Chlorophyll-a Content in the Surface Sea Water Observed in 1970-1971 during the Cruise of Fuji to Antarctica

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「ふじ」航路（1970–1971）における表面海水中のクロロフィルa量

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要旨：第12次南極観測海洋生物部門の定常観測として1970年11月26日から1971年5月1日まで観測船「ふじ」の航路にそって，北太平洋西部・インド洋・南極洋にわたる115地点の表面海水中のクロロフィルa量の測定を行なった．南極洋および南緯32°以南のインド洋ではクロロフィルa量の分布にかなりの変動がみられたが，全体的にはその他の海域におけるよりも高い値が見られた（0.05～1.10 mg/m³）．北太平洋西部・南シナ海・南緯32°以北のインド洋では，比較的高い値がみられたオーストラリア沿岸・南アフリカ沿岸・マダガスカル島沿岸・マラッカ海峡などの沿岸海域を除けば，南極洋などに比べ全体的には低い値がみられた（0.02～0.17mg/m³）．今回の観測で得られたクロロフィルa量の地理的分布の様相は，これまでのほぼ同じ航路において得られた結果と全般的傾向としてはほぼ一致していた．

Measurement of the chlorophyll-a content in the sea water furnishes the basic data for the study of marine ecosystem, especially for the estimation of standing crop or photosynthetic capacity of phytoplankton. In addition, a survey of the geographical distribution of the chlorophyll-a content in various oceans is important for clarifying the ecological characteristics of each ocean. Therefore, determination of the chlorophyll-a content in the surface sea water along the course of the research vessel Fuji to Antarctica has been performed as a part of the routine work in marine biological programme since the 7th Japanese Antarctic Research Expedition in 1965–1966.

The present paper reports the results of observations on the chlorophyll-a content in the surface sea water obtained during the 12th Japanese Antarctic Research Expedition from November 1970 to May 1971.

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Sampling of the sea water was made as a rule every day at 08 : 00 and 18 : 00 by local time through the whole course of the research vessel FUJI, but it was made in some cases at different local time or suspended in consequence of bad weather or inevitable circumstances.

Station and local time of sampling of the sea water are shown in Table 1, and the track of the research vessel FUJI is illustrated in outline in Fig. 1.

Sea water samples were scooped up by a plastic bucket, and filtrated through the glass fiber filter paper (Reeve Angel, 984-H, 47 mm in diameter) with the aid of a vaccum-pump. The filter paper containing the trapped pigment materials was ground down in a glass mortar with 92% acetone solution, and pigments were extracted by 92% acetone solution for 24 hours in a dark refrigerator. After the extraction, the acetone solution containing pigments was filtrated again through the glass fiber filter of the same kind for eliminating the dust of glass fiber. The concentration of chlorophyll-a in the filtrate was determined by a spectrophotometer, Hitachi Type 101. The amount of the chlorophyll-a in the sample sea water was calculated according to the following formula:

$$\text{Chlorophyll-a } (\text{mg/m}^3) = (11.64\,E_{663} - 2.16\,E_{645} - 0.10\,E_{630}) \times (f)$$

$$(f) = \frac{\text{Volume of 92\% acetone solution (ml)}}{\text{Volume of sample sea water (l)} \times \text{Light path (cm)}}$$

The results of determination of chlorophyll-a content are shown in Table 1, with the data of surface water temperatures which were offered by the meteorological observatory of the research vessel FUJI. In Fig. 1 is illustrated a geographical distribution of the chlorophyll-a content along the route of the research vessel FUJI.

The pattern of geographical distribution of chlorophyll-a content obtained by the present observations was similar in general tendency to those observed along the similar route by the past Japanese Antarctic Research Expeditions, *i. e.* JARE-5 in 1960-1961 (ICHIMURA and FUKUSHIMA, 1963), JARE-7 in 1965-1966 (HOSHIAI, 1968), JARE-9 in 1967-1968 (TOMINAGA, 1971) and JARE-10 in 1968-1969 (TAKAHASHI, 1969), although a detailed comparison on restricted areas reveals some differences in distributional pattern from the past records.

By a rough comparison of the results obtained by the present observations, it was noticed that the distribution of chlorophyll-a content in the Antarctic and the southern part of the Indian Oceans (St. 20-63 from Fremantle to Cape Town *via* Antarctica) was significantly different from that in the other Oceans including the northern part of the Indian Ocean, the Western North Pacific Ocean and the South China Sea (St. 1-19 from Tokyo to Fremantle and St. 64-115 from Cape Town to Tokyo). Chlorophyll-a content in the Antarctic and the southern part

Table 1. Chlorophyll-a content along the route of FUJI.

Date	Station	Time (Local)	Latitude	Longitude	Water temp. (°C)	Chlorophyll-a (mg/m³)
1970						
Nov. 26	1	0800	31°42.5′N	137°46.0′E	22.1	0.09
	2	1800	30°02.5′N	136°46.5′E	22.3	0.06
27	3	0800	27°25.5′N	135°30.5′E	23.1	0.09
	4	1800	25°33.0′N	134°37.8′E	24.7	0.05
28	5	0800	22°49.5′N	133°20.2′E	26.4	0.07
	6	1800	20°57.0′N	132°22.5′E	26.4	0.02
29	7	0800	18°17.0′N	131°12.5′E	27.9	0.05
	8	1800	16°23.5′N	130°31.5′E	28.2	0.02
30	9	0800	13°32.0′N	129°09.0′E	28.6	0.04
	10	1700	11°32.5′N	128°17.0′E	28.6	0.02
Dec. 1	11	0800	8°17.0′N	127°09.0′E	28.6	0.06
	12	1800	5°47.6′N	126°07.5′E	28.2	0.04
5	13	1800	10°35.0′S	115°12.5′E	28.9	0.04
6	14	0800	13°21.2′S	114°41.8′E	28.6	0.08
	15	1800	15°17.0′S	114°32.7′E	28.6	0.06
7	16	0800	18°21.0′S	113°56.0′E	26.4	0.08
	17	1800	20°21.0′S	113°43.0′E	25.5	0.02
8	18	0800	23°12.1′S	113°13.6′E	19.3	0.27
	19	1800	25°17.8′S	112°39.5′E	22.2	0.20
	Fremantle					
17	20	0800	33°53.0′S	111°57.0′E	17.9	0.09
	21	1800	34°51.9′S	110°26.2′E	17.7	0.05
18	22	0800	37°18.2′S	109°59.5′E	13.8	0.15
	23	1800	38°46.0′S	110°04.4′E	13.3	0.13
19	24	0900	41°36.7′S	110°02.7′E	11.1	0.17
	25	1800	43°01.2′S	109°59.3′E	10.2	0.28
20	26	0800	45°02.0′S	109°23.3′E	10.4	0.24
	27	1800	46°56.0′S	109°20.0′E	7.5	0.13
21	28	0900	49°57.0′S	109°19.5′E	5.0	0.14
	29	1800	51°29.3′S	109°46.5′E	3.8	0.64
22	30	0900	54°16.0′S	108°18.5′E	2.5	0.86
	31	1800	55°25.5′S	106°17.8′E	2.8	0.55
23	32	0800	57°40.8′S	102°13.8′E	1.4	0.55
	33	1800	58°52.4′S	100°19.3′E	0.8	0.24
24	34	0800	60°54.0′S	96°16.8′E	−0.4	0.53
	35	1800	62°07.0′S	93°47.5′E	−0.6	0.20
25	36	0800	62°19.4′S	87°47.7′E	−1.0	0.19
	37	1800	62°34.0′S	84°23.0′E	−1.0	0.68
26	38	0800	61°33.0′S	83°34.0′E	−1.5	1.10

Date	Station	Time (Local)	Latitude	Longitude	Water temp. (°C)	Chlorophyll-a (mg/m³)
26	39	1800	61°52.5′S	80°01.8′E	−0.9	1.03
27	40	0800	62°39.2′S	73°35.2′E	−0.8	0.71
28	41	0800	63°03.5′S	67°13.4′E	−0.9	0.07
	42	1800	62°43.0′S	64°16.0′E	−1.0	0.07
29	43	0800	63°26.3′S	58°54.2′E	−1.4	0.09
	44	1800	64°14.0′S	55°17.0′E	−1.3	0.30
	Antarctic ice field					
1971						
March 18	45	0800	66°29.3′S	34°36.0′E	−0.5	0.50
	46	1735	65°26.0′S	33°50.0′E	0.3	0.05
19	47	0800	63°10.0′S	32°49.0′E	0.6	0.07
	48	1700	61°39.0′S	31°16.0′E	0.7	0.06
20	49	0800	59°41.6′S	28°24.0′E	1.5	0.28
21	50	0800	57°24.5′S	28°09.0′E	1.4	0.24
	51	1900	56°35.1′S	27°09.6′E	2.1	0.35
22	52	0800	55°45.1′S	24°56.1′E	1.7	0.44
	53	1700	55°04.0′S	24°45.0′E	1.3	0.44
23	54	0900	53°07.0′S	23°18.0′E	1.5	0.34
	55	1830	51°41.0′S	22°30.0′E	2.0	0.26
24	56	0800	49°06.0′S	21°45.0′E	3.4	0.17
	57	1900	48°21.0′S	21°32.0′E	5.0	0.07
25	58	0800	46°31.0′S	21°05.5′E	7.2	0.09
26	59	0800	45°37.0′S	19°22.0′E	8.1	0.13
	60	1800	43°04.0′S	19°42.0′E	12.1	0.43
27	61	0800	39°36.8′S	18°58.3′E	16.1	0.13
	62	1900	37°37.0′S	18°34.0′E	20.2	0.35
28	63	0800	34°52.0′S	18°06.0′E	18.2	0.33
	Cape Town					
April 4	64	0800	35°01.0′S	21°56.0′E	19.2	0.26
	65	1800	34°45.0′S	23°28.0′E	18.8	0.59
6	66	1800	31°57.0′S	31°06.0′E	23.5	0.09
7	67	0800	30°33.7′S	34°26.6′E	25.6	0.09
	68	1800	29°58.0′S	36°54.0′E	25.5	0.07
8	69	0800	27°59.7′S	40°24.8′E	26.1	0.17
	70	1800	27°08.2′S	42°23.5′E	26.7	0.09
9	71	0800	25°58.0′S	45°21.0′E	24.8	0.22
	72	1800	25°12.4′S	47°44.0′E	27.5	0.15
10	73	0800	24°00.0′S	50°23.9′E	27.1	0.05
	74	1800	23°11.8′S	52°34.8′E	26.8	0.09
11	75	0800	22°00.0′S	55°05.0′E	26.3	0.04
	76	1800	21°05.6′S	57°07.2′E	26.8	0.04

Date	Station	Time (Local)	Latitude	Longitude	Water temp. (°C)	Chlorophyll-a (mg/m^3)
12	77	0800	19°24.5′S	59°20.4′E	26.6	0.04
	78	1800	18°04.0′S	60°51.3′E	26.6	0.02
13	79	0800	16°30.0′S	63°08.0′E	27.2	0.05
	80	1800	15°24.5′S	64°46.8′E	27.4	0.05
14	81	0800	13°34.0′S	66°40.0′E	27.4	0.07
	82	1800	12°29.5′S	68°21.3′E	27.6	0.11
15	83	0800	11°05.4′S	70°07.2′E	27.6	0.07
	84	1800	9°39.5′S	72°59.8′E	27.9	0.04
16	85	0800	7°38.4′S	75°47.8′E	28.4	0.04
	86	1800	6°19.0′S	77°33.3′E	29.1	0.07
17	87	0800	4°14.3′S	80°16.8′E	29.3	0.07
	88	1800	2°53.0′S	82°09.0′E	29.3	0.04
18	89	0800	1°02.0′S	84°47.0′E	29.3	0.07
	90	1800	0°14.5′N	86°32.1′E	29.3	0.11
19	91	0800	2°02.2′N	89°05.0′E	29.5	0.07
	92	1800	3°02.2′N	90°42.1′E	29.5	0.11
20	93	0800	4°46.2′N	92°56.5′E	29.4	0.07
	94	1800	5°53.7′N	94°27.3′E	29.8	0.09
21	95	0800	5°40.3′N	96°54.0′E	30.1	0.26
	96	1800	4°53.6′N	98°23.2′E	29.7	0.15
22	97	0800	3°20.7′N	100°29.6′E	29.4	0.33
	98	1800	2°24.0′N	101°44.0′E	29.2	0.38
23	99	0800	1°20.9′N	103°15.1′E	28.9	0.50
	100	1800	2°06.0′N	104°52.1′E	28.6	0.07
24	101	0800	4°32.7′N	106°28.3′E	28.4	0.07
	102	1800	6°06.5′N	107°48.9′E	28.2	0.09
25	103	0800	8°24.8′N	109°43.0′E	28.2	0.09
	104	1800	10°16.0′N	111°19.0′E	28.1	0.09
26	105	0800	12°49.0′N	113°39.5′E	27.8	0.11
	106	1800	14°24.5′N	115°28.0′E	28.0	0.05
27	107	0800	16°30.3′N	117°54.7′E	26.4	0.07
	108	1800	17°55.6′N	119°27.7′E	26.5	0.05
28	109	0800	19°58.8′N	121°39.0′E	26.2	0.05
	110	1800	21°21.7′N	123°25.7′E	26.1	0.12
29	111	0800	23°20.2′N	125°28.8′E	23.4	0.04
	112	1800	24°42.5′N	126°51.5′E	24.4	0.07
30	113	1800	28°14.0′N	130°28.5′E	21.5	0.09
May 1	114	0800	30°23.6′N	132°19.3′E	21.7	0.15
	115	1800	31°29.0′N	133°09.2′E	19.7	0.15

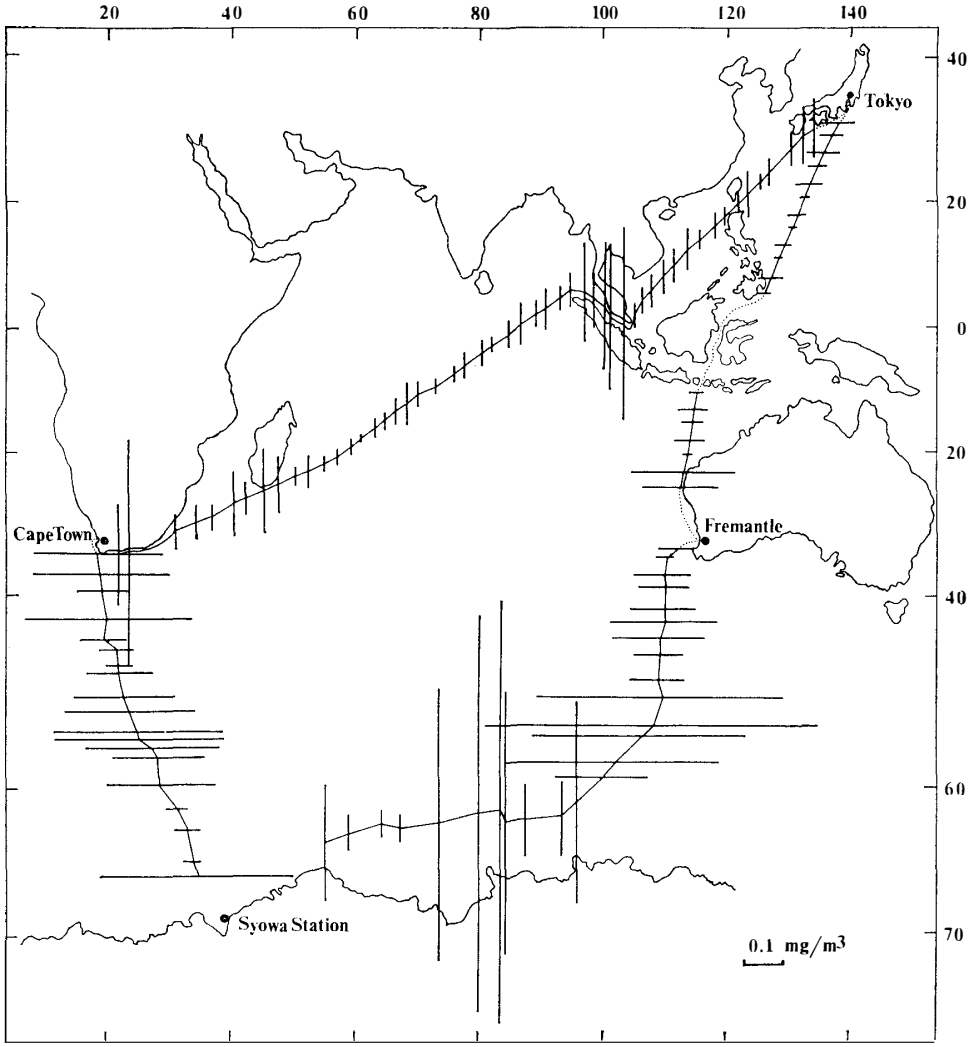

Fig. 1. Geographical distribution of chlorophyll-a along the route of FUJI.

of the Indian Oceans showed generally higher values (0.05–1.10mg/m^3) as compared with those of the other Oceans, although fairly large fluctuations in distribution were observed. Although comparatively high values were observed also in the coastal waters near Western Australia (St. 18, 19), South Africa (St. 62–65), Madagascal Island (St. 71, 72) and in Malacca Strait (St. 95–99), chlorophyll-a content in the other Oceans showed generally lower values (0.02–0.17mg/m^3) as compared with those of the Antarctic and the southern part of the Indian Oceans.

References

HOSHIAI, T. (1968) : Chlorophyll-a contents in the surface water observed during the cruise of FUJI to the Antarctic in 1965–1966. Antarctic Rec., **32**, 55–62.

ICHIMURA, S. and H. FUKUSHIMA (1963) : On the chlorophyll content in the surface water of the Indian and the Antarctic Oceans. Bot. Mag., **76**, 395–399.

TAKAHASHI, E. (1969) : Chlorophyll-a content in the surface water observed in 1968–1969 during the cruise of FUJI to Antarctica. Antarctic Rec., **39**, 65–72.

TOMINAGA, H. (1971) : Chlorophyll a and phaeophytin contents in the surface water of the Antarctic Ocean through the Indian Ocean. Antarctic Rec., **42**, 119–129.

(*Received February 18, 1972*)