

Chlorophyll-a Content in the Surface Water Observed in 1968-1969 during the Cruise of FUJI to Antarctica

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「ふじ」航路(1968-1969)における表面水中のクロロフィル-a量

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要 旨

1968年12月1日から1969年4月22日まで「ふじ」の航路に沿って、太平洋西部・インド洋・南極海の162地点の表面水中のクロロフィル-a量の定量を行なった。クロロフィル-a量は、南極海が最も多く、インド洋の南緯32度以南、太

平洋西部、南支那海の順に少なくなり、インド洋の南緯32度以北は最も少なかった。クロロフィル-a量の変動の様子は、これまでの結果と似ているが、細部については必ずしも一致せず、論議のためには更に多くの観測結果が必要である。

As part of the routine work in marine biology of the Japanese Antarctic Research Expedition, measurement of the surface chlorophyll-a content was made aboard the research vessel FUJI along its course. The results obtained during a period from December 1968 to April 1969 are reported in this paper.

Water samples were taken by a plastic bucket and were filtrated through Millipore filter HA (47mm). Pigment in the samples was extracted by 90% acetone and it took 24 hours in the dark refrigerator. After centrifuging the amount of chlorophyll-a was determined by spectrophotometer, Hitachi 101. The chlorophyll-a content was calculated according to the following formula:

$$\text{Chlorophyll-a (mg/m)} = 11.64 E_{663} - 2.16 E_{645} - 0.10 E_{630} \\ \times \frac{\text{Volume of acetone (ml)}}{\text{Volume of sample water (l)}}$$

The chlorophyll-a content and water temperature are shown in Table 1 and Fig. 1.

In general, the horizontal distribution of chlorophyll-a in 1968 to 1969 resembled that observed in 1965 to 1966 along the similar course (HOSHIAI, 1968). Namely, chlorophyll-a concentration was low in the western Pacific and in the northern

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Table 1 Chlorophyll-a content along the route of FUJI

Date	Station	Time (Local)	Latitude	Longitude	Water temp. (°C)	Chlorophyll-a (mg/m ³)
1968						
Dec. 1	1	0800	32°15'N	138°28' E	21.4	0.31
	2	1900	29-54	137-13	22.2	0.21
2	3	0800	27-00 6	135-44 1	24.8	0.08
	4	1900	25-25 5	134-28.5	24.0	0.12
3	5	0800	22-49	133-16	25.2	0.09
	6	1900	20-43	132-16	26.0	0.05
4	7	0800	18-10	131-01 5	25.0	0.11
	8	1900	15-50	130-08	28.7	0.06
5	9	0800	13-10	129-08 5	27.0	0.08
	10	1900	10-56	128-04	27.0	0.06
6	11	0800	8-27	127-07	26.4	0.07
	12	1900	5-53	126-20	26.5	0.13
7	13	0800	3-43	123-34.5	28.0	0.15
	14	1900	2-22	121-33 5	28.6	0.11
8	15	0800	0-18 8N	119-24	27.9	0.15
	16	1900	1-47 S	118-46 8	30.1	0.10
9	17	0800	4-35 8	118-42	29.5	0.14
	18	1900	6-38 3	117-53 8	29.2	0.21
10	19	0800	8-44	115-44	29.4	0.12
	20	1900	11-14	115-15	29.4	0.09
11	21	0800	14-06	114-39	28.7	0.05
	22	1900	16-27	114-23 5	28.9	0.06
12	23	0800	19-11	114-02	26.2	0.06
	24	1900	21-08	113-38 3	24.4	0.04
13	25	0800	23-33	112-50 5	23.5	0.08
	26	1900	25-16	112-39	22.5	0.05
14	27	1900	29-29	113-49	20.1	0.05
	Fremantle					
21	28	1900	32-48 9	114-24.9	19.0	0.07
22	29	0800	34-39 9	113-01 3	16.7	0.07
	30	1400	35-28 8	112-17 4	16.5	0.12
	31	1900	36-07	111-47	16.1	0.09

Date	Station	Time (Local)	Latitude	Longitude	Water temp (°C)	Chlorophyll-a (mg/m ³)
23	32	0800	38°12'S	110°06.5'E	14.6	0.12
	33	1400	39-17.9	109-50	13.6	0.10
	34	1900	40-25.2	109-50.8	12.6	0.15
24	35	1900	45-03.1	111-05.2	9.5	0.21
25	36	0800	47-28.2	111-41.9	8.6	0.66
	37	1400	48-42	111-45	6.2	0.21
	38	1900	49-37	111-46	5.6	0.14
26	39	0800	52-00	111-46	2.9	0.51
	40	1400	53-06	111-54	2.0	0.45
	41	1900	54-01	112-16	1.4	0.22
27	42	0800	56-41	112-31	1.1	0.10
	43	1400	57-50.2	112-05.5	0.9	0.17
	44	1900	58-51.7	111-28	0.8	0.19
28	45	0800	61-01.3	108-40	0.3	0.13
	46	1400	61-09.3	106-31.4	0.9	0.15
	47	1900	61-24.2	103-51.7	0.4	0.22
29	48	0800	61-49.5	98-45.8	0.2	0.27
	49	1400	62-03	96-18	0.2	0.53
	50	1900	62-14	94-15	0.4	0.66
30	51	0800	62-38.4	88-13.7	-0.3	0.38
	52	1400	62-51	85-35.9	-0.4	0.18
	53	1900	63-06	83-14.3	0.2	0.40
31	54	0800	63-27.5	77-16.7	-0.1	0.12
	55	1400	63-36.8	74-41	0.0	0.15
	56	1900	63-46.9	72-21.9	-0.2	0.07
1969						
Jan. 1	57	0800	64-14.7	65-50.5	-0.6	0.09
	58	1400	64-06.7	63-57	0.1	0.05
	59	1900	64-19.5	61-29.8	0.4	0.04
2	60	0800	65-00.2	54-59.3	-0.5	0.07
	61	1400	64-53	52-40	-1.2	0.13
	62	1900	64-54	51-48	0.4	0.19
3	63	0800	65-03	47-42.7	-0.4	0.74
	64	1400	65-27.3	45-43.1	-0.1	0.28
	65	1900	66-07	44-04.5	-0.5	0.50

Date	Station	Time (Local)	Latitude	Longitude	Water temp (°C)	Chlorophyll-a (mg/m ³)
4	66	0800	67°00'S	41°42'5'E	- 2 ●	1.37
	67	2200			- 1.4	1.26
5	68	0800	68-44	38-30	- 1.0	1.27
	69	1700			0.8	0.49
6	70	1400	68-50	39-00	- 1.0	1.89
	71	2000	69-00	39-36	0.1	2.10
Ongul Isls.						
Feb 20	72	1100	69-01.3	39-16.5	- 1.0	0.28
21	73	0800	68-05.4	35-13.1	- 1.8	0.47
22	74	0930	68-47.0	31-35.0	- 1.2	1.30
23	75	0800	68-44.8	31-13.2	- 0.7	0.91
26	76	0800	68-34.2	29-44.9	- 0.5	0.29
	77	1900	68-45.9	29-15.7	0.0	0.16
27	78	0800	68-45.8	20-37.8	0.2	0.15
	79	1900	68-44.1	17-13.1	- 0.5	1.00
28	80	0800	68-31.2	12-11.2	0.1	0.28
	81	1900	68-11.2	8-11.8	0.3	0.20
March 1	82	0800	68-02	4-07.2	0.6	0.15
	83	1900	68-09.4	2-25.9	0.7	0.35
2	84	0800	69-09.2	0-44.7	- 0.1	0.32
3	85	0800	68-35.4	1-58 W	0.6	0.55
	86	1900	67-58	2-10	0.8	0.52
4	87	0800	66-25	1-53	1.3	0.43
	88	1900	65-14	2-51.6	1.8	0.13
5	89	0800	65-52.3	3-28.3	2.4	0.08
	90	1900	61-20.6	3-26.9	2.0	0.08
6	91	0800	58-42.8	1-35.8	2.0	0.17
	92	1900	57-14.3	0-16.5	2.1	0.15
7	93	0800	55-00	2-35.7 E	2.0	0.11
	94	1900	53-25	3-48.5	1.7	0.26
8	95	0800	50-55.1	5-44.8	4.4	0.21
	96	1900	49-34.8	6 41.8	4.3	0.13
9	97	0800	47-13	8-30.8	6.2	0.14
	98	1900	45-25.2	10-21.3	8.2	0.46

Date	Station	Time (Local)	Latitude	Longitude	Water temp. (°C)	Chlorophyll-a (mg/m ³)
10	99	0800	43°10.3'S	11°50.9'E	9.5	0.38
	100	1900	41-51.3	12-54.8	13.0	0.31
11	101	0800	39-38.6	14-26.5	16.0	0.36
	102	1900	38-14	15-34.5	19.2	0.26
12	103	0800	36-25.8	16-57.5	19.4	0.24
	104	1900	35-21.3	16-19.7	19.9	0.21
13	105	0800	33-55	18-10	17.7	0.72
	Cape Town					
20	106	1900	34-47.2	19-04.1	16.0	2.51
21	107	0800	34-38.1	21-50.2	20.4	0.37
	108	1900	34-38.5	24-42.6	19.4	1.46
22	109	0800	33-51.8	27-16	24.5	0.33
	110	1900	32-59.4	29-09.4	24.4	0.15
23	111	0800	31-47	31-46.2	23.6	0.19
	112	1900	30-46	34-15	26.4	0.15
24	113	0800	29-36	37-13.6	25.2	0.09
	114	1900	28-34.2	39-39.6	26.7	0.12
25	115	0800	27-41.2	42-00.5	25.5	0.22
	116	1900	26-30.9	44-15.8	25.5	0.34
26	117	0800	25-24.3	47-03	26.8	0.09
	118	1900	24-15.7	49-27.9	26.2	0.15
27	119	0800	23-09.1	52-42	27.5	0.05
	120	1900	21-56	55-05	27.6	0.04
28	121	0800	20-42.3	57-48	28.0	0.03
	122	1900	19-06.5	59-37.5	28.0	0.03
29	123	0800	17-25.4	61-39.7	27.7	0.06
	124	1900	15-51	63-34	28.2	0.05
30	125	0800	13-54	65-48.5	28.7	0.07
	126	1900	12-23	67-35	28.8	0.04
31	127	0800	10-30.8	69-45.4	28.5	0.08
	128	1900	8-56.6	71-27	29.0	0.10
April 1	129	0800	7-17.2	73-17.5	28.9	0.07
	130	1900	4-55	74-27	28.7	0.06

Date	Station	Time (Local)	Latitude	Longitude	Water temp (°C)	Chlorophyll-a (mg/m ³)
2	131	0800	2°24' S	75°36 1'E	28 3	0 11
	132	1900	0-11 5N	76-42 4	29 4	0 06
3	133	0800	2-53.5	78-01	29 2	0 07
	134	1900	4-49 1	78-38	29.5	1.08
4	135	0800	6-55 1	79-40	29 6	0 13
	Colombo					
9	136	1900	5-42.7	80-44 7	29 1	0 17
10	137	0800	5-49 4	83-27 7	29 3	0 12
	138	1900	5-53 1	86-02 2	28 9	0 12
11	139	0800	5-54 3	88-55 4	29 4	0 10
	140	1900	5-58 2	91-25 8	30 0	0 08
12	141	0800	6-12 8	94-28	29 7	0 08
	142	1900	5-48	96-36 8	29 6	0 09
13	143	0800	4-44	98-36 1	29.5	0 15
	144	1900	3-22 5	100-17	30 3	0 17
14	145	0800	1-54 5	102-24	29 3	0 51
	146	1900	1-25.8	104-29	29.3	0 33
15	147	0800	3-56 5	105-57.9	28.6	0 14
	148	1900	5-49	107-29	29 4	0 08
16	149	0800	8-06 1	109-28 5	28 4	0 07
	150	1900	10-04.9	111-05.5	28 8	0.06
17	151	0800	12-14 2	112-57.1	27 6	0 06
	152	1900	13-51	114-46 3	28 4	0.07
18	153	0800	15-44 2	116-49.4	27.6	0.09
	154	1900	17-08 4	118-38 3	26 8	0 07
19	155	0800	19-17.9	120-54 8	26 6	0.11
	156	1900	20-53	122-44	25 2	0.08
20	157	0800	22-52	124-45 4	24 2	0 07
	158	1900	24-35 5	126-30	23 9	0 07
21	159	0800	26-33	128-39	23 3	0 10
	160	1900	28-20	130-31	21 7	0 09
22	161	0800	30-14 3	132-43 3	20 0	0 18
	162	1900	32-19	135-04 5	20 8	0 26

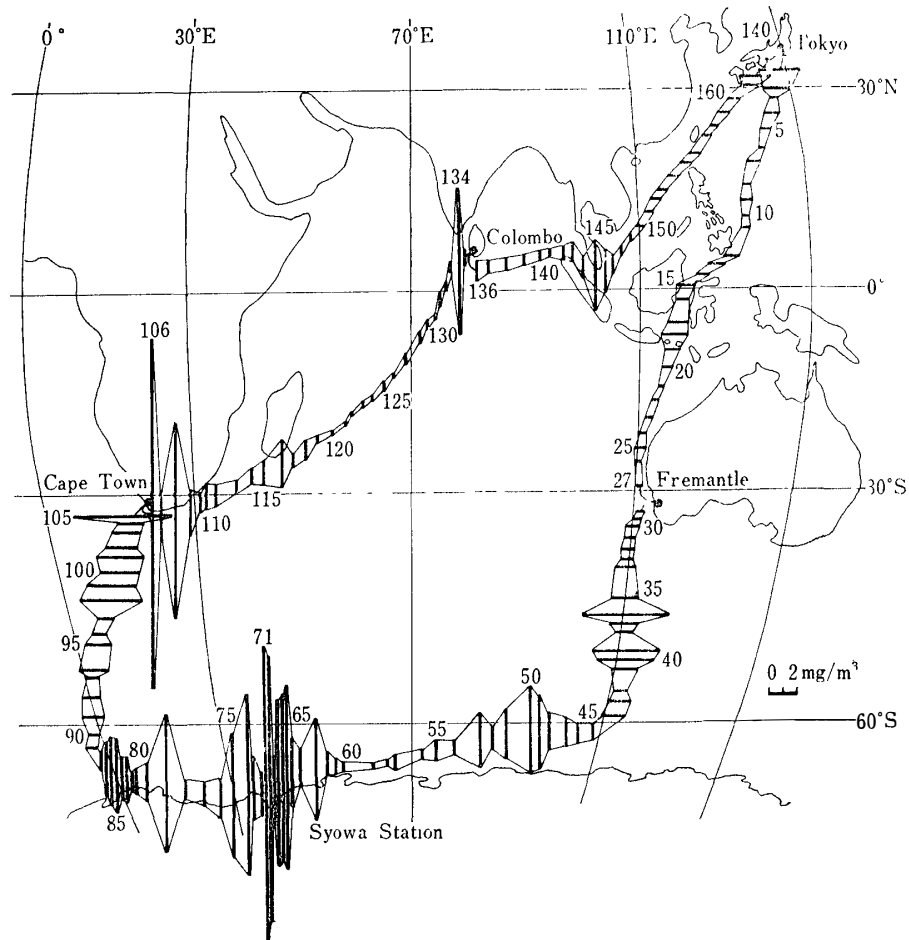


Fig. 1. Distribution of chlorophyll-a along the route of FUJI.

part of the Indian Ocean, and high in the southern part of the Indian Ocean and in the Antarctic Ocean. And also high concentration of chlorophyll-a was observed in Makassal Strait, in Malacca Strait, and near Cape Town, Madagascal Island, Ceylon and in the area southwest of Japan.

From Fremantle to Antarctica

As mentioned above, the chlorophyll-a content was relatively high but its distribution was uneven between Fremantle and Antarctica. Along about the 110th degree of east longitude, high concentration of chlorophyll-a was observed between 45° and 48°S beyond Subtropical Convergence that seems to lie between 40° and 45°S. Chlorophyll-a decreased remarkably at about 49°S, where Antarctic Convergence occurs. Beyond Antarctic Convergence, chlorophyll-a increased between 52° and 54°S but decreased between 56° and 61°S. In the sector between 80° and 100°E, HOSHIAI (1968) found high chlorophyll-a concentration in a wider area (41° to 61°S) than that in the present work. The decrease of chloro-

phyll-a at Antarctic Convergence was more remarkable in 1968 than in 1965.

Along Antarctic Continent

Chlorophyll-a concentration was high between 100° and 80°E and low between 80° and 45°E. From the western part of the Prince Olav Coast to the Princess Astrid Coast high chlorophyll-a concentration was observed. The horizontal distribution of chlorophyll-a mentioned above generally agreed with that in 1965-1966 (HOSHIAI, 1968). However, it was notable that around Lutzow-Holm Bay chlorophyll-a concentration was higher in 1969 than in 1966 and that the content varied extremely from place to place within a relatively narrow area.

Between Antarctica and Cape Town

From 65° to 47°S chlorophyll-a concentration was low, except between 50° and 53° S, and from 45° S to Cape Town it was high. Variation of chlorophyll-a concentration at Subtropical Convergence was not very clear but the content decreased slightly at about 53°S where Antarctic Convergence is located. It was remarkable that a high value of chlorophyll-a content was found and that the content near Cape Town was extremely variable.

ICHIMURA and FUKUSHIMA (1963) reported that chlorophyll-a concentration was high between 40° and 69°S. According to HOSHIAI (1968), on the other hand, chlorophyll-a concentration was low between 69° and 50°S, except from 61° to 63° S, and high from 49° S to Cape Town, which agrees with the present work. The distribution of chlorophyll-a concentration in this area is an interesting problem, but available data is not sufficient for discussing the cause of the difference in the horizontal distribution of chlorophyll-a. It is necessary to accumulate data along the similar route during the relief expedition by FUJI.

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