Chlorophyll-*a* Content in the Surface Water along the Course of the Fuji to and from Antarctica in 1976-1977

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「ふじ」航路 (1976-1977) における表面海水中のクロロフィル-*a* 量

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要旨: 1976年11月から1977年4月まで，第18次南極地域観測隊の海洋生物定常観測の一環として，「ふじ」の航路に沿って表面海水の採水およびクロロフィル-*a* 量の測定を150点において実施した．クロロフィル-*a* 量の分布は，概して過去の観測結果と似ていた．プリンスオラフ海岸沖のパックアイス域において最高値 (2.40 mg/m^3) が見られた．また，セレベス海，マカッサール海峡およびマラッカ海峡においても高い値が観測された．

Abstract: During the relief cruise of the Fuji to Syowa Station, Antarctica, from November 1976 to April 1977, the chlorophyll-*a* contents in the surface water were measured at 150 stations as a part of the routine observations of marine biological program of the 18th Japanese Antarctic Research Expedition. The chlorophyll-*a* distributions were generally similar to those noticed in the previous observations. The maximum value was observed in the pack ice area off Prince Olav Coast, Antarctica (2.40 mg chl-*a*/m^3). The high values were also seen in the Celebes Sea, Makassar and Malacca Straits.

1. Introduction

In assessing phytoplankton standing crop in the oceans, several methods have been employed, such as the measurements of settling and displacement volumes, the counting of phytoplankton cell number, and determinations of organic carbon and chlorophyll-*a* in a unit amount of sea water. Among them, the chlorophyll-*a* measurement is the simplest and relatively reliable method to evaluate the phytoplankton standing crop. For this reason, the chlorophyll-*a* measurement was selected as a part of the routine observations in the marine biological program of the Japanese Antarctic Research Expedition (JARE).

The relief ship Fuji has been making the voyages to the Syowa Station in

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the Antarctica during the austral summer every year since 1965. The observations of the regional distribution of chlorophyll-*a* on board FUJI have been continued by the members of the JARE and some results have already been published (HOSHIAI, 1968; TAKAHASHI, 1969; TOMINAGA, 1971; NISHIWAKI, 1972; HOSHINO, 1974; OHNO, 1976; OHYAMA and MAYAMA, 1976).

The author had an opportunity to participate in the marine biological program of the JARE-18. The present paper deals with the results obtained during the period from November 1976 to April 1977.

2. Methods and Materials

Surface water sampling by a plastic bucket was performed two to three times a day at 0800, 1200 and 1800 by local time at 150 stations. The sea water of 5–10 liter was filtered through a Whatman GF/C glass fiber filter (dia. 47mm) under reduced pressure. The chlorophyll-*a* concentration was determined by the colorimetric method of UNESCO (1966) using a HITACHI model 101 spectrophotometer on board. All values were expressed in mg chlorophyll-*a* per cubic meter. Concurrently, the water temperature was measured and a aliquot of 500 m*l* of sea water was preserved in *ca* 5% neutralized formalin solution for the identifications and the cell number countings of phytoplankton species. Detailed data of sampling and the values of chlorophyll-*a* are listed in Appendix 1.

3. Results and Discussion

The sampling was started on November 28th 1976 in the western part of the North Pacific and discontinued on April 15th 1977 in the same area. The present observations extended from the North Pacific to the Antarctic Ocean through the equatorial region. The cruise track of the present observations was similar to that in 1975–1976 (OHYAMA and MAYAMA, 1976). The chlorophyll-*a* concentrations in the surface water along the cruise track of FUJI are shown in Fig. 1. The observed values ranged from an undetectable value at Sta. 6 east of the Philippine Islands to the maximum value of 2.40 mg at Sta. 61 in the pack ice area off the Prince Olav Coast, Antarctica. The high values were also found in the Celebes Sea and the Makassar Strait as well as in the Malacca Strait. On the other hand, the chlorophyll-*a* concentrations were low in the Indian Ocean, the South China Sea and the western part of the North Pacific. Although the present observations were extended over a period of five months,

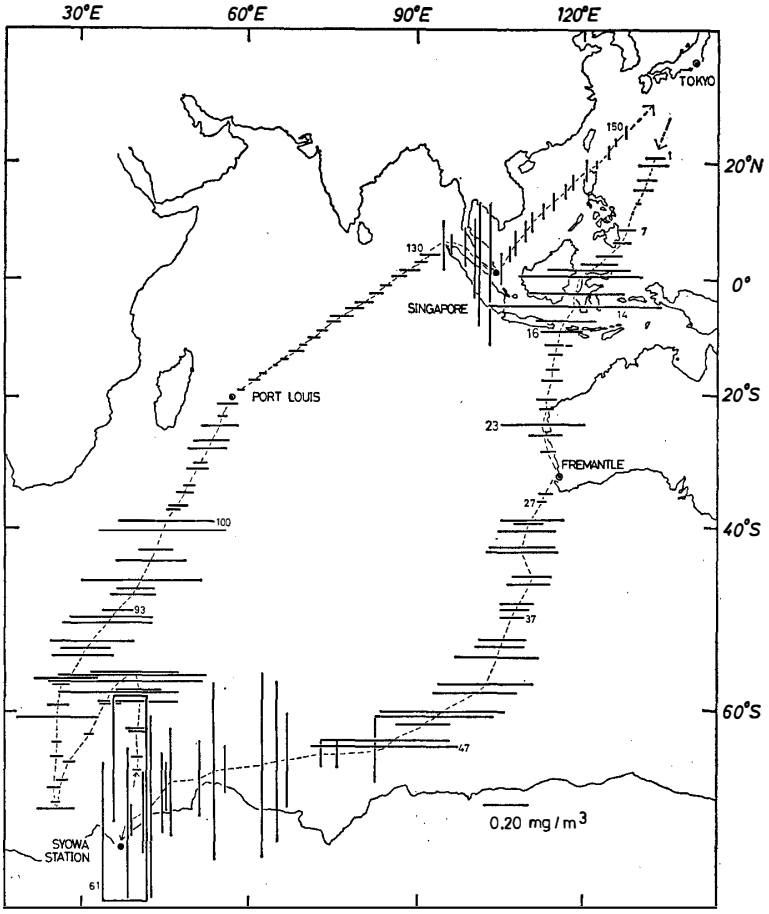

Fig. 1. The distribution of chlorophyll-a (——) along the cruise track of FUJI (- - -) in 1976-1977. Number indicates the serial number of the sampling station.

the regional distribution of chlorophyll-*a* concentrations and the comparison with the previous results will be discussed.

3. 1. Western part of North Pacific

On the outward leg in this region (Stas. 1–7), the chlorophyll-*a* concentration ranged from 0.00 to 0.14 mg and in the range of 0.03–0.06 mg on homeward leg (Stas. 147–150). The values on homeward leg were slightly lower than that on outward leg. These values, however, are in the range of the previous results (Hoshiai, 1968; Ohno, 1976).

3. 2. Celebes Sea and Makassar Strait

The chlorophyll-*a* concentrations increased in the Celebes Sea and reached to the high level of 0.77 mg in the Makassar Strait (Sta. 14). This record is much higher than the value of 0.52 mg reported by Ohyama and Mayama (1976).

3. 3. Eastern part of Indian Ocean

After entering into the Indian Ocean through the Lombok Strait, the chlorophyll-*a* concentration decreased from 0.19 mg (Sta. 16) to 0.04 mg (Sta. 27), although an exceptional high value was recorded at Sta. 23 (0.37 mg) off the west coast of western Australia. In this region, OHYAMA and MAYAMA (1976) observed the high value of 0.43 mg off the south coast of Java Island.

3. 4. From Indian Ocean to Antarctica

It is well known that the oceanographic peculiarities exist in the Southern Ocean, such as the Subtropical and the Antarctic Convergences (SVERDRUP *et al.*, 1946; DEACON, 1937, 1963). MACKINTOSH (1946) showed the relationships between the locations of the Antarctic Convergence and the distribution of the water temperature.

The longitudinal changes in the water temperature and the chlorophyll-*a* concentrations between 35°S and 63°S latitudes are shown in Fig. 2. Judging from the distributions of temperatures (Fig. 2A) and nutrient salts (ODA and IMANISHI, 1978), the Subtropical and the Antarctic Convergences might exist at about 46°S between Stas. 32 and 34 and at about 55°S between Stas. 39 and 41, respectively. The chlorophyll-*a* increased to the value of 0.32 mg at Sta. 32 in the northern part of the Subtropical Convergence. However, the

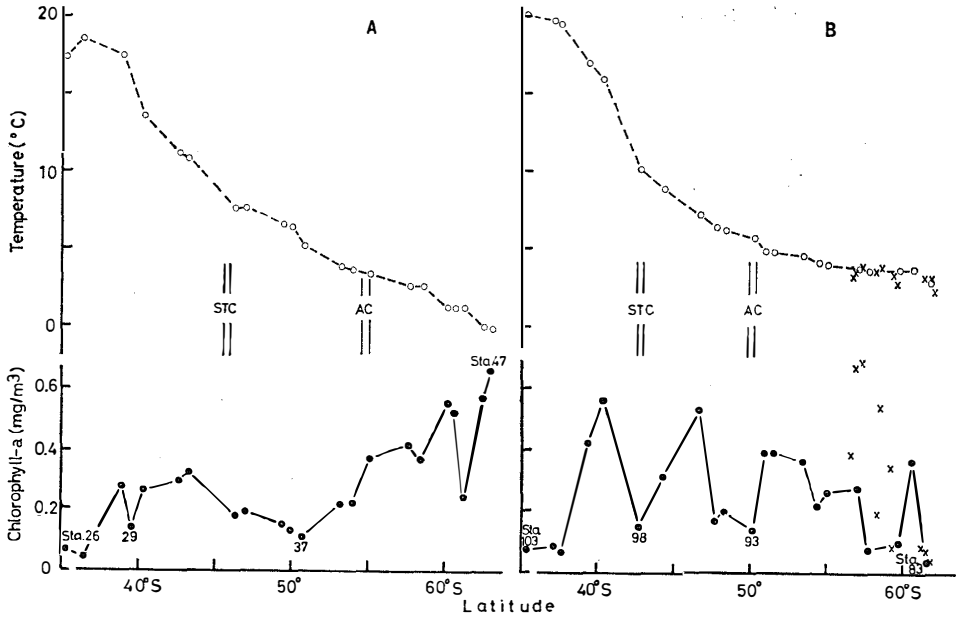

Fig. 2. Longitudinal changes in water temperature (- - o - -) and chlorophyll-a (—●—) on outward leg (A) and on homeward leg (B) between 35°S and 63°S latitudes. Values obtained in February 19–24 are shown as a cross. STC and AC denote approximate locations of Subtropical and Antarctic Convergences, respectively.

value decreased rapidly to the level of 0.17 mg at Sta. 33 in the Subtropical Convergence. In the region of the Subantarctic Upper Water between the Subtropical and the Antarctic Convergences, the chlorophyll-*a* concentrations remained at moderate levels (0.11–0.22 mg). The value increased again in the Antarctic Convergence to the level of 0.37 mg at Sta. 40. The chlorophyll-*a* increased and fluctuated in the Antarctic Surface Water south of the Antarctic Convergence toward the pack ice area (0.24–0.65 mg).

The present results differed from the observation by TAKAHASHI (1969) who reported that the chlorophyll-*a* decreased toward the pack ice area, but agreed with the records by TOMINAGA (1971), HOSHINO (1974) and OHYAMA and MAYAMA (1976). HOSHIAI (1968) and TAKAHASHI (1969) reported the low concentrations both in the Subtropical and in the Antarctic Convergences. Their findings partly coincided with the present results.

3. 5. Along Antarctic Continent

In the region south of 63°S latitude, the FUJI turned west toward Syowa Station and cruised along the Antarctic Continent. In Fig. 3, the latitudinal changes of the water temperature and the chlorophyll-*a* are shown. In late December, the chlorophyll-*a* concentration fluctuated largely and kept the high level (0.11–2.40 mg) in the region between 63°E and 39°E longitudes (Stas. 48–64). On the other hand, the values were very low (0.04–0.17 mg) between 40°E and 25°E in late February (shown as a cross in Fig. 3). The latitudinal

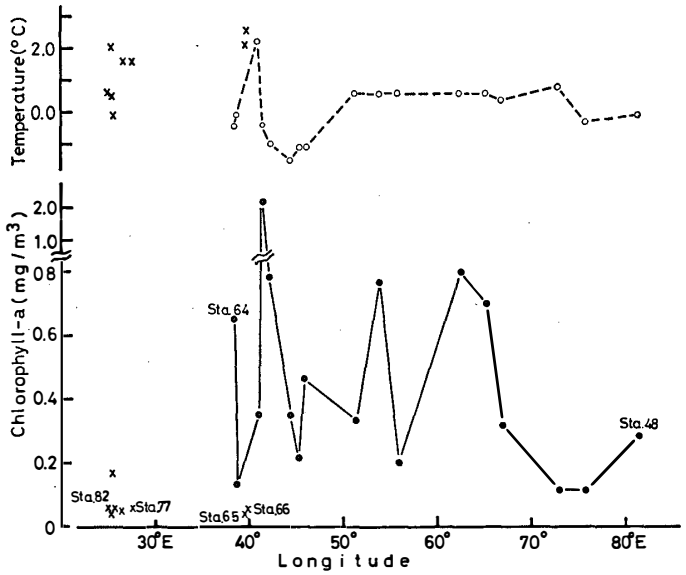

Fig. 3. Latitudinal changes in water temperature (- -o- -) and chlorophyll-a (—●—) along the Antarctic Continent south of 63°S latitude. Values obtained on homeward leg are shown as a cross.

change of chlorophyll-*a* was quite different from that reported by HOSHIAI (1968) and TAKAHASHI (1969) who recorded the low level of chlorophyll-*a* concentration between 80°E and 45°E longitudes.

3. 6. From Antarctic Ocean to Indian Ocean

The changes in the surface temperature and the chlorophyll-*a* concentration in the region north of 63°S latitude on the homeward leg are shown in Fig. 2B. The values shown as a cross in Fig. 2B indicate the results obtained from February 19th to February 23rd 1977 (Stas. 67–76). The high values were seen in the region north of 59°S latitude and the low values were concentrated in the region south of 60°S latitude (*cf.* Fig. 1). HOSHINO (1974) observed the same area in the same season and concluded that the chlorophyll-*a* concentrations were high in the coastal areas south of 64°S and low between 57° and 64°S latitudes. These two opposite results seem to suggest the annual variation of the chlorophyll-*a* concentration in the Antarctic coastal region.

From Fig. 2B, the Antarctic and the Subtropical Convergences were thought to exist at about 50°S between Stas. 92 and 94 and at about 43°S between Stas. 97 and 99, respectively. The chlorophyll-*a* concentrations were observed to decrease not only in the Antarctic Convergence but also in the Subtropical Convergence. This is the same result as that reported by HOSHIAI (1968), TOMINAGA (1971) and OHNO (1976). In other parts of the Antarctic Ocean, EL-SAYED (1968) also found that the lowest productivity values coincided with the Antarctic Convergence in the Drake Passage.

As can be seen from Fig. 2A and 2B, both a close similarity and a dissimilarity were found in the longitudinal changes of the chlorophyll-*a* distributions between the outward leg and the homeward leg. For example, the high values were seen in the regions of the Antarctic Surface Water and the northern part of the Subtropical Convergence, and the decrease in the Subtropical Convergence on both outward and homeward legs. In the Antarctic Convergence and the region along the Antarctic Continent, the values increased on outward leg but decreased on homeward leg. The chlorophyll-*a* concentration in the Subantarctic Upper Water was higher on homeward leg than that on outward leg. The values, however, were generally higher on outward leg (Fig. 2A) to the Antarctic than on homeward leg (Fig. 2B) from the Antarctic. OHNO (1976) also mentioned that the longitudinal variation of chlorophyll-*a* on homeward leg from the Antarctic Ocean was similar to that seen on outward leg to the Antarctica, and the concentration on the outward leg were higher than that observed on homeward leg.

At Stas. 99 and 100 around the 40°S latitude northern part of the Sub-

tropical Convergence, the high values were observed (0.43–0.56 mg). TOMINAGA (1971) also reported the high value (0.60 mg) at about 38°S north of the Subtropical Convergence on the way to Cape Town from Antarctica. He concluded that this high value corresponded closely to the Agulhas Convergence, which was proposed by FUKASE (1962).

Although the route from the Antarctic Ocean on homeward leg in the present observations was the same as the one observed by OHYAMA and MAYAMA (1976), they reported the low values around 63°S latitude and a high peak value of 0.49 mg around the latitude 58°S, and showed the decreasing tendency toward north. Their results were much different from the longitudinal distributions of the present observations. This would suggest that there is the year-to-year variation of chlorophyll-*a* concentration in the Antarctic Ocean.

3. 7. Western and northern parts of Indian Ocean

In the western and the northern parts of the Indian Ocean between 38°S and 6°N latitudes (Stas. 101–130), the chlorophyll-*a* concentrations remained low and did not fluctuate to a large extent (0.01–0.17 mg). HOSHINO (1974) and OHNO (1976) found the low values of chlorophyll-*a* (0.02–0.16 mg) in the same areas, and these values were in the same range of the present results. However, the values obtained in the eastern part of the Indian Ocean (Stas. 16–27) were higher than those in the western and the northern parts of the Indian Ocean.

3. 8. Malacca Strait and South China Sea

The values were very low in the Indian Ocean, but increased greatly in the Malacca Strait ranging from 0.06 to 0.65 mg. HOSHINO (1974) and OHNO (1976) also found the high values of 0.88 mg and 0.90 mg, respectively.

In the South China Sea, the chlorophyll-*a* concentrations became low and ranged from 0.06 mg to 0.14 mg. These values were comparable to the previous results.

3. 9. Summary of regional distributions

As mentioned above, the chlorophyll-*a* concentrations in the surface water were different from region to region. Summarizing these results, the mean value and the standard deviation of chlorophyll-*a* concentrations in each observed region are listed in Table 1. The chlorophyll-*a* concentration in the Antarctic Surface Water including the region along the Antarctic Continent was the highest throughout the observed regions, ranging from 0.04 mg to 2.40 mg (mean value: 0.36 mg). Secondly, the Celebes Sea, the Makassar and the Malacca Straits were the highly concentrated regions in the range of 0.08–0.77 mg with the mean value of 0.34 mg. The region in the northern part of the Subtropical Convergence was the thirdly concentrated

Table 1. Mean value and standard deviation of chlorophyll-a and range of water temperature in observed regions.

Regions	Stations	Month	Chl-*a*(mg/m³) Mean±S.D. (N)	Range of water temp. (°C)
Western part of North Pacific	1-7	Late Nov.	0.07±0.05 (7)	26.4-28.9
	147-150	Middle Apr.	0.04±0.01 (4)	25.0-27.7
Celebes Sea and Makassar Strait	8-15	Early Dec.	0.34±0.24 (8)	28.0-29.2
Malacca Strait	131-136	Late Mar.	0.34±0.22 (6)	27.9-30.0
South China Sea	137-146	Early Apr.	0.09±0.02(10)	27.1-28.1
Eastern part of Indian Ocean	16-27	Dec.	0.12±0.09(12)	17.5-28.4
Western and northern Indian Ocean	101-130	Mar.	0.07±0.04(30)	19.6-29.2
Northern part of Subtropical Convergence	28-32	Middle Dec.	0.26±0.07 (5)	10.8-17.0
	99-100	Early Mar.	0.49±0.10 (2)	16.0-17.0
	(28-32, 99-100)		(0.33±0.14 (7))	
Subtropical Convergence	33	Middle Dec.	0.17 (1)	7.6
	98	Early Mar.	0.15 (1)	10.1
Subantarctic Upper Water	34-39	Late Dec.	0.17±0.05 (6)	3.6- 7.6
	94-97	Early Mar.	0.30±0.17 (4)	6.2- 8.9
	(34-39,94-97)		(0.22±0.12(10))	
Antarctic Convergence	40	Late Dec.	0.37 (1)	3.4
	93	Early Mar.	0.14 (1)	5.7
	(40,93)		(0.26±0.17 (2))	
Antarctic Surface Water	41-47	Late Dec.	0.48±0.14 (7)	−0.1- 2.6
	67-76,83-92	Late Feb.	0.28±0.20(20)	2.4- 4.8
Along Antarctic Continent	48-64	Late Dec.	0.53±0.54(17)	−1.5- 2.2
	65-66,77-82	Late Feb.	0.07±0.04 (8)	−0.1- 2.4
	(41-92)		(0.36±0.37(52))	

region in the range of 0.14–0.56 mg (mean value : 0.33 mg). Then, it was followed by the regions in the Antarctic Convergence (mean value: 0.26 mg) and the Subantarctic Upper Water (mean value: 0.22 mg). The chlorophyll-*a* concentrations in other regions were relatively low compared with these regions.

4. Conclusion

The clear regional distributions of chlorophyll-*a* in the surface water along the course of the FUJI were distinguished in these observations. The characteristics of the distributions resemble the previous reports to some extent. However, the different patterns of the distributions were also recognized among them. The reasons of the resemblance or the difference could not be clarified. In this report, the regional distributions were considered mainly on the basis of the general oceanographic conditions in the observed regions.

However, the distribution of the chlorophyll-*a* is thought to correlate not only with the physical and chemical properties of sea water but also with the biological characteristics of the phytoplankton. Furthermore, the chlorophyll-*a* concentration of phytoplankton would change with the advance of the seasons which,

in turn, reflects the difference in the growing stage of the phytoplankton. There would be also the year-to-year variation in the regional distribution of chlorophyll-*a*.

Although the chlorophyll-*a* measurements as well as the oceanographic observations have been continued since 1956 as a part of the Japanese Antarctic Research Expedition, the obtained results on the chlorophyll-*a* distributions have been discussed independently. In order to elucidate the distributional pattern of the chlorophyll-*a*, it will be necessary to perform the integrated investigations on the results accumulated by the JARE scientists. Also, the fundamental studies on the regional occurrence of phytoplankton species should be carried out, concurrently.

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Appendix 1. Chlorophyll-a contents and water temperatures obtained during the relief voyage of FUJI to Syowa Station, Antarctica, in 1976–1977.

Station No.	Date	Time (LMT)	Latitude	Longitude	Chlorophyll-*a* (mg/m³)	Water temp. (°C)
1	1976 Nov. 28	1200	21°03′N	132°33′E	0.09	26.4
2		1800	19 59	132 09	0.14	27.0
3	29	0800	17 29	131 05	0.09	28.4
4		1800	15 46	130 13	0.09	28.7
5	30	0800	13 12	129 08	0.02	28.7
6		1800	11 24	128 24	0.00	28.7
7	Dec. 1	0800	8 46	127 25	0.07	28.9
8		1800	6 33	126 38	0.08	29.2
9	2	0800	4 10	124 11	0.12	28.8
10		1800	2 46	122 39	0.17	28.7
11	3	0800	1 29	120 34	0.37	28.0
12		1800	0 03	119 27	0.55	28.6
13	4	0800	2 27 S	118 40	0.42	28.8
14		1800	4 48	118 19	0.77	29.0
15	5	0800	7 27	116 34	0.27	29.2
16		1800	8 57	115 40	0.19	28.3
17	6	0800	11 27	115 04	0.12	28.2
18		1800	13 19	114 43	0.06	28.2
19	7	0800	15 56	114 17	0.06	26.6
20		1800	17 50	113 53	0.09	25.1
21	8	0800	20 41	113 18	0.09	25.3
22		1800	22 27	113 12	0.07	24.2
23	9	0800	24 52	112 38	0.37	21.1
24		1800	26 30	112 51	0.15	21.4
25	10	0800	29 07	113 36	0.07	20.3
Fremantle						
26	17	0800	35°18′S	113°08′E	0.07	17.5
27		1800	36 31	112 19	0.04	18 6
28	18	0800	38 59	110 32	0.28	17.5
29		1200	39 35	110 05	0.14	—
30		1800	40 27	109 37	0.26	13.6
31	19	0800	42 43	108 41	0.29	11.2

Station No.	Date	Time (LMT)	Latitude	Longitude	Chlorophyll-*a* (mg/m³)	Water temp. (°C)
32	Dec. 19	1200	43°18′S	108°48′E	0.32	10.8
33	20	0800	46 25	110 25	0.17	7.6
34		1200	47 03	109 59	0.19	7.6
35	21	0800	49 25	108 00	0.15	6.5
36		1200	49 59	107 29	0.13	6.4
37		1800	50 51	106 54	0.11	5.2
38	22	0800	53 15	105 28	0.21	3.8
39		1200	54 00	105 00	0.22	3.6
40		1800	55 10	104 20	0.37	3.4
41	23	0800	57 43	102 26	0.42	2.6
42		1800	58 34	100 03	0.37	2.5
43	24	0800	60 12	94 39	0.55	1.2
44		1200	60 37	93 12	0.53	1.2
45		1800	61 14	91 01	0.24	1.2
46	25	0800	62 38	85 51	0.57	−0.1
47		1200	62 59	84 31	0.65	−0.1
48		1800	63 16	82 29	0.28	−0.1
49	26	0800	63 41	75 54	0.11	−0.3
50		1800	63 39	73 07	0.11	0.8
51	27	0800	64 03	67 03	0.41	0.4
52		1200	64 10	65 19	0.70	0.6
53		1800	64 21	62 30	0.80	0.6
54	28	0800	64 47	55 50	0.20	0.6
55		1200	64 54	53 56	0.77	0.6
56		1800	65 27	51 32	0.33	0.6
57	29	0800	65 43	46 04	0.46	−1.1
58		1200	66 01	45 23	0.21	−1.1
59		1800	66 28	44 34	0.35	−1.5
60	30	0800	67 21	42 18	0.79	−1.0
61		1200	67 32	41 49	2.40	−0.4
62		1800	67 47	41 16	0.35	2.2
63	31	0800	68 24	38 51	0.13	−0.1
64		1100	68 25	38 43	0.65	−0.4
Ice edge off Syowa Station						
65	1977 Feb. 18	0800	64°50′S	39°59′E	0.04	2.1
66		1800	63 52	40 00	0.05	2.4
67	19	0800	61 48	40 00	0.08	3.1
68		1800	61 28	40 00	0.08	3.2
69	20	0800	59 20	40 17	0.35	3.3
70		1800	58 27	40 19	0.20	3.6

Station No.	Date	Time (LMT)	Latitude	Longitude	Chlorophyll-*a* (mg/m³)	Water temp. (°C)
71	Feb. 21	0800	56°43′S	39°37′E	0.39	3.4
72		1200	56 55	38 56	0.67	3.6
73		1800	57 18	38 07	0.69	3.8
74	22	0800	58 38	36 45	0.54	3.8
75		1800	59 31	35 34	0.09	2.8
76	23	1800	61 58	31 26	0.04	2.4
77	24	0800	64 16	27 50	0.06	1.6
78		1800	65 29	26 44	0.05	1.6
79	25	0800	67 34	25 40	0.17	−0.1
80	26	1200	67 09	25 35	0.04	0.5
81		1800	66 13	25 28	0.06	0.6
82	27	0800	63 54	25 42	0.05	2.1
83		1800	62 46	25 45	0.04	2.8
84	28	0800	60 38	25 54	0.36	3.7
85		1800	59 39	26 03	0.10	3.6
86	Mar. 1	0800	57 45	26 31	0.08	3.6
87		1800	57 06	27 22	0.28	3.8
88	2	0800	55 00	30 13	0.27	4.0
89		1200	54 24	31 00	0.22	4.1
90		1800	53 28	32 09	0.37	4.6
91	3	0800	51 28	34 51	0.40	4.8
92		1200	50 57	35 33	0.39	4.8
93		1800	50 09	36 39	0.14	5.7
94	4	0800	48 20	39 10	0.20	6.2
95		1200	47 42	39 56	0.17	6.4
96		1800	46 48	40 56	0.53	7.2
97	5	0800	44 18	42 45	0.31	8.9
98		1800	42 51	43 27	0.15	10.1
99	6	0800	40 25	44 47	0.56	16.0
100		1800	39 23	45 29	0.43	17.0
101	7	0800	37 39	46 51	0.06	19.6
102		1800	37 16	47 45	0.09	19.8
103	8	0800	35 21	48 51	0.08	20.1
104		1800	34 19	49 31	0.05	21.4
105	9	0800	31 57	51 01	0.09	23.5
106		1800	30 54	51 38	0.06	23.9
107	10	0800	28 43	52 55	0.17	26.3
108		1800	27 31	53 36	0.16	26.2
109	11	0800	24 58	54 54	0.17	26.9
110		1800	23 37	55 12	0.04	27.8
111	12	0800	21 27	56 09	0.10	27.8

Station No.	Date	Time (LMT)	Latitude	Longitude	Chlorophyll-*a* (mg/m^3)	Water temp. (°C)
Port Louis						
112	Mar. 18	1800	19°10′S	58°45′E	0.03	28.8
113	19	0800	17 45	61 06	0.05	28.5
114		1800	16 35	62 39	0.03	28.2
115	20	0800	15 15	64 51	0.01	28.2
116		1800	14 10	66 27	0.03	28.5
117	21	0800	12 50	68 25	0.07	28.6
118		1800	11 47	69 50	0.04	28.7
119	22	0800	10 17	71 46	0.05	28.4
120		1800	9 10	73 16	0.05	28.9
121	23	0800	7 39	75 19	0.06	29.1
122		1800	6 41	76 46	0.11	29.2
123	24	0800	5 14	78 56	0.09	29.1
124		1800	4 09	80 35	0.09	28.6
125	25	0800	2 41	82 51	0.07	28.8
126		1800	1 23	84 28	0.05	30.1
127	26	0800	0 17N	86 47	0.07	29.4
128		1800	1 26	88 27	0.09	29.8
129	27	0800	3 01	90 36	0.06	29.2
130		1800	4 16	92 16	0.09	29.8
131	28	0800	5 57	94 31	0.22	30.0
132		1800	6 11	96 18	0.09	28.8
133	29	0800	5 42	98 38	0.17	28.8
134	30	0800	3 37	100 18	0.35	28.8
135		1800	2 48	101 02	0.54	28.9
136	31	0800	1 30	103 02	0.65	27.9
Singapore						
137	Apr. 8	1800	2°01′N	104°59′E	0.14	28.1
138	9	0800	4 30	106 23	0.07	27.4
139		1800	6 11	107 30	0.11	27.4
140	10	0800	8 30	109 06	0.10	27.4
141		1800	10 01	110 29	0.09	27.4
142	11	0800	11 53	112 38	0.08	27.1
143		1800	13 15	114 09	0.08	27.8
144	12	0800	15 16	116 17	0.07	26.8
145		1800	16 42	117 52	0.06	28.0
146	13	0800	18 43	120 08	0.10	27.5
147		1800	19 56	121 58	0.04	27.7
148	14	0800	21 42	123 57	0.06	26.8
149		1800	23 09	125 22	0.03	26.1
150	15	0800	24 47	127 06	0.05	25.0