

Preliminary Report
of
The Hakuho Maru Cruise KH-71-3
(IBP Cruise)

June 18—July 29, 1971

The Western North Pacific
Ogasawara and Kuril Areas

Ocean Research Institute
University of Tokyo
1973

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By
The Scientific Members of the Expedition
Edited by
Akihiko Hattori

Preface

This volume contains the oceanographic data obtained on the KH-71-3 Cruise of the R/V Hakuho Maru during June 18-July 29, 1971. Brief summaries of the research work carried out by the scientists aboard, either individually or cooperatively, are also included.

The main objectives of this cruise were to collect information in subarctic and subtropical waters of the western North Pacific Ocean on: (1) the flow rates of subsurface and bottom waters, and (2) the mode and extent of translocation and metabolism of inorganic and organic matter of both dissolved and suspended forms. The second project formed a part of International Biological Programme (IBP) and was partially supported by a grant (No. 99125) from the Ministry of Education, Japan. CSK standards provided by the courtesy of Dr. K. Sugawara, Sagami Chemical Research Center, were used as the references for chemical analyses of oxygen and nutrient salts in sea water samples.

Thirty-two scientists from 10 universities and research institutes participated in this cruise, and the study was conducted with emphasis on integrating the disciplines involved (physical, chemical and biological oceanography). The oceanographic observations were mainly undertaken in two sea areas centered at 28°30'N and 145°00'E, and at 44°00'N and 154°00'E, where the Hakuho Maru stayed for 9 days, and 7 days, respectively. Additional data were obtained on several occasions during the cruise along 145°W longitude, along 28°30'N latitude, and at a station located in the center of the Kuroshio Current. A seismological investigation was also made in basin regions east of the Japan Island Arc.

On behalf of all the scientists aboard, I would like to express my gratitude to Captain I. Tadama and all crew members of the Hakuho Maru for their kind cooperation and skillful assistance throughout the cruise.

Akihito Hattori

Chief Scientist

The ocean Research Institute, University
of Tokyo

Contents

Preface	i
Outline of the cruise	1
Scientists aboard	5
1. General description of oceanographic observations at Stations 11 and 19	6
2. Hydrographic section along 28°30'N latitude	17
3. Currentmetry by moored Savonius meters	25
4. Measurement of deep ocean floor current	27
5. Measurement of solar insolation and submarine light	27
6. STD Observation	43
7. Chemical studies on major and minor components and radioactive nuclides	43
8. Studies on radioactive and stable nuclides	45
9. Vertical distribution of ^{13}C in sea water	46
10. Dissolved and particulate organic matter	46
11. Chemical studies on organic compounds of marine particulate	46
12. Production of organic materials by the photosynthetic reaction of phytoplankton .	49
13. Distribution of dissolved organic carbon	50
14. Variation of inorganic nitrogenous compounds with special reference to biochemical processes, and natural ^{15}N abundance in nitrate and net-samples	50
15. Studies on marine heterotrophic bacteria with special reference to nitrate reduction and nitrate assimilation	51
16. Marine microbiological studies	52
17. Chlorophyll distribution and photosynthetic activity	60
18. Studies on distribution and metabolism of urea	60
19. Dissolved proteinaceous substances in sea water and the utilization of amino acids by microorganisms in aquatic ecosystem	61
20. Size distribution of suspended particles	61
21. Biogeochemistry of minor elements in suspended matter	63
22. Diurnal change of vertical distribution and migration of massive species of zooplankton in the northern North Pacific	65
23. Observation of earthquakes with ocean bottom seismometers at ocean basin	68

Outline of the cruise

The cruise consisted of three legs, from Tokyo to Yokohama, Yokohama to Kushiro and Kushiro to Tokyo (Fig. 1). The location of the hydrographic stations and the dates are given in Table 1. The itinerary of the cruise and items of observation at each station are summarized in Tables 2 and 3.

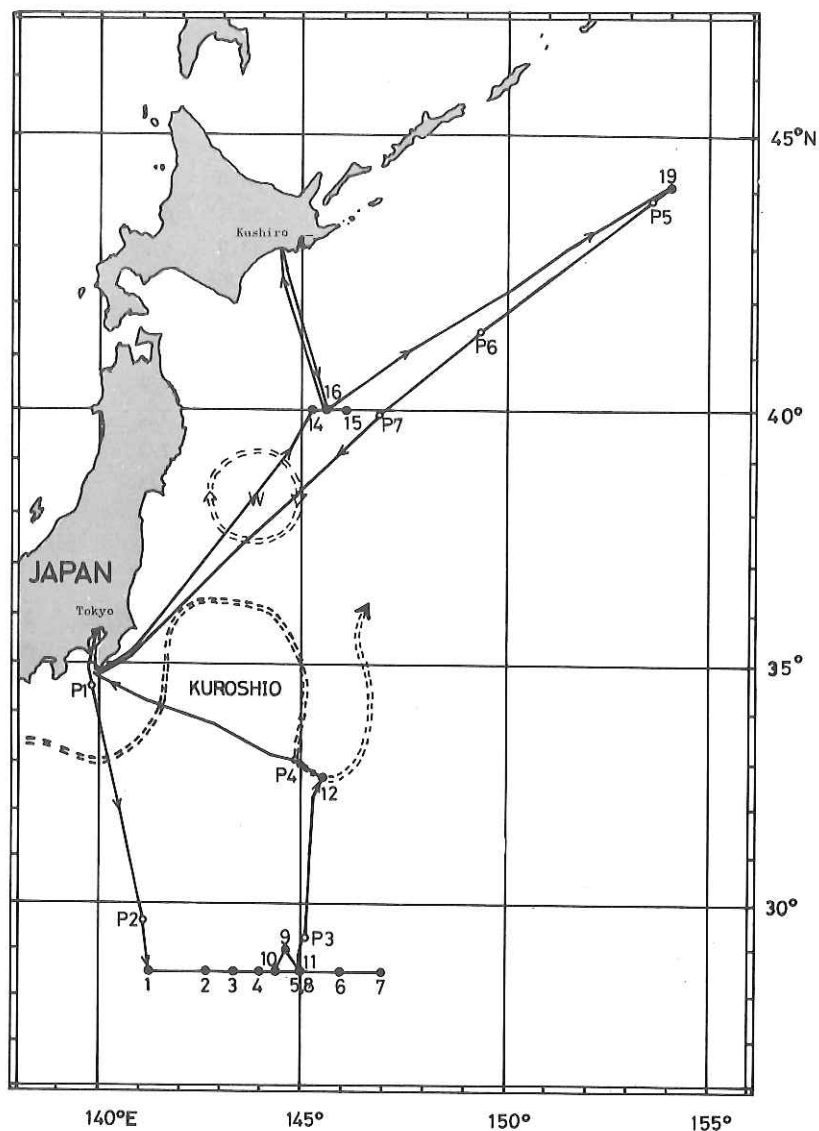


Fig. 1 Track chart of Cruise KH-71-3

Table 1. Location of hydrographic stations and dates

Stations	Latitudes		Longitudes		Dates	
Leave Tokyo					6/18	14:00
P ₁	34°31.0'	29.6'	139°48.5' -	47.9'	6/18	20:27-21:40
P ₂	29°39.5' -	36.1'	141°03.0' -	02.5'	6/19	20:43-21:57
1	28°29.1' -	31.8'	141°12.0' -	17.8'	6/20	05:05-09:40
2	28°29.0' -	28.5'	142°40.3' -	42.0'	6/20	15:57-19:26
3	28°30.2' -	32.0'	143°20.0' -	22.5'	6/20-6/21	22:45-00:25
4	28°32.0' -	33.2'	144°01.8' -	143°59.5'	6/21	11:09-18:00
5	28°29.5' -	26.9'	145°00.0' -	144°56.0'	6/21-6/22	22:15-03:10
6	28°30.5' -	31.0'	145°59.6' -	59.0'	6/22	08:05-13:00
7	28°30.0' -	31.9'	146°59.0' -	58.0'	6/22-6/23	17:15-01:55
8	28°30.5' -	29.8'	144°59.0' -	58.1'	6/23	10:05-12:53
9	28°56.9' -	59.8'	144°39.0' -	43.0'	6/23	16:35-17:47
10	28°31.1' -	27.2'	144°20.6' -	17.6'	6/23	08:00-09:07
11	28°23.6' -	29.1'	144°55.8' -	145°01.6'	6/23-7/1	21:18-05:03
9'	28°58.9' -	59.2'	144°46.2' -	45.6'	7/1	09:45-13:15
10'	28°29.1' -	27.0'	144°20.0' -	20.0'	7/1	16:37-19:55
11'	28°28.1' -	25.4'	144°58.1' -	57.9'	7/2	08:53-15:47
P ₃	29°14.6' -	16.7'	145°04.2' -	04.3'	7/2	20:09-21:12
12	32°35.3' -	39.4'	145°24.6' -	37.0'	7/3	13:23-15:49
P ₄	33°01.7' -	59.0'	144°53.3' -	50.0'	7/3	20:07-21:11
Arrive Yokohama					7/5	
Leave Yokohama					7/8	
14	39°59.9' -	40°01.7'	145°15.7' -	11.0'	7/9-7/10	22:09-02:26
15	39°58.0' -	55.5'	146°03.0' -	01.2'	7/10	06:34-09:58
16	40°04.7' -	39°58.8'	145°37.7' -	37.8'	7/10	12:08-17:06
Arrive Kushiro					7/11	
Leave Kushiro					7/15	
19	44°11.0' -	43°56.1'	154°04.0' -	153°39.0'	7/18-7/24	10:57-23:54
P ₅	43°56.1' -	54.3'	153°39.0' -	35.5'	7/25	00:07-01:18
P ₆	41°25.7' -	24.5'	149°25.3' -	23.4'	7/25	20:10-21:24
P ₇	39°56.0' -	54.5'	146°57.0' -	53.2'	7/26	12:03-13:50
Arrive Tokyo					7/29	

Table 2. Cruise itinerary

	Arrival	Departure
Tokyo		Jun. 18, 1971
Sta. 11	Jun. 23	Jul. 1
Yokohama	Jul. 5	Jul. 8
Kushiro	Jul. 11	Jul. 15
Sta. 19	Jul. 18	Jul. 24
Tokyo	Jul. 29	

Table 3. Items of observation

Station	P ₁	P ₂	1	2	3	4	5	6	7	8	9	10	11	P ₃	12	P ₄	14	15	16	19	P ₅	P ₆	P ₇
Nansen Cast (N)			o	o	o	o	o	o	o								o	o					
Nansen-ORIT cast (N)													o							o			
Sampling by Van Dorn bottle (25 l x2) (V)													o		o					o			
Sampling by Van Dorn bottle with pinger (V)													o							o			
Sampling by 200-liter sampler (L)													o							o			
BT observation			o	o	o	o	o	o	o				o		o		o			o			
STD observation													o						o	o			
GEX observation													o		o		o		o	o			
Measurement of oceanic current										o									o	o			
Measurement of insolation and sub- marine light			o	o	o	o	o	o	o				o		o		o	o	o	o			
Measurement by under- water spectrophoto- meter						o							o							o			
<u>In situ</u> experiment													o							o			
Vertical haul by Norpac net													o							o			
Oblique haul by ORI net (P)			o	o									o							o	o	o	o
Horizontal tow by MTD net													o		o								
Observation of Earthquakes at Ocean Basin (OBS)										o	o	o							o	o			

Scientists aboard

Hattori, Akihiko Chief Scientist	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Fujita, Yoshihiko	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Seki, Humitaka	Ocean Res. Inst., Univ. of Tokyo	Biology
Wada, Eitaro	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Sugimori, Yasuhiro	Ocean Res. Inst., Univ. of Tokyo	Physical Oceanography
Nakai, Toshisuke	Ocean Res. Inst., Univ. of Tokyo	Physical Oceanography
Otobe, Hirotake	Ocean Res. Inst., Univ. of Tokyo	Physical Oceanography
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Maita, Yoshiaki	Fac. Fisheries, Hokkaido Univ.	Chemistry
Kido, Katsutoshi	Fac. Fisheries, Hokkaido Univ.	Chemistry
Nozaki, Yoshiyuki	Fac. Fisheries, Hokkaido Univ.	Chemistry
Asada, Satoshi	Fac. Sci., Univ. of Tokyo	Geophysics
Shimamura, Hidenori	Fac. Sci., Univ. of Tokyo	Geophysics
Ishibashi, Katsuhiko	Fac. Sci., Univ. of Tokyo	Geophysics
Matsumoto, Eiji	Fac. Sci., Tokyo Kyoiku Univ.	Chemistry
Matsuike, Kanau	Tokyo Univ. of Fisheries	Physical Oceanography
Nakamoto, Nobutada	Fac. Sci., Tokyo Metrop. Univ.	Biology
Takano, Kenzo	Inst. Phys. Chem. Res.	Physical Oceanography
Okazaki, Moriyoshi	Inst. Phys. Chem. Res.	Physical Oceanography
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Handa, Nobuhiko	Fac. Sci., Nagoya Univ.	Chemistry
Matsunaga, Katsuji	Fac. Sci., Nagoya Univ.	Chemistry
Mitamura, Osamu	Fac. Sci., Nagoya Univ.	Biology
Kunishi, Hideaki	Fac. Sci., Kyoto Univ.	Physical Oceanography
Imawaki, Shiro	Fac. Sci., Kyoto Univ.	Physical Oceanography
Yamamoto, Toshio	Kyoto Kyoiku Univ.	Chemistry
Tokura, Ryoichi	Kyoto Kyoiku Univ.	Chemistry
Okaichi, Tomotoshi	Fac. Agr. Sci., Kagawa Univ.	Biochemistry
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1. General description of oceanographic observations

at Stations 11 and 19

by

Akihito Hattori

At stations 11 and 19, detailed investigations were carried out with respect to oceanographic characteristics under an interdisciplinary coordination.

Nansen bottle casts were made to obtain measurements of temperature, salinity, and the concentrations of dissolved oxygen, inorganic nutrients and dissolved organic carbon and nitrogen. Three casts were made to cover a whole water column from surface to near bottom. At each cast, 15 Nansen bottles were attached at intervals to a stainless steel wire. The observations were repeated twice at each station. The names of the persons who conducted the measurements are given after each item.

Water temperature was measured by a pair of protected reversing thermometers. The sampling depths were estimated from wire lengths, wire angles and the differences between readings of protected and unprotected reversing thermometers (T. Nakai and H. Otobe).

Salinity was determined aboard ship using an Auto Lab 601 MK III Inductive Salinometer (H. Otobe, S. Asada, S. Imawaki, M. Kishino, H. Kunishi, K. Matsuike, M. Okazaki, H. Shimamura, Y. Sugimori and K. Takano).

Dissolved oxygen was determined by the Winkler method (S. Tsunogai). pH was measured with a Hitachi-Horiba F-5 pH meter (E. Matsumoto and Y. Nozaki). The alkalinity was estimated, according to Strickland and Parsons (1968), from the pH shift after the addition of a definite amount of HCl to sea water samples (E. Matsumoto and Y. Nozaki).

Reactive silicate was determined by the method described in the Manual of Oceanographic Observations (Oceanographic Society of Japan, 1970) (T. Yamamoto and R. Tokura), reactive phosphate by the method of Murphy and Riley (1962) (K. Kido) and total phosphate by the same method after hydrolysis at 120°C for 30 minutes in the presence of persulfate (Menzel and Corwin, 1965) (Y. Maita).

Nitrate was determined by the method of Wood, Armstrong and Richards (1967), nitrite by the method of Bendschneider and Robinson (1952) (E. Wada, T. Miyazaki and I. Koike), and ammonia by the method of Sagi (1966) as modified by Hattori and Wada (1971) (K. Matsunaga).

Dissolved organic carbon (T. Ochi and T. Okaichi) and dissolved organic nitrogen (O. Mitamura and Y. Saijo) were measured, respectively, by the method of Menzel and Vaccaro

(1964) and by the method of Armstrong, Williams and Strickland (1966) with water samples which had been filtered through a Whatman type C glass fiber filter.

The results obtained are tabulated in Tables 4 to 7, and illustrated in Figs. 2 to 11.

Large volumes of water samples were collected by Van Dorn bottles (25 liter) from 22 layers from the surface down to near bottom. Aliquots were filtered through Whatman type C glass fiber filters to collect particulate materials. Chlorophylls (N. Handa and N. Nakamoto), mass of total seston (S. Tsunogai) and C and N contents (O. Mitamura and Y. Saijo) were determined. The analyses have not yet been completed. The data available at present are entered in Tables 8 to 11.

Information was simultaneously collected, with the same and other water samples as well as with samples collected by Norpac nets, on the distributions of urea, DNA, particulate P, Si, Fe and Al, radioactive (^3H , ^{14}C , ^{210}Pb , ^{210}Po and ^{226}Ra) and stable (^{13}C and ^{15}N) isotopes, chemical compositions of particulate organic matter, and standing crops of phyto- and zooplankton and other microorganisms including bacteria and fungi. Experiments were also performed with respect to the mode and extent of primary production, decomposition of organic compounds and metabolism of inorganic and organic nitrogenous compounds. The methods and an outline of these investigations will appear in the separate chapters of this volume. Some of the results obtained are also included in Tables 8 to 11.

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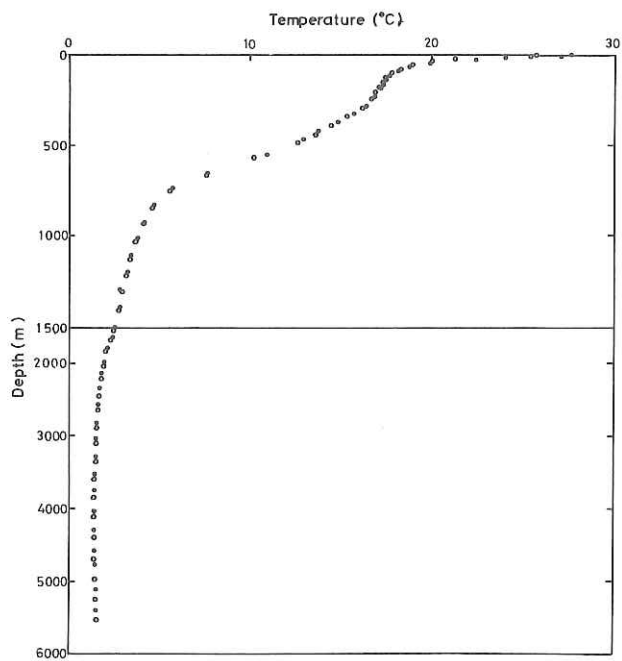


Fig. 2 Vertical distribution of water temperature ($^{\circ}\text{C}$) at Sta. 11

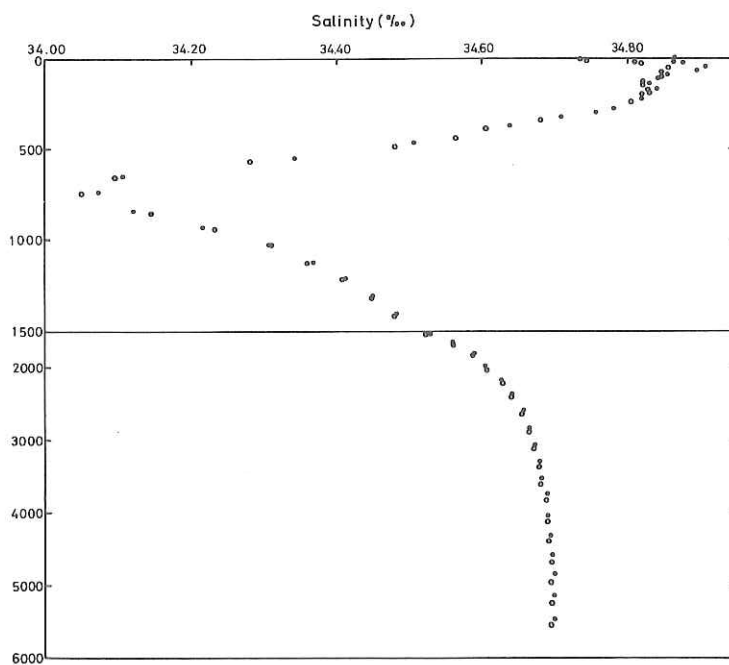


Fig. 3 Vertical distribution of salinity (‰) at Sta. 11

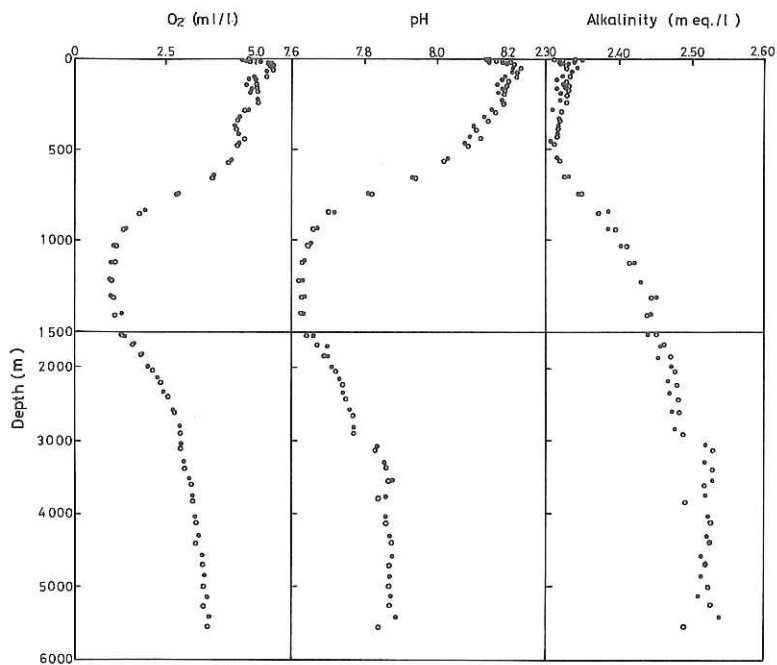


Fig. 4 Vertical distribution of dissolved oxygen (ml/l), pH and alkalinity (m eq./l) at Sta. 11

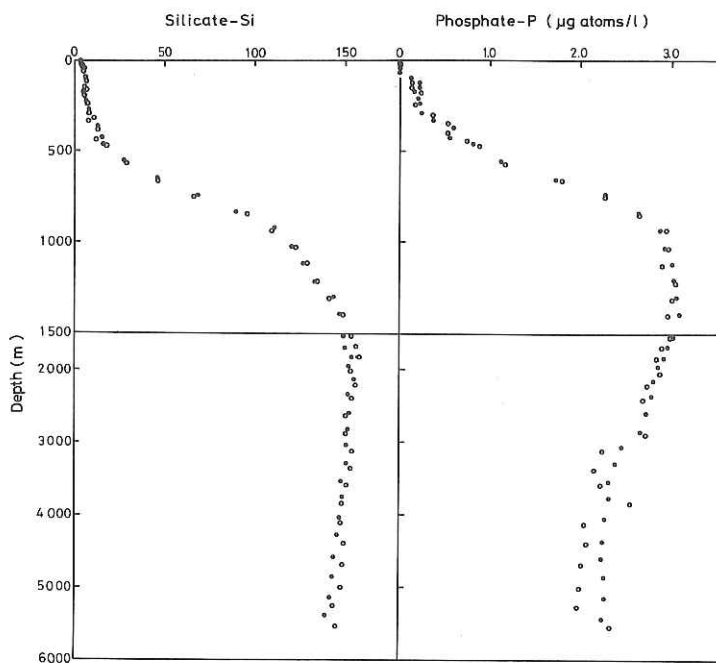


Fig. 5 Vertical distribution of reactive silicate ($\mu\text{g atoms/l}$) and reactive phosphate ($\mu\text{g atoms/l}$) at Sta. 11

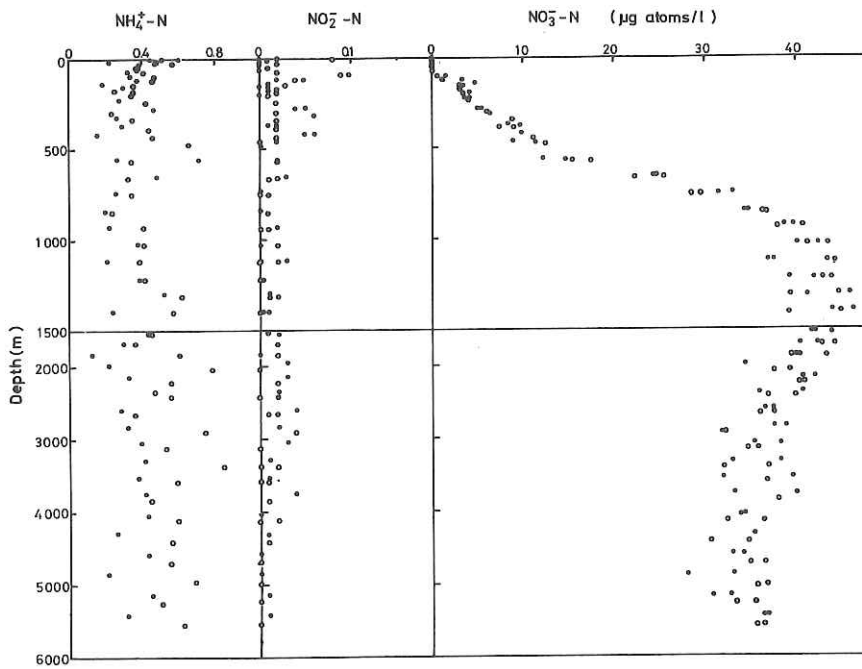


Fig. 6 Vertical distribution of ammonia ($\mu\text{g atoms/l}$), nitrite ($\mu\text{g atoms/l}$) and nitrate ($\mu\text{g atoms/l}$) at Sta. 11

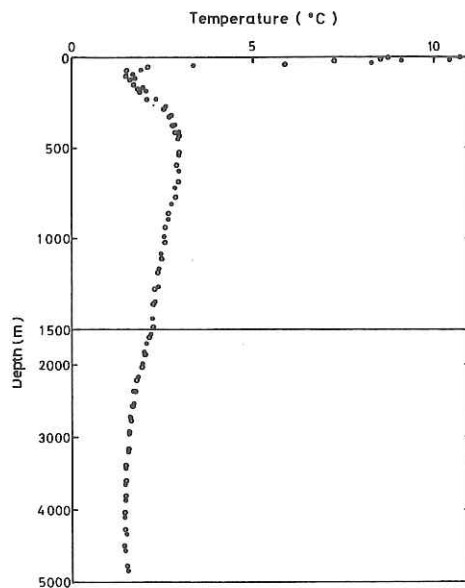


Fig. 7 Vertical distribution of water temperature ($^{\circ}\text{C}$) at Sta. 19

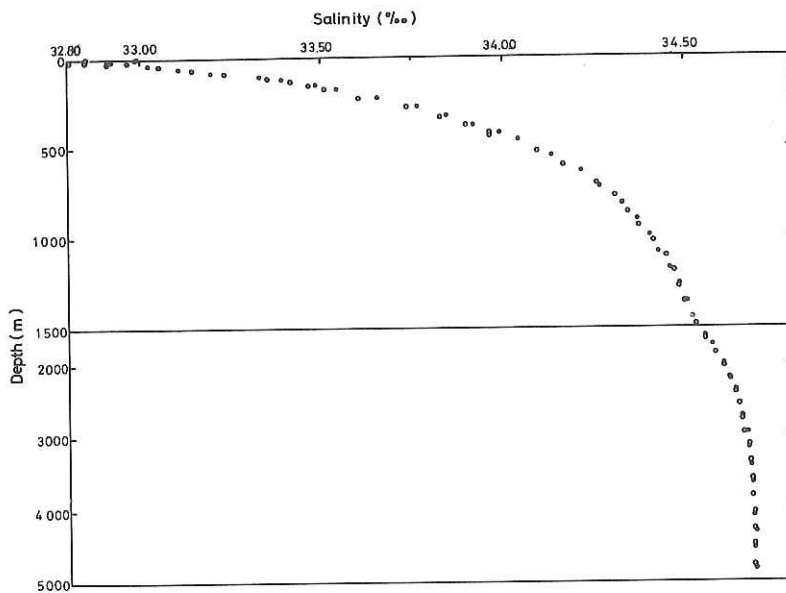


Fig. 8 Vertical distribution of salinity (‰) at Sta. 19

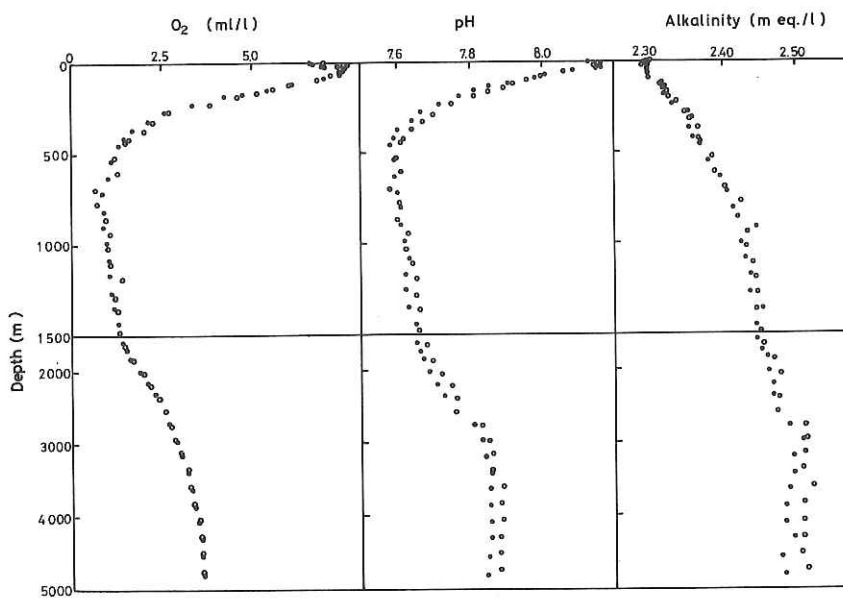


Fig. 9 Vertical distribution of dissolved oxygen (ml/l), pH and alkalinity (m eq./l) at Sta. 19

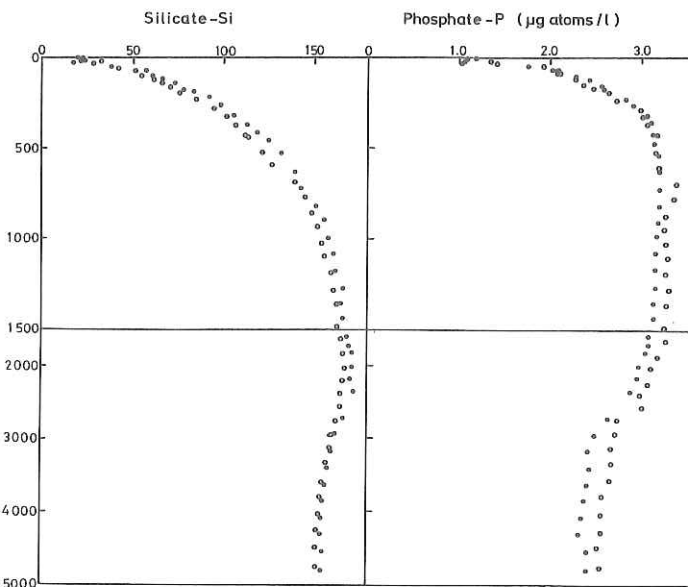


Fig. 10 Vertical distribution of reactive silicate ($\mu\text{g atoms/l}$) and reactive phosphate ($\mu\text{g atoms/l}$) at Sta. 19

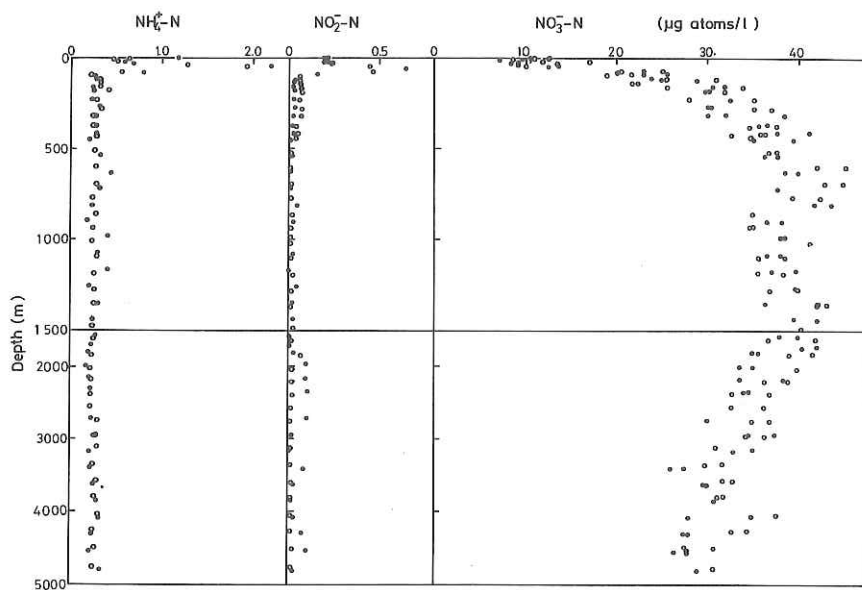


Fig. 11 Vertical distribution of ammonia ($\mu\text{g atoms/l}$), nitrite ($\mu\text{g atoms/l}$) and nitrate ($\mu\text{g atoms/l}$) at Sta. 19

Table 4.

Sta. No.	Lat.	N		Date	Current		Air Temp.		Weather		Sea														
11 N-1	28-29.0 ~ 28-27.4			1971-6-23 24			(dry) 25.6°C		clear		SW-3														
Depth	Long.	E		Time	Transp.		Air Temp.		Wind		Swell														
5870 m	144-58.5 ~ 145-01.6			21:18 ~ 03:49			(wet) 25.4°C		SW-5.5m/s		W-3														
Sample	D (m)	T (°C)	S (‰)	σ _t	O ₂ (ml/l)	pH	Alk (m eq./l)	SiO ₂ -Si (	PO ₄ ³⁻ -P	Total-P	NH ₄ ⁺ -N μg	NO ₂ ⁻ -N atoms/l	NO ₃ ⁻ -N	DON (	DOC (mg/l)										
0	0	25.7	34.733	34.737	22.94	4.79	4.80	8.14	8.14	2.32	2.30	1.5	4.5	0.00	0.00	0.12	0.20	0.54	0.48	0.03	-	0.0	0.1	14.4	1.61
10	10	25.41	743	747	23.06	4.82	4.82	8.16	8.15	2.33	2.32	3.0	4.4	0.00	0.00	0.16	0.10	0.46	0.50	0.09	0.10	0.1	0.1	11.4	1.31
20	20	21.18	808	810	24.33	5.37	5.38	8.20	8.20	2.32	2.32	3.1	4.2	0.02	0.00	0.13	0.12	0.53	0.40	0.02	-	0.0	0.0	12.8	1.31
30	30	19.97	816	821	66	5.42	-	8.21	8.21	2.33	2.33	2.8	4.8	0.00	0.00	0.07	0.08	0.56	0.57	0.02	0.03	0.0	0.1	10.9	1.14
50	49	18.97	852	860	95	5.47	5.49	8.23	8.23	2.33	2.33	7.2	5.6	-	-	0.13	0.08	0.38	0.35	0.00	0.03	0.1	0.1	11.2	1.23
75	74	18.32	846	852	25.10	5.44	5.46	8.23	8.22	2.35	2.33	6.1	4.5	0.00	0.00	0.09	0.13	0.49	0.33	0.03	0.03	0.1	0.1	12.0	1.17
100	98	17.83	844	852	23	5.26	5.30	8.22	8.22	2.35	2.32	5.5	5.3	0.13	0.11	0.15	0.19	0.59	0.34	0.11	-	0.8	0.7	12.6	1.18
125	123	17.44	819	824	29	4.99	5.00	8.20	8.20	2.33	2.32	7.3	5.8	0.14	0.14	0.39	0.37	0.50	0.41	0.05	-	2.9	2.8	10.0	0.87
150	147	17.26	822	823	35	5.03	5.04	8.20	8.20	2.34	2.32	7.3	3.0	0.08	0.14	0.33	0.42	0.34	0.37	0.04	-	3.3	3.1	10.2	0.93
175	172	17.12	825	831	38	4.97	5.00	8.19	8.19	2.35	2.32	6.1	6.1	0.24	0.22	0.30	0.36	0.25	0.26	0.03	0.03	3.4	3.6	8.6	0.78
200	196	16.88	821	821	44	5.00	5.01	8.19	8.19	2.33	2.33	8.1	0.9	0.23	0.18	0.25	0.34	0.45	0.25	0.03	0.02	3.7	3.7	8.7	0.83
250	245	16.65	800	810	47	5.04	5.05	8.19	8.18	2.34	2.32	7.3	7.2	0.13	0.17	0.33	0.32	0.58	0.25	0.03	-	4.1	4.1	9.2	0.86
300	293	16.18	755	761	57	4.73	4.74	8.17	8.17	2.33	2.31	7.5	8.7	0.37	0.36	0.49	0.45	0.28	0.20	0.03	0.03	6.2	6.1	8.3	0.68
350	341	15.34	678	681	68	4.50	-	8.14	8.14	2.32	2.31	5.9	9.7	0.54	0.53	0.60	0.56	0.35	0.35	0.03	-	9.0	8.6	8.5	0.68
400	389	14.40	604	610	82	4.47	4.47	8.11	8.11	2.32	2.31	16.3	10.2	0.50	0.56	0.65	0.69	0.43	0.45	0.03	-	9.0	7.4	8.0	0.65
450	438	13.63	562	570	95	4.69	4.69	8.12	8.13	2.33	2.31	13.8	10.7	0.74	0.74	0.80	0.87	0.35	0.56	0.03	-	10.9	11.3	8.3	0.67
500	474	12.57	474	479	26.10	4.53	4.54	8.09	8.08	2.33	2.31	20.2	15.8	0.86	0.87	0.87	1.03	0.31	1.00	0.00	-	11.2	13.8	8.5	0.78
600	567	10.12	278	282	40	4.23	4.25	8.02	8.02	2.32	2.32	32.5	28.1	1.18	1.16	1.45	1.60	0.41	0.29	0.03	0.03	15.6	17.6	9.4	0.88
700	660	7.56	095	097	65	3.84	3.84	7.94	7.93	2.33	2.33	47.8	43.8	1.80	1.79	1.71	1.80	0.34	0.31	0.02	0.03	22.5	25.5	8.8	0.77
800	753	5.61	046	050	87	2.80	2.86	7.83	7.81	2.35	2.35	64.4	70.1	2.27	2.28	2.54	2.43	0.34	0.36	0.01	0.02	29.4	28.6	-	0.82
900	846	4.57	145	146	27.07	1.77	1.75	7.71	7.70	2.37	2.37	98.3	93.5	2.65	2.64	2.83	2.82	0.28	0.20	0.02	0.02	36.7	36.3	9.0	0.81
1000	939	4.12	232	232	19	1.34	1.35	7.67	7.66	2.40	2.39	114.6	106.6	2.96	2.91	2.96	2.96	0.31	0.50	0.02	0.01	40.8	38.1	8.8	0.75
1100	1033	3.70	305	316	29	1.12	1.15	7.65	7.64	2.42	2.40	122.5	125.1	2.96	2.96	3.20	3.12	0.33	0.49	0.03	-	43.6	41.2	8.9	0.77
1200	1126	3.40	360	-	37	1.02	1.00	7.63	7.63	2.42	2.41	125.1	133.2	2.90	2.90	3.09	3.19	0.43	0.34	0.01	0.03	43.5	44.3	8.5	0.67
1300	1221	3.17	407	408	42	1.00	1.01	7.62	7.63	2.44	2.42	132.8	137.7	3.04	3.06	3.24	3.22	0.38	0.45	0.01	-	44.0	43.0	8.7	0.62
1400	1314	2.94	449	447	49	1.06	1.07	7.62	7.64	2.45	2.44	141.8	141.8	3.00	3.02	3.17	3.16	0.46	0.77	0.02	0.03	44.9	39.4	8.7	0.63
1500	1407	2.78	476	485	52	1.13	1.12	7.63	7.63	2.45	2.42	150.6	147.9	2.95	2.50	3.21	3.21	0.70	0.44	0.01	0.02	45.0	39.2	8.9	0.73
1600	1547	2.49	522	523	58	1.32	1.32	7.62	7.66	2.46	2.45	147.9	158.0	3.02	2.98	3.04	3.21	0.45	0.45	0.02	0.02	42.0	41.8	8.8	0.71
1700	1688	2.32	560	563	62	1.62	-	7.66	7.69	2.47	2.46	156.6	154.7	2.90	-	2.94	3.09	0.40	0.31	0.03	0.03	44.4	43.0	-	0.68
1800	1831	2.08	585	589	66	1.81	1.80	7.67	7.70	2.48	2.46	159.0	158.5	2.84	-	3.12	3.22	0.70	0.51	-	0.03	43.4	39.6	9.0	0.74
2000	2034	1.94	606	609	69	2.11	2.12	7.71	7.74	2.49	2.46	151.2	155.2	2.91	2.84	2.85	2.93	0.70	0.86	0.01	0.01	39.4	37.4	8.5	0.68
2200	2225	1.83	630	629	71	2.38	2.36	7.72	7.75	2.49	2.47	158.5	157.1	2.77	2.70	2.87	2.98	0.66	0.45	0.03	0.03	41.0	40.4	8.9	0.71
2400	2417	1.72	642	642	73	2.61	2.61	7.74	7.77	2.49	2.47	133.2	154.7	2.63	2.75	3.07	2.84	0.81	0.30	0.03	0.01	40.0	37.0	8.4	0.68
2600	2656	1.66	655	656	75	2.80	2.79	7.76	7.78	2.50	2.47	146.6	154.3	-	-	2.94	2.84	0.50	0.27	0.03	0.02	37.6	36.0	8.3	0.72
2800	2895	1.63	664	665	76	2.95	2.92	7.77	7.78	2.50	2.48	147.0	154.7	2.73	-	2.68	3.39	0.50	1.0	-	0.05	32.2	-	8.2	0.71
3000	3132	1.56	670	671	77	2.95	2.94	7.83	7.86	2.54	2.52	155.2	152.9	2.27	2.23	2.47	2.59	0.64	0.40	0.00	0.01	34.8	35.8	8.4	0.76
3200	3368	1.54	678	680	78	3.06	3.04	7.84	7.88	2.54	2.52	156.1	151.0	2.20	2.17	2.19	2.20	0.94	0.75	0.03	0.01	37.1	31.2	8.0	0.71
3400	3604	1.50	682	683	79	3.22	3.22	7.85	7.88	2.53	2.50	155.7	147.0	2.30	-	2.27	2.23	0.60	0.58	0.01	0.02	36.6	-	8.3	0.80
3600	3839	1.48	687	689	79	3.36	3.22	7.83	7.86	2.50	2.48	150.1	146.6	2.54	2.55	2.36	2.44	0.43	0.46	0.02	0.02	37.9	-	7.9	0.78
3800	4123	1.48	692	690	79	3.34	3.34	7.84	7.88	2.54	2.52	147.0	149.3	1.99	2.07	2.33	2.26	0.70	0.45	0.03	0.01	36.3	32.3	8.4	0.72
4000	4408	1.47	695	690	80	3.42	3.31	7.86	7.89	2.54	2.51	151.0	149.3	2.07	-	2.01	1.95	0.65	0.46	-	0.02	34.8	30.6	8.9	0.76
4250	4695	1.48	698	694	80	3.52	3.54	7.86	7.88	2.53	2.51	1													

Table 5.

Sta. No.	Lat. N		Date		Current		Air Temp.		Weather		Sea														
11 N-2	28-29.1 ~ 28-27.2		1971-6-28				(dry) 26.9°C		fine		WNW-2														
Depth	Long. E		Time		Transp.		Air Temp.		Wind		Swell														
5850 m	145-03.9 ~ 145-00.0		13:22 ~ 22:00				(wet) 26.2°C		WNW-35m/s		SE-1														
Sample	D (m)	T (°C)	S (‰)	σ_t	O ₂ (ml/l)	pH	Alk (m eq./l)		SiO ₂ -Si (		PO ₄ ³⁻ -P		Total-P		NH ₄ ⁺ -N μg atoms/l		NO ₂ ⁻ -N		NO ₃ ⁻ -N		DON)		DOC (mg/l)		
0	0	27.6	34.866	34.865	22.45	4.64	4.64	8.13	8.14	2.35	2.33	3.4	2.7	0.00	0.00	0.03	-	0.53	0.78	0.00	0.00	0.0	0.1	11.6	1.33
10	10	27.07	864	862	63	4.77	4.75	8.14	8.15	2.35	2.35	3.6	3.4	0.00	0.00	0.01	-	0.56	0.34	0.03	0.02	0.1	0.1	10.2	1.33
20	19	24.12	863	863	23.53	5.13	5.10	8.17	8.18	2.35	2.33	4.2	4.2	0.00	0.00	0.00	-	0.25	0.21	0.00	0.00	-	0.1	11.0	1.23
30	28	22.44	878	877	24.03	5.33	5.34	8.18	8.20	2.33	2.33	3.9	3.9	0.00	0.00	0.04	0.03	0.23	0.54	0.03	0.02	-	0.1	9.8	1.10
50	47	19.88	909	905	75	5.78	5.36	8.21	8.21	2.35	2.34	4.0	4.0	0.01	0.00	0.00	0.00	0.31	0.45	0.01	0.01	0.1	0.1	-	0.99
75	70	18.68	897	895	25.05	5.27	5.25	8.21	8.21	2.35	2.33	5.8	4.5	0.01	0.00	0.00	0.15	0.43	0.23	0.01	0.01	0.2	0.2	10.3	0.95
100	94	18.17	853	855	15	4.98	4.94	8.19	8.20	2.32	2.32	5.1	4.3	0.14	0.10	0.20	0.16	0.36	0.31	0.10	0.10	1.7	1.9	9.6	0.90
125	117	17.74	845	838	24	4.78	4.78	8.18	8.18	2.31	2.32	5.3	5.3	0.21	0.22	0.21	0.20	0.25	0.50	0.06	0.03	3.4	3.4	9.1	0.88
150	140	17.52	831	831	27	4.73	4.73	8.17	8.17	2.32	2.33	5.1	6.1	0.22	0.20	0.15	0.25	0.19	0.18	0.02	0.02	4.9	4.9	9.1	0.80
175	164	17.30	842	839	36	4.87	4.91	8.17	8.18	2.31	2.32	5.3	4.7	0.18	0.14	0.23	0.25	0.32	0.30	0.01	0.02	3.4	3.5	8.9	0.82
200	187	17.08	834	827	39	4.81	4.82	8.17	8.17	2.31	2.33	5.8	6.5	0.22	0.21	0.25	0.29	0.20	0.51	0.02	0.03	4.2	4.3	9.6	0.78
250	233	16.84	825	815	44	5.01	5.01	8.18	8.18	2.33	2.32	5.8	6.8	0.21	0.22	0.19	0.21	0.30	0.25	0.02	0.01	3.5	4.2	-	0.80
300	279	16.37	783	778	51	4.79	4.78	8.15	8.16	2.31	2.31	8.7	7.3	0.24	0.25	0.25	0.32	0.71	0.23	0.06	0.05	5.0	5.5	9.0	0.73
350	325	15.70	711	709	61	4.56	4.57	8.13	8.14	2.32	2.32	10.5	11.0	0.38	0.38	0.40	0.39	0.19	0.34	0.07	0.07	6.4	6.4	8.7	0.69
400	372	14.76	641	635	78	4.44	4.42	8.11	8.10	-	2.32	12.3	13.2	0.59	0.59	0.53	0.60	0.24	0.35	0.02	0.03	9.8	8.4	8.2	0.73
450	419	13.67	566	567	94	4.54	4.55	8.11	8.08	2.31	2.32	16.3	13.5	0.57	0.55	0.55	0.73	1.2	0.20	0.07	0.06	9.9	9.8	7.4	0.73
500	464	12.93	503	505	26.04	4.52	4.51	8.09	8.08	2.31	2.30	15.8	15.3	0.81	0.81	0.65	0.96	0.78	0.63	0.03	-	9.0	11.5	8.0	0.73
600	556	10.88	341	344	31	4.33	4.32	8.03	8.04	2.32	2.31	27.1	26.4	1.14	1.13	1.10	1.40	0.31	0.22	0.03	-	12.2	14.8	8.4	0.80
700	651	7.55	104	101	66	3.83	3.83	7.93	7.93	2.33	2.33	46.6	46.3	1.74	1.72	1.63	1.76	0.60	0.38	0.04	-	24.8	24.5	8.7	-
800	744	5.69	063	084	90	2.85	2.85	7.81	7.81	2.36	2.34	69.5	69.0	2.30	2.25	2.30	2.42	0.21	0.30	0.01	-	33.2	31.5	8.9	0.78
900	838	4.73	117	123	27.04	1.97	1.97	7.72	7.72	2.39	2.39	90.6	87.7	2.67	2.61	2.60	2.72	0.24	0.15	0.01	-	34.8	34.5	9.2	0.77
1000	932	4.16	213	217	17	1.37	1.37	7.67	7.67	2.37	2.40	106.4	115.2	2.85	2.88	2.83	2.85	0.22	0.21	0.03	-	38.9	39.8	9.7	0.82
1100	1026	3.69	308	311	30	1.08	1.07	7.64	7.66	2.40	2.41	115.6	126.8	2.97	2.93	2.98	3.05	0.53	0.23	0.01	-	40.2	42.5	8.5	0.63
1200	1120	3.39	367	367	38	0.99	0.96	7.62	7.64	2.42	2.43	128.0	126.4	3.04	2.98	3.05	2.99	0.16	0.26	0.04	-	37.6	37.0	8.0	0.56
1300	1215	3.17	407	411	42	0.99	0.96	7.62	7.64	2.42	2.44	133.7	133.7	3.04	3.04	2.98	3.25	0.54	0.23	0.01	-	39.4	42.0	8.8	-
1400	1309	2.92	444	452	48	0.99	1.00	7.63	7.64	2.47	2.43	147.0	141.9	3.08	3.04	3.09	2.99	0.49	0.54	0.02	-	41.2	46.0	9.2	0.78
1500	1403	2.72	479	484	52	1.03	1.03	7.63	7.63	2.44	2.45	147.0	146.2	3.11	3.08	3.07	3.04	0.23	0.25	0.01	-	44.0	46.5	8.5	0.67
1600	1545	2.49	523	534	58	1.38	1.39	7.66	7.66	2.45	2.43	148.8	148.4	3.03	2.99	2.87	2.97	0.35	0.53	0.03	-	42.0	44.0	9.9	0.86
1700	1686	2.30	558	564	62	1.66	1.63	7.70	7.70	2.46	2.46	151.5	149.3	2.98	2.94	2.87	3.06	0.25	0.34	0.03	-	40.5	42.5	9.2	0.88
1800	1828	2.10	583	593	66	1.82	1.81	7.69	7.70	2.46	2.45	156.1	152.4	2.93	2.93	2.95	2.98	0.01	0.25	0.01	-	40.5	39.8	10.1	0.86
2000	1967	2.00	604	606	69	2.00	2.00	7.70	7.73	2.48	2.47	150.6	153.8	2.89	2.83	2.81	2.86	0.19	0.24	0.04	-	34.4	34.5	9.2	0.79
2200	2158	1.84	624	629	71	2.28	2.27	7.73	7.74	2.47	2.47	155.2	155.2	2.80	2.83	2.85	2.85	0.30	0.35	0.04	-	40.8	42.0	9.4	0.81
2400	2350	1.75	639	644	73	2.42	2.43	7.73	7.75	2.47	2.47	146.6	155.2	2.79	2.80	2.76	2.52	0.26	0.67	0.03	-	40.8	36.0	8.8	0.78
2600	2587	1.66	656	659	75	2.71	2.70	7.76	7.77	2.48	2.47	155.6	150.6	2.73	2.74	2.66	2.52	0.29	0.28	0.05	-	36.6	37.5	9.5	0.75
2800	2823	1.61	663	667	76	2.94	2.93	7.77	7.77	2.48	2.47	151.5	151.0	2.69	2.65	2.49	2.72	0.40	0.23	0.03	-	37.7	39.0	9.4	0.69
3000	3056	1.56	671	677	78	2.96	2.94	7.83	7.84	2.52	2.52	151.9	151.0	2.48	2.43	2.42	2.40	0.53	0.26	0.04	-	35.4	38.5	-	0.63
3200	3289	1.54	679	683	79	3.05	3.04	7.85	7.88	2.52	2.52	151.0	150.2	2.42	2.36	2.42	2.19	0.31	0.53	0.02	-	33.0	38.5	9.3	0.67
3400	3520	1.51	682	683	79	3.20	3.18	7.87	7.88	2.53	2.53	148.4	147.9	2.35	2.32	2.22	2.25	0.25	0.50	0.02	-	32.0	39.5	-	0.67
3600	3751	1.48	690	690	79	3.27	3.26	7.86	7.86	2.52	2.51	150.6	147.9	2.34	2.32	2.23	2.13	0.39	0.44	0.05	-	33.2	40.0	8.5	0.67
3800	4028	1.48	690	692	79	3.36	3.33	7.86	7.87	2.53	2.52	146.6	146.6	3.29	2.28	2.18	2.31	0.51	0.34	0.01	-	34.4	34.0	9.5	0.71
4000	4305	1.47	698	694	80	3.45	3.45	7.87	7.87	2.53	2.52	147.0	145.8	2.29	2.23	2.19	2.41	0.22	0.32	0.02	-	35.4	-	8.4	0.62
4250	4582	1.48	698	697	80	3.53	3.54	7.87	7.88	2.51	2.52	144.0													

Table 6.

Sta. No.	Lat.		N		Date	Current		Air Temp.		Weather		Sea													
19 N-1	44-09.6 ~ 44-07.5				1971-7-18	220°0.5 ^{kt}		(dry) 11.0°C		fog		E-3													
Depth	Long.		E		Time	Transp.		Air Temp.		Wind		Swell													
5200 m	154-01.9 ~ 154-00.6				13:50 ~ 19:58			(wet) 11.0°C		E-8 m/s		E-3													
Sample	D	T	S		σ_t	O ₂	pH		Alk.	SiO ₂ -Si	PO ₄ ³⁻ -P	Total-P	NH ₄ ⁺ -N	NO ₂ ⁻ -N	NO ₃ ⁻ -N	DON	DOC								
	(m)	(°C)	(‰)			(ml/l)			(m eq./l)	(			μg atoms/l			)	(mg/l)								
0	0	8.7	32.855	32.854	25.51	6.97	7.02	8.14	8.12	2.31	2.30	22.0	24.1	1.18	1.24	1.51	1.69	0.69	0.58	0.21	0.21	12.5	10.9	11.9	1.73
10	11	8.53	849	849	54	7.05	7.08	8.16	8.15	2.30	2.30	22.4	24.3	1.22	1.22	1.37	1.34	0.45	0.48	0.22	0.23	11.5	8.6	10.3	1.19
20	21	7.24	802	803	68	7.37	7.39	8.14	8.04	2.30	2.28	33.4	33.6	1.34	1.38	1.61	1.59	0.60	0.40	0.22	0.22	-	11.9	8.3	1.00
30	30	5.84	967	967	26.00	7.60	7.60	8.16	8.14	2.31	2.30	28.5	29.3	1.42	1.42	1.57	1.54	1.27	1.26	0.24	0.24	9.0	13.4	9.1	0.97
50	48	2.06	33.058	33.051	44	7.44	7.44	8.06	8.06	2.30	2.30	42.7	43.7	1.90	1.98	1.96	1.98	1.85	2.00	0.44	0.44	10.0	-	7.0	0.93
75	71	1.52	146	146	54	7.19	7.20	8.00	7.99	2.30	2.30	51.1	52.2	2.06	2.11	2.13	2.05	0.50	0.60	0.46	0.46	-	20.4	8.3	0.93
100	94	1.48	235	236	62	6.80	6.80	7.97	7.96	2.31	2.30	53.5	55.3	2.11	2.12	1.93	2.13	0.15	0.31	0.06	0.06	18.9	21.8	10.8	1.02
125	117	1.62	356	356	70	6.03	6.03	7.93	7.91	2.32	2.32	62.3	61.3	2.26	2.29	2.31	2.28	0.24	0.38	0.06	0.06	-	25.6	8.3	0.84
150	139	1.70	416	415	75	5.57	5.57	7.89	7.88	2.33	2.32	66.1	65.8	2.35	2.41	2.44	2.35	0.24	0.40	0.06	0.06	22.5	21.8	9.5	0.89
175	162	1.77	464	465	79	5.10	5.11	7.86	7.85	2.33	2.33	70.5	71.3	2.44	2.52	2.47	2.47	0.24	0.42	0.07	0.07	33.8	25.6	8.4	0.86
200	184	1.82	512	511	82	4.61	4.59	7.81	7.81	2.34	2.33	78.3	77.2	2.58	2.65	2.64	2.52	0.54	0.30	0.07	0.06	-	32.0	8.4	0.86
250	229	2.05	604	605	87	3.83	3.84	7.76	7.75	2.34	2.35	86.0	85.7	2.72	2.76	2.95	2.73	0.31	0.25	0.06	0.06	35.0	28.0	-	0.87
300	275	2.55	742	743	95	2.72	2.70	7.69	7.68	2.35	2.35	95.9	95.3	2.94	3.04	2.96	2.74	0.25	0.40	0.07	0.06	35.0	37.0	9.7	0.89
350	321	2.69	828	824	27.00	2.27	2.25	7.67	7.66	2.36	2.36	101.4	102.1	2.98	3.06	3.05	3.05	0.25	0.25	0.07	0.04	38.5	38.4	9.0	-
400	368	2.76	891	894	05	2.01	2.03	7.66	7.63	2.37	2.37	107.3	107.3	3.02	3.13	3.13	3.09	0.25	0.25	0.04	0.04	37.5	34.6	9.1	0.86
450	416	2.87	959	960	10	1.60	1.60	7.62	7.62	2.37	2.37	111.3	114.0	3.10	3.26	3.23	3.27	0.26	0.25	0.07	0.03	36.3	35.8	-	0.87
500	430	2.91	991	992	12	1.50	1.48	7.61	7.61	2.37	2.37	112.3	115.1	3.10	3.29	3.18	3.25	0.31	0.24	0.02	-	32.6	34.8	9.6	0.87
600	517	2.94	34.094	34.097	19	1.20	1.18	7.60	7.60	2.39	2.39	117.9	124.8	3.18	3.13	3.39	3.39	0.26	0.25	0.01	-	36.8	37.8	8.9	0.87
700	602	2.88	167	183	26	1.38	1.19	7.61	7.60	2.39	2.40	126.3	127.1	3.16	3.26	3.21	3.13	0.20	0.35	0.01	-	42.0	45.2	9.1	0.76
800	687	2.94	257	263	33	0.67	0.59	7.59	7.57	2.40	2.42	140.7	140.3	3.38	3.36	3.55	3.31	0.25	0.31	0.01	-	45.0	43.0	8.4	0.73
900	770	2.82	307	309	38	0.71	0.69	7.63	7.58	2.44	2.42	145.4	145.0	3.32	3.39	3.29	3.27	0.25	0.25	0.01	-	42.5	39.4	8.3	0.76
1000	855	2.63	342	339	43	0.94	0.91	7.59	7.60	2.42	2.43	149.4	149.0	3.24	3.32	3.13	3.17	0.23	0.31	0.02	-	-	35.0	7.4	0.73
1100	938	2.52	370	372	45	1.01	1.01	7.63	7.63	2.44	2.44	151.7	151.7	3.22	3.32	3.22	3.22	0.25	0.25	0.01	-	34.9	35.0	8.1	0.68
1200	1022	2.52	410	418	49	1.02	0.99	7.62	7.63	2.43	2.44	154.4	154.0	3.21	3.32	3.23	3.21	0.24	0.25	0.01	-	-	41.4	8.1	0.68
1300	1106	2.47	448	450	52	1.05	1.05	7.64	7.64	2.45	2.45	156.3	155.8	3.24	3.33	3.27	3.37	0.20	0.38	0.01	-	35.5	38.6	8.4	0.65
1400	1190	2.36	465	473	55	1.35	1.39	7.67	7.64	2.46	2.45	161.1	158.7	3.20	3.35	3.21	3.21	0.19	0.31	0.02	-	35.6	38.4	8.2	0.71
1500	1276	2.28	482	486	57	1.18	1.16	7.66	7.64	2.45	2.46	162.1	160.2	3.26	3.35	3.33	3.38	0.20	0.31	0.01	-	36.8	40.0	-	0.67
1600	1360	2.23	499	502	58	1.21	1.25	7.66	7.66	2.46	2.45	164.1	163.1	3.22	3.35	3.33	3.34	0.25	0.25	0.01	-	41.9	43.0	7.1	0.65
1700	1491	2.22	531	536	60	1.27	1.31	7.67	7.65	2.46	2.46	164.6	163.6	3.20	3.32	3.23	3.10	0.25	0.25	0.02	-	-	40.4	8.0	0.67
1800	1626	2.12	555	561	63	1.45	1.44	7.68	7.67	2.47	2.46	164.6	164.6	3.24	3.32	3.23	3.30	0.25	0.25	0.01	-	36.8	42.0	7.6	0.62
2000	1830	2.00	584	588	67	1.64	1.63	7.69	7.71	2.47	2.48	166.1	165.6	3.16	3.22	2.98	3.07	0.19	0.25	0.05	0.07	39.0	41.8	7.4	0.63
2200	2015	1.92	607	608	69	1.94	1.96	7.72	7.72	2.49	2.49	167.1	166.1	3.14	3.15	2.71	2.64	0.19	0.24	0.02	-	40.0	-	7.8	0.67
2400	2198	1.78	625	627	72	2.13	2.16	7.75	7.74	2.48	2.48	165.6	165.1	2.97	3.17	2.92	3.00	0.18	0.26	0.02	-	39.0	36.4	8.1	0.62
2600	2382	1.74	638	640	73	2.38	2.38	7.76	7.76	2.48	2.49	165.1	164.6	2.93	3.09	2.90	2.98	0.19	0.25	0.02	-	32.8	37.0	7.6	0.62
2800	2567	1.69	648	650	75	2.56	2.56	7.77	7.76	2.48	2.49	165.1	164.1	2.91	3.04	2.85	2.99	0.18	0.26	0.01	-	36.4	32.7	-	0.67
3000	2750	1.61	657	660	76	2.67	2.69	7.85	7.82	2.52	2.52	164.1	160.7	2.63	2.84	2.57	2.74	0.20	0.38	0.01	-	35.0	37.0	7.9	0.63
3200	2935	1.58	660	670	77	2.81	2.84	7.86	7.85	2.52	2.53	160.7	159.7	2.66	2.78	2.47	2.40	0.25	0.31	0.01	-	34.3	36.4	8.4	0.63
3400	3118	1.54	672	675	78	2.96	2.98	7.87	7.85	2.51	2.52	159.7	158.7	2.58	2.75	2.49	2.33	0.26	0.32	0.01	-	31.0	-	-	0.62
3600	3347	1.50	677	680	79	3.20	3.20	7.88	7.85	2.52	2.51	158.2	155.8	2.58	2.75	2.44	2.59	0.27	0.20	0.01	-	29.8	31.8	8.1	0.62
3800	3577	1.49	679	684	79	3.22	3.20	7.89	7.89	2.52	2.54	155.8	154.4	2.58	2.73	2.33	2.31	0.25	0.31	0.01	-	32.8	31.8	6.9	0.60
4000	3807	1.47	686	686	79	3.32	3.34	7.89	7.88	2.51	2.52	154.9	154.0	2.51	2.63	2.38	2.21	0.26	0.25	0.01	-				

Table 7.

Sta. No.	Lat. N		Date		Current		Air Temp.		Weather		Sea														
19 N-2	44-03.9 ~ 44-03.5		1971-7-22				(dry) 12.0°C		fog		W-2														
Depth	Long. E		Time		Transp.		Air Temp.		Wind		Swell														
5170 m	154-02.6 ~ 154-05.0		08:58 ~ 15:26				(wet) 11.8°C		W-5		S-2														
Sample	D (m)	T (°C)	S (‰)	σ_t	O ₂ (ml/l)	pH	Alk. (m eq./l)	SiO ₂ -Si (	PO ₄ ³⁻ -P	Total-P	NH ₄ ⁺ -N μg atoms/l	NO ₂ ⁻ -N	NO ₃ ⁻ -N	DON)	DOC (mg/l)										
0	0	10.7	32.996	32.995	25.30	6.64	6.66	8.13	8.13	2.30	2.30	18.0	22.5	1.07	1.12	1.11	1.19	0.60	0.53	0.18	0.21	10.3	9.6	10.0	1.23
10	10	10.40	991	990	34	6.69	6.68	8.16	8.15	2.30	2.30	22.0	23.4	1.02	1.09	1.19	1.19	0.47	0.50	0.18	0.20	8.5	7.0	8.3	0.98
20	19	9.06	924	922	52	6.93	6.91	8.17	8.16	2.30	2.30	23.7	20.4	1.02	1.09	1.26	1.23	0.50	0.45	0.19	0.18	8.3	9.0	8.7	1.08
30	28	8.26	912	906	62	7.02	7.03	8.19	8.17	2.30	2.29	16.5	18.7	1.03	1.04	1.20	1.18	0.62	0.75	0.22	0.21	8.4	8.5	8.7	0.96
50	45	3.35	33.029	33.023	26.32	7.52	7.51	8.09	8.08	2.31	2.30	37.0	39.6	1.74	1.77	1.90	1.84	2.28	2.12	0.31	0.31	12.5	13.5	8.7	0.87
75	67	1.93	110	106	50	7.47	7.47	8.02	8.00	2.31	2.30	58.0	57.6	2.02	2.03	2.10	2.02	0.85	0.75	0.64	0.64	23.0	20.0	8.8	0.91
100	90	1.71	201	198	58	7.02	7.03	7.99	7.97	2.30	2.30	62.7	59.2	2.07	2.10	2.17	2.10	0.29	0.19	0.15	0.15	23.0	25.5	9.9	0.85
125	112	1.74	332	331	68	6.10	6.14	7.92	7.90	2.34	2.31	66.7	65.0	2.28	2.27	2.32	2.31	0.25	0.25	0.03	0.03	23.8	25.4	8.8	0.83
150	134	1.70	398	396	74	5.40	5.39	7.86	7.84	2.33	2.32	73.9	74.2	2.42	2.44	2.53	2.40	0.31	0.24	0.02	0.02	28.8	25.0	9.7	0.88
175	157	1.97	490	489	79	4.72	4.74	7.82	7.80	2.34	2.32	76.8	79.1	2.58	2.54	2.77	2.81	0.26	0.20	0.02	0.02	32.0	30.5	-	0.81
200	180	2.06	550	545	83	4.23	4.23	7.77	7.76	2.34	2.31	85.6	83.1	2.65	2.55	2.69	2.65	0.24	0.26	0.02	0.03	29.5	30.0	8.6	0.79
250	226	2.34	658	653	90	3.33	3.33	7.71	7.71	2.35	2.33	94.2	91.9	2.82	2.84	2.82	2.85	0.19	0.26	0.02	0.02	32.5	32.5	8.3	0.72
300	272	2.59	767	762	97	2.58	2.58	7.68	7.65	2.36	2.36	100.6	99.7	2.97	2.84	3.06	3.01	0.24	0.40	0.02	0.03	30.5	30.0	8.2	0.73
350	318	2.71	850	846	27.02	2.13	2.12	7.65	7.62	2.36	2.36	105.3	107.6	3.04	3.04	3.02	3.06	0.25	0.29	0.02	0.01	32.0	30.0	7.2	0.66
400	365	2.86	922	917	06	1.66	1.68	7.62	7.58	2.36	2.36	111.9	115.7	3.10	3.13	3.17	3.13	0.25	0.29	0.02	0.02	35.5	36.5	8.4	0.73
450	412	2.89	991	989	12	1.42	1.43	7.61	7.57	2.37	2.37	118.1	119.6	3.11	3.14	3.22	3.22	0.26	0.25	0.02	0.03	37.5	41.2	8.4	0.62
500	449	2.91	34.043	34.045	16	1.27	1.29	7.60	7.57	2.38	2.37	126.5	123.6	3.13	3.16	3.22	3.22	0.17	0.23	0.01	-	39.3	35.0	7.8	0.64
600	539	2.94	135	134	23	1.06	1.07	7.59	7.58	2.39	2.38	130.7	133.9	3.17	3.21	3.17	3.30	0.27	0.38	0.01	-	36.2	37.5	8.0	0.71
700	629	2.89	215	215	28	0.97	0.99	7.61	7.58	2.31	2.40	139.1	138.3	3.17	3.24	3.09	3.17	0.44	0.41	0.01	-	40.0	38.3	-	-
800	720	2.81	269	270	35	0.89	0.88	7.62	7.57	2.42	2.40	143.8	142.9	3.17	3.21	3.22	3.30	0.25	0.40	0.01	-	37.5	37.5	7.9	0.74
900	810	2.71	326	323	40	0.87	0.89	7.62	7.60	2.44	2.41	150.3	151.7	3.14	3.28	2.97	3.15	0.26	0.19	0.04	-	43.5	41.6	8.5	0.72
1000	900	2.64	371	367	44	0.82	0.84	7.61	7.60	2.44	2.47	154.8	156.3	3.14	3.23	3.07	3.13	0.19	0.16	0.02	-	38.0	36.5	7.1	0.78
1100	990	2.52	409	405	48	0.95	0.96	7.61	7.62	2.44	2.43	158.1	158.1	3.14	3.19	3.25	3.18	0.31	0.46	0.01	-	38.5	37.9	8.6	-
1200	1080	2.44	430	428	51	1.00	1.00	7.63	7.62	2.44	2.43	161.0	160.5	3.13	3.18	3.26	3.20	0.27	0.26	0.02	-	38.0	36.6	-	0.64
1300	1170	2.41	458	458	53	1.05	1.01	7.63	7.61	2.45	2.44	161.5	162.0	3.13	3.18	3.30	3.35	0.38	0.42	0.00	-	39.5	37.0	8.9	-
1400	1261	2.37	489	487	57	1.07	1.06	7.62	7.62	2.45	2.44	167.5	164.4	3.13	3.19	3.30	3.33	0.16	0.22	0.04	-	39.5	39.5	7.6	-
1500	1352	2.30	510	513	58	1.12	1.17	7.62	7.63	2.46	2.46	166.4	164.4	3.14	3.16	3.06	3.18	0.21	0.35	0.01	-	36.3	42.0	8.2	-
1600	1443	2.20	526	524	60	1.27	1.26	7.65	7.64	2.46	2.45	167.0	165.4	3.09	3.16	3.39	3.30	0.25	0.20	0.02	-	39.4	42.0	8.3	0.70
1700	1578	2.15	554	556	63	1.35	1.37	7.65	7.65	2.46	2.45	166.4	169.0	3.05	3.11	3.13	3.17	0.31	0.22	0.00	-	40.0	38.0	8.7	-
1800	1713	2.05	575	575	65	1.51	1.49	7.67	7.65	2.47	2.45	168.4	170.0	3.06	3.11	3.17	3.21	0.22	0.22	0.00	-	40.5	42.0	8.1	0.62
2000	1810	2.00	586	586	67	1.59	1.60	7.68	7.67	2.47	2.46	171.6	169.5	3.04	3.08	3.06	3.17	0.20	0.19	0.02	-	35.5	35.0	9.2	-
2200	1992	1.92	607	607	69	1.86	1.84	7.69	7.68	2.48	2.46	171.1	170.6	2.94	3.01	2.98	2.95	0.15	0.19	0.09	0.09	33.5	35.0	7.6	0.64
2400	2175	1.81	622	622	71	2.07	2.06	7.72	7.70	2.48	2.48	169.5	170.6	2.94	2.96	2.95	2.97	0.16	0.25	0.08	0.09	38.5	33.5	8.4	0.62
2600	2357	1.72	641	642	73	2.32	2.30	7.74	7.73	2.48	2.47	172.1	171.1	2.88	2.89	2.69	2.83	0.24	0.19	0.10	0.10	34.5	34.0	8.1	0.70
2800	2539	1.65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3000	2719	1.62	658	658	75	2.64	2.65	7.81	7.80	2.50	2.49	166.4	165.9	2.64	2.64	2.67	2.55	0.20	0.24	0.09	0.09	30.0	30.0	8.6	-
3200	2947	1.57	666	669	78	2.86	2.84	7.84	7.82	2.52	2.51	162.5	161.5	2.48	2.49	2.53	2.61	0.27	0.25	0.01	-	34.5	37.4	8.8	0.58
3400	3171	1.52	678	674	78	3.04	3.03	7.84	7.84	2.51	2.50	160.1	159.6	2.44	2.44	2.44	2.32	0.19	0.20	0.00	-	35.0	32.9	-	-
3600	3396	1.49	678	677	78	3.15	3.13	7.86	7.85	2.51	2.50	158.1	157.2	2.44	2.48	2.44	2.64	0.22	0.19	0.07	0.09	26.0	27.5	-	0.70
3800	3623	1.49	684	684	79	3.26	3.26	7.87	7.84	2.50	2.49	157.2	156.3	2.39	2.44	2.07	2.21	0.25	0.20	0.02	-	30.0	29.5	7.9	0.64
4000	3850	1.47	684	687	79	3.38	3.37	7.87	7.84	2.50	2.49	156.3	155.8	2.39	2.38	2.27	2.24	0.31	0.27	0.01	-	30.8	30.8	7.0	0.62
4250	4078	1.46	687	689	79	3.44	3.45	7.87	7.84	2.50	2.49	155.8	154.4	2.31	2.37	2.27	2.24	0.32	0.30	0.02	-	28.0	-	7.6	

Table 8. Composition of particulate matter

Sta. 11	28°27.6'N	28°25.0'N	6/24/'71						
L-1	144°55.8'N	144°55.8'E	19:00-22:10						
Depth	Salinity	Total weight*	Total Chl.**	Chl.a**	POC***	DNA ⁺	Fe [†]	Al [‡]	
m	‰	mg/l	µg/m ³		µgC/l	µg/l	µg atoms/l		
0	34.742	0.33 0.03	39.0	23.0	95.1	0.724	0.099	0.037	
10	740	0.20 0.33	41.9	21.4	66.7	0.698	0.041	0.089	
20	786	0.23 0.08	49.0	19.8	107	1.36	0.029	0.037	
30	832	0.45 0.45	42.8	13.6	68.5	0.698	0.049	0.068	
50	807	0.60 0.32	49.9	12.3	27.2	1.00	0.080	0.082	
75	830	0.36 0.43	164.5	40.3	31.7	0.996	0.032	0.040	
100	832	0.07 0.26	326.4	86.8	44.7	0.274	0.035	0.072	
125	826	0.43 0.35	190.1	42.7	30.8	0.122	0.066	0.056	
150	828	0.24 0.34	56.4	10.9	25.4	0.353	0.057	0.062	
175	819	0.41 0.28	20.8	3.8	20.2	0.300	0.048	0.054	
200	817	0.15 0.38	17.2	1.9	33.8	0.300	0.087	0.077	
300	727	0.29 0.19	-	-	29.0	0.342	0.057	0.054	
500	459	0.34 0.46	-	-	37.4	0.137	0.023	0.041	
Sta. 11	28°29.0'N	28°27.7'N	6/24/'71						
VD-1	144°56.2'E	144°55.2'E	13:00-18:40						
644 A34.096B.098									
653 C 078D 089					39.5	0.135	0.050	0.060	
920	240 235	0.21 0.48			42.3	0.417	0.086	0.102	
929	252 250								
1380	492 493	0.25 0.19			24.8	0.244	0.062	0.065	
1389	496 498								
1839	590 594	0.22 0.14			43.5	0.167	0.072	0.048	
1848	598 581								
2299	627 634	0.26 0.17			57.7	0.105	0.057	0.078	
2308	636 637								
2759	649 649	0.21 0.23			30.2	0.089	0.104	0.113	
2768	651 657								
3202	673 -	0.32 0.19			22.9	0.143	0.086	0.089	
3211	671 673								
4117	683 668	0.19 0.20			54.9	0.578	0.100	0.071	
4126	687 678								
5032	693 685	0.35 0.26			42.3	0.720	0.107	0.103	
5041	682 692								

* Determined by S. Tsunogai

** Determined by N. Handa & N. Nakamoto

*** Determined by N. Handa & K. Matsunaga

+ Determined by H. Seki

‡ Determined by T. Yamamoto & R. Tokura

Table 9. Composition of particulate matter

Sta.11		28°23.6'N		28°23.0'N		6/29-30/'71			
L-2		144°59.0'E		144°59.0'E		22:00-01:00			
Depth	Salinity	Total weight [*]		Total Chl. ^{**}		Chl.a ^{**}	POC ^{***}	Fe [†]	Al [†]
m	‰	mg/l		µg/m ³			µgC/l	µg atoms/l	
0	34.844	0.56	0.24	53.3	14.1	111	0.030	0.038	
10	840	0.47	-	55.0	28.8	82.1	0.040	0.086	
20	864	0.47	0.24	75.7	32.0	93.9	0.032	0.050	
30	873	0.55	0.17	70.7	25.4	95.1	0.030	0.045	
50	915	0.24	0.10	86.0	30.5	81.5	0.051	0.164	
75	881	0.13	0.25	616	158	103	0.081	0.030	
100	854	0.34	0.31	288	67.8	86.3	0.067	0.036	
125	845	0.43	0.13	118	24.3	89.1	0.047	0.058	
150	833	0.35	0.19	73.9	15.7	80.0	0.036	0.059	
175	840	0.21	0.32	13.8	4.12	101	0.031	0.056	
200	839	0.27	0.27	84.3	14.7	51.0	0.030	0.030	
300	746	0.41	0.30	-	-	40.8	0.041	0.025	
500	422	0.45	0.45	-	-	59.2	0.067	0.100	
Sta.11		28°25.6'N		28°23.6'N		6/29/'71			
VD-2		144°57.0'E		144°59.0'E		16:10-21:50			
644 A34.145B.132		0.28	0.29			81.5	0.062	0.117	
653 C 122D 126									
920	224 226	0.30	0.29			84.5	0.042	0.032	
929	229 227								
1380	483 483	0.32	0.19			63.4	0.045	0.045	
1389	483 482								
1868	591 589	0.41	0.14			78.5	0.038	0.037	
1878	588 589								
2336	633 640	0.46	0.29			94.5	0.105	0.167	
2345	638 -								
2803	661 651	0.29	0.29			61.9	0.045	0.051	
2812	650 658								
3178	673 660	-	0.27			62.8	0.060	0.037	
3187	674 672								
4086	695 692	0.29	0.09			93.9	0.072	0.040	
4095	685 690								
4994	696 692	0.32	0.25			-	0.034	0.066	
5003	696 694								

Table 10. Composition of particulate matter

Sta. 19		44°05.4'N - 44°04.0'N		7/19/'71					
L-1		154°01.2'E - 153°58.0'E		03:45-07:30					
Depth	Salinity	Total weight [*]		Total Chl. ^{**}	Chl.a ^{**}	POC ^{***}	Fe [†]	Al [‡]	
m	‰	mg/l		µg/m ³		µgC/l	µg atoms/l		
0	32.882	0.37	0.29	516	243	119	0.109	0.076	
10	873	0.28	0.43	518	228	138	0.055	0.106	
20	865	0.35	0.49	588	242	138	0.019	0.065	
30	911	0.54	0.46	576	178	119	0.017	0.045	
50	33.070	0.27	0.25	298	104	80.1	0.079	0.138	
75	152	0.26	0.20	120	27	145	0.008	0.069	
100	313	0.24	0.31	74	6	104	0.018	0.071	
125	373	-	0.22	67	4	96.6	0.018	0.073	
150	447	-	0.35	73	2	103	0.012	0.094	
175	493	0.21	0.29	79	3	93.2	0.031	0.133	
200	563	0.37	0.03	74	1	91.3	0.033	0.105	
300	784	0.34	0.23	-	-	90.1	0.042	0.112	
500	34.051	0.24	0.27	-	-	80.0	0.079	0.114	
Sta. 19		44°04.2'N - 44°05.4'N		7/18-19/'71					
VD-1		154°01.1'E - 154°01.3'E		21:44-03:22					
634	A 34.090	B 34.085		0.22	0.23				
643	C 33.503	D 33.272				87.9	0.044	0.071	
905	34.230	34.226		0.59	0.17				
914	-	-				93.2	0.072	0.150	
1358	34.500	34.498		0.24	0.46				
1367	503	503				87.9	0.048	0.093	
1838	591	589		0.29	-				
1848	584	587				66.0	0.042	0.050	
2298	635	637		-	0.29				
2307	636	632				81.1	0.052	0.092	
2758	674	660		0.50	0.06				
2767	658	660				92.4	0.070	0.095	
3115	669	670		0.43	0.32				
3124	665	671				126	0.044	0.060	
3560	669	678		0.35	0.33				
3569	680	680				106	0.034	0.040	
4450	691	685		0.34	0.04				
4459	692	692				53.4	0.067	0.083	

Table 11. Composition of particulate matter

Sta.19		44°04.5'N		44°02.0'N		7/22/'71			
L-2		154°03.6'E		154°04.2'E		16:40-19:50			
Depth	Salinity	Total weight*		Total Chl.**	Chl.a**	DNA ⁺	Fe [†]	Al [†]	
m	‰	mg/l		µg/m ³		µg/l	µg atoms/l		
0	32.977	0.36	0.31	566	281	0.758	0.031	0.169	
10	977	0.21	0.53	470	141	-	0.025	0.101	
20	927	0.27	0.23	432	167	1.78	0.015	0.060	
30	903	0.31	0.28	430	78	-	0.030	0.102	
50	33.033	0.36	0.28	422	116	-	0.053	0.086	
75	151	0.30	0.13	365	27	-	0.018	0.081	
100	266	0.26	0.34	186	18	-	0.064	0.100	
125	331	0.15	0.16	136	7	-	0.030	0.085	
150	422	0.17	0.36	128	7	-	0.010	0.038	
175	548	0.31	0.36	107	8	-	0.034	0.065	
200	598	0.32	0.30	57	1	0.337	0.013	0.030	
300	804	0.35	0.30	-	-	-	0.021	0.083	
500	34.076	0.29	0.30	-	-	-	0.032	0.084	
Sta.19		44°03.7'N		44°00.7'N		7/23/'71			
VD-2		154°01.0'E		154°01.5'E		01:20-07:08			
622	A 34.206	B 34.205		0.29	0.44		0.131	0.022	0.067
631	C 221	D 215							
889	357	356		0.07	0.20		1.158	0.026	0.080
898	355	355							
1333	498	494		0.26	0.27		0.293	0.034	0.071
1342	480	510							
1798	581	579		0.26	0.34		0.180	0.034	0.069
1807	582	483							
2248	610	630		0.19	0.28		0.218	0.048	0.068
2257	638	631							
2697	661	656		0.17	0.13		0.149	0.018	0.046
2706	655	659							
3140	671	669		0.11	0.22		0.075	0.025	0.069
3149	671	674							
3589	685	686		0.37	0.22		0.422	0.018	0.045
3598	682	684							
4486	690	691		0.39	0.29		0.138	0.010	0.048
4495	692	696							

2. Hydrographic section along $28^{\circ}30'N$ latitude

by

Shiro Imawaki and Hideaki Kunishi

Concerning the circulation of the deep water of the North Pacific, the Izu-Mariana Ridge is regarded as a western boundary and the flows near the ridge are considered to be closely related to the general circulation. So we made a hydrographic section from $140^{\circ}E$ to $147^{\circ}E$ on $28^{\circ}30'N$, with 7 stations, especially concentrating upon the observations below 1500m. In the deep water, temperatures were measured with reversing thermometers of range -1° to $3^{\circ}C$ (minimum scale $0.02^{\circ}C$). They were read off in a water bath controlled near in situ temperature ($1.5 \sim 2.0^{\circ}C$), so that errors induced from temperature corrections were reduced and the relative precision was of $\pm 0.005^{\circ}C$. Salinities were measured with an Auto-Lab 601 salinometer with the precision of $\pm 0.003\%$. Dissolved oxygen was determined by S. Tsunogai. The data are tabulated in Tables 12-20. Temperatures expressed to 3 places of decimas are of relative precision of $\pm 0.005^{\circ}C$ and absolute precision of $\pm 0.01^{\circ}C$.

Cross sections at $28^{\circ}30'N$ of potential temperature, salinity dissolved oxygen and potential steric anomaly are shown in Figs 12 - 15, respectively. As a whole, below 1000m, isopleths of both potential temperature and salinity slop a little downward toward the east. So assuming 0-level at the deeper layer, we can obtain a current with a weak northward component (at most 2cm/sec). Further discussions on actual figure of the deep water flow, however, demand observations on a further eastwardly extended section and also some north-south cross section.

Meanwhile, direct current measurements were made at Station 5 by Takano and by Okazaki. We will compare those results with our data.

Table 12. KH 71-3 Station 1, 28°30.5'N, 141°14.9'E, Jun.
19-20, 1971, 2005-0040 GMT, Depth 4120 m,
Wave 3/SW, Wind 3/SW, Air Temp. 25.8°C.

D (m)	T (°C)	S (‰)	O ₂ (ml/l)
0	25.6	34.929	4.70
50	21.45	.894	5.25
99	20.01	.878	5.12
196	17.97	.839	4.94
291	16.91	.788	4.65
384	15.09	.658	4.38
478	12.75	.483	4.25
571	9.65	.249	4.04
665	7.13	.127	3.32
760	5.57	.160	2.29
856	4.59	.202	1.74
951	4.10	.257	1.38
1186	3.10	.424	1.18
1421	2.60	.503	1.40
1623	2.282	.555	1.73
1854	2.018	.594	2.06
2086	1.881	.621	2.48
2319	1.769	.642	2.70
2552	1.706	.651	2.93
2785	1.641	.657	3.04
3017	1.598	.669	3.06
3249	1.537	.679	3.10
3483	1.496	.680	3.22
3716	1.485	.682	3.33

Table 13. KH 71-3 Station 2, 28°28.8'N, 142°41.2'E, Jun. 20,
1971, 0657-1026 GMT, Depth 3800 m, Wave 4/WSW,
Wind 4/WSW, Air Temp. 27.0°C

D (m)	T (°C)	S (‰)	O ₂ (ml/l)
0	25.0	34.743	4.75
48	20.74	.918	5.24
96	18.80	.868	5.07
191	17.63	.832	4.81
286	16.72	.765	4.70
381	15.13	.663	4.49
476	12.68	.482	4.23
570	9.81	.262	4.02
665	6.79	.082	3.39
759	5.26	.097	2.37
853	4.39	.200	1.59
947	3.85	.274	1.19
1182	3.00	.408	0.99
1422	2.61	.481	1.01
1669	2.246	.559	1.50
1908	2.027	.597	1.93
2146	1.831	.627	2.38
2386	1.733	.644	2.61
2625	1.657	.654	2.82
2865	1.583	.666	2.87

Table 14. KH 71-3 Station 3, 28°31.1'N, 143°21.3'E, Jun. 20,
1971, 1345-2130 GMT, Depth 7360 m, Wave 3/WSW,
Wind 4/WSW, Air Temp. 26.6°C

D (m)	T (°C)	S (‰)	O ₂ (ml/l)
0	25.4	34.752	4.78
48	19.38	.795	5.40
95	18.18	.856	4.89
189	17.11	.807	4.88
288	16.04	.742	4.88
378	13.94	.573	4.44
474	11.68	.397	4.32
570	9.10	.214	3.79
666	6.97	.101	3.32
762	5.45	.103	2.43
858	4.50	.176	1.68
953	3.94	.260	1.20
1187	3.14	.390	0.97
1422	2.61	.487	1.00
1660	2.269	.553	1.43
1899	2.026	.590	1.84
2457	1.726	.644	2.58
2695	1.650	.656	2.81
2936	1.573	.664	3.02
3174	1.546	.674	3.15
3415	1.520	.677	3.21
3655	1.493	.683	3.24
3884	1.489	.686	3.34
4130	1.486	.689	3.48
4370	1.489	.690	3.30
4608	1.498	.694	3.50
4846	1.522	.694	3.46
5219	1.56	.696	3.68
5800	1.62	.694	3.75
6283	1.67	.696	3.75

Table 15. KH 71-3 Station 4, 28°31.0'N, 143°59.8'E, Jun. 21,
1971, 0430-0900 GMT, Depth 6000 m, Wave 3/SW,
Wind 4/SW, Air Temp. 27.0°C

D (m)	T (°C)	S (‰)	O ₂ (ml/l)
0	26.2	34.772	4.72
48	21.28	.967	4.92
96	18.83	.881	5.02
188	17.59	.847	4.84
277	16.44	.775	4.64
364	14.74	.630	4.41
453	12.86	.483	4.32
544	10.43	.302	4.06
635	8.02	.147	3.59
724	6.04	.086	2.79
812	5.15	.123	2.27
900	4.46	.204	1.57
1127	3.36	.375	1.04
1365	2.78	.479	1.04
1654	2.322	.546	1.35
1895	2.034	.594	1.91
2135	1.860	.623	2.27
2374	1.735	.651	2.57
2614	1.661	.658	2.82
2853	1.586	.664	3.01
3093	1.560	.672	3.12
3332	1.520	.679	3.14
3571	1.506	.681	3.20
3809	1.501	.685	3.30
4049	1.492	.683	3.44
4289	1.492	.691	3.44
4532	1.498	.693	3.54
4775	1.522	.692	3.55
5263	1.56	.694	3.62
5655	1.60	.697	3.70

Table 16. KH 71-3 Station 5, 28°28.3'N, 144°58.5'E, Jun. 21,
1971, 1315-1812 GMT, Depth 5850 m, Wave 3/WSW,
Wind 4/WSW, Air Temp. 25.9°C

D (m)	T (°C)	S (‰)	O ₂ (ml/l)
0	25.4	34.703	4.80
49	18.73	.835	5.43
98	17.57	.824	5.01
194	16.91	.810	5.02
290	16.10	.742	4.74
386	14.47	.606	4.44
482	12.31	.452	4.37
579	9.48	.237	3.98
677	6.53	.049	3.44
775	5.18	.086	2.31
872	4.43	.172	1.62
968	3.97	.259	1.23
1209	3.13	.400	0.94
1451	2.61	.507	1.29
1660	2.357	.551	1.60
1900	2.088	.584	1.83
2139	1.912	.616	2.22
2379	1.787	.633	2.59
2616	1.690	.646	2.78
2854	1.623	.662	2.94
3091	1.578	.669	3.02
3327	1.552	.675	3.07
3563	1.523	.680	3.18
3799	1.504	.685	3.32
4037	1.496	.686	3.41
4278	1.492	.692	3.44
4517	1.501	.696	3.54
4753	1.52	.693	3.58
5237	1.55	.696	3.70

Table 17. KH 71-3 Station 6, 28°30.8'N, 145°59.3'E, Jun.
21-22, 1971, 2305-0400 GMT, Depth 5750 m,
Wave 3/WSW, Wind 4/WSW, Air Temp. 28.0°C

D (m)	T (°C)	S (‰)	O ₂ (ml/l)
0	26.5	34.904	4.72
48	22.17	.855	5.25
96	18.84	.917	5.16
194	16.81	.802	4.70
289	15.58	.691	4.54
384	13.68	.537	4.57
480	11.52	.381	4.38
578	8.79	.183	3.90
676	6.38	.078	3.02
774	5.09	.101	2.22
870	4.45	.188	1.53
966	3.95	.276	1.16
1204	3.15	.411	0.97
1447	2.69	.502	1.22
1663	2.326	.555	1.58
1905	2.054	.596	2.04
2147	1.894	.620	2.33
2389	1.776	.637	2.58
2631	1.683	.649	2.76
3113	1.587	.668	3.06
3353	1.543	.674	3.06
3592	1.512	.678	3.20
3829	1.510	.681	3.32
4066	1.496	.686	3.46
4304	1.498	.691	3.46
4543	1.502	.693	3.56
4783	1.519	.694	3.61
5263	1.56	.696	3.68

Table 18. KH 71-3 Station 7, 28°30.0'N, 146°58.9'E, Jun.
22, 1971, 0906-1658 GMT, Depth 5870 m,
Wave 3/W, Wind 3/W, Air Temp. 26.5°C

D (m)	T (°C)	S (‰)	O ₂ (ml/l)
0	26.3	34.808	4.71
49	20.96	.900	5.28
98	18.28	.893	5.04
195	16.60	.795	4.84
288	15.32	.677	4.56
380	13.51	.526	4.58
474	11.13	.330	4.30
569	8.66	.162	3.85
665	6.79	.083	3.13
761	5.51	.105	2.21
855	4.46	.166	2.06
950	4.08	.260	1.71
1189	3.20	.397	1.75
1430	2.80	.484	1.29
1686	2.250	.568	1.76
1928	2.023	.601	2.04
2170	1.859	.625	2.34
2414	1.772	.643	2.62
2657	1.681	.657	2.88
*2900	1.630	.663	2.88
3142	1.581	.672	3.10
3384	1.550	.676	3.10
3626	1.526	.681	3.20
3865	1.520	.685	3.30
4105	1.503	.692	3.48
4346	1.510	.694	3.48
4587	**1.49	.693	3.56
*4829	1.531	.694	3.60
5314	1.55	.695	3.68

* values interpolated

** value doubtful

Table 19. KH 71-3 Station 14, 40°00.8'N, 145°13.4'E, Jul.
09, 1971, 1309-1726 GMT, Depth 5370 m,
Wave 2/SSW, Wind 3/SSW, Air Temp. 18.7°C

D (m)	T (°C)	S (‰)	O ₂ (ml/l)
0	18.5	34.316	5.53
46	13.43	.502	5.32
92	11.37	.352	5.16
184	8.57	.109	5.93
273	8.83	.222	6.04
365	7.11	.33.961	6.09
459	5.45	.819	5.57
552	3.99	.782	4.17
645	3.70	.882	2.94
735	3.74	34.034	1.96
824	3.71	.152	1.44
915	3.56	.238	1.25
1103	2.89	.327	0.91
1260	2.80	.422	1.01
1440	2.52	.478	1.00
1617	2.321	.532	1.17
1796	2.179	.559	1.34
2021	2.016	.591	1.60
2246	1.884	.615	1.93
2470	1.770	.634	2.24
2695	1.675	.649	2.49
2920	1.618	.661	2.74
3145	1.575	.668	2.90
3369	1.542	.676	3.04
3592	1.524	.678	3.19
3818	1.50	.683	3.33
4043	1.499	.685	3.36
4774	1.515	.693	3.56

Table 20. KH 71-3 Station 15, 39°56.8'N, 146°02.1'E, Jul.
 09-10, 1971, 2134-0058 GMT, Depth 5130 m,
 Wave 2/SW, Wind 3/SW, Air Temp. 19.2°C

D (m)	T (°C)	S (‰)	O ₂ (ml/l)
0	18.9	34.388	5.42
45	12.99	.465	4.31
89	9.25	.064	5.03
175	6.82	33.888	5.85
263	4.74	.756	5.44
351	3.39	.706	4.39
440	3.67	.878	3.04
528	2.69	.842	2.40
615	3.05	.997	1.67
700	2.96	34.084	1.29
784	3.02	.181	1.18
869	3.07	.263	1.09
1049	2.85	.378	0.98
1281	2.55	.461	1.02
1465	2.37	.505	1.11
1646	2.166	.549	1.36
1830	2.055	.574	1.53
2059	1.905	.606	1.85
2290	1.770	.630	2.19
2519	1.684	.646	2.45
2749	1.610	.657	2.71
2977	1.570	.667	2.91
3205	1.535	.674	3.05
3433	1.503	.678	3.20
3661	1.494	.684	3.34
3889	1.47	.687	3.48
4116	1.473	.689	3.45
4665	1.499	.693	3.64

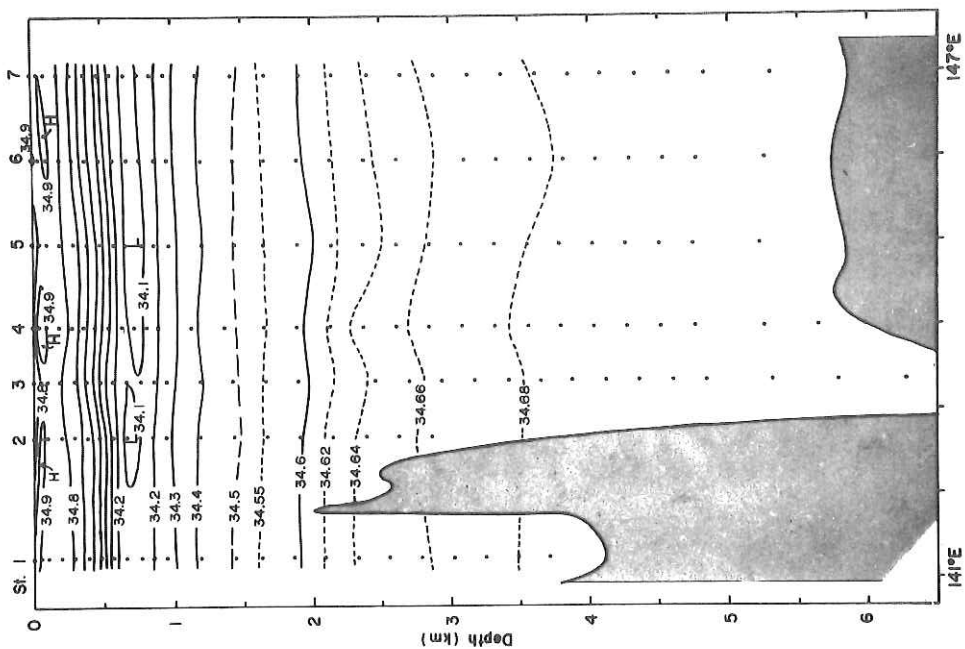
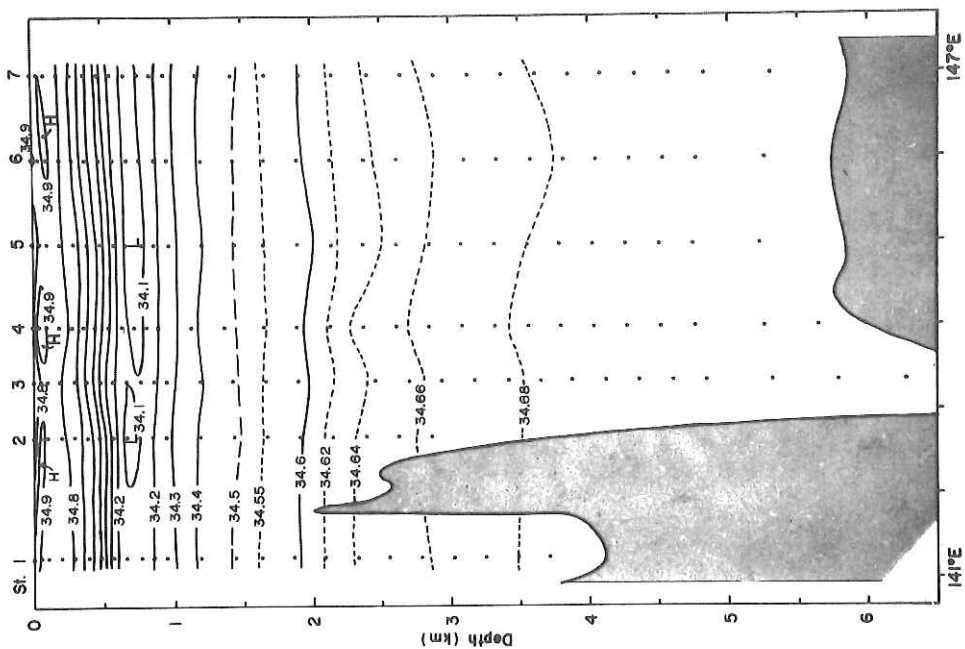
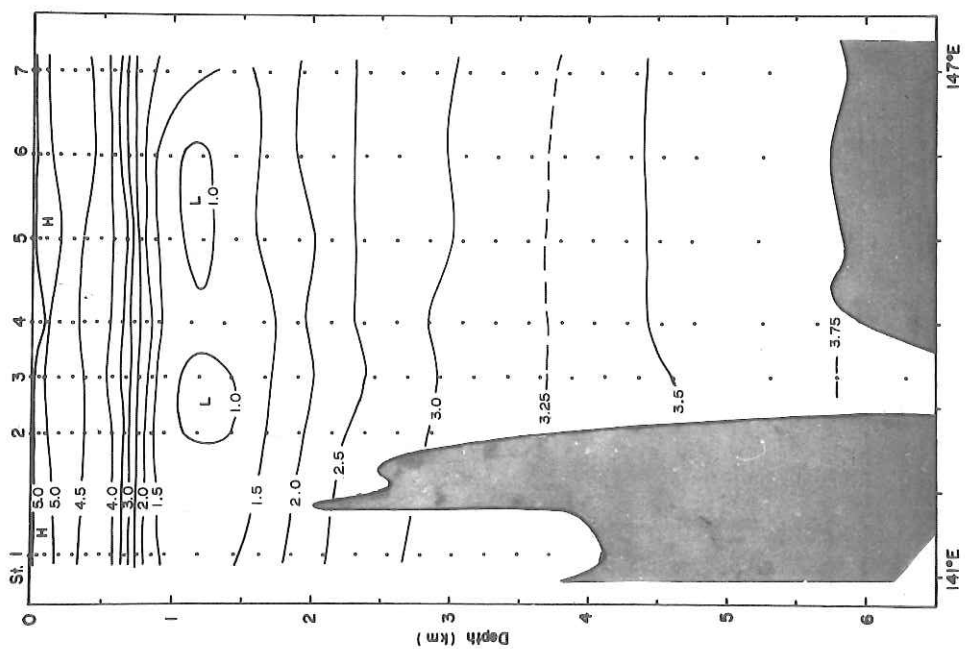
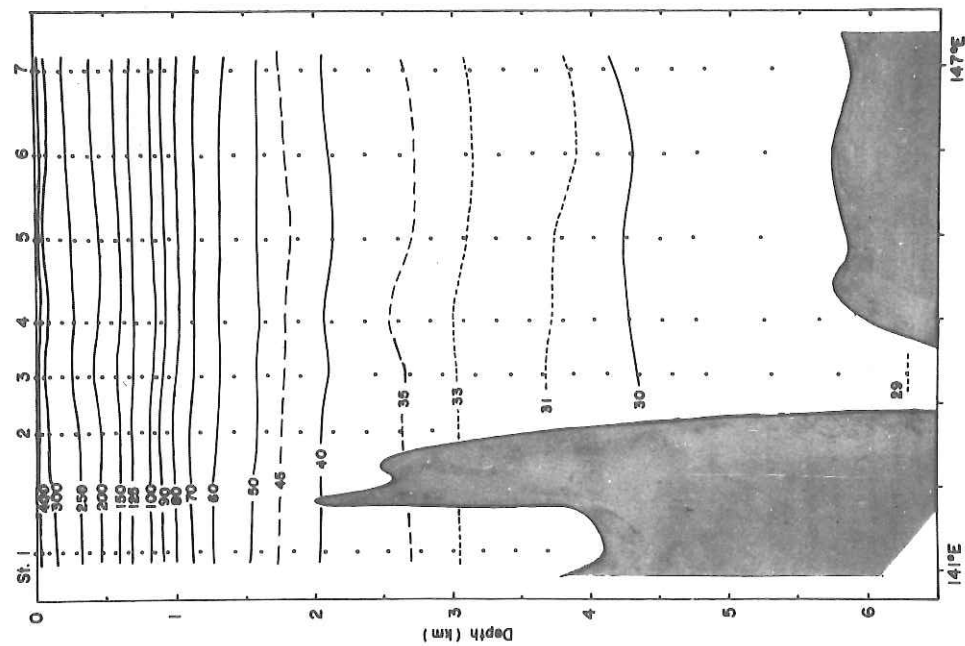


Fig. 12 Potential temperature section (°C)





3. Currentmetry by moored Savonius meters

by

Kenzo Takano

Four Savonius current meters (Geodyne 102) were aligned by a mooring line with a pendulum current meter, a seismometer and two tension meters at $28^{\circ}29.8'N$, $144^{\circ}58.1'E$ on June 23, 1971, as is sketched in Fig. 16 (see also Okazaki; Asada, Shimamura and Ishibashi). Its objective is to have information on the vertical profile of the current velocity (see Imawaki and Kunishi) as well as on the mooring motion in the deep-sea. The retrieval was done with success on July 2. All the current meters worked properly except the second one from the bottom which did not record the current speed because of malfunction of the rotor switch. No strong mooring motion is found. The data processing is not yet completed.

The second mooring, similar to the first one but with four Geodyne meters and two tension meters only, was set at $39^{\circ}58.8'N$, $145^{\circ}38.2'E$ on July 10. The depth is 5160m. Its surface buoys were not seen on July 15, though the hydrographic and weather conditions seem to have been fairly well for this period. All has been lost. The cause is unknown.

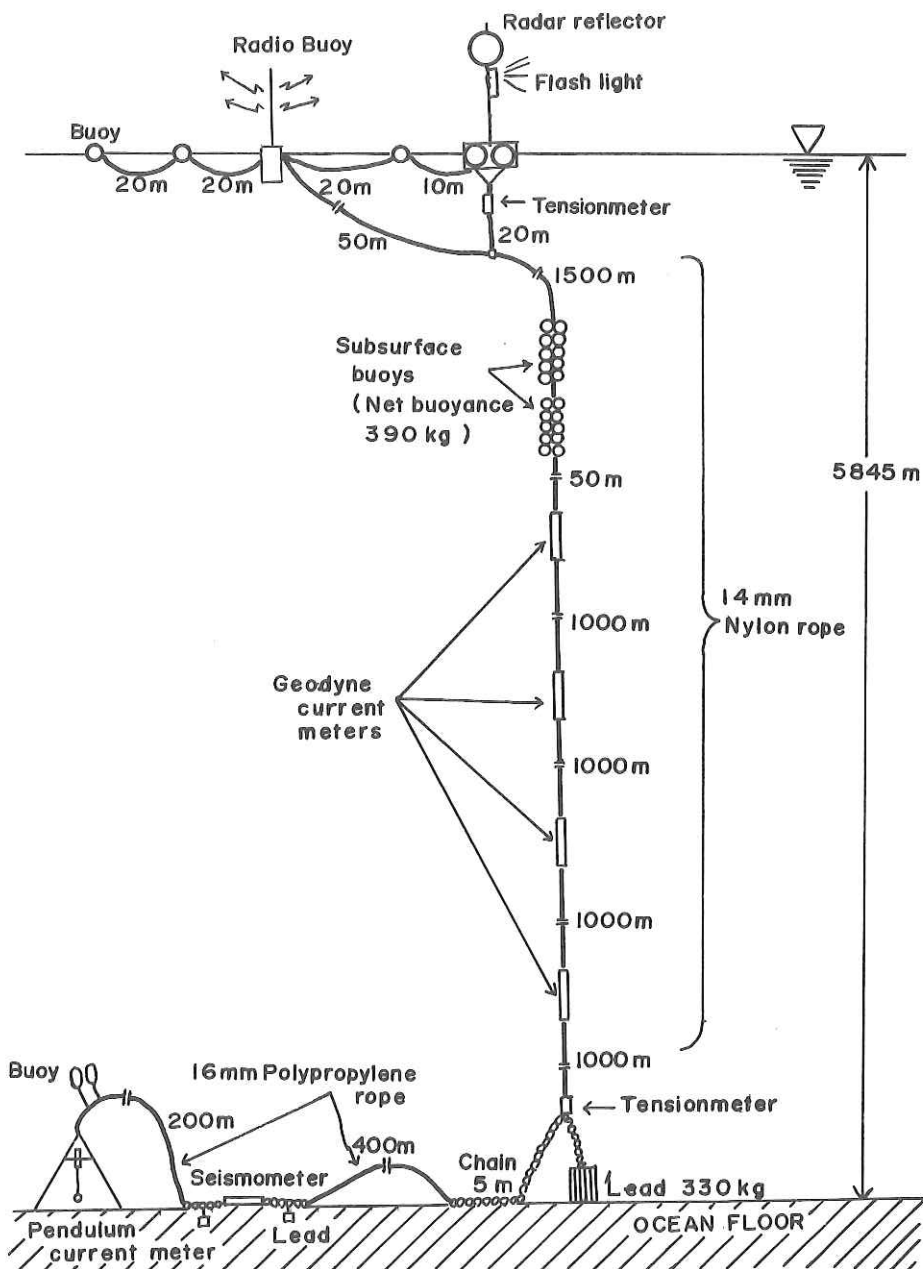


Fig. 16 Mooring line

4. Measurement of ocean floor current

by

Moriyoshi Okazaki

The deep water in North Pacific basin is inferred to flow in from South Pacific, and the major one probably flows northwards through the eastern area of Mariana, Bonin and Izu Islands. However, only a few direct measurements of deep current have been carried out. In the present work, a measurement of floor current was performed at Station 8 ($28^{\circ}29.8'N$, $144^{\circ}58.1'E$, 5845m deep, flat floor of red clay) for 212.3 hours. A pendulum current meter was used which had been designed to obtain 3 data an hour on floor current 60 cm above the bottom. Mooring line is shown in Fig. 16. Preliminary results are as follows; the average velocity of floor current is 4.57 cm/sec in direction of $24^{\circ}23'$ to magnetic north, and the velocity changes with a period of about 12 hours. Details of the result will be reported later.

5. Measurement of insolation and submarine light

by

K. Matsuike and M. Kishino

1. Insolation

An Eppley actinograph was mounted on the top of the radar mast of the ship to measure the solar insolation reached on the sea. The solar insolation delivered to the sea surface was continuously recorded everyday throughout daytime during the survey by connecting the actinograph to an EPR-2T high sensitive recorder.

2. Submarine irradiance

The upward and downward irradiance of submarine light was measured, from the surface down to 100m, using an underwater irradiance meter fitted with violet (maximum transmittance: 400 nm), blue (maximum transmittance: 460 nm), green (maximum transmittance: 540 nm) or amber (sharp-cut, VO-57) filter. The irradiance values within the most surface water were obtained by means of the extrapolation method so that possible immersion effect at the air-water interface has to be eliminated.

Band-width errors caused by gravity center shiftings of different filters were calculated through the formula introduced by Joseph (Über die messung des "Vertikalen

Extinktions koeffizienten," Deut. Hydrograph. Z., 2: 255 - 267, 1949).

		Center of gravity				
Ogasawara	filter	depth	in air	1 meter	10 meter	100 meter
	Violet		411 nm	425 nm	427 nm	434 nm
	Blue		479 nm	485 nm	480 nm	461
	Green		543	542	539	513
	Amber		630	623	591	569
Sub-arctic	filter					
	Violet		411 nm	422 nm	430 nm	444 nm
	Blue		479	485	481	470
	Green		543	546	538	516
	Amber		630	585	581	561

3. Submarine scaler irradiance

Submarine scaler irradiance was measured using a 4π scaler irradiance meter with a blue filter (maximum transmittance: 460 nm) combined with a silicon blue cell from surface to 100 m deep.

4. Attenuation of collimated beam

Attenuation of collimated beam was measured with a turbidity meter (light path: 1m) fitted with a blue filter (maximum transmittance: 460 nm) from surface to 300m.

5. Volume scattering function

Volume scattering functions of the water samples collected from various depth were measured by a light scattering photometer (wave lengths of the incident light 436 nm and 546 nm). The data obtained are summarized in Table 21 - 23.

Table 21. Solar insolation and submarine light

Date, time of the meridian sun and ship-position											
1971 Jun.											
19	20	21	22	23	24	25	26	27	28	29	30
Local time	11:39	11:34	11:26	11:18	11:22	11:23	11:23	11:26	11:23	11:23	11:23
31°-35'N	28°-32'N	28°-32'N	28°-31'N	28°-30'N	28°-29'N	28°-24'N	28°-23'N	28°-23'N	28°-23'N	28°-23'N	28°-27'N
140°-37'E	141°-46'E	144°-02'E	145°-59'E	144°-58'E	144°-47'E	144°-55'E	144°-56'E	144°-03'E	144°-56'E	145°-01'E	145°-01'E
2 ^h	0	0	0	0	0	0	0	0	0	0	-
3	0	0	0.04	0	0	0	0	0	0	0	-
4	2.92	1.44	3.47	2.55	4.55	-	4.91	3.33	1.48	2.61	-
5	9.00	6.13	10.07	21.20	19.80	-	14.20	11.66	9.27	13.87	-
6	23.50	19.47	31.80	34.33	34.07	-	21.33	24.13	27.93	33.27	-
7	37.10	33.53	58.20	50.20	48.67	-	43.93	33.93	35.73	49.07	-
8	50.80	46.47	68.47	52.53	67.00	-	69.33	58.53	56.00	66.87	62.87
9	64.60	61.53	75.87	77.87	68.07	73.20	69.13	79.07	69.40	78.53	77.67
10	67.13	79.13	82.93	84.47	75.73	80.67	70.47	82.53	79.80	83.07	68.13
11	34.27	77.47	81.80	84.80	78.80	81.33	53.33	83.80	78.47	86.27	43.80
12	39.40	78.80	81.00	73.53	77.60	78.87	66.53	79.60	72.87	81.47	44.60
13	37.80	29.07	68.27	46.27	68.47	66.47	50.27	54.47	69.60	64.33	41.80
14	44.33	35.20	53.20	20.20	50.27	48.80	36.73	55.93	48.53	55.20	31.13
15	34.33	11.80	33.80	21.80	16.00	26.73	18.07	31.47	34.67	37.47	15.67
16	14.80	2.33	16.93	9.20	16.00	15.20	10.47	12.33	15.80	17.13	14.20
17	3.16	1.27	4.20	3.33	3.47	4.33	0.73	2.96	4.67	3.47	4.53
18	0	0	0.07	0	0.08	0	0	0	0.27	0	0
19	0	0	0	0	0	0	0	0	0	0	0
20 ^h	0	0	0	0	0	0	0	0	0	0	0
Total	463.14	483.64	670.12	582.28	629.18	658.41	529.43	613.74	604.49	672.63	-

Table 21. (Continued)

Date, time of the meridian sun and ship-position														
1971 Jul.														
1	2	3	4	5	8	9	10	11	12	13	14			
Local time	11:24	11:24	11:23	11:45	11:46	11:46	11:30	11:23	11:28	11:28	11:28	11:28	11:28	11:28
	28°-59'N	28°-28'N	32°-19'N	35°-00'N	35°-28'N	35°-12'N	38°-20'N	40°-05'N	42°-57'N	42°-57'N	42°-57'N	42°-57'N	42°-57'N	42°-57'N
	144°-49'E	144°-59'E	145°-18'E	139°-50'E	139°-39'E	139°-44'E	143°-42'E	145°-38'E	144°-23'E	144°-23'E	144°-23'E	144°-23'E	144°-23'E	144°-23'E
TATEYAMA YOKAHAMA														
2h	0	0	0	0	0	-	0	0	0	0	0	0	0	0
3	0.03	0	0.18	0.43	0.12	-	0.15	1.01	0.14	0.68	0.92	0.92	0	0
4	3.67	2.61	7.47	3.93	3.80	-	4.87	6.60	3.13	5.33	10.73	10.73	1.40	1.40
5	18.53	10.53	9.67	5.07	9.27	-	8.20	13.07	6.13	27.87	26.67	26.67	4.67	4.67
6	29.67	17.27	37.67	19.33	25.20	-	18.93	22.67	10.07	33.80	41.27	41.27	8.47	8.47
7	55.33	26.47	52.13	50.87	33.00	-	20.33	27.80	7.40	58.13	53.73	53.73	8.47	8.47
8	66.67	25.80	74.93	40.40	35.53	-	24.67	33.60	7.13	70.60	67.67	67.67	10.13	10.13
9	80.67	60.33	81.20	53.20	59.73	-	44.07	48.67	5.33	49.00	63.27	63.27	13.73	13.73
10	78.67	57.60	77.67	74.00	74.33	62.87	37.73	66.93	5.47	70.47	78.47	78.47	13.47	13.47
11	85.33	48.40	63.47	51.80	78.40	86.73	52.20	54.20	5.53	80.87	77.20	77.20	16.33	16.33
12	81.07	53.20	54.60	52.33	69.00	75.87	37.33	73.07	4.93	75.93	67.53	67.53	12.80	12.80
13	76.87	45.00	63.87	24.07	58.30	65.67	41.87	67.27	3.87	66.00	33.47	33.47	16.73	16.73
14	59.33	31.27	46.53	10.53	46.00	53.67	30.67	53.00	4.73	55.47	34.00	34.00	12.07	12.07
15	34.13	13.20	23.07	9.53	32.50	36.00	40.00	35.73	2.80	33.13	11.00	11.00	9.93	9.93
16	23.33	5.87	11.87	11.07	17.33	16.00	17.33	24.07	2.33	18.00	9.00	9.00	9.27	9.27
17	3.00	0.85	4.67	4.00	3.53	2.33	5.53	7.07	0.87	9.33	4.67	4.67	2.67	2.67
18	0	0	0.12	0.16	0.04	0.07	0.24	1.60	0.33	1.32	0.95	0.95	0.28	0.28
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20h	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	696.3	398.4	609.12	410.72	546.08	-	384.12	536.36	70.19	655.93	580.55	580.55	140.42	140.42

Table 21. (Continued)

Date, time of the meridian sun and ship-position													
1971 Jul.		16	17	18	19	20	21	22	23	24	25	26	27
Local	11:27	11:23	11:10	10:50	10:50	10:50	10:50	10:50	10:50	10:51	11:01	11 19	11:36
time	42°-18'N	39°-59'N	41°-45'N	44°-11'N	44°-04'N	44°-08'N	44°-09'N	44°-03'N	44°-05'N	43°-59'N	42°-29'N	39°-56'N	36°-34.5'N
	144°-39'E	145°-38'E	148°-58'E	154°-04'E	154°-01'E	153°-59'E	153°-59'E	154°-03'E	154°-02'E	153°-52'E	151°-18'E	146°-57'E	142°-32'E
2 ^h	0	0	0	0	0	0	-	0.05	0.48	0.60	0	0	0
3	0	0.09	0	2.00	2.61	1.80	-	2.20	4.60	4.07	0.48	0.27	0.10
4	1.07	2.07	1.33	6.87	5.67	4.70	-	6.27	10.07	11.20	2.67	3.27	3.33
5	2.80	4.67	3.47	13.47	12.67	10.07	-	13.73	13.13	27.73	6.33	13.67	9.80
6	5.00	12.87	10.20	20.93	17.27	25.93	-	26.67	17.13	55.60	10.67	26.53	22.20
7	13.13	36.13	13.53	28.13	29.40	28.27	-	26.67	26.07	65.93	11.27	23.27	48.80
8	9.33	33.00	16.47	40.00	33.53	25.07	44.87	34.00	36.20	70.60	13.53	23.67	66.67
9	13.13	37.33	11.80	42.53	11.40	55.53	74.71	28.93	27.07	74.60	13.60	18.40	41.47
10	34.27	61.20	11.47	41.47	12.67	50.47	75.87	28.33	28.33	75.93	26.07	15.60	69.20
11	60.60	56.07	11.87	36.73	13.34	47.73	75.07	50.67	28.93	70.53	22.27	13.20	79.33
12	52.33	32.60	7.13	40.20	-	35.13	63.67	48.53	18.87	66.07	19.60	12.60	77.67
13	47.87	30.27	4.67	29.20	-	19.73	51.00	50.07	14.93	52.27	25.13	8.47	71.20
14	47.60	15.00	6.80	20.47	-	16.60	33.20	33.53	10.67	30.53	31.60	5.27	49.60
15	26.87	4.07	4.93	9.67	-	11.33	16.47	10.93	8.27	24.20	14.20	2.33	40.80
16	23.07	3.47	1.93	4.00	-	1.87	5.67	3.33	5.33	8.07	6.80	3.00	28.13
17	10.73	1.80	1.13	0.18	-	0.30	0.86	0.14	0.60	0.66	4.87	0.87	7.87
18	0.98	0.20	0.19	0	-	0	0	0	0	0	0.31	0.07	0.11
19	0	0	0	0	-	0	0	0	0	0	0	0	0
20 ^h	0	0	0	0	-	0	0	0	0	0	0	0	0
Total	348.78	330.84	106.92	335.85	-	334.53	-	364.05	250.68	638.59	209.40	170.49	616.28

Table 22. Relative irradiance and attenuation coefficient of diffuse light

Sta. 4	Lat. 28°-30'N Long. 144°-00'E	Date 1971. 6.21	Time 13:30 ~ 13:55	Weather bc				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	93.5	83.8	52.3	90.8	0.0134	0.0354	0.129	0.0193
10	87.2	70.8	28.2	82.4	0.0139	0.0337	0.123	0.0195
20	69.4	50.2	11.1	67.1	0.0228	0.0343	0.0930	0.0205
30	56.3	33.2	5.58	54.7	0.0210	0.0414	0.0686	0.0205
40	45.2	22.4	3.13	44.7	0.0219	0.0394	0.0578	0.0203
50	35.1	13.7	1.76	35.8	0.0253	0.0490	0.0576	0.0221
60	28.9	8.89	1.01	27.1	0.0196	0.0433	0.0555	0.0279
70	20.7	4.86	0.558	21.1	0.0334	0.0603	0.0594	0.0249
80	-	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

Sta. 11	Lat. 28°-29'N Long. 144°-55'E	Date 1971. 6.24	Time 13:40 ~ 14:05	Weather bc				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	91.1	82.2	46.1	91.3	0.0184	0.0392	0.155	0.0184
10	84.9	68.5	24.5	84.6	0.0142	0.0364	0.127	0.0152
20	69.9	47.2	10.8	71.0	0.0196	0.0373	0.0820	0.0175
30	54.8	29.7	5.32	58.3	0.0244	0.0463	0.0707	0.0198
40	43.4	17.5	2.77	45.8	0.0233	0.0530	0.0652	0.0242
50	33.8	10.2	1.56	36.2	0.0249	0.0539	0.0573	0.0235
60	26.5	6.26	0.902	28.3	0.0244	0.0488	0.0548	0.0246
70	19.0	3.78	0.529	20.1	0.0332	0.0504	0.0534	0.0343
80	13.1	2.22	0.317	13.8	0.0373	0.0532	0.0513	0.0375
90	8.47	1.29	0.184	7.94	0.0435	0.0543	0.0546	0.0553
100	5.58	0.766	0.110	4.14	0.0419	0.0520	0.0513	0.0652

Table 22. (Continued)

Sta. 11	Lat. 28°-24'N Long. 144°-55'E	Date 1971. 6.25	Time 13:10 ~ 13:30	Weather b				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	90.3	81.3	47.0	92.2	0.0204	0.0414	0.151	0.0163
10	84.5	67.5	23.7	85.9	0.0132	0.0373	0.137	0.0141
20	68.8	45.9	10.4	71.7	0.0205	0.0385	0.0817	0.0180
30	53.0	29.9	4.72	59.6	0.0262	0.0659	0.0797	0.0184
40	41.1	17.1	2.39	47.6	0.0256	0.0560	0.0677	0.0223
50	32.4	10.1	1.22	36.8	0.0237	0.0525	0.0670	0.0258
60	24.5	5.90	0.671	27.2	0.0279	0.0539	0.0603	0.0302
70	17.6	3.51	0.381	18.0	0.0332	0.0518	0.0566	0.0412
80	12.4	2.02	0.234	11.8	0.0350	0.0553	0.0486	0.0421
90	8.24	1.19	0.140	7.51	0.0408	0.0530	0.0513	0.0454
100	5.27	0.695	0.0854	4.49	0.0447	0.0539	0.0495	0.0513

Sta. 11	Lat. 28°-27'N Long. 144°-57'E	Date 1971. 6.26	Time 10:15 ~ 10:35	Weather bc				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	91.1	79.0	47.5	91.6	0.0189	0.0472	0.149	0.0175
10	82.6	61.9	24.1	82.6	0.0193	0.0487	0.136	0.0206
20	68.1	39.7	9.94	69.3	0.0194	0.0444	0.0887	0.0175
30	55.3	24.1	5.14	58.0	0.0207	0.0500	0.0661	0.0177
40	40.7	14.9	2.69	49.3	0.0306	0.0481	0.0647	0.0163
50	30.6	9.97	1.42	34.5	0.0286	0.0403	0.0638	0.0357
60	24.1	5.97	0.758	27.1	0.0237	0.0513	0.0626	0.0242
70	20.0	3.55	0.457	19.8	0.0184	0.0518	0.0507	0.0313
80	13.5	2.01	0.287	12.8	0.0394	0.0569	0.0465	0.0437
90	8.20	1.18	0.163	7.13	0.0500	0.0532	0.0566	0.0585
100	4.86	0.674	0.0921	3.74	0.0523	0.0560	0.0571	0.0645

Table 22. (Continued)

Sta. 11	Lat. Long. 144°-59'E	Date 1971. 6.27	Time 10:10 ~ 10:30	Weather bc				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	88.8	79.4	39.0	91.1	0.0238	0.0461	0.188	0.0187
10	77.8	62.9	19.7	81.4	0.0265	0.0467	0.137	0.0224
20	61.2	38.7	7.38	66.7	0.0239	0.0486	0.0981	0.0200
30	51.0	24.5	3.57	55.6	0.0182	0.0458	0.0725	0.0182
40	40.5	16.6	1.92	44.2	0.0230	0.0389	0.0619	0.0230
50	32.1	10.6	0.955	35.3	0.0233	0.0447	0.0700	0.0223
60	23.9	5.97	0.489	25.6	0.0295	0.0573	0.0670	0.0322
70	16.9	3.42	0.310	18.2	0.0348	0.0557	0.0456	0.0341
80	11.4	2.03	0.183	10.9	0.0394	0.0520	0.0527	0.0513
90	7.35	1.09	0.103	6.22	0.0437	0.0622	0.0573	0.0560
100	5.15	0.700	0.0596	3.50	0.0355	0.0442	0.0546	0.0573

Sta. 11	Lat. 28°-23'N Long. 145°-01'E	Date 1971. 6.29	Time 11:00 ~ 11:25	Weather bc				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	88.6	81.2	48.9	91.0	0.0242	0.0416	0.143	0.0189
10	82.0	67.7	25.0	83.3	0.0154	0.0363	0.134	0.0178
20	64.9	45.0	10.3	69.0	0.0235	0.0408	0.0887	0.0189
30	54.2	28.5	4.56	57.3	0.0180	0.0458	0.0815	0.0187
40	41.0	18.9	2.33	45.7	0.0279	0.0410	0.0672	0.0226
50	29.8	9.92	1.19	36.3	0.0318	0.0645	0.0672	0.0230
60	21.9	5.58	0.608	24.7	0.0309	0.0573	0.0672	0.0385
70	-	-	-	-	-	-	-	-
80	-	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

Table 22. (Continued)

Sta. 11	Lat. 28°-28'N Long. 145°-00'E	Date 1971. 6.30	Time 11:10 ~ 11:35	Weather o				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	89.7	81.1	48.0	91.0	0.0217	0.0419	0.147	0.0189
10	80.8	65.2	26.5	82.3	0.0209	0.0436	0.118	0.0202
20	64.7	45.1	11.9	69.9	0.0221	0.0368	0.0806	0.0163
30	52.0	28.1	4.98	57.7	0.0219	0.0474	0.0868	0.0193
40	41.2	16.9	2.53	44.6	0.0233	0.0509	0.0679	0.0258
50	29.3	10.0	1.33	34.5	0.0341	0.0525	0.0638	0.0256
60	21.3	5.54	0.758	23.7	0.0318	0.0589	0.0564	0.0375
70	14.8	3.06	0.430	-	0.0364	0.0594	0.0566	-
80	-	-	0.235	-	-	-	0.0603	-
90	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

Sta. 12	Lat. 32°-38'N Long. 145°-28'E	Date 1971. 7. 3	Time 14:00 ~ 14:10	Weather c				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	87.1	76.9	58.9	87.9	0.0276	0.0525	0.106	0.0258
10	76.7	59.6	35.3	79.1	0.0253	0.0510	0.103	0.0211
20	58.6	36.2	12.0	59.9	0.0269	0.0500	0.108	0.0279
30	44.6	21.9	5.96	48.8	0.0274	0.0502	0.0700	0.0205
40	-	-	-	-	-	-	-	-
50	-	-	-	-	-	-	-	-
60	-	-	-	-	-	-	-	-
70	-	-	-	-	-	-	-	-
80	-	-	-	-	-	-	-	-
90	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

Table 22. (Continued)

Sta. 17	Lat. 39°-55'N Long. 146°-02'E	Date 1971. 7.10	Time 09:27 ~ 09:53	Weather f				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	81.2	71.2	48.4	81.2	0.0416	0.0682	0.145	0.0416
10	65.5	49.2	22.6	63.8	0.0429	0.0741	0.159	0.0484
20	46.4	26.7	7.33	41.2	0.0343	0.0613	0.113	0.0438
30	30.7	14.6	2.92	24.1	0.0412	0.0606	0.0921	0.0537
40	18.7	7.80	1.17	11.7	0.0497	0.0624	0.0916	0.0723
50	12.5	4.72	0.551	6.85	0.0403	0.0502	0.0751	0.0537
60	7.95	2.38	0.252	3.97	0.0451	0.0684	0.0781	0.0546
70	4.76	1.54	0.120	2.66	0.0514	0.0438	0.0744	0.0401
80	3.14	0.900	0.0472	1.62	0.0414	0.0539	0.0930	0.0497
90	1.80	0.452	0.0221	0.753	0.0557	0.0688	0.0758	0.0767
100	1.02	0.196	-	0.382	0.0566	0.0836	-	0.0677

Sta. 18	Lat. 39°-59'N Long. 145°-38'E	Date 1971. 7.10	Time 15:30 ~ 15.55	Weather b				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	79.7	72.1	44.7	81.2	0.0454	0.0654	0.161	0.0416
10	66.7	53.7	20.4	67.8	0.0358	0.0589	0.157	0.0358
20	42.3	25.7	6.33	47.5	0.0454	0.0739	0.117	0.0355
30	28.7	13.7	2.18	27.2	0.0389	0.0629	0.106	0.0557
40	12.1	4.92	0.670	7.97	0.0861	0.102	0.118	0.123
50	4.80	1.94	0.212	3.01	0.0928	0.0930	0.115	0.0974
60	2.86	0.987	0.0765	1.79	0.0518	0.0672	0.102	0.0523
70	1.80	0.556	0.0237	1.12	0.0463	0.0573	0.117	0.0472
80	1.26	0.333	-	0.678	0.0359	0.0511	-	0.0497
90	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

Table 22. (Continued)

Sta. 19	Lat. 44°-09'N Long. 154°-00'E	Date 1971. 7.18	Time 14:50 ~ 15:10	Weather f				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100	0.0488	0.0682	0.235	0.0617
5	78.4	71.2	30.8	73.5	0.0511	0.0644	0.152	0.0594
10	60.7	51.6	14.4	54.6	0.0474	0.0665	0.110	0.0608
20	37.8	26.5	4.79	29.7	0.0594	0.0585	0.0923	0.0758
30	20.8	14.8	1.90	13.9	0.0783	0.0880	0.110	0.0905
40	9.52	6.12	0.633	5.65	0.0447	0.0458	0.0716	0.0769
50	6.09	3.87	0.309	2.62	0.0534	0.0718	0.115	0.0737
60	3.56	1.88	0.0983	1.25	0.0474	0.0748	0.0893	0.0661
70	2.22	0.892	0.0403	0.649	0.0543	0.0619	0.0868	0.0477
80	1.29	0.480	0.0169	0.403	0.0504	0.0603	-	0.0606
90	0.779	0.262	-	0.220	0.0438	0.0677	-	0.0638
100	0.503	0.133	-	0.116				

Sta. 19	Lat. 44°-05'N Long. 154°-01'E	Date 1971. 7.19	Time 05:00 ~ 05:20	Weather f,d				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100	0.0709	0.0834	0.249	0.0820
5	70.1	65.9	28.8	66.3	0.0741	0.0939	0.232	0.0958
10	48.4	41.2	9.00	41.1	0.0709	0.0843	0.143	0.0836
20	23.8	17.7	2.15	17.8	0.0718	0.0666	0.120	0.0988
30	11.6	9.12	0.646	6.63	0.0808	0.0891	0.117	0.0820
40	5.19	3.74	0.201	2.92	0.0693	0.0898	0.173	0.104
50	2.59	1.52	0.0359	1.03	0.0583	0.0999	0.161	0.0718
60	1.45	0.559	0.00717	0.505	0.0659	0.104	-	0.0804
70	0.750	0.197	-	0.226	0.0530	-	-	0.0808
80	0.441	-	-	0.101	-	-	-	-
90	-	-	-	-	-	-	-	-
100	-	-	-	-				

Table 22. (Continued)

Sta. 19	Lat. 44°-06'N Long. 15°-00'E	Date 1971. 7.19	Time 10:20 ~ 10:33	Weather d				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	63.7	61.9	29.3	60.3	0.0908	0.0958	0.246	0.101
10	43.9	37.8	9.00	33.7	0.0741	0.0986	0.235	0.117
20	19.0	17.0	2.21	13.9	0.0840	0.0799	0.140	0.0882
30	8.60	8.06	0.755	4.97	0.0790	0.0746	0.107	0.103
40	4.39	4.13	0.223	1.97	0.0672	0.0670	0.122	0.0926
50	2.42	1.72	0.0740	0.848	0.0599	0.0875	0.110	0.0843
60	1.26	0.653	-	0.387	0.0649	0.0969	-	0.0783
70	0.756	0.338	-	0.252	0.0514	0.0661	-	0.0428
80	-	0.125	-	0.130	-	0.0995	-	0.0665
90	-	-	-	-	-	-	-	-
100	-	-	-	-	-	-	-	-

Sta. 19	Lat. 44°-08'N Long. 154°-01'E	Date 1971. 7.20	Time 10:50 ~ 11:10	Weather d				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	75.6	68.9	35.3	73.4	0.0557	0.0746	0.208	0.0617
10	61.3	50.0	17.6	54.4	0.0419	0.0640	0.139	0.0599
20	34.7	25.7	6.79	33.3	0.0571	0.0663	0.0951	0.0490
30	22.2	13.5	2.71	17.0	0.0447	0.0645	0.0921	0.0672
40	13.2	6.96	1.00	8.19	0.0520	0.0663	0.0995	0.0735
50	8.04	3.89	0.411	3.65	0.0493	0.0583	0.0889	0.0808
60	3.53	2.04	0.207	1.73	0.0824	0.0647	0.0684	0.0751
70	2.36	1.24	0.105	0.816	0.0403	0.0495	0.0684	0.0748
80	1.40	0.559	0.0374	0.497	0.0518	0.0797	0.103	0.0495
90	0.759	0.258	0.0120	0.222	0.0615	0.0771	0.114	0.0806
100	-	-	-	-	-	-	-	-

Table 22. (Continued)

Sta. 19	Lat. 44°-08'N Long. 153°-59'E	Date 1971. 7.21	Time 13:00 ~ 13:20	Weather f				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100	0.0543	0.0576	0.241	0.0470
5	76.2	75.0	30.0	79.1	0.0401	0.0516	0.119	0.0534
10	62.4	58.0	16.5	60.6	0.0502	0.0866	0.121	0.0629
20	37.8	24.4	4.91	32.3	0.0583	0.0615	0.102	0.0808
30	21.1	13.2	1.76	14.4	0.0447	0.0608	0.0764	0.0594
40	13.5	7.19	0.823	7.94	0.0721	0.0910	0.111	0.100
50	6.56	2.90	0.272	2.91	0.0677	0.0675	0.0861	0.0686
60	3.33	1.48	0.115	1.47	0.0412	0.0523	0.0921	0.0693
70	2.21	0.875	0.0459	0.734	0.0589	0.0709	0.0732	0.0403
80	1.22	0.431	0.0221	0.491	0.0272	0.0477	0.0698	0.0495
90	0.932	0.267	0.0110	0.300	0.0463	-	-	-
100	0.587	-	-	-				

Sta. 19	Lat. 44°-03'N Long. 154°-03'E	Date 1971. 7.22	Time 09:40 ~ 10:00	Weather f				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100	0.0470	0.0751	0.216	0.0465
5	79.0	68.7	33.9	79.2	0.0543	0.0649	0.145	0.0493
10	60.2	49.7	16.4	61.8	0.0470	0.0762	0.118	0.0583
20	37.6	23.2	5.06	34.6	0.0433	0.0714	0.104	0.0585
30	24.4	11.4	1.80	19.2	0.0507	0.0661	0.0965	0.0847
40	14.7	5.87	0.684	8.27	0.0686	0.0739	0.0986	0.0663
50	7.40	2.80	0.255	4.26	0.0626	0.0767	0.0767	0.0836
60	3.95	1.30	0.119	1.85	0.0530	0.0534	0.0986	0.0686
70	2.33	0.762	0.0443	0.931	0.0447	0.0513	0.0698	0.0583
80	1.49	0.456	0.0220	0.520	-	-	-	-
90	-	-	-	-	-	-	-	-
100	-	-	-	-				

Table 22. (Continued)

Sta. 19	Lat. 44°-03'N Long. 154°-03'E	Date 1971. 7.22	Time 14:15 ~ 14:38	Weather b				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	79.3	71.9	31.0	75.1	0.0511	0.0658	0.234	0.0571
10	59.4	53.8	14.6	56.6	0.0580	0.0580	0.152	0.0566
20	37.2	25.7	4.44	32.3	0.0467	0.0739	0.119	0.0562
30	20.9	11.7	1.56	15.5	0.0578	0.0788	0.104	0.0735
40	11.7	4.79	0.507	5.82	0.0583	0.0891	0.113	0.0981
50	5.80	2.35	0.176	2.62	0.0702	0.0712	0.105	0.0799
60	3.24	1.23	0.0780	1.42	0.0583	0.0647	0.0817	0.0615
70	1.90	0.559	0.0325	0.783	0.0532	0.0790	0.0875	0.0594
80	1.13	0.313	0.0137	0.391	0.0520	0.0580	0.0864	0.0695
90	0.707	0.158	0.00578	0.219	0.0467	0.0684	0.0866	0.0583
100	0.429	0.0800	0.00244	0.121	0.0502	0.0682	0.0864	0.0590

Sta. 19	Lat. 44°-00'N Long. 153°-55'E	Date 1971. 7.24	Time 07:30 ~ 07:50	Weather bc				
Depth m	Relative irradiance (%)				Attenuation coefficient			
	Blue	Green	Amber	Violet	Blue	Green	Amber	Violet
surf.	100	100	100	100				
5	73.9	64.1	41.5	69.5	0.0603	0.0888	0.176	0.0728
10	52.6	41.1	17.9	47.6	0.0682	0.0888	0.168	0.0755
20	28.5	17.7	5.70	22.8	0.0610	0.0840	0.115	0.0737
30	14.6	6.86	1.68	8.71	0.0670	0.0949	0.122	0.0963
40	7.60	3.14	0.593	3.79	0.0654	0.0783	0.104	0.0834
50	4.65	1.67	0.241	1.88	0.0491	0.0631	0.0898	0.0700
60	2.73	0.905	0.0938	1.07	0.0532	0.0610	0.0946	0.0566
70	1.56	0.459	0.0389	0.592	0.0564	0.0679	0.0880	0.0592
80	0.968	0.224	0.0165	0.332	0.0474	0.0721	0.0861	0.0580
90	0.609	0.125	0.00691	0.175	0.0463	0.0580	0.0868	0.0638
100	0.418	0.0730	-	0.106	0.0375	0.0539	-	0.0502

Table 23. Attenuation coefficient (m^{-1})

Station	1	2	3	4	5	6	7
Date	6/20	6/20	6/20	6/21	6/21	6/22	6/22
Time	07:44	16:32	23:07	11:25	22:25	08:47	18:22
Depth							
0m	.159	.182	.145	.142	.186	.173	.172
10	.159	.189	.145	.148	.186	.168	.166
30	.163	.182	.145	.153	.186	.173	.179
50	.163	.175	.149	.160	.186	.188	.179
70	.163	.170	.195	.160	.248	.188	.179
100	.175	.159	.133	.173	.192	.196	.219
120	.133	.113	.094	.157	.148	.205	.157
140	.155	.101	.085	.136	.136	.153	.132
160	.106	.090	.073	.118	.125	.130	.124
180	.101	.080	.073	.107	.118	.117	.112
200	.094	.080	.073	.095	.107	.109	.101
220	.094	.076	.073	.084	.107	.106	.095
240	.090	.076	.071	.084	.107	.101	.089
260	.085	.071	.066	.084	.101	.098	.089
280	-	.066	.066	.084	.101	.092	.089
300	-	.066	.066	.087	.095	.092	.089

Station	11	11	11	11	11	11	11
Date	6/24	6/24	6/25	6/26	6/27	6/28	6/30
Time	14:50	20:05	14:10	11:33	11:28	13:15	12:40
Depth							
0m	.162	.198	.230	.188	.196	.195	.173
10	.156	.178	.235	.188	.214	.196	.173
30	.169	.184	.221	.194	.202	.209	.198
50	.156	.171	.205	.199	.208	.203	.207
70	.144	.171	.182	.191	.192	.190	.198
100	.181	.207	.163	.236	.202	.239	.219
120	.144	.161	.152	.160	.165	.165	.147
140	.113	.136	.117	.143	.141	.124	.129
160	.102	.117	.140	.126	.123	.112	.117
180	.090	.108	.117	.118	.117	.107	.108
200	.084	.102	.108	.115	.111	.101	.103
220	.078	.096	.101	.109	.106	.101	.106
240	.084	.090	.094	.105	.101	.098	.100
260	.090	.090	.090	.099	.095	.095	.095
280	.090	.090	.090	.099	.089	.095	.092
300	-	.087	.085	-	.085	-	-

Table 23. (Continued)

Station	12	14	15	19	19	19	19
Date	7/3	7/9	7/10	7/18	7/19	7/19	7/20
Time	14:00	10:25	16:30	15:23	05:45	10:38	10:35
Depth							
0m	.244	.245	.298	.455	.380	.446	.458
10	.244	.235	.284	.455	.388	.446	.458
30	.225	.220	.214	.502	.351	.271	.299
50	.218	.216	.389	.280	.206	.200	.244
70	.260	.189	.185	.182	.138	.149	.205
100	.283	.140	.136	.141	.123	.114	.117
120	.276	.129	.118	.119	.111	.111	.099
140	.193	.117	.112	.113	.101	.106	.085
160	.230	.111	.109	.116	.109	.098	.090
180	.200	.106	.107	.108	.107	.092	.101
200	.163	.108	.107	.126	.101	.100	.101
220	.133	.108	.107	.113	.101	.100	.090
240	.133	.105	.101	.102	.101	.095	.092
260	.129	.103	.095	.102	.092	.106	.094
280	.129	.105	.098	.099	.095	.103	-
300	-	.100	.101	.102	.095	.095	-
Station	19	19	19	19	19	19	19
Date	7/21	7/22	7/22	7/23	7/24	7/24	7/24
Time	13:40	15:05	18:09	08:46	08:17	15:21	18:00
Depth							
0m	.284	.315	.336	.340	.281	.352	.363
10	.305	.315	.336	.340	.281	.380	.384
30	.264	.301	.318	.304	.450	.292	.326
50	.302	.219	.206	.185	.219	.260	.340
70	.163	.146	.175	.142	.168	.204	.259
100	.112	.101	.115	.121	.116	.129	.124
120	.095	.101	.112	.127	.102	.119	.101
140	.087	.089	.112	.124	.113	.108	.095
160	.087	.089	.107	.130	.108	.101	.089
180	.089	.098	.101	.136	.108	.094	.084
200	.089	.095	.098	.112	.108	.101	.084
220	.095	.095	.098	.104	.105	.101	.089
240	.095	.095	.098	.104	.105	.101	.092
260	.098	.098	.095	.095	.108	.106	.092
280	-	-	.092	.095	.108	.106	.095
300	-	-	.089	-	.096	-	-

6. STD observation

by

Toshisuke Nakai and Hirotaka Otake

STD observations using a HYTECH Model 9006 Salinity Temperature Depth Data Acquisition System were carried out three times for the study of the vertical distributions of salinity and temperature combined with Nansen casts in KUROSHIO and OYASHIO region. (The operation log is shown in Table 24.)

The STD was also operated to investigate the influence of the noises, caused by ON-OFF operations of balancing motor switch and by the trigger pulse switch for Rosette Multi Sampler (Model RMS-12). The signal was collected continuously on a FACOM 270620 Computer system. The noise of only the trigger pulse switch exerted a bad influence on it.

Table 24 Location of STD Observation

Station No.	Lowering No.	Date	Time	Lat.	Long.	Lowering depth
11	1	Jun. 28	03:32-05:40	28-27.0'N	144-59.1'W	1000 m
11	2	Jun. 28	17:20-17:47	28-27.7'	145-03.0'	30 m
19	3	Jul. 24	06:10-09:19	44-00.0'	153-55.5'	1000 m

7. Chemical studies on major and minor components and radioactive nuclides

by

S. Tsunogai, K. Kido and Y. Nozaki

1) Major ions in sea water

Among major ions in sea water, calcium and potassium have the largest tendency to deviate from the mean composition of sea water. We intend to clarify the variation of sea salt composition by the analyses of calcium, potassium and chlorinity and the determination of conductivity. From the Nansen bottles, 180 samples were collected. Calcium is to be determined by the method of Tsunogai et al. (1968). Exact and rapid analytical methods of potassium and chlorinity are now under consideration.

2) Iodine

To know the factor controlling the concentration of iodide which is a thermodynamically unstable form of iodine in oxygenated sea water, 220 sea water samples were obtained.

The determination of iodide and iodate are done by the method of Tsunogai (1971).

3) Inorganic components in particulate matter

Seston in sea water is studied by means of its inorganic components. Each 10 liters of duplicate samples was filtered through Millipore type HA (pore size, $0.45\ \mu$) filter. The filters were boiled, dried and weighed before the filtration. We got 88 samples during the cruise. Following quantities are to be determined for particulate matter on the filter; dry weight, ash weight and the concentrations of sodium, magnesium, potassium, calcium and chloride in ash divided into three fractions. They are water soluble (salts), acid soluble (carbonates) and acid insoluble (silicates) fractions.

4) Lead-210 and polonium-210

A chief purpose of this study is to use these nuclides as tracers of particulate matter in sea water. These nuclides were coprecipitated with calcium carbonate from 30-50 l of sea water samples. After separation of polonium from lead by using bismuth as a carrier, its activity is counted. The amount of ^{210}Pb is determined by the activity of its daughter. From the two stations, 161 samples were obtained including 24 samples from the bottom water.

5) Radioactive tracers for the water movement

The two radioactive nuclides, ^{14}C (half life, 5570 yr.) and ^{226}Ra (half life, 1620 yr.), are considered to be good tracers for investigation of circulation or mixing of water masses. Radiocarbon was extracted from acidified sea water of 100 l and fixed in alkaline solution as sodium carbonate. The apparatus was similar to that of Fonselius and Östlund (1959). Radium was coprecipitated with carbonate from 20 l of sea water. The activity of radium is counted after the separation of radium from other alkaline-earth metals. The number of samples obtained amounts to 25 for ^{14}C and 75 for ^{226}Ra .

6) Chemical nature of bottom water

To investigate the interaction between the ocean bottom and overlying sea water, bottom water samples were obtained by Van Dorn type samplers (25 l) with the aid of a sonar pinger fastened to the end of the wire. The lowest sampler was affixed 2-4 m above the sonar pinger. Other four samplers were attached to the wire at intervals of 5-150 m. We tried four casts and obtained water 3-8 m above the bottom. The water samples were subjected to analyses of salinity, dissolved oxygen, nitrate, nitrite, ammonia, phosphate, silicate, pH, alkalinity, calcium, iodine, inorganic components in particulate, ^{210}Pb , ^{226}Ra , ^{13}C and dissolved organic carbon.

7) Chemical composition of maritime aerosol

To detect continental aerosol in the air over the ocean, the air was sucked in and aerosols were collected on filters or in water. Millipore type HA (pore size, $0.45\ \mu$) and type VC ($0.1\ \mu$) filters were used. 12 samples were obtained for each filter and water dissolving aerosols. The samples were weighed and ashed. The ash was divided into two fractions, water soluble and water insoluble fractions. The latter was dissolved by the fluoric acid treatment. These solutions are analyzed for sodium, magnesium, potassium, calcium, chloride and sulfate.

8. Studies on radioactive and stable nuclides

by

E. Matsumoto

(1) Tritium concentration in the upper layer

Tritium concentration profile in the upper layer would give us information on mixing process of sea water below mixed layer. For tritium analysis 53 samples, 10 liter each, were collected from various depths down to 400 m at intervals of approximately 25 m. The samples collected were stored in polyethylene bottles.

(2) Stable isotope ratios of dissolved inorganic carbon

^{13}C values of oceanic inorganic carbon would be a good tracer for studying carbon cycle in the ocean. Especially ^{13}C would give us information on contribution of particulate organic carbon and carbonate to abyssal dissolved inorganic carbon. A total of 55 samples was collected by Van Dorn samplers from various depths. Shortly after arrival on deck, parts of the contents were drained into 250 milliliter polyethylene bottles. Small amount of HgCl_2 were added to prevent bacterial activity.

(3) ^{238}U - ^{234}Th disequilibrium in the sea water

^{234}Th (half-life = 24.1 days) injected in situ within the ocean by the alpha-decay of ^{238}U which uniformly distributes in the sea water is adsorbed on suspended particles and settling. Therefore ^{238}U - ^{234}Th disequilibrium in the upper layer of the ocean would be expected. The vertical distribution of ^{234}Th concentration would be governed by eddy diffusion, particle settling velocity, radioactive decay and production from ^{238}U . ^{234}Th is therefore a good tracer for studying such physical phenomena.

To a depth of 200 meters the sampling interval was generally 25 meters.

^{234}Th concentration was determined in profile samples on board ship.

9. Vertical distribution of ^{13}C in sea water

by

N. Handa and N. Nakai

Measurement of ^{13}C content in sea water is a useful method to estimate how much of ΣCO_2 in deep water is originated from oxidation of organic matter.

The samples were collected from 36 water layers from the surface down to 5,500 m depth at the stations 11 and 19. Immediately after its arrival on deck, the sea water was transferred to 3 glass bottles (250 ml). After filling, 0.5 g of solid mercuric chloride were added to the bottle. The bottles were stored in darkness at 5° . ^{13}C was analysed by mass spectrometric method.

10. Dissolved and particulate organic matter

by

Nobuhiko Handa and Katsuji Matsunaga

The distribution and composition of dissolved and particulate organic materials in the ocean were studied for the better understanding of organic fertility in the ocean (Tables 25-27).

Particulate material was collected onto glass filter by filtration of sea water samples collected from 22 water layers from the surface through 5,000 m depths. Organic carbon, carbohydrate, protein and amino acid, lipid and chlorophyll a were analysed.

Dissolved organic compounds such as carbohydrate, protein and amino acids lipid and carboxylic acid were analysed by using sea water samples filtered through glass fiber filter.

11. Chemical studies on organic compounds of marine particulate matter

by

N. Handa

At stations 11 and 19, ca 210 kl of sea water samples were taken from the surface and

Table 25. Composition of particulate organic matter at Sta. 11 (71-6-24)

Depth m	POC μgC/l	PCC μgC/l	PCC/POC %	PPC μgC/l	PPC/POC %	PFC μgC/l	PFC/POC %	PWCC μgC/l	PWCC/PCC %
0	95.1	5.71	6.00	14.3	15.0	3.20	3.36	2.40	43.0
10	66.7	3.62	5.43	12.0	18.0	5.21	7.81	1.37	37.8
20	107	8.61	8.05	37.0	34.5	4.76	4.45	3.16	36.7
30	68.5	4.95	7.23	23.4	34.2	4.63	6.76	2.13	43.0
50	27.2	1.94	7.13	7.70	28.3	6.76	24.9	1.83	94.3
75	31.7	1.90	5.99	7.12	22.4	4.16	13.1	0.80	42.1
100	44.7	3.16	7.07	9.83	22.0	2.86	6.40	0.88	27.8
125	30.8	2.06	6.69	5.60	18.2	4.26	13.8	0.57	27.7
150	25.4	0.80	3.15	5.60	22.0	2.56	10.1	0.00	0.0
175	20.2	2.36	11.7	5.94	29.4	1.68	8.32	0.00	0.0
200	33.8	3.12	9.23	3.89	11.5			0.08	2.6
300	29.0	2.36	8.14	5.32	18.4	1.03	3.55	0.00	0.0
500	37.4	1.90	5.08	1.90	5.08	1.53	4.09	0.19	10.0
648	39.5	2.78	7.04	8.40	21.3	0.93	2.35	0.11	4.0
925	42.3	1.75	4.14	5.13	12.1	1.63	3.85	0.00	0.0
1385	24.8	0.38	1.53	1.42	5.73	1.35	5.44	0.00	0.0
1844	43.5	3.20	7.36	4.75	10.7	0.93	2.14	0.00	0.0
2304	57.7	2.78	4.82	5.70	9.88	1.20	2.08	0.00	0.0
2764	30.2	1.94	6.42	7.83	25.9	2.73	9.04	0.61	31.4
3207	22.9	3.09	13.5	2.85	12.5	2.28	9.96	0.69	22.3
4122	54.9	3.09	5.63	6.17	11.2	2.30	4.19	0.57	18.4
5037	42.3	5.33	12.6	3.80	8.98	2.61	6.17	0.30	5.6

Table 26. Composition of particulate organic matter at Sta. 11 (71-6-29)

Depth m	POC μgC/l	PCC μgC/l	PCC/POC %	PPC μgC/l	PPC/POC %	PFC μgC/l	PFC/POC %	PWCC μgC/l	PWCC/POC %
0	111	7.89	7.11	12.1	10.9	4.16	3.75	3.43	43.5
10	82.1	7.05	8.59	17.2	21.0	2.63	3.20	3.85	54.6
20	93.9	7.47	7.96	18.5	19.7	2.88	3.07	3.35	44.8
30	95.1	6.02	6.33	14.1	14.8			3.73	62.0
50	81.5	6.10	7.48	15.3	18.8	6.24	7.66	3.43	56.2
75	103	5.41	5.25	21.8	21.2	11.0	10.7	3.16	58.5
100	86.3	2.36	2.73	10.4	12.1	5.51	6.38	1.41	59.7
125	89.1	1.79	2.01	7.83	8.79	4.36	4.89	0.57	31.8
150	80.0	6.70	8.38	17.4	21.8	3.01	3.76	0.53	7.9
175	101	2.82	2.79	8.55	8.47	2.63	2.60	0.61	21.6
200	51.0	3.62	7.10	9.97	19.5	1.80	3.53	0.30	8.3
300	40.8	6.10	15.0	14.2	34.8	1.25	3.06	0.19	3.1
500	59.2	2.59	4.38	8.07	13.6	2.93	4.95	0.00	0.0
649	81.5	6.25	7.67	12.4	15.2	1.23	1.51	0.30	4.8
925	84.5	8.76	10.4	14.2	16.8	1.88	2.22	0.72	8.2
1385	63.4	3.12	4.92	9.01	14.2	1.60	2.52	0.00	0.0
1873	78.5	8.53	10.9	13.8	17.6	2.05	2.61	0.50	5.9
2341	94.5	4.95	5.24	27.5	29.1	2.48	2.62	0.30	6.1
2808	61.9	4.65	7.51	12.3	19.9	3.63	5.86	0.42	9.0
3183	62.8	6.32	10.1	7.36	11.7	3.61	5.75	1.14	18.0
4091	93.9	9.56	10.2	16.8	17.9	2.51	2.67	1.14	11.9

Table 27. Composition of particulate organic matter at Sta. 19

Depth m	POC $\mu\text{gC/l}$	PCC $\mu\text{gC/l}$	PCC/POC %	PPC $\mu\text{gC/l}$	PPC/POC %	PFC $\mu\text{gC/l}$	PFC/POC %	PWCC $\mu\text{gC/l}$	PWCC/PCC %
0	119	14.2	11.9	33.3	28.0	11.1	9.33	7.03	49.6
10	138	14.9	10.8	35.2	25.5	12.1	8.77	9.10	61.1
20	138	20.3	14.7	45.1	32.7	17.5	12.7	7.91	39.0
30	119	10.1	8.49	34.2	28.7	12.5	10.5	5.33	52.8
50	80.1	8.46	10.6	22.9	28.6	6.39	7.98	5.65	66.8
75	145	11.7	8.07	15.7	10.8	4.31	2.97	3.01	25.7
100	104	9.55	9.18	10.6	10.2	2.56	2.46	3.07	32.1
125	96.6	4.80	4.97	9.74	10.1	3.46	3.58	1.51	31.5
150	103	4.80	4.66	10.6	10.3	3.73	3.62	0.94	19.6
175	93.2	2.29	2.46	14.3	15.4	3.06	3.28	1.07	46.7
200	91.3	1.37	1.50	5.22	5.71	1.85	2.03	0.88	64.2
300	90.1	5.94	6.60	18.0	20.0	2.38	2.64	2.32	39.1
500	80.0	0.46	0.575	19.5	24.4	1.80	2.25	0.75	163.0
639	87.9	1.83	2.08	7.72	8.79	1.70	1.93	0.31	16.9
910	93.2	3.89	4.17	10.9	11.7	1.45	1.56	0.63	16.2
1363	87.9	2.15	2.45	7.36	8.37	2.13	2.43	0.31	14.4
1843	66.0	6.49	9.84	11.9	18.0	2.63	3.98	0.31	4.8
2303	81.1	0.91	1.12	4.98	6.15	3.01	3.71	0.50	54.9
2763	92.4	3.75	4.06	7.24	7.83	2.76	2.99	0.31	8.3
3119	126	3.47	2.75	12.2	9.69	2.56	2.03	1.44	41.5
3565	106	2.51	2.37	9.49	8.95	3.53	3.33	0.31	12.4
4455	53.4	2.74	5.13	8.43	15.8	2.78	5.21	0.31	11.3

1,000 m depth and filtered through glass fiber filter to collect particulate matter.

Carbohydrate, protein and lipid were separated by various chromatographic technics.

Chemical nature of carbohydrate was determined by periodate oxidation, end-group assay, Smith's degradation, methylation technique and monosaccharide composition. Protein was further fractionated by disc-chromatography. Each of the fractions was analysed for the determination of amino acid composition.

Physico-chemical nature was also determined. Glyceride fractions of lipid was mainly examined. Isolation of glycerides was conducted by thin layer chromatography. Each of the glycerides was analysed for the determination of fatty acid composition and molar ratio of fatty acid and glycerin.

The chemical natures of carbohydrate, protein and lipid isolated from the particulate materials from two different depth were compared, and decomposition processes of particulate organic materials during the sinking of the particulate matter from the surface to the depth were investigated.

12. Production of organic materials by the photosynthetic reaction of phytoplankton
by

N. Handa and K. Matsunaga

At the station 11 and 19, production of various organic components of phytoplankton by the photosynthetic reaction was examined, using tracer technique, with the sea water samples obtained from various depth down to 150 m by in situ and tank methods. ^{14}C labeled organic materials produced by the photosynthetic reaction were fractionated into mono- and oligo-saccharides, β -glucan, hemicellulose, protein and amino acids and lipid by various chromatographic techniques.

Production rate of these organic compounds by the photosynthesis of phytoplankton was estimated on the basis of the increase in the radioactivity of these compounds with time.

13. Distribution of dissolved organic carbon

by

Tadashi Ochi and Tomotoshi Okaichi

Seawater samples were collected with Nansen samples at Sts. 11, 14 and 19. The samplings of seawater were carried out in duplicate at Sts. 11 and 19. Seawater was filtered through Whatman GF83 glass fiber filter immediately after sampling and dissolved organic carbon was determined by the method of Menzel and Vaccaro with some modifications.

Two hundred mg of potassium persulphate, 5 ml of sample, and 0.25 ml of 3 % phosphoric acid were added in a 10-ml ampoule. After removing inorganic carbonate, the ampoules were sealed on board. Organic carbon in the water was oxidized to carbon dioxide by heating the sealed ampoule at 121°C for 60 min. This carbon dioxide was determined in the laboratory by using an infrared absorption gas analyzer. The analytical data of dissolved organic carbon in seawaters shown in tables 8-11.

14. Variation of inorganic nitrogenous compounds with special reference to biochemical processes, and natural ^{15}N abundance in nitrate and net-samples

by

E. Wada, T. Miyazaki and A. Hattori

(1) Assimilation of ammonia, nitrite and nitrate

Potential activities of inorganic nitrogen assimilation were measured using the sea water samples obtained from various depths down to 200 m at Stas. 11 and 19. Incubations were carried out for several hours on board ship both in an incubater (12,000 lux, 20°C) and in a surface water cooled tank on deck (exposed to natural sun-light) in the presence of 10 μg at.-N/l. of ^{15}N -labeled ammonia, nitrite or nitrate.

(2) Production of nitrite from ammonia and nitrate

Rates of ammonia oxidation and nitrate reduction were estimated with the same samples as those used for assimilation experiments using ^{15}N tracer technique. The contribution of the nitrate reduction to the nitrite production was higher in the samples collected from Sta. 19 where several μg at.-N/l. of nitrate were found throughout euphotic layer than in those from Sta. 11. The variation of nitrite content during the incubation ranged from 0.0000 to 0.01 μg at.-N/l./hr.

(3) The residence time of inorganic nitrogenous compounds

1.0 μg at.-N of ^{15}N -labeled ammonia, nitrite and nitrate were introduced into 1.0 liter sample waters collected from surface to 200 m, and the samples were incubated at 20°C in dark or light (12,000 lux). After 3, 6, 9 and 20 hours' incubation, aliquots of samples (ca. 100 ml) were removed and filtered through a Millipore filter (HA 0.45 μ). The filtrates were frozen for mass spectrometric analysis.

(4) Natural ^{15}N abundance in nitrate and net samples

Sea water samples for analysis of $^{15}\text{N}/^{14}\text{N}$ ratio of nitrate were collected from eighteen layers (surface to bottom). The nitrate in sea water samples was concentrated on board ship approximately four-fold by repetition of freezing and thawing (40 to 10 liter). These samples were stored in frozen state. A P56 net with 0.1 mm mesh filtering cloth was vertically hauled from an estimated depth of 50 m upward to the surface. Samples will be used for $^{15}\text{N}/^{14}\text{N}$ analysis and isolation of nitrate reductase.

15. Studies on marine heterotrophic bacteria with special reference to nitrate reduction and nitrate assimilation

by

I. Koike and A. Hattori

(1) Experimental research

The effects of anoxic condition on the rate of the reduction of nitrate to nitrite and assimilation of nitrate were examined using water samples collected from 20 m to 50 m depths at St. 19. The samples were incubated under both aerobic and anaerobic condition in the dark at about 10°C. Anaerobic state was achieved by bubbling the waters with oxygen-free argon for 30 minutes. Control samples were bubbled with air.

The effects of ammonia, amino acids, organic acid, and carbohydrates on the rate of nitrate assimilation were also examined with the water samples collected from the euphotic layers at St. 11 and St. 19.

(2) Bacteriological examination

The same water samples were filtered through a sterile Millipore filter (HA-47 mm). The inoculated filters were placed on the agar plates of Medium 2216E and incubated at about 10°C for a month. Fifty isolated colonies were collected at random and transferred to agar slants of the same medium.

Physiological characters of these isolates were examined with respect to aerobic and anaerobic glucose degradation (Leifson, 1963), nitrite production, nitrogen gas production, and anaerobic nitrate respiration (Komagata et al., 1965).

16. Marine Microbiological Studies

by

H. Seki and I. Koike

As a microbiological study within the general framework of the KH 71-3 cruise, the role of microorganisms in the cycling of substances in the ocean was studied. The main purpose of this study was to quantify various pathways in the microbial ecosystem leading up to the dynamics of biological elements in the sea.

Microbiological analyses

Total bacteria, microbial aggregates, heterotrophic bacteria: Determined after the procedures of Seki (1970). Pacific Science, 24(2), 269-274. (Tables 28-32).

Respiration: Determined after the method of Seki (1968). J. Fish. Res. Board Canada, 25(4), 625-637.

Assimilation of organic matter: Determined after the method of Wright and Hobbie (1965). Limnol. Oceanogr, 10, 22-28.

Mineralization of organic matter: Determined after the method of Nuclear-Chicago (1966). Liquid Scintillation Counting. Publication No. 711580. 32pp.

The results are summarized in Tables 28-44.

DNA: Determined after the method of Strickland and Parsons (1968). A Practical Handbook of Seawater Analysis. Fisheries Research Board of Canada, Bulletin 167. 311pp. (Tables 8-11).

Table 28. Total bacteria, bacterial aggregates and heterotrophic bacteria (Western North Pacific Central Water)

Station 11 (N1) Date: June 24, 1971

Depth* m	Total bacteria** (clumps/ml)	Aggregates+ (clumps/ml)	Heterotrophic bacteria (clumps/100ml)
0	3.2x10 ³	6.4x10	1200
10	5.8x10 ³	1.9x10 ²	1200
20	2.9x10 ³	4.5x10 ²	1200
30	4.1x10 ⁴	1.9x10 ²	1100
49	1.2x10 ³	1.3x10 ²	610
74	5.1x10 ²	6.4x10	460
98	9.0x10 ²	0	660
123	7.7x10 ²	2.6x10 ²	200
147	2.7x10 ⁴	4.5x10 ²	280
172	1.4x10 ⁴	1.9x10 ²	170
196	2.3x10 ³	2.6x10 ²	230
245	2.6x10 ²	0	250
293	4.7x10 ³	1.9x10 ²	150
341	1.2x10 ³	1.3x10 ²	130
389	2.4x10 ⁴	3.2x10 ²	100
438	3.1x10 ³	6.4x10	120
474	9.0x10 ²	1.3x10 ²	270
567	5.7x10 ³	6.4x10	150
660	1.9x10 ²	6.4x10	82
753	9.0x10 ²	7.0x10 ²	120
846	9.0x10 ²	6.4x10 ²	-
939	6.4x10 ²	1.9x10 ²	75
1033	2.9x10 ³	1.3x10 ³	-
1126	1.2x10 ³	5.8x10 ²	33
1314	3.6x10 ⁴	1.9x10 ²	3
1407	5.8x10 ²	6.4x10	32
1547	3.8x10 ²	1.3x10 ²	43
1688	2.6x10 ²	1.3x10 ²	28
1831	4.5x10 ²	3.8x10 ²	61
2417	1.9x10 ³	1.9x10 ³	22
2656	1.0x10 ³	1.3x10 ²	3
2895	8.3x10 ²	6.4x10	52
3132	7.7x10 ²	2.6x10 ²	41
3604	1.2x10 ³	1.0x10 ³	12
4123	1.3x10 ³	3.8x10 ²	110
4408	7.7x10 ²	6.4x10	48
4695	9.0x10 ²	0	10
5548	1.7x10 ³	1.3x10 ³	10

*: Sample number

** : Enumerated by direct microscopy.

+: Both free-living and clumping bacteria.

++ : Enumerated by direct microscopy.

‡: Aggregates having bacterial cells more than 25.

‡: Enumerated by Medium 2216.

Table 29. Total bacteria and bacterial aggregates (Western North Pacific Central Water)

Station 11 (N2) Date: June 28, 1971

Depth* m	Total bacteria** (clumps/ml)	Aggregates+ (clumps/ml)
0	3.1x10 ³	6.4x10
10	6.1x10 ³	1.9x10 ²
19	1.5x10 ⁴	2.6x10 ²
28	9.5x10 ³	0
47	2.4x10 ⁴	5.7x10 ²
70	8.3x10 ²	2.6x10 ²
94	8.3x10 ²	0
117	4.9x10 ³	1.3x10 ²
140	7.9x10 ³	6.4x10
164	1.6x10 ⁴	1.3x10 ²
187	3.1x10 ³	1.3x10 ²
233	5.1x10 ²	6.4x10
279	6.3x10 ³	6.4x10
325	5.1x10 ²	6.4x10
372	5.4x10 ³	1.3x10 ²
419	5.7x10 ³	6.4x10
464	1.8x10 ³	1.9x10 ²
556	3.8x10 ³	0
651	2.2x10 ³	6.4x10
744	1.0x10 ⁴	1.9x10 ²
838	5.7x10 ³	6.4x10
932	1.5x10 ³	1.9x10 ²
1026	5.8x10 ³	1.7x10 ³
1120	2.6x10 ³	1.3x10 ²
1215	7.7x10 ²	0
1309	2.2x10 ⁴	4.5x10 ²
1403	1.1x10 ³	1.3x10 ²
1686	9.0x10 ³	0
1828	2.0x10 ³	3.8x10 ²
2158	5.1x10 ²	6.4x10
2350	4.4x10 ³	1.9x10 ²
2387	3.5x10 ³	5.1x10 ²
2823	5.1x10 ²	0
3056	5.7x10 ³	3.2x10 ²
3751	1.2x10 ³	6.4x10
4028	2.6x10 ³	0
4305	5.8x10 ²	0
4858	9.6x10 ²	0
5415	2.3x10 ³	1.3x10 ²

Table 30. Total bacteria, bacterial aggregates and heterotrophic bacteria (Subarctic Pacific Water)

Station 19 (N1) Date: July 18, 1971

Depth* m	Total bacteria** (clumps/ml)	Aggregates+ (clumps/ml)	Heterotrophic bacteria (clumps/100ml)
0	4.5x10 ³	0	1100
11	4.2x10 ³	1.9x10 ²	800
21	1.5x10 ³	6.4x10	1300
30	2.0x10 ³	6.4x10	620
48	1.4x10 ⁴	4.5x10 ²	3700
71	2.5x10 ³	3.2x10 ²	120
94	2.8x10 ³	1.3x10 ²	40
117	7.0x10 ²	0	80
139	1.3x10 ⁴	1.3x10 ²	50
162	2.2x10 ³	0	10
184	1.4x10 ⁴	1.9x10 ²	20
229	1.7x10 ⁴	2.6x10 ²	10
275	6.1x10 ³	0	20
321	1.0x10 ³	0	260
368	2.2x10 ⁴	3.2x10 ²	40
416	4.0x10 ⁴	5.1x10 ²	580
430	3.8x10 ²	0	76
517	1.9x10 ²	0	8
602	2.6x10 ³	6.4x10	40
687	2.2x10 ³	0	28
770	1.6x10 ³	3.8x10 ²	12
855	1.5x10 ³	6.4x10	12
938	1.0x10 ³	0	32
1022	7.0x10 ²	4.5x10 ²	44
1106	1.1x10 ³	2.6x10 ²	12
1190	2.8x10 ³	1.3x10 ²	44
1276	3.0x10 ³	1.9x10 ²	330
1360	4.0x10 ³	1.9x10 ²	44
1626	1.6x10 ⁴	2.6x10 ²	28
1830	4.2x10 ³	6.4x10	10
2015	5.2x10 ³	1.9x10 ²	2
2198	2.5x10 ³	6.4x10	4
2567	1.0x10 ³	6.4x10	18
2750	1.3x10 ³	0	10
2935	6.2x10 ³	1.9x10 ²	8
3118	4.0x10 ³	4.5x10 ²	2
3347	2.2x10 ³	2.6x10 ²	<1
3807	3.1x10 ³	1.9x10 ²	<1
4038	5.1x10 ²	6.4x10	<1
4267	9.0x10 ²	0	3
4498	1.0x10 ⁴	3.2x10 ²	1

Table 31. Total bacteria and bacterial aggregates (Subarctic Pacific Water)

Station 19 (N2) Date: July 22, 1971

Depth* m	Total bacteria** (clumps/ml)	Aggregates+ (clumps/ml)
0	4.9x10 ³	0
10	7.3x10 ³	1.3x10 ²
19	1.8x10 ³	6.4x10
28	3.1x10 ³	6.4x10
45	1.2x10 ⁴	3.8x10 ²
67	1.2x10 ³	3.8x10 ²
90	3.3x10 ³	6.4x10
112	2.3x10 ³	6.4x10
134	8.4x10 ³	2.6x10 ²
157	4.8x10 ³	1.3x10 ²
180	1.4x10 ⁴	1.9x10 ²
226	7.5x10 ³	0
272	5.0x10 ³	3.8x10 ²
318	2.2x10 ³	6.4x10
365	2.7x10 ⁴	6.4x10
412	2.2x10 ⁴	3.2x10 ²
449	1.7x10 ³	0
539	4.5x10 ²	0
629	5.1x10 ²	0
720	1.9x10 ²	0
810	2.0x10 ³	5.1x10 ²
900	3.8x10 ²	0
990	5.1x10 ²	0
1080	3.8x10 ²	0
1170	1.2x10 ³	0
1261	3.2x10 ³	6.4x10
1352	6.0x10 ³	3.2x10 ²
1443	4.9x10 ³	1.3x10 ²
1578	1.1x10 ³	2.6x10 ²
1713	1.1x10 ⁴	2.6x10 ²
1810	3.1x10 ³	6.4x10
1992	7.4x10 ³	2.6x10 ²
2175	3.3x10 ³	1.9x10 ²
2357	9.0x10 ²	1.3x10 ²
2719	2.4x10 ³	6.4x10
2947	8.2x10 ³	2.6x10 ²
3171	3.0x10 ³	0
3396	7.0x10 ²	0
4307	4.6x10 ³	3.2x10 ²
4536	3.9x10 ³	1.9x10 ²
4811	4.5x10 ²	1.3x10 ²

Table 32. Total bacteria and bacterial aggregates
(E sampling)

Depth m	Total bacteria* (clumps/ml)	Aggregates** (clumps/ml)
Station 11		
50m(E1)	3.8x10 ⁴	5.1x10 ²
50m(E5)	1.3x10 ⁴	2.6x10 ²
100m(E5)	1.1x10 ³	6.4x10
Pinger1 (6m from bottom)	3.0x10 ²	5.2x10
Pinger2 (11m from bottom)	2.6x10 ²	0
Pinger3 (20m from bottom)	1.7x10 ³	1.3x10 ²
Pinger4 (43m from bottom)	9.6x10 ²	0
Pinger5 (66m from bottom)	4.5x10 ²	6.4x10
Pinger6 (88m from bottom)	3.8x10 ²	0
Station 12 (The Kuroshio Current)		
50m	3.8x10 ²	6.4x10
Station 19		
0m(E1)	1.2x10 ³	0
5m(E2)	2.3x10 ³	0
10m(E5)	9.0x10 ²	6.4x10
15m(E5)	1.0x10 ³	0
20m(E1)	1.2x10 ³	0
20m(E3)	1.5x10 ³	3.2x10
30m(E1)	1.7x10 ³	6.4x10
50m(E7)	7.4x10 ³	1.9x10 ²
75m(E7)	4.5x10 ²	0
Pinger (bottom)	1.5x10 ³	3.2x10

Table 33. Assimilation of organic matter by microorganisms
in seawater (Western North Pacific Central
Water) at Sta. 11 (E6)

Depth m	Glucose uptake* (μ gC / m ³ per hr)	Uptake of protein hydrolysate** (μ g / m ³ per hr)	Date: June 30, 1971 Depth: Vertical profile
0	1.49	22.0	
10	1.07	24.2	
20	1.27	23.9	
30	0.709	25.5	
50	1.32	23.2	
75	1.01	20.1	
100	0.404	18.3	
125	0.412	17.8	
150	0.678	17.4	

Carrier added to the sample

*: 250 mg C glucose / m³

**: 5,000 mg protein hydrolysate / m³

Table 34. Respiration by the microorganisms in seawater at
Sta. 11 (E6)

Depth m	Respiration* / Glucose***	Assimilation**(%) Protein Hydrolysate****
0	171	47.0
10	177	43.7
20	108	50.2
30	199	55.3
50	307	35.7
75	301	37.9
100	107	16.8
125	151	14.8
150	179	16.4

*: Carbon dioxide released from each substrate into
seawater

**: Net assimilation of protein hydrolysate

***: Carrier added: 250 mg C glucose per cubic meter

****: Carrier added: 5,000 mg protein hydrolysate per
cubic m.

Table 35. Assimilation of organic matter by microorganisms in seawater
(Western North Pacific Central Water) at Sta. 11 (E2)

Date: June 26, 1971
Depth: 50 m

Substrate	(Kt + Sn) (mg/m ³)	Tt (hr)	V (μg / m ³ per hr)
Aspartic acid	47	14,000	3.36
Glutamic acid	94	10,600	8.87
Glycine	182	29,700	6.13
Alanine	8.7	3,900	2.23
Lysine	23	6,900	3.33
Glucose	84	20,900	4.02
Galactose	146	32,400	4.51
Protein Hydrolysate	429	11,900	36.1

Kt: transport constant

Sn: in situ substrate concentration

Tt: the time requirement for complete removal of natural substrate (Sn)

V: maximum attainable rate of uptake

Table 36. Assimilation of organic matter by microorganisms in seawater
(Western North Pacific Central Water) at Sta. 11 (E3)

Date: June 27, 1971
Depth: 100 m

Substrate	(Kt + Sn) (mg/m ³)	Tt (hr)	V (μg / m ³ per hr)
Aspartic acid	42	10,900	3.85
Glutamic acid	98	14,300	6.85
Glycine	114	17,100	6.67
Alanine	17	6,800	2.50
Lysine	9.8	6,100	1.61
Glucose	31	14,200	2.18
Galactose	224	44,900	4.99
Protein Hydrolysate	1,140	39,800	28.6

Table 37. Assimilation of organic matter by microorganisms in seawater
(The Kuroshio current) at Sta. 12 (E2)

Date: July 3, 1971
Depth: 50 m

Substrate	(Kt + Sn) (mg/m ³)	Tt (hr)	V (μg / m ³ per hr)
Aspartic acid	42	8,200	5.12
Glutamic acid	23	2,400	9.58
Glycine	21	2,600	8.08
Alanine	32	3,800	8.42
Lysine	14	4,600	3.04
Glucose	22	4,600	4.78
Galactose	32	4,600	6.96
Protein Hydrolysate	360	4,400	81.8

Table 38. Assimilation of organic matter by microorganisms in seawater
(Subarctic Pacific Water) at Sta. 19 (E6)

Date: July 24, 1971
Depth: Vertical profile

Depth (m)	Glucose uptake* ($\mu\text{gC}/\text{m}^3$ per hr)	Uptake of protein hydrolysate** ($\mu\text{g} / \text{m}^3$ per hr)
0	3.73	39.3
5	4.16	40.4
10	4.04	97.1
15	4.49	65.5
20	4.49	82.1
30	3.84	80.5
50	0.381	19.2
75	0.556	29.3

Carrier added to the sample

*: 250 mg C glucose per m^3

**: 5,000 mg protein hydrolysate per m^3

Table 39. Respiration by the microorganisms in seawater at Sta. 19 (E6)

Depth (m)	Respiration* / Glucose***	Assimilation**(%) Protein Hydrolysate****
0	94.0	7.3
5	51.5	5.0
10	67.6	2.6
15	32.7	4.4
20	79.3	19.9
30	76.4	24.1
50	74.2	24.3
75	26.2	29.7

* : Carbon dioxide released from each substrate into seawater

** : Net assimilation of protein Hydrolysate

*** : Carrier added; 250 mg C glucose per cubic meter

**** : Carrier added; 5,000 mg protein hydrolysate per cubic meter

Table 40. Assimilation of organic matter by microorganisms in seawater
(Subarctic Pacific Water) at Sta. 19 (E3)

Date: July 21, 1971
Depth: 20 m

Substrate	(Kt + Sn) (mg/m^3)	Tt (hr)	V ($\mu\text{g} / \text{m}^3$ per hr)
Aspartic acid	87	8,000	10.9
Glutamic acid	69	3,700	18.6
Glycine	38	3,600	10.6
Alanine	29	2,100	13.8
Lysine	22	2,900	7.39
Glucose	30	2,100	14.3
Galactose	43	3,200	13.4
Protein Hydrolysate	500	3,300	152

Kt: transport constant

Sn: in situ substrate concentration

Tt: the time requirement for complete removal of natural substrate (Sn)

V: maximum attainable rate of uptake

Table 41. Respiration by the microorganisms in seawater

Substrate	Respiration* / Assimilation** (%)			
	Station 11(E2) (50m)	Station 11(E3) (100m)	Station 12(E) (50m)	Station 19(E3) (20m)
Aspartic acid	35.9	36.9	35.7	23.7
Glutamic acid	49.3	49.8	31.7	33.9
Glycine	62.8	89.9	37.4	40.9
Alanine	17.8	17.1	26.2	19.9
Lysine	16.0	23.6	21.0	10.9
Glucose	249.4	86.2	72.0	62.3
Galactose	129.3	87.3	49.3	43.5
Protein Hydrolysate	32.8	12.9	44.2	11.9

* Carbon dioxide released into seawater

** Net assimilation. Gross assimilation = Net assimilation + Respiration

Table 42. Respiration measured at Station 11
(Western North Pacific Central Water)

Depth (m)	Respiration (mg O ₂ / m ³ per hr)	Dissolved oxygen* (g O ₂ / m ³)
0	0.375 (E7)	6.699 (E7)
10	0.750 (E7) 0.617 (E7)	6.682 (E7)
30	0.450 (E7) 0.400 (E7)	7.142 (E7)
50	1.03 (E5) 1.46 (E5) 1.22 (E5)	7.431 (E5)
75	0.490 (E7) 0.975 (E7)	7.243 (E7)
100	0.075 (E5) 0.163 (E5)	7.284 (E5)
125	0.565 (E7) 0.510 (E7)	7.104 (E7)
150	0.215 (E7) 0.170 (E7)	7.063 (E7)

* Dissolved oxygen in the sample for the measurement of
respiration when the incubation started

Table 43. Respiration measured at Station 12
(The Kuroshio Current)

Depth (m)	Respiration (mg O ₂ / m ³ per hr)	Dissolved oxygen* (g O ₂ / m ³)
50	0.313 (E)	7.058 (E)
	1.606 (E)	

Table 44. Respiration measured at Sta. 19
(Subarctic Pacific Water)

Depth (m)	Respiration (mg O ₂ / m ³ per hr)	Dissolved oxygen* (g O ₂ / m ³)
0	3.32 (E2)	7.049 (E2)
	2.02 (E2)	
	1.77 (E2)	
	2.22 (E2)	
	1.88 (E2)	
5	0.483 (E2)	6.932 (E2)
	0.242 (E2)	
	0.528 (E2)	
	1.26 (E2)	
10	1.28 (E5)	6.967 (E5)
	1.59 (E5)	
	1.82 (E5)	
	0.69 (E5)	
15	0.288 (E5)	6.885 (E5)
	0.231 (E5)	
	0.613 (E5)	
	0.875 (E5)	
20	1.89 (E1)	7.403 (E1)
	1.33 (E1)	
	2.90 (E1)	
30	2.10 (E1)	7.798 (E1)
	2.61 (E1)	
50	0.180 (E7)	7.715 (E7)
	0.543 (E7)	
75	0.643 (E7)	7.644 (E7)
	0.667 (E7)	

* Dissolved oxygen in the sample for the measurement of
respiration when the incubation started

17. Chlorophyll distribution and photosynthetic activity

by

Nobutada Nakamoto

For the estimation of phytoplankton biomass and its activity, the water samples were collected from various depth (from surface to 200 m) at stations 11 and 19.

The samples are filtered through Whatman GF/C filters immediately after sampling, and the amounts of chlorophyll a and pheophytin a were determined on board ship by a fluorometric technique. Another set of filters was stored in frozen state to determine the amount of chlorophylls by a colorimetric technique.

The photosynthetic activity was determined by in situ and tank methods. ^{14}C labelled carbonate was used as a tracer.

Solar radiation was measured by a TOSHIBA PSZ-1 radiation meter which is sensitive to radiations from 380 to 710 nm. Underwater irradiance was measured by a Jerlov's quantum-meter.

For the estimation of nutrient availability for phytoplankton, surface water samplings were done at 27 stations. Salinity, temperature, and the amount of chlorophylls and seston were measured. Filtrate of water samples were frozen for analysis of nutrients and enrichment culture.

18. Study on distribution and metabolism of urea

by

Osamu Mitamura

To extend our knowledge of the distribution and metabolism of urea in the ocean, samplings and experiments were carried out at Sta. 11 and Sta. 19. Water samples taken from various layers were filtered through Whatman type C glass fiber filters, frozen and stored at -20°C . Urea determination was later made in the laboratory by the method of Newell, Morgan and Candy (1967).

Rate of urea decomposition was determined using ^{14}C labelled urea with the samples taken from the euphotic layer. Sample water was poured into one pair of light and dark bottle, and 1 μC of radioactive urea was inoculated in each bottle. These bottles were kept hanged from a buoy from noon to sunset simultaneously with in situ productivity

experiment. Sample water was filtered through a Millipore HA filter. $^{14}\text{CO}_2$ in filtrate was liberated by addition of H_2SO_4 and adsorbed in monoethanolamine using microdiffusion technique. Radioactivity of ^{14}C was determined with a liquid scintillation counter.

19. Dissolved proteinaceous substances in sea water and the utilization of amino acids by microorganisms in aquatic ecosystem

by

Y. Maita

The objective of this study is to collect data on proteinaceous substances dissolved in sea water to make clear the content and the activity of microorganisms which utilize these substances as an energy source. Former is related to the problem of the vertical profile and the amino acid compositions of the proteinaceous substances from surface to deep sea water, and the latter to the problem of the measurement of uptake rate by microorganisms using ^{14}C -labeled amino acids as a substrate (acid hydrolyzate of Chlorella protein). Maximum velocity, affinity constant and turn over time are derived from their kinetics by testing uptake over a wide range of substrate concentrations. The process of decomposition and the uptake rate of several amino acids are also examined with heterotrophic bacteria which were collected at a depth of 50 meters of the observational stations in this cruise.

Samples collected at the various depths were filtered through HA-Millipore filters. Filtered samples were stored in a deep freezer after the treatment of preservation. Total amino acids will be analyzed by gas-chromatographic method at the laboratory of Hokkaido University. On the other hand, the uptake activity of amino acids by heterotrophic organisms were measured with samples collected at the subsurface layers (from surface to 100 meter in depth). Samples were incubated in dark bottles at a controlled temperature. After filtration, the radioactivity of dried filters was measured in a proportional counter. The result of analysis will be published in near future.

20. Size distribution of suspended particles

by

E. Matsumoto and N. Nakamoto

Particle size of suspended particles in seawaters was determined by using a Model B

Coulter Counter fitted with a 100 microns aperture. Calibration was made using mono disperse particles, Ragweed Pollen (19.5 microns). Therefore, only particles greater than 2.56 microns and less than 100 microns were countable. The counts summarized in Tables 45 and 46 represent the numbers of particles per cubic centimeter between upper and lower threshold diameters given.

Table 45. Particle counts at Sta. 11

Depth (m)	Threshold diameter (μ)								
	2.56	3.23	4.06	5.11	6.44	8.12	10.23	12.86	16.22
0	1290	556	234	128	50	30	20	6	
20	1256	506	286	120	36	30	10	4	
30	1062	370	196	112	50	38	10	6	
50	1052	514	228	122	48	28	16	8	
75	1256	622	296	136	42	12	6	6	
100	1040	460	236	114	52	34	12	0	
150	630	236	94	40	16	6	2	6	
200	234	90	36	16	6	2	2	0	
500	216	88	44	16	2	2	2	0	
1000	330	142	52	26	6	2	0	0	

Table 46. Particle counts at Sta. 19

Depth (m)	Threshold diameter (μ)								
	2.56	3.23	4.06	5.11	6.44	8.12	10.23	12.86	16.22
0	3002	2480	1300	544	222	126	36	12	
10	2828	2212	1292	608	244	84	26	6	
20	2782	2144	1334	644	232	72	24	6	
30	2780	1992	1212	568	196	64	20	2	
50	1480	750	312	152	60	18	14	2	
75	670	460	206	174	100	30	24	6	
100	864	450	148	66	30	22	8	2	
125	742	318	132	50	14	4	0	0	
150	744	308	136	42	20	8	6	2	
175	1318	2194	1280	160	24	8	4	2	
200	992	498	228	78	16	6	6	2	
300	858	518	280	92	28	10	2	2	

21. Biogeochemistry of minor elements in suspended matter

by

Toshio Yamamoto and Ryoichi Tokura

It has been presumed that the occurrence of minor elements in suspended matter plays an important role in areal distribution of those elements in World Ocean. However, there is a little amount of information relating to individual suspended matters. We attempted to approach the subject from the comparative view-point of biology and geochemistry.

The suspended matters were separated from 10 liter sea water samples of L-1, L-2, VD-1 and VD-2 with HA Millipore filter. Microscopical examination of the suspended matter samples has been carried out, and the contents of minor elements such as iron and aluminum in the same samples were determined (Tables 8-11).

As reference samples for analysis, marine plankton were collected at stations 11 and 19. The following plankton of individual species were sorted mechanically from the mixed plankton samples; POLYCHETA (1 species), SAGITTOIDEA (3), COPEPODA (15), MALACOSTRACA (2) and UROCHORDATA (2).

Figure 17 shows an example of microscopical figure of the suspended matter on a Millipore filter. The difference between the mineral and organic particulate matter was distinguishable.

Table 47 gives an estimate of the number of particulate matter.

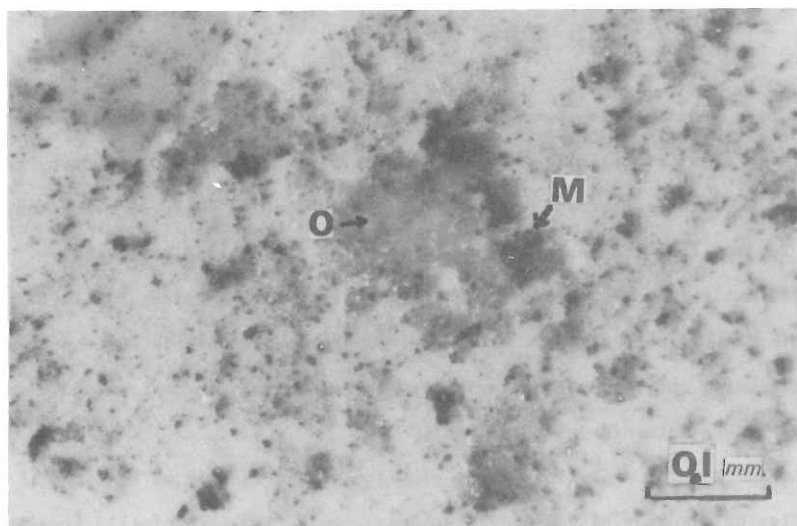


Fig. 17 Photomicrograph of suspended matter on Millipore Filter
(Sample of VD-1 at 2768 m depth in station 11)

M ; Mineral particulate matter

O ; Organic particulate matter

Table 47. Number of mineral and organic particulate matters
(per 100 ml of sea water)

Station	Depth (m)	Mineral matter	Organic matter
11	50	10,600	2,400
	2768	100,000	8,400
19	50	1,700	5,000
	2767	50,000	11,800

22. Diurnal change of vertical distribution and migration of massive species of zooplankton in the northern North Pacific

by

S. B. Lee

The vertical distributions and migrations of zooplankton in the Oyashio and the Kuroshio water were investigated.

The massive species of zooplankton in the Oyashio waters consisted of 3 copepods species (Calanus cristatus, Calanus plumchrus, Eucalanus bungii bungii), of which Calanus plumchrus accounted for more than 90 % in biomass.

The data on diel vertical distribution and migration of massive species of zooplankton now available are given in Table 48. Numerical figures refer to numbers of plankton at indicated stages per a haul. The depths covered by each haul are also indicated.

Table 48. The diel migration of Calanus plumchrus at sta. 19* on 22 July 1971

Depth	Time	cop.1	cop.2	cop.3	cop.4	cop.5	cop.6
0-5	1800	68	142	91	151	982	0
0-5	2000	79	175	105	126	1937	0
0-5	2200	112	130	61	117	241	0
0-5	0000	76	93	68	74	252	0
0-5	0200	61	53	30	60	23	0
0-5	0400	54	20	9	0	2	0
0-5	0900	12	2	0	0	0	0
0-5	1200	0	2	0	0	0	0
0-5	1400	0	1	0	0	0	0
0-5	1630	50	69	46	4	0	0

* Numerical figures refer to numbers of individuals per one haul; Norpac net vertical haul (0-5, 0-10, 0-20, 0-50, 0-100 m); -- location: 44-03.0 N, 154-03.2 E
44-01.9 N, 154-07.0 E

Depth	Time	cop.1	cop.2	cop.3	cop.4	cop.5	cop.6
0-10	1800	49	243	193	409	1297	0
5-10	1800	-19	101	102	258	315	0
0-10	2000	52	235	138	255	1397	0
5-10	2000	-27	60	33	129	-540	0
0-10	2200	182	299	85	200	451	0
5-10	2200	70	169	24	83	200	0
0-10	0000	76	160	117	123	539	0
5-10	0000	0	67	49	49	287	0
0-10	0200	106	107	75	107	87	0
5-10	0200	45	54	45	47	65	0
0-10	0400	138	32	20	58	2	0
5-10	0400	84	12	11	58	0	0
0-10	0900	68	1	0	0	0	0
5-10	0900	56	-1	0	0	0	0
0-10	1200	0	0	0	0	0	0
5-10	1200	0	-1	0	0	0	0
0-10	1400	8	2	0	0	0	0
5-10	1400	-8	-1	0	0	0	0
0-10	1630	64	96	49	5	0	0
5-10	1630	14	27	3	1	0	0

Depth	Time	cop.1	cop.2	cop.3	cop.4	cop.5	cop.6
0-20	1800	52	394	358	580	1885	0
10-20	1800	3	151	166	171	588	0
0-20	2000	70	568	319	542	3487	0
10-20	2000	18	333	186	287	2090	0
0-20	2200	196	570	197	397	675	0
10-20	2200	14	271	112	197	224	0
0-20	0000	64	229	219	256	787	0
10-20	0000	-12	69	102	133	248	0
0-20	0200	18	80	104	158	424	0
10-20	0200	-88	-27	29	50	337	0
0-20	0400	174	110	104	130	182	0
10-20	0400	36	78	84	72	180	0
0-20	0900	77	140	118	237	9	0
10-20	0900	9	139	118	237	9	0
0-20	1200	67	104	112	228	3	0
10-20	1200	67	104	112	228	3	0
0-20	1400	54	117	136	276	19	0
10-20	1400	46	115	136	276	18	0
0-20	1630	71	148	144	158	3	0
10-20	1630	7	52	95	153	3	0

Depth	Time	cop.1	cop.2	cop.3	cop.4	cop.5	cop.6
0-50	1800	22	407	693	682	3400	0
20-50		-30	11	335	102	1515	0
0-50	2000	136	732	660	864	5188	0
20-50		66	64	35	322	1701	0
0-50	2200	103	440	354	417	657	0
20-50		-93	-130	157	20	-20	0
0-50	0000	23	111	338	274	808	0
20-50		-41	118	119	18	21	0
0-50	0200	51	198	380	353	677	0
20-50		33	118	276	197	253	0
0-50	0400	185	190	195	444	772	0
20-50		11	80	91	34	590	0
0-50	0900	80	214	385	475	965	0
20-50		3	74	267	-40	956	0
0-50	1200	55	107	169	277	1051	0
20-50		-17	3	57	-59	1048	0
0-50	1400	11	81	319	503	1964	0
20-50		-43	-46	183	227	1945	0
0-50	1630	42	173	260	303	560	0
20-50		-29	25	29	145	557	0

Depth	Time	cop.1	cop.2	cop.3	cop.4	cop.5	cop.6
0-100	1800	17	282	557	949	677	0
50-100		-5	-125	-136	265	-2723	0
0-100	2000	18	439	425	614	1913	0
50-100		-85	-293	-235	-250	-3275	0
0-100	2200	49	327	343	284	518	0
50-100		-54	-73	-11	-133	-139	0
0-100	0000	0	13	282	303	863	0
50-100		-23	-98	-56	29	55	0
0-100	0200	0	35	373	584	1462	0
50-100		-51	-163	-7	231	785	0
0-100	0400	4	36	157	389	820	0
50-100		-181	-154	-38	-55	8	0
0-100	0900	6	189	466	395	634	0
50-100		-74	-25	81	-80	-331	0
0-100	1200	0	28	175	285	950	0
50-100		-55	-79	6	8	-101	0
0-100		0	35	651	541	1777	0
50-100		-11	-46	332	38	185	0
0-100	1630	0	55	226	306	314	0
50-100		-42	-118	-34	3	-246	0

9

23. Observation of earthquakes with ocean bottom seismometers at ocean basin

by

T. Asada and H. Shimamura

Observations of earthquakes with Ocean Bottom Seismometers were made at 3 stations located near Ogasawara Islands, off Sanriku, and Kurils. At the site off Sanriku, the recovery of the OBS's were not successful, but at the other sites the recording were successful. The periods and locations of the observations and the depths of the sites are listed in Table 49.

Slow speed D.R. magnetic tape recorders were used in our OBS's. When played back, the band width were limited within the frequency range from 5 to 20 Hz. The center frequency of the frequency band is probably a little too high for recording the earthquakes with epicentral distance about 200-1000 km, however, fairly large number of events had been recorded. 180 events were recorded during a 150-hour period at the site, Ogasawara, and 142 events during a 120-hour period at the site near Kurils. Among these earthquakes, S-P of 118 events at Ogasawara, and S-P of 90 events at Kurils were measured on the records. The histograms of S-P are shown in Fig. 18. The location of the sites including the sites where the observations were made on another cruise is also shown in the same figure. The observations at Mariana and Eaurpik ridge were made on the KH-71-1 cruise. The level of seismicity around these sites are estimated to be higher than the average level of seismicity in Honshu, considering that the average epicentral distance is about several hundred km.

As the velocity of S-P wave is 10 km/s in the ocean bottom, we may conclude that the earthquakes occur in the ocean side of the trench axis. This conclusion is different from that deduced from the results obtained by the networks on land.

It should be noted that the predominant frequencies of the waves passing through ocean bottom are higher than those of waves travelling in the crust and the upper mantle in Honshu as shown in Fig. 19.

Table 49. Sites, time and depth for O.B.S. observation

SITE	BEGINNING	END	DEPTH
OGASAWARA A ¹ 28°59.4'N 146°45.6'E	19h00m, Jun. 23, 1971	01h40m, Jun. 30, 1971	5930 m
KURILS A 44°10.2'N 154°03'E	12h40m, Jul. 18, 1971	15h00m, Jul. 23, 1971	5200 m

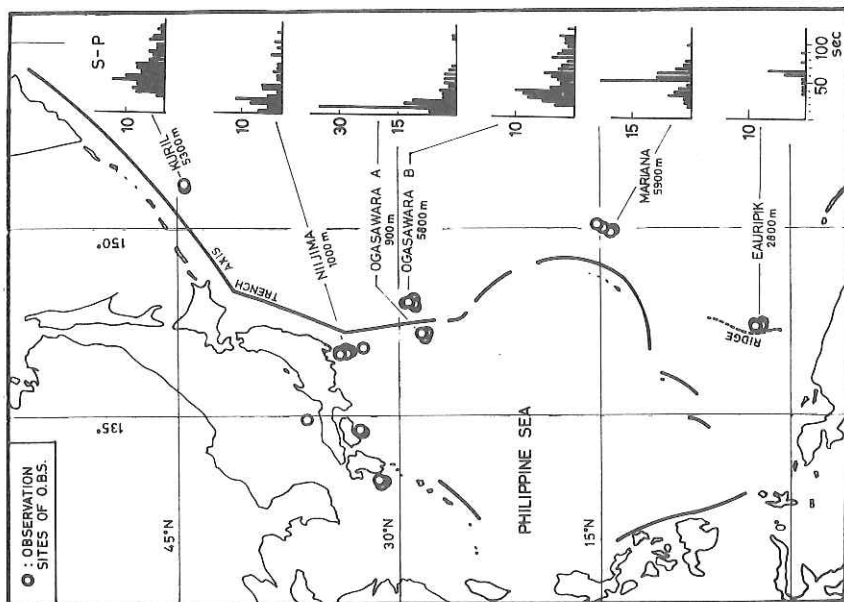


Fig. 18 The location of the sites of O.B.S. and S-P histograms

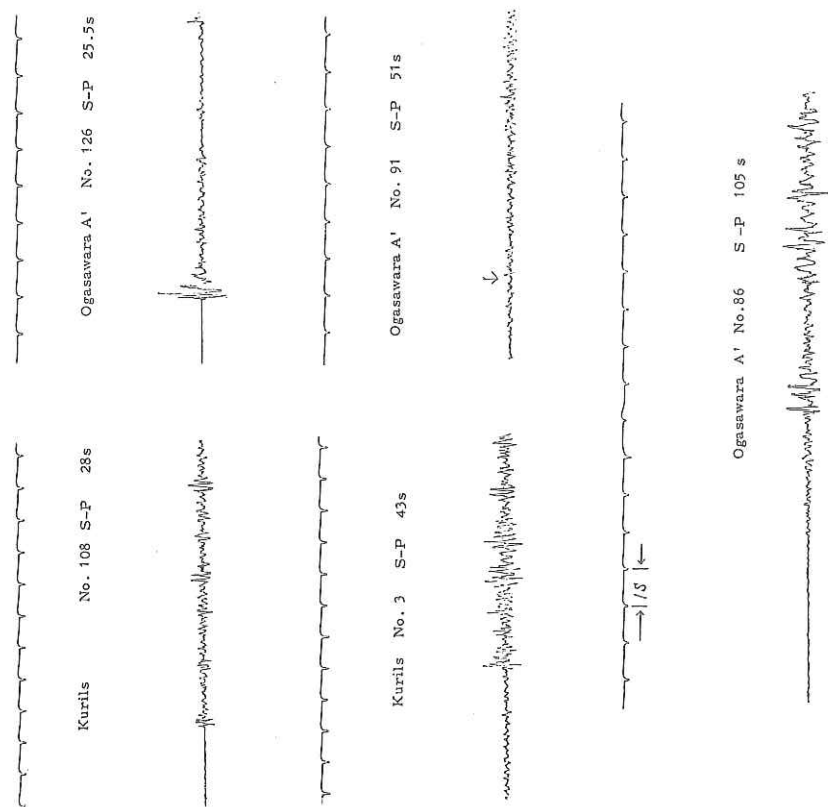


Fig. 19 S-P data sheet at Ogasawara and Kuris