	3	1100	545
Means		574.65	11	>1100	546

*: The inner bay means the sea area in the Gulangyu Island.

(1) The number of the hydrocarbon bacteria of each station varied from 3 cell/L to 1100 cell/L, and the degree of the average changes is 3 order of magnitude. The total average number is 546 cell/L . There are 10 stations whose number exceeds the inspection range (1100 cell/L) . Among them, there are 3 times in Dec. 1993 and 7 times in Feb. 1994. There are 15 stations whose number is lower than 100 cell/L . There are 11 times in Jan. 1994 and 4 times in Dec. 1993(Table 2).

(2) The number in the inner bay is higher than that out of it. This tendency can be learned from these 3 investigations. It is not obvious when viewed at an angle of the average value of each sea area(Table 3).

(3) The number of the hydrocarbon bacteria, which is in the inner Great Wall Bay, the mouth of the inner bay, varied obviously in a month. The average value of each station is the maximum in Feb. 1994, and it is higher than 1100 cell/L. The minimum is in Jan. 1994 and its value is only 11 cell/L. The number of Dec. 1993 is between them.

5 Discussion

The researching history the hydrocarbon bacteria dated more than one hundred years. There are more than 70 generic microbes, which can catabolize hydrocarbon and exist in ocean widely (Kennicutt *et al.* 1991). However, there is less report on Antarctic hydrocarbon bacteria in the documentations.

Four genera of microbe, which catabolize hydrocarbon, have been checked in the Great Wall Station's adjacent area. They belong to *Havobacterium*, *Pseudomonas*, *Acinetobacteria* and *Kurthia*. Their number varies from 3 cell/L to 1100 cell/L. The total average value is 546 cell/L every time. The distinction of the results of the different days is obvious. The minimum is 3 cell/L and the maximum is 1100 cell/L.

By the general analysis, clearly the number of hydrocarbon bacteria of the inner bay, which is higher than that out of the bay. This result is obtained according to the rich hydrocarbon resource of inner bay, slight wave, little exchange with other sea area and stable environment.

Because of the several days' storms, the exchanging quantity of sea water between the inside and outside on the Great Wall Bay in Jan. 1994. It should be the main reason why the amount of hydrocarbon bacteria in Jan. 1994 is much lower than that of other two research times.

In the present research, there is no obvious relation between the density change of hydrocarbon bacteria and the content of hydrocarbon. The hydrocarbon content is relatively stable. While the hydrocarbon bacteria density varies violently (We should report the polluted condition of the sea area in another paper).

As compared with the hydrocarbon bacteria density of neritic sea area of our country, the value of the Antarctic Great Wall Bay and adjacent sea area is lower. For instance, in the Bohai Sea(Wang 1983), the hydrocarbon bacteria density varies from 1×10^{2} cell/L to 1.536×10^{6} cell/L from 1980 to 1981. There are 14 genera. *Pseudomonas*, *Acinetobacter*, *Bacillus*, *Corynebacterium* are the dominant species. In the Jiaozhou Bay(Ding *et al.* 1979) the hydrocarbon bacteria density varies from 2×10^{4}cell/ml to 1.4×10^{5} cell/ml. The amount of July is higher than that of March. *Pseudomonas*, *Flavobacterium*, *Acinetobacter* are frequent species. In the Dalian Bay (Li *et al.* 1987), the hydrocarbon bacteria density varies from 1.102×10^{3} cell/L to

1.5×10^5 cell/L during May of 1982 - May of 1983. There are 12 genera. In the area of Helogoland of the North Sea(Gunkel 1973), there are a large number of oil-oxidizing bacteria in the whole year. It varies from 930 cell/L to 4.6×10^5 cell/L, and the minimum is in winter.

At the same time of the present researching of the Antarctic oil hydrocarbon, the hydrocarbon bacterium of the Jiaozhou Bay in winter was used for comparing study. In the corresponding period, the hydrocarbon bacterium of the Jiaozhou Bay varies from 10 cell/ml to 900 cell/ml. There are 10 genera. Amony them, *Pseudomonaus*, *Acinetobacter*, *Flavobacterium* were checked out from Antarctica and the Jiaozhou Bay samples. In addition, *Coryebacterum*, *Arthrobacterer*, *Alealzenes*, *Micrococcus*, *Staphylococ*, etc. were checked out from the Jiaozhou Bay samples. This shows that the hydrocarbon bacteria amount of the Great Wall Bay and adjacent sea area is lower than that of temperate zone and the species are also smaller in number than that of temperate zone.

The temperature of Antarctic sea water is low throughout the year. In the most days of a year, sea water was covered by ice. So the oil hydrocarbon volatilizes slowly. Once being polluted, it is difficult to remove it. In the studied area, the activity of the persons is frequent. Much fuel oil and lube oil flowed into the sea water for the all kinds of the reasons. These made oil pollution and the oil hydrocarbon study becomes the important task of environmental conservation. Hydrocarbon bacterium is the index of oil hydrocarbon polluting degree. It also plays an important role in eliminating the pollution(ZoBell 1973). It is very important to enhance the study on this aspect.

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