

## Chlorophyll-a Contents in the Surface Water Observed during the Cruise of FUJI to the Antarctic in 1965-1966

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### 「ふじ」航路(1965-1966)における表面水中のクロロフィル a 量

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#### 要 旨

1965年11月から1966年4月まで、「ふじ」の航路に沿って、表面水中のクロロフィル a の定量を行なった。クロロフィル a 量の水平分布は、

これまでに「ふじ」航路の付近から報告された結果と必ずしも一致しないが、この点についての論議は更に資料の集積をまっけて行なう必要がある。

As one of the routine observations in marine biological program of the 7th Japanese Antarctic Research Expedition, surface chlorophyll-a contents were measured on board along the course of research vessel FUJI.

Water samples were taken by a plastic bucket and filtrated through Millipor filter HA (47 mm). Chlorophyll-a determination was made according to the method of ODUM *et al.* Water sampling for biological research was done more frequently than physical and chemical observations along the Antarctic continent and between the Princess Astrid Coast and Cape Town, while in the rest of the cruise the biological sampling was made at the same station as other oceanographic observations. Therefore, the surface temperature data taken by HORI and others (1967) of the 7th Japanese Antarctic Research Expedition is cited in Table 1. The results of chlorophyll-a analysis are illustrated in Fig. 1.

As shown in Fig. 1 and Table 1, chlorophyll-a concentration was 0.04 to 0.19 mg/m<sup>3</sup> in the western Pacific and 0.04 to 0.18 mg/m<sup>3</sup> in the northern part of the Indian Ocean and it increased near Colombo (0.37 mg/m<sup>3</sup>), Makassal Strait (0.37 mg/m<sup>3</sup>), Malacca Strait (0.38 mg/m<sup>3</sup>), and in the area southwest of Japan (1.86

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Table 1. Chlorophyll-a contents along the course of FUJI.

Date	Time (Local)	Latitude	Longitude	Water temp. °C	Chlorophyll-a mg/m <sup>3</sup>
1965-11-21	0900	32°-31'N	137°-54'E	25.5	0.17
	1800	30-19	137-07	—	0.12
22	0900	27-13	135-40	24.5	0.19
	1800	25-08	134-35	25.2	0.15
23	0900	22-17	133-42	27.1	0.14
	1800	20-48	133-59	27.3	0.10
24	0900	18-36	134-32.5	27.7	0.12
	1800	17-07.4	133-32	27.9	0.10
25	0900	14-02	131-35	27.9	0.10
	1800	12-55.5	130-23	28.5	0.06
26	0900	10-08.5	128-22	28.6	0.06
	1800	8-24	127-24	28.8	0.04
27	0900	4-51.5	125-14	28.2	0.08
	1800	3-37.8	123-19.8	28.4	0.12
28	0900	1-26.8	120-17	28.3	0.37
	1800	0°-06'S	119°-17.6'E	29.0	0.09
29	0900	3-42.9	118-40.5	29.2	0.16
	1800	5-46.8	118-48.5	29.6	0.22
30	0900	8-05	116-11.5	29.8	0.34
	1800	9-58	115-26	28.6	0.14
12- 1	0900	13-14	114-50	28.2	0.14
	1800	15-12.5	114-33.5	27.4	0.05
2	0900	18-42	113-42	25.3	0.09
	1800	20-20	113-21	24.3	0.09
3	0900	23-25	112-45	21.6	0.09
	1800	25-15.5	112-05	22.7	0.10
4	0900	28-30.2	112-52	20.6	0.09
	1800	30-05	113-43	21.1	0.09
5	1000	Arrived at Fremantle			
11	1000	Left Fremantle			
	1500	32-15.5	114-55.2	23.5	0.09
	2000	32-54	114-05	19.6	0.05
12	0900	34-39.5	111-15	17.5	0.07
	1500	35-30	110-04.5	16.5	0.13
	2100	36-22	108-57	16.2	0.10
13	0900	37-55.1	106-33.4	14.0	0.28
	1500	38-41	105-22	14.1	0.31
	2100	39-26.2	104-12	12.5	0.03
14	0900	41-02	101-42.4	11.4	0.37

Date	Time (Local)	Latitude	Longitude	Water temp. °C	Chlorophyll-a mg/m <sup>3</sup>
1965-12-14	1500	41°-49.3'S	100°-25.0'E	11.2	0.57
	2100	42-25.2	99-09.6	11.2	0.75
15	0900	44-04.4	97-09.1	10.4	0.67
	1500	45-11.5	97-12.0	7.4	0.24
	2100	46-35.0	97-14.2	6.7	0.31
16	0900	49-03.0	97-12.0	5.9	0.56
	1500	50-17.8	97-12.0	4.5	0.75
	2100	51-35.0	97-14.2	4.5	0.54
17	0900	54-08.0	97-20.8	1.6	0.37
	1500	55-24.8	97-24.0	1.2	0.28
	2100	56-41.5	97-25.0	0.6	0.45
18	0900	59-16.0	97-19.0	0.2	0.48
	1500	59-48.0	97-12.0	—	0.51
	2100	60-25.0	97-10.0	-0.3	0.45
19	0900	62-13.0	92-30.5	-0.4	0.89
	1500	62-54.0	89-36.0	—	0.85
	2100	62-54.0	88-54.0	—	0.76
20	0900	64-01.5	81-25.0	-0.9	0.24
	1500	64-00.0	81-24.0	—	0.09
	2100	64-13.5	78-43.5	-0.8	0.13
21	0900	64-11.5	72-44.0	-0.9	0.10
	1500	64-36.0	71-24.0	—	0.15
	2100	64-18.0	71-06.0	-1.1	0.13
22	0900	62-25.6	70-24.5	-1.0	0.09
	1500	62-46.7	68-31.0	—	0.09
	2100	62-49.0	66-35.0	-1.1	0.06
23	0900	63-49.0	60-53.0	-0.2	0.15
	1500	63-41.1	58-55.5	1.9	0.30
	2100	64-29.2	56-47.8	0.3	0.33
24	0900	64-39.7	53-20.0	-1.6	0.15
	1500	64-30.0	53-18.0	—	0.09
	2100	64-27.2	51-58.0	-1.4	0.12
25	0900	64-41.0	49-06.5	-1.0	0.15
	1500	65-06.0	47-48.0	—	0.16
	2100	64-38.8	47-07.0	-1.6	0.18
26	0900	64-39.8	46-45.8	—	0.18
	1500	64-40.8	46-13.5	—	0.23
27	0900	64-43.3	45-22.0	-1.7	0.18
	1800	65-51.0	45-13.0	-1.6	0.19
28	0900	65-58.8	44-42.5	-1.5	0.37
	1800	65-57.9	44-22.0	-0.9	0.24

Date	Time (Local)	Latitude	Longitude	Water temp. °C	Chlorophyll-a mg/m <sup>3</sup>
1965-12-29	1800	67°-20.0'S	43°-35.0'E	-0.8	0.30
30	0900	68-26.6	40-42.0	-0.8	0.16
1966- 2- 1	2100	69-06.0	39-36.0	—	0.51
2	1300	68-07.0	38-52.0	—	0.45
3	1600	67-24.0	45-00.0	—	0.21
4	1700	67-26.8	45-36.0	—	0.22
6	1700	67-11.4	43-50.0	—	0.15
9	0900	70-19.0	24-23.0	-1.4	1.04
10	0900	70-18.0	24-20.0	—	0.31
11	1200	70-18.0	24-06.0	-1.5	0.82
12	1300	70-18.0	24-03.0	—	0.30
	1830	69-40.0	23-45.0	—	0.54
	2300	69-33.7	20-41.0	—	0.45
13	0600	69-17.0	18-15.0	—	0.80
	1200	69-07.0	16-18.0	—	0.15
	1800	68-32.7	14-11.9	-1.2	0.22
	2100	68-30.0	13-00.0	—	0.22
14	0900	64-41.8	13-42.1	0.8	0.24
	1700	64-58.3	13-54.7	1.9	0.19
15	1500	62-31.7	14-22.0	0.9	0.45
	1900	61-48.2	14-24.0	—	0.37
16	0600	59-57.5	12-14.0	—	0.15
	1800	59-54.0	10-48.0	—	0.15
17	0500	57-26.3	9-01.0	0.9	0.18
	1230	56-19.3	9-03.0	1.0	0.02
	2100	55-06.5	9-37.0	1.1	0.03
18	0930	53-38.0	10-20.0	1.3	0.01
	1515	52-02.1	10-21.4	—	0.11
	2100	51-17.9	10-23.6	3.0	0.10
19	0300	50-02.5	10-29.4	3.8	0.16
	1040	48-48.0	10-49.0	—	0.31
	1700	47-34.0	11-34.0	4.7	0.13
	2300	46-17.0	11-38.0	—	0.37
20	0500	45-12.5	11-44.0	7.6	0.43
	1430	44-05.0	12-34.0	—	0.31
	2330	42-41.0	13-26.0	9.0	0.34
21	0630	41-20.0	14-02.0	—	0.28
	2000	39-57.0	14-54.0	15.0	0.28
22	0800	38-45.0	15-36.0	—	0.45
	1630	37-24.5	16-03.0	19.4	0.69
	2300	36-26.0	16-32.0	—	0.31

Date	Time (Local)	Latitude	Longitude	Water temp. °C	Chlorophyll-a mg/m <sup>3</sup>
1966- 2-23	0930	34°-04. 3'S	18°-01. 5'E	19.1	0.31
24	0700	33-53.0	18-17.0	—	0.67
	0800	Arrived at Cape Town			
3- 3	1000	Left Cape Town			
	1800	34-45.3	18-57.1	20.3	0.16
4	0900	34-51.0	22-38.9	22.2	0.13
	1800	34-34.8	24-37.4	23.5	0.09
5	0900	33-37.3	27-50.8	26.5	0.09
	1800	32-51.0	29-31.4	24.1	0.08
6	0900	31-31.0	32-52.0	24.5	0.14
	1800	30-37.7	34-49.5	24.5	0.06
7	0900	29-26.4	37-42.9	25.3	0.14
	1800	28-46.2	39-36.8	27.2	0.05
8	0900	27-23.1	42-26.0	27.3	0.11
	1800	26-40.0	43-58.3	27.1	0.05
9	0900	25-35.8	46-23.3	26.6	0.16
	1800	24-54.4	48-09.4	27.6	0.09
10	0900	23-01.7	49-48.0	26.7	0.18
	1800	22-11.1	51-35.7	27.0	0.09
11	0900	20-56.5	54-36.7	27.4	0.06
	1800	20-09.0	56-35.0	27.3	0.05
12	0900	18-52.7	59-32.0	27.4	0.06
	1800	17-47.0	61-08.7	27.5	0.06
13	0900	15-40.5	63-25.9	27.0	0.04
	1800	14-27.2	64-50.2	27.5	0.11
14	0900	12-25.0	67-12.5	28.5	0.10
	1800	11-21.1	68-46.8	29.5	0.10
15	0900	9-12.0	71-05.5	28.5	0.04
	1800	7-51.0	72-35.0	27.9	0.09
16	0900	4-45.3	74-20.8	28.8	0.08
	1800	2-56.0	75-13.5	28.6	0.04
17	0900	0°-06. 2'N	76°-42. 3'E	29.3	0.05
	1800	1-39.7	77-28.9	29.3	0.03
18	0845	4-12.7	78-45.6	28.8	0.05
	1800	5-22.5	79-08.4	28.8	0.04
19	0600	6-48.0	79-48.0	—	0.37
	0700	Arrived at Colombo			
23	1100	Left Colombo			
	1200	6-49.0	79-49.9	—	0.05

Date	Time (Local)	Latitude	Longitude	Water temp. °C	Chlorophyll-a mg/m <sup>3</sup>
1966- 3-23	1800	5°-49.0'N	80°-32.8'E	28.7	0.15
24	0900	5-48.9	83-44.8	29.4	0.07
	1800	5-50.5	85-37.6	29.2	0.05
25	0900	5-53.9	88-49.5	29.4	0.09
	1900	6-02.0	90-53.5	29.2	0.09
26	0900	6-13.0	93-57.2	28.9	0.14
	1800	5-56.7	95-57.1	29.1	0.10
27	0900	4-27.0	98-50.2	28.8	0.28
	1800	3-11.0	100-26.2	29.4	0.29
28	0900	1-22.2	103-13.0	29.2	0.38
	1800	1-52.1	104-46.8	29.2	0.20
29	0900	4-37.0	106-35.0	28.9	0.17
	1800	6-07.3	107-48.0	29.4	0.15
30	0900	8-34.9	110-02.4	28.9	0.11
	1800	10-03.3	111-23.0	29.0	0.09
31	0900	12-36.5	113-23.9	28.5	0.08
	1800	13-55.0	114-55.8	28.6	0.08
4- 1	0900	15-55.2	117-14.0	27.5	0.08
	1800	17-07.7	118-43.1	27.9	0.09
2	0900	19-20.3	121-01.6	26.1	0.14
	1800	20-43.0	122-16.2	26.7	0.09
3	0900	24-04.0	123-15.5	28.3	0.14
	1800	25-24.0	124-30.0	24.0	0.18
4	0900	27-44.3	126-56.5	24.1	0.20
	1800	29-14.0	127-51.5	23.2	0.80
5	0900	30-38-8	130-18.0	21.4	0.51
	1300	31-04.2	131-20.0	—	1.86
	1800	31-30.0	132-00.0	—	0.68

mg/m<sup>3</sup>).

On the way from Australia to the Antarctic Ocean, high chlorophyll-a concentrations were found between 41° and 63°S (0.37-0.89 mg/m<sup>3</sup>), but decrease was observed at 45°S (0.25 mg/m<sup>3</sup>) and 55°S (0.28 mg/m<sup>3</sup>), corresponding with Subtropical and Antarctic Convergence respectively. SAIJO and KAWASHIMA (1964) reported that chlorophyll-a values in this area varied from 0.04 to 0.72 mg/m<sup>3</sup> and relatively high concentrations were observed between Subtropical and Antarctic Convergence. In the present observation it is noted that high concentration area was wider than that reported by SAIJO and KAWASHIMA (1964).

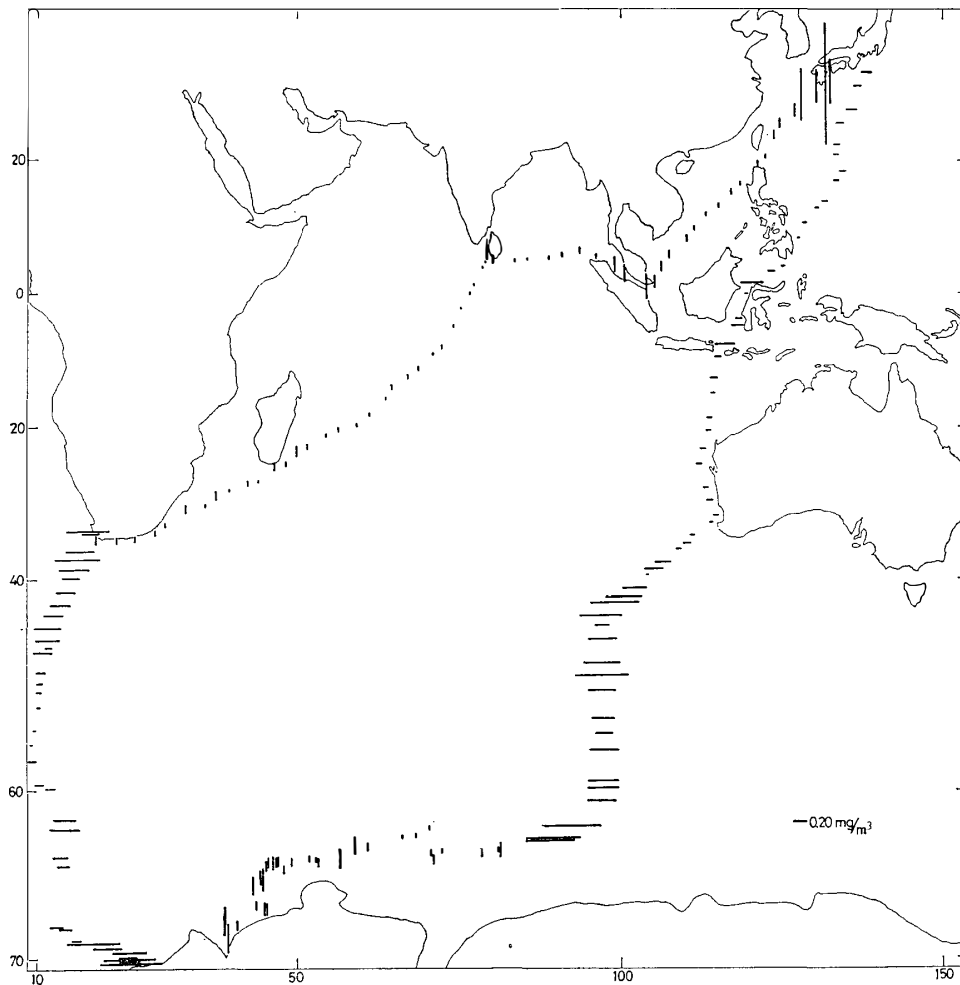


Fig. 1. Route of FUJI and distribution of chlorophyll-a.

In the Antarctic Ocean, chlorophyll-a contents were relatively low ( $0.06\text{--}0.33\text{ mg/m}^3$ ) in the area between  $45^\circ$  and  $82^\circ\text{E}$  and between  $62^\circ$  and  $65^\circ\text{S}$  and high in the area along the west part of the Prince Olav Coast and Princess Ragnhild Coast ( $0.15\text{--}0.82\text{ mg/m}^3$ ). But the difference in season when observations were made must be taken into consideration.

Between the Antarctic and Cape Town, ICHIMURA and FUKUSHIMA (1963) measured the horizontal distribution of surface chlorophyll-a contents estimated by ODUM's method, and revealed high concentration between  $40^\circ$  and  $70^\circ\text{S}$ . In the present observation, chlorophyll-a concentration was low from  $69^\circ$  to  $50^\circ\text{S}$  ( $0.01\text{--}0.22\text{ mg/m}^3$ ) except between  $61^\circ$  and  $63^\circ\text{S}$  ( $0.37\text{--}0.45\text{ mg/m}^3$ ), where the minimum ( $0.01\text{ mg/m}^3$ ) was observed at the Antarctic Convergence near  $53^\circ\text{S}$ . From  $49^\circ\text{S}$  to Cape Town it became high ( $0.13\text{--}0.69\text{ mg/m}^3$ ) though a slight decrease was observed near Subtropical Convergence at about  $42^\circ\text{S}$  ( $0.28\text{ mg/m}^3$ ).

Currently available data of chlorophyll-a is not sufficient for detailed discussions, especially on temporal and spatial change in horizontal distribution. In order to elucidate this problem it is necessary to accumulate data for many years along the similar route of relief expeditions by FUJI.

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#### References

- HORI, S., M. SHIOZAKI and T. AKIYAMA (1967): Oceanographic observations of the 7th Japanese Antarctic Research Expedition 1965-1966. *Antarctic Rec.*, **27**, 18-44.
- 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.
- SAIJO, Y. and T. KAWASHIMA (1964): Primary production in the Antarctic Ocean. *J. Oceanogr. Soc. Jap.*, **19**, 22-28.

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