A Primary Analysis on Concentration and Distribution of Chlorophyll-a in Surface Water of Great Wall Bay and Its Adjacent Area during Austral Summer 1993/1994

(南极长城湾及邻近海区1993/1994年度夏季表水中叶绿素a的浓度及其分布状况)

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ABSTRACT The concentration and distribution of Chlorophyll-a in surface seawater of Chinese Great Wall Bay and its adjacent waters, Antarctica were determined once monthly, altogether three times during an austral summer period from Dec. 1993 to Feb. 1994.

The results obtained show:

The concentration of Chl-a is about 1.29 mg/m^3, ranging from 0.18~6.75 mg/m^3. The concentrations are higher inside the Bay than that outside and in Ardely Bay, This situation is consistent with that respect of the water temperature of surface layer in the area surveyed. However, the time for the occurrences of high and low values of Chl-a concentration are not the same as those for water temperature.

The results of analysis correlation between each of the 4 concentrations of nutrient salts and Chl-a show that there is an apparent positive correlation only between (NO_2-N) and Chl-a in the sea water surveyed.

It is inferred from the results obtained that the distribution and changes of Chl-a in the Bay and its adjacent waters are still interfered with by other ecological factors including activities of the heterotrophic microbes.

KEYWORDS Chinese Great Wall Bay in Antarctica, surface sea water in austral summer, concentration and distribution of Chlorophyll-a

1 INTRODUCTION

The main cellular organelle for carrying on photosynthesis by plants is autoplast and the center of photosynthesis is Chlorophyll-a(abbr. Chl-a the same below).

Since the main plant-phytoplankton in the sea/ocean accomplishes its primary production and performs energy transformation mainly upon Chl-a, the concentration of Chl-a and its content are closely related to the quantity and species of its photosynthesis rate. Besides the distribution of the Chl-a concentration in the sea and environmental parameters confirm each other. The standing crop or stocking crop of phytoplankton can be found from Chl-a. Hence Chl-a becomes an important indicator of marine ecosystems.

The Chinese Great Wall Bay and its adjacent waters are inshore shallow water bodies. The understanding of the situation about the concentration and distribution of Chl-a in the bay waters has aroused people's attention and some research results have been published(Wu and Zhu, 1992; Lu and Huang, 1989).

This paper presents a preliminary analysis of Chl-a concentration monitored during December 1993~February 1994, in the surface water of the Bay and its adjacent sea area.

2 MATERIALS AND METHODS

Samples totaling up to 29 were taken from the surface water of the Chinese Great Wall Bay re-

spectively from stations No. 4,5,6,7,8 and 9 (zone Ⅰ), 5 samples from sites No. 1,2,3,10 and 11 from outside the Bay respectively (i. e. zone Ⅱ), and three samples (i. e. No. 12,13,14) respectively from zone Ⅲ near by the side of Ardely Bay. Samples were taken three times respectively in December 1993, January 1994 and February 1994.

Details about the sampling stations, etc. were described in Fig. 1 and another paper (Chen *et al.*, 1998).

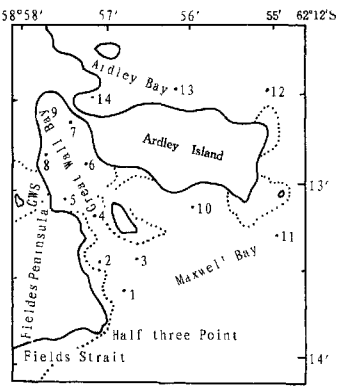

Fig. 1 Sampling stations for Chlorophyll-a from surface water in Chinese Great Wall Bay and its adjacent sea area, Antarctica, during austral summer of 1993/1994

Turner fluorimeter was used and determination was made according to the methods described in the references (State Technological Superintendency Administration, 1991). Micropore (0.65 μ) filters were used as filter membranes, except otherwise noted. The standard Chl-a was purchased from Shanghai.

When taking the water samples for analyzing Chl-a the data on water temperature, transparency and nutrient salt concentration were monitored together with the primary production and some relevant microbial conditions. Samples were determined one by one so as to illustrate the relationship between Chl-a and these parameters.

3 RESULTS AND DISCUSSION

Table 1 listing the Chl-a concentrations determined during Dec. 1993～Feb. 1994, it can be seen that the Chl-a concentrations averaged 1.29 mg/m^3, the extreme difference is 6.57 mg/m^3. The highest value is 37.50 times higher than the lowest one and also higher than that one of Prydz Bay during 1989～1990, East Antarctica.

Table 1 Table of Chl-a concentrations in surface water of the Chinese Great Bay and its adjacent sea area, Antarctica

No. of sampling station	1993-12	1994-01	1994-02	Average value
1	0.53	0.29	0.33	0.38
2	0.53	～	0.22	0.38
3	1.00	～	0.26	0.63
4	0.34	0.38	0.49	0.40
5	1.16	～	0.32	0.74
6	1.02	1.46	0.61	0.70
7	0.63	0.75	3.10	1.28
8	1.12	～	2.76	1.94
9	6.75	2.30	3.84	4.30
10	0.31	-	-	0.31
11	5.37	0.81	-	2.78
12	1.53	-	-	1.53
13	0.39	-	-	0.39
14	0.49	-	-	0.49
average	1.51	0.73	1.33	1.16

Note: Unit of Chl-a concentration: mg/m^3; "～": No determined; "-": Undetected.

Table 2 Comparison of Chl-a concentration from surface water in three surveyed zones respectively in the Chinese Great Wall Bay and its adjacent sea area, Antarctica

Surveyed zones	1993-12	1994-01	1994-02	Average valuse
Ⅰ	1.84	0.97	1.85	1.55
Ⅱ	1.55	0.24	0.27	0.69
Ⅲ	0.80	-	-	0.80
average	1.40	0.61	1.06	1.01

Note: Unit of Chl-a concentration: mg/m^3; "-": Undetected.

Table 2 was obtained by dividing these data into three groups corresponding to the 3 zones in the area surveyed.

The data in Table 2 showed that the average Chl-a concentration for zone Ⅰ is greater than that for zone Ⅱ (for short, zone Ⅰ > zone Ⅱ) (for zone Ⅲ, only one datum available, discussion follows).

This state of regional distribution of the surface water Chl-a concentration i. e. the distribution in zone Ⅰ and Ⅱ is the corresponding surface water temperature(T), i. e. where there is lower water temperature, there is also lower Chl-a concentration.

A comparison of Table 2 and Table 3 showed that the variation in the Chl-a concentration in the surface water determined in each zone was consistent with that of the corresponding surface water temperatures measured on the same date, e. g., the data in December showed that for both Chl-a and T, zone Ⅰ >zone Ⅱ >zone Ⅲ. The other two determinations also resulted in the same way. But the variation in the occurrence time for the average Chl-a concentration and that of water temperature (T) were not consistent in terms of the occurrence time. For example, in zone Ⅰ, the descending order of the occurrence date in terms of the magnitude of Chl-a concentration was Feb. 3, 1994, Dec. 13, 1993, Jan. 17, 1994, but for that of water temperature the order was Jan. 17 ,1994, Feb. 3, 1994, Dec. 13, 1993. For Chl-a, in zone Ⅱ, the order was: Dec. 13, 1993, Feb. 3, 1994, Jan. 17, 1994, but for that of water temperature, Jan. 17, 1994, Feb. 3, 1994, Dec. 13, 1993. Looking at the three zones together, we can find that: in the whole area investigated the time order of the occurrence of the dates Chl-a concentration was: Dec. 13, 1993～Feb. 3, 1994～Jan. 17, 1994, but for the water temperature, the order was Jan. 17, 1994, Feb. 3, 1994, Dec. 13, 1993.

Table 3 Comparison of average values of surface water temperature in three surveyed zones respectively in the Chinese Great Wall Bay and its adjacent sea area, Antarctica

Surveyed	1993-12	1994-01	1994-02	Average values
Ⅰ	1.29	1.63	1.48	1.47
Ⅱ	1.00	1.30	1.20	1.17
Ⅲ	-0.73	-	-	-0.73
Average values	0.52	1.47	1.34	0.64

Note: Unit of water temperature, ℃; "-": No determined.

The analytical result of the correlation between Chl-a concentration and water temperature (in Table 4) show that most of the correlation coefficients were not significant and moreover they were mainly negative. Among them, the negative one in December, 1993 was significant. Besides, the correlation in February, 1994 in zone Ⅰ was significant but also positive. This result might suggest the acceleration of the course of Chl-a degradation to phaeophytin at a certain temperature in the shallow sea area such as this surveyed area. Thus it can be seen that the variation pattern of the relationship between water temperature and Chl-a concentration in the surveyed area is not fixed at a certain period. This may suggest that the Chl-a concentration is subjected to the interference from other factors to a fairly large extent. It is possible that if only one method is used to analyze the relationship between the factors and trends for the change in Chl-a concentration, it is liable to come to a one-sided.

Table 4 Comparison correlation coefficient of water temperature and Chl-a content of surface water in the Chinese Great Wall Bay and its adjacent sea area, Antarctica

Surveyed zones	1993-12	1994-01	1994-02	1993-12 ～1994-02
Ⅰ	-0.54(n=5)	-0.81(n=6)	0.92(n=6)	-
Ⅱ	0.92(n=5)	-0.34(n=4)	-	-
Ⅰ Ⅱ Ⅲ	-	-	-	-0.56(n=26)

Note: "-": Indicate them were not computed respectively.

Nutrient salts, such as ammonium salts, nitrates, nitrites, phosphates and a ratio, i. e. $\Sigma N/P$ are the needs of phytoplankton and other organisms for their existence and the environmental indications. The concentrations of nutrient salts should affect obviously their photosynthesis and growth. The analytical results of the correlation between Chl-a concentration and concentration of nutrient salts listed in Table 5 show that their relationships are not completely clear.

Only the correlation coefficient between Chl-a and NO_2-N is more significant positive. In some sites surveyed, a contrary condition occurred between Chl-a and nutrient salts, for example, at station No. 2 (in the December), the Chl-a concen-

tration was higher, but the concentration of NH_4-N was lower (Table 1) which indicated that the propagation of phytoplankton consumes nutriments in the specific environment. Under certain conditions, their correlation appeared to be negative, such as the relationship between (Chl-a) ~ (PO_4 P). In this case, it is possible that bacteria might take part in a mechanism of the recycling of nutrients(Smith, 1992).

Table 5 Table of comparison correlation coefficient among Chl-a concentration and four nutrient salts concentrations of surface water in the Chinese Great Wall Bay and its adjacent sea area, Antarctica

Pairs of parameters	*R*	*n*
Chl-a-(NH_4-N)	0.084	23
Chl-a-(NO_3-N)	0.069	23
Chl-a-(NO_2-N)	0.357	22
Chl-a-(PO_4-P)	-0.126	19
Chl-a-(ΣN/P)	0.025	33

The results obtained in the paper might suggest that there are sufficient nutrients, such as N, P etc. in the sea area surveyed and that situation does not become a limit to photosynthesis-growth and reproduction of the relevant phytoplankton and autotrophic organisms.

4 CONCLUSIONS

The highest concentration of Chl-a in surface water in the area surveyed was 6.75 mg/m^3 and the lowest one only 0.18 mg/m^3, the range of the respective average concentration of the sites surveyed was 0.31～4.30 mg/m^3. The mean concentration for the whole area investigated was about 1.99 mg/m^3, slightly higher than that during the summer of 1988～1989 and lower than that one during the summer of 1985～1986 in Great Wall Bay, Antarctica. The highest and lowest Chl-a concentrations occurred in December 1993 in station No. 9 and on January, 1994 in station No. 11. The distribution of Chl-a has a more obvious regionalism, i.e. the concentration of Chl-a within Great Wall Bay is higher than outside. It is inferred that this situation may be affected by the land environment and melting snow entering into the sea, beside its relation to the supply of nutrients and heterotrophic organisms in the area surveyed.

The analytical results of the correlation between Chl-a concentration and some environmental-ecological factors indicated that there is not a fixed pattern of correlation among them, i.e. to a certain extent there are some relationships of supplementing each other as well as some phenomenon of opposing each other and yet also complementing each other indicating that there occur a variety of interaction among the Chl-a concentration and even phytoplanktonic distribution against various environmental-ecological factors.

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