Preliminary Report
of
The Hakuhō Maru Cruise KH-78-3

June 5 - August 22, 1978
The Bering and Chukchi Seas
and the northern North Pacific

Ocean Research Institute
University of Tokyo
1979

Preliminary Report
of
The Hakuhō Maru Cruise KH-78-3

June 5 - August 22, 1978
The Bering and Chukchi Seas
and the northern North Pacific

By
The Scientific Members of the Expedition
Edited by
Akihiko HATTORI

1979

Preface

This volume contains the oceanographic data obtained on Cruise KH-78-5 of the R. V. Hakuho Maru, 5 July through 22 August 1978. Brief summaries of the research carried out by the scientists aboard are included.

The cruise formed a part of an integrated research project on biological and biochemical activities and the dynamics and recycling of biological materials and other elements in the Bering and Chukchi seas and the northern North Pacific Ocean and was in close collaboration with the PROBES project sponsored by the Office of Polar Programs, NSF, USA. The results of an earlier investigation, undertaken within the same framework in summer 1975, appeared in the report of Hakuho Maru Cruise KH-75-4, Ocean Research Institute, University of Tokyo, 1977.

Twenty eight scientists from 10 universities and research institutions, Japanese and US, participated in this interdisciplinary cruise.

On behalf of the scientists, I wish to express my gratitude to Captain I. Tadama, the other officers and the crew members of the Hakuho Maru for their cooperation and skillful assistance throughout the cruise. I acknowledge the help of Dr. J. J. Kelley, University of Alaska, in making this cruise possible and successful, Miss Masae Ohtsu for her assistance in compiling this volume, and Dr. F. A. Richards, University of Washington and Office of Naval Research in Tokyo, for editorial assistance.

A US-Japan seminar entitled the "Bering Sea ecosystem", sponsored by the Institute of Marine Science, University of Alaska, was held on 7 August when we had a port call at Seward, and almost all of our Japanese scientists aboard were provided with the opportunity to joint it and to discuss the recent progress in Bering Sea studies. I would like take this opportunity to extend my sincere appreciation to Drs. J. R. Moore, J. J. Goering, T. Nishiyama, C. P. McRoy and

other colleagues of the Institute of Marine Science, University of Alaska, for their efforts materializing the seminar.

Akihiko Hattori
Chief Scientist
Ocean Reseach Institute
University of Tokyo

Contents

Outline of the cruise

The cruise consisted of three legs: Leg 1, from Tokyo to Nome, Alaska; Leg 2, from Nome, Alaska to Seward, Alaska; and Leg 3, from Seward, Alaska to Tokyo (Fig.1). The location of the oceanographic stations and the dates are given in Table 1.

Emphasis was placed on chemical, biochemical and biological aspects with special reference to cycling of biophilic elements. Information was collected for: (1) distribution of temperature and salinity, (2) distribution of dissolved gases, nutrients, chlorophylls, trace metals, dissolved and particulate organic matter, stable and radioactive nuclides, (3) distribution of phytoplankton, zooplankton and micronekton, and (4) underwater irradiance and tubidity. Simultaneous shipboard experiments on carbon and nitrogen metabolism were carried out using isotope tracer techniques.

At selected stations sediment was collected using a piston core sampler, a gravity core sampler or a grab sampler to investigate chemical, biological and geological characteristics. Meteorological variables such as air temperature, wind speed, wind direction, pressure, solar radiation and dew point, and gravity were continuously recorded throughout the cruise.

The names and specialities of the scientists who participated in this cruise are listed in Table 2, and the observations at each station are summarized in Table 3.

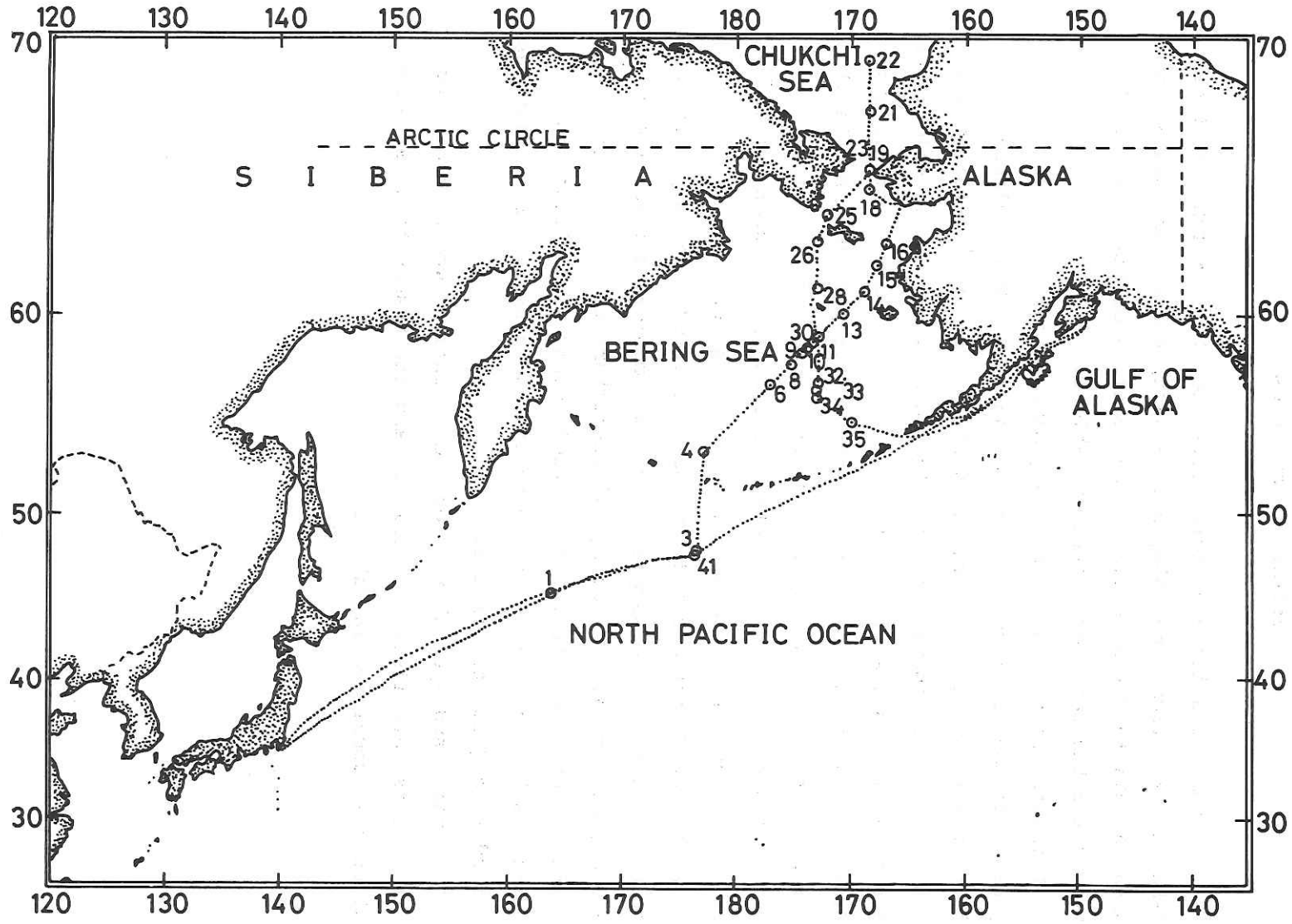

Fig. 1. Track chart of the KH-78-3 Cruise of the Hakuho Maru.

Table 1. Location of oceanographic stations and dates

Legs	Stations	Latitudes	Longitudes	Dates
1	Leave Tokyo			7/ 5 1400
	1	45°14.2'-45°15.0'N	163°45.5'-163°46.0'E	7/10 0900-7/10 1123
	3	47°55.1'-47°58.9'N	176°20.6'-176°41.1'E	7/11 1230-7/13 1805
	4	53°25.5'-53°35.2'N	177°01.1'-177°31.6'E	7/14 2208-7/16 0425
	6	56°58.0'-56°59.0'N	176°59.1'-177°08.1'W	7/17 0550-7/17 1746
	8	57°57.9'-58°03.3'N	175°03.5'-175°16.0'W	7/18 0123-7/18 1756
	9	58°14.4'-58°15.6'N	174°28.8'-174°31.3'W	7/18 2004-7/18 2326
	10	58°30.1'-58.30.7'N	173°59.8'-174°00.5'W	7/19 0132-7/19 0308
	11	58°43.7'-58°44.3'N	173°29.6'-173°32.0'W	7/19 0507-7/19 0813
	13	59°59.4'-59°59.7'N	170°53.6'-170°56.5'W	7/17 1730-7/19 2054
	14	60°59.7'N	168°57.9'-169°00.3'W	7/20 0509-7/20 0650
	15	61°59.6'-61°59.9'N	168°01.3'-168°01.6'W	7/20 1239-7/20 1330
	16	63°00.0'-63°00.6'N	166°57.6'-166°59.9'W	7/20 1920-7/20 2023
	Arrive Nome, Alaska			7/21 0845
2	Leave Nome, Alaska			7/23 1340
	18	64°59.2'-65°01.3'N	168°34.8'-168°37.1'W	7/23 2030-7/23 2223
	19	65°46.3'-65°46.5'N	168°35.5'W	7/24 0206-7/24 0230
	21	67°39.8'-67°41.5'N	168°32.8'-168°33.5'W	7/24 1203-7/24 1422
	22	69°09.1'-69°10.4'N	168°36.1'-168°37.2'W	7/24 2157-7/24 2350
	23	65°46.8'-65°47.9'N	168°34.5'-168°35.0'W	7/25 1807-7/26 0203
	25	64°01.1'-64°01.9'N	172°00.5'-172°03.7'W	7/26 1539-7/26 1637
	26	62°59.3'-63°00.6'N	173°00.0'-173°01.0'W	7/26 2244-7/27 0007
	28	60°58.5'-61°00.6'N	172°56.9'-173°00.1'W	7/27 1100-7/27 1345
	30	58°59.3'-59°01.9'N	173°00.0'-173°02.0'W	7/28 0110-7/28 0423
	32	56°59.7'-57°00.0'N	173°00.0'-173°05.9'W	7/28 1817-7/28 2011
	33	56°34.8'-56°35.1'N	173°00.1'-173°00.7'W	7/28 2243-7/29 0301
	34	56°07.3'-56°08.4'N	173°01.8'-173°02.8'W	7/29 0531-7/29 1044
	35	54°55.5'-55°00.7'N	169°53.6'-170°00.6'W	7/29 2132-7/30 0353
	Arrive Seward, Alaska			8/ 2 1012
3	Leave Seward, Alaska			8/ 8 1343
	41	47°54.6'-47°55.7'N	176°06.0'-176°20.6'W	8/14 1730-8/14 2319
	Arrive Tokyo			8/22 1000

Table 2. Scientists aboard

Akihiko HATTORI Chief Scientist	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Takahisa NEMOTO	Ocean Res. Inst., Univ. of Tokyo	Biology
Toshisuke NAKAI	Ocean Res. Inst., Univ. of Tokyo	Physical Oceanography
Isao KOIKE	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Hiromi FUJIMOTO	Ocean Res. Inst., Univ. of Tokyo	Geophysics
Hirotaka OTOBE	Ocean Res. Inst., Univ. of Tokyo	Physical Oceanography
Toshiro SAINO	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Hitoshi IIZUMI	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
Ken FURUYA	Ocean Res. Inst., Univ. of Tokyo	Biology
Yuichi HIROTA	Ocean Res. Inst., Univ. of Tokyo	Biology
Shizuo TSUNOGAI	Fac. Fisheries. Hokkaido Univ.	Geochemistry
Yasunori WATANABE	Fac. Fisheries. Hokkaido Univ.	Geochemistry
Mitsuo UEMATSU	Fac. Fesheries. Hokkaido Univ.	Geochemistry
Ko HARADA	Fac. Fesheries. Hokkaido Univ.	Geochemistry
Kazuo HIRANO	Fac. Fesheries. Hokkaido Univ.	Biology
Akira TANIGUCHI	Fac. Agr. Sci., Tohoku Univ.	Biology
Yoshinari ENDO	Fac. Agr. Sci., Tohoku Univ.	Biology
Noriyuki SUZUKI	Fac. Sci., Tohoku Univ.	Geology
Kazuyasu MIYATA	Envirom. Sci., Tsukuba Univ.	Biology
Kanau MATSUIKE	Tokyo Univ. of Fisheries	Physical Oceanography
Masaru MAEDA	Tokyo Univ. of Fisheries	Geochemistry
Masataka HAGA	Tokyo Univ. of Fisheries	Physical Oceanography
Takashi NAKANISHI	Fac. Sci., Kanazawa Univ.	Geochemistry
Eiichiro TANOUE	Water Res. Inst., Nagoya Univ.	Geochemistry
Takeo HAMA	Water Res. Inst., Nagoya Univ.	Geochemistry
Tsuneo NISHIYAMA	Inst. Marine Sci., Univ. of Alaska	Biology
Thomas Gosink	Geophysi. Inst., Univ. of Alaska	Geochemistry
Yoji ENDO	Inst. Marine Sci., Univ. of Alaska	Biology

Table 3. Items of observation at each station

Stations	1	3	4	6	8	9	10	11	13	14	15	16	18	19	21	22	23	25	26	28	30	32	33	34	35	41
CTD observation	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		
Water sampling with																										
Niskin bottles	x	x	x	x	x	x	x	x	x	x		x	x		x	x	x	x	x	x	x	x	x	x		
a centrifugal pump			x		x				x														x			
Sediment sampling with																										
a piston core sampler		x	x	x																						
a Phleger core sampler					x			x		x	x	x			x	x					x					
an Okean grab sampler		x	x					x		x	x	x			x	x					x					
Plankton sampling with																										
NORPAC net	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	
LHPR*		x	x	x	x															x						
MTD nets*		x	x	x	x																x				x	
IKMT*			x	x	x																				x	
ORI net*				x	x								x		x	x			x	x	x				x	
Underwater irradiance		x	x	x	x	x			x		x				x			x		x				x		
Turbidity	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x		
Moring																										
Sediment traps		x																								
Current meters														x												

* LHPR: Longhurst-Hardy plankton recorder; MTD net: Motoda multilayer plankton net;
IKMT: Isaacs-Kidd mid-water trawl; ORI net: Ocean Research Institute plankton net.

Routine observations of oceanographic variables

At each station, casts of 23-ℓ Nistin bottles were made to collect information for water temperature, salinity, dissolved oxygen, inorganic nutrients, chlorophylls, and particulate matter. Plankton were sampled by vertical haul of a twin NORPAC net. The names of the persons who conducted the measurements are given after each item.

Water temperature was measured using a pair of protected reversing thermometers. The sampling depths were estimated from wire lengths, wire angles and the difference between readings of protected and unprotected reversing thermometers [Nakai and Otobe]. Salinity was determined with an Auto Lab 601 MK III inductive salinometer [Otobe, Nakanishi, Endo, Suzuki and Haga]. Detailed depth profiles of temperature and salinity were also obtained using a Bissett-Berman 9040-2A CTD system [Nakai and Otobe].

Dissolved oxygen was determined by the Winkler method [Maeda], pH was measured with a pH meter, and the alkalinity was estimated, according to Strickland and Parsons (1972), from the pH shift after the addition of a definite amount of HCl to seawater samples [Watanabe and Harada].

Reactive silicate was determined by a modification of the method described in the Manual of Oceanographic Observations (Oceanographical Society of Japan, 1970)[Tsunogai and Harada], and reactive phosphate by the method of Murphy and Riley (1962)[Tsunogai and Harada]. Nitrate, nitrite and ammonium were determined using a Technicon AutoAnalyzer [Koike and Iizumi]. The Cd-Cu method described by Strickland and Parsons (1972) for nitrate, the method of Bendschneider and Robinson (1952) for nitrite, and the phenol method of Solorzano (1969) for ammonium were used with minor modifications. Dissolved organic carbon was determined by the method of Menzel and Vaccaro (1964)[Tanoue and Hama].

Particulate matter was collected on Reeve Angel 984H glass fibre filters. Chlorophylls were determined by the spectroscopic

method as described by Strickland and Parsons (1972)[Furuya, Hirota and Hirano], and C and N contents by a dry combustion technique using a Yanagimoto CHN analyzer [Tanoue and Hama].

Plankton biomass was determined by drying aliquots of the net samples fixed with 2% neutral formalin [Nemoto, Furuya and Hirota].

The data availabe at present are tabulated in Tables 4-27, and cross sections of oceanographic variables and T-S diagrams from legs 1 and 2 are illustrated in Figs. 2-16.

References

Bendscheider, K. and R. J. Robinson (1952) J. Mar. Res., 11: 87.

Menzel, D. W. and R. F. Vaccaro (1964) Limnol. Oceanogr., 9: 138.

Murphy, J. and J. P. Riley (1962) Anal. Chim. Acta, 27: 31.

Oceanographical Society of Japan (1970) Manual of Oceanographic Observations. Tokyo. p.185.

Solorzano, L. (1969) Limnol. Oceanogr., 14: 799.

Strickland, J. D. H. and T. R. Parsons (1972) A Practical Handbook of Seawater Analysis. Fisheries Research Board of Canada, Ottawa.

Table 4. Summary of hydrographic data at Station 1.

Date	Time	Lat.	Long.	Depth	Transparency
10, Jul., 1978	0955-1030	45°14.8'-45°14.5'N	163°45.6'-163°45.7'E	6170m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
1000	E-8.0m/s	1019.7mb	cloudy	3	9.3°C	7	1	10

D	T	S	σt	DO		O_2sat.		AOU		pH		Alk		PO_4^{3-}P	
m	°C	‰		mℓ/ℓ		%		mℓ/ℓ				mequ./ℓ		μg atoms/ℓ	
0	9.7	33.132	25.57	6.704	6.716	104.2	104.4	-0.269	-0.281	8.008	8.012	2.296	2.290	1.08	1.07
12	9.63	33.137	25.58	6.721	6.717	104.3	104.2	-0.277	-0.272	8.006	8.005	2.294	2.290	1.10	1.10
14		33.144													
33	6.41	33.338	26.21	7.326	7.323	105.7	105.7	-0.398	-0.394	7.985	7.988	2.303	2.298	1.18	1.15
35		33.346													
52	5.24	33.566	26.54	7.127	7.102	100.2	99.8	-0.013	0.012	7.913	7.922	2.309	2.313	1.42	1.41
54		33.586													
73	6.10			6.766		97.2		0.192		7.931	7.920	2.310	2.311	1.31	1.31
75		33.796													
117	5.74	33.808	26.67	6.757	6.688	96.3	95.3	0.261	0.330	7.914	7.914	2.309	2.310	1.27	1.27
119		33.806													
180	5.09	33.765	26.71	6.415	6.452	90.0	90.5	0.715	0.678	7.871	7.879	2.311	2.310	1.48	1.55
182		33.763													

Abbreviations and symbols used:
D, depth
T, temperature
S, salinity
σt, sigma t [=(ρ-1)x1000]
DO, dissolved oxygen
O_2sat, percent oxygen saturation
AOU, apparent oxygen utilization
Alk, alkalinity
DOC, dissolved organic carbon
SS, suspended solid
POC, particulate organic carbon
PON, particulate organic nitrogen
P.Vol, total volume of particles larger than 2.0μm and smaller than 40μm in diameter
P.No., numbers of particles between 2.00 and 2.52μm in diameter

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS	POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ					nℓ/ℓ	N/mℓ	m
3.4	3.1	3.71	3.71	0.17	0.17	0.22	0.193	670	83			52	608	0
6.1	3.2	3.36	3.37	0.17	0.17	0.23	0.195	690	44					12
														14
8.1	7.6	3.71	3.72	0.18	0.18	0.70	0.142	830	55					33
														35
27.3	31.4	4.93	4.92	0.30	0.31	1.64	0.258	750	58			43	504	52
														54
30.2	29.3	5.14	5.18	0.18	0.19	0.24	0.357	680	45			29	545	73
														75
28.0	31.4	5.36	5.37	0.02	0.02	0.12	0.021	660	39			21	219	117
														119
38.5	36.8	6.17	6.12	0.01		0.11	0.011		38			11	131	180
														182

Table 5. Summary of hydrographic data at Station 3.

Date	Time	Lat.	Long.	Depth	Transparency
11, Jul., 1978	1640-2252	47°56.3'-47°57.7'N	176°24.2'-176°28.8'E	5400m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
2200	W-7.5m/s	1031.0mb	cloudy	4	6.9°C	7	1	10

D	T	S	σt	DO		O_2sat.		AOU		pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ		%		mℓ/ℓ				mequ./ℓ		μg atoms/ℓ	
0	7.1	32.982	25.84	7.456	7.448	109.1	109.0	-0.623	-0.615	7.963	7.956	2.293	2.289	1.70	1.70
10	7.02	32.984	25.85	7.464	7.468	109.0	109.1	-0.618	-0.623	7.979	7.975	2.280	2.285	1.62	1.68
12		32.980													
20	7.06	32.983	25.85	7.476	7.474	109.3	109.3	-0.637	-0.635	7.979	7.970	2.280	2.275	1.66	1.70
22		32.978													
30	6.28	32.980	25.95	6.970	6.934	100.1	99.5	-0.004	0.031	7.968	7.974	2.277	2.275	1.71	1.68
32		32.980													
50	4.29	33.042	26.22	7.481	7.475	102.4	102.3	-0.176	-0.170	7.887	7.896	2.280	2.291	1.92	1.90
52		33.046													
74	2.80	33.148	26.45	7.583	7.549	100.1	99.6	-0.008	0.027	7.833	7.831	2.283	2.284	2.12	2.10
76		33.154													
99	2.10	33.159	26.51	7.468	7.438	96.9	96.5	0.242	0.272	7.825	7.811	2.289	2.294	1.96	1.93
101		33.155													
124	2.50	33.316	26.61	6.026	6.010	79.0	78.8	1.598	1.615	7.730	7.716	2.295	2.293	2.38	2.38
126		33.330													
149	3.22	33.674	26.83	2.759	2.736	36.9	36.6	4.711	4.733	7.528	7.520	2.321	2.332	2.99	2.99
151		33.701													
171	3.54	33.818	26.91	1.497	1.457	20.2	19.7	5.906	5.946	7.439	7.452	2.331	2.333	3.10	3.22
173		33.818													
194	3.58	33.893	26.97	0.954	0.931	12.9	12.6	6.438	6.461	7.406	7.432	2.337	2.354	3.27	3.28
196		33.892													
292	3.47	34.002	27.07	0.706	0.719	9.5	9.7	6.701	6.688	7.409	7.417	2.357	2.370	3.20	3.30
294		34.006													
486	3.36	34.194	27.23	0.528	0.520	7.1	7.0	6.890	6.897	7.425	7.458	2.385	2.387	3.21	3.20
488		34.192													
729	2.99	34.328	27.37	0.541	0.570	7.2	7.6	6.939	6.910	7.450	7.477	2.406	2.409	3.21	3.23
731		34.328													
972	2.67	34.408	27.46	0.670	0.654	8.9	8.7	6.866	6.882	7.484	7.500	2.427	2.424	3.20	3.16
974		34.409													
1192	2.45	34.471	27.53	0.736	0.725	9.7	9.6	6.839	6.850	7.493	7.483	2.433	2.437	3.21	3.11
1194		34.471													
1430	2.19	34.526	27.60	1.051	1.036	13.8	13.6	6.571	6.586	7.513	7.524	2.445	2.446	3.11	3.15
1432		34.529													
1670	2.00	34.566	27.65	1.338	1.358	17.5	17.7	6.320	6.299	7.544	7.564	2.452	2.451	3.09	2.94
1672		34.567													
1909	1.88	34.595	27.68	1.721	1.708	22.4	22.2	5.958	5.972	7.585	7.585	2.458	2.457	2.96	3.00
1911		34.595													
2291	1.72	34.628	27.72	2.258	2.263	29.3	29.3	5.452	5.447	7.616	7.623	2.461	2.461	2.82	2.81
2293		34.627													
2676				2.678	2.656	34.6	34.4	5.054	5.076	7.653	7.674	2.465	2.462	2.81	2.78
2678		34.646													
3068	1.52	34.666	27.76	3.031	3.023	39.1	39.0	4.716	4.725	7.679	7.721	2.463	2.463	2.69	2.60
3070		34.666													
3451	1.48	34.673	27.77	3.301	3.329	42.6	42.9	4.454	4.426	7.712	7.696	2.460	2.461	2.56	2.58
3453		34.667													
3833	1.47	34.680	27.78	3.524	3.505	45.4	45.2	4.232	4.251	7.708	7.716	2.461	2.459	2.57	2.59
3835		34.679													
4217	1.48	34.684	27.78	3.636	3.629	46.9	46.8	4.118	4.125	7.705	7.727	2.459	2.461	2.55	2.54
4219		34.684													
4602	1.49	34.686	27.78	3.669	3.672	47.3	47.4	4.083	4.080	7.708	7.729	2.461	2.461	2.52	2.54
4604		34.686													
4987	1.55	34.685	27.78	3.715	3.729	48.0	48.2	4.025	4.011	7.715	7.737	2.462	2.459	2.43	2.48
4989		34.686													

SiO_2-Si µg atoms/ℓ		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a µg/ℓ	DOC	SS		POC	PON	P.Vol. nℓ/ℓ	P.No. N/mℓ	D m
43.4	43.2	20.19	20.23	0.17	0.18	0.17	0.982	990	425	386	164	30	283	3194	0
41.0	42.7	20.22	20.22	0.18	0.18	0.16	0.949	850	264				317	3457	10
										710	291	48			12
40.8	44.4	20.17	20.16	0.18	0.18	0.15	0.992	890	304				319	3463	20
										864	353	69			22
47.6	41.8	20.47	20.53	0.19	0.18	0.23	0.886	820	304				227	2059	30
										455	197	34			32
45.2	43.7	22.66	22.65	0.26	0.26	1.37	0.597	1090	103				74	750	50
										212	80.5	12			52
50.2	57.7	25.42	25.43	0.54	0.53	0.85	0.194	850	71				48	709	74
										83	38.2	4.5			76
52.9	47.3	24.85	24.60	0.16	0.15	0.16	0.076	750	75				29	616	99
										66	20.7	2.7			101
68.0	61.6	31.37	31.37	0.00	0.00	0.09	0.114	740	242						124
										156	38.8	5.0			126
90.8	86.4	39.79	39.74	0.00	0.00	0.07	0.020	640	107				29	364	149
										100	34.9	4.5			151
100	101	42.89	42.94	0.00	0.00	0.20	0.020	600	70				39	527	171
											30.7	3.1			173
108	105	44.10	44.10	0.00	0.00	0.11	0.006	610	63				18	255	194
										91	34.1	3.4			196
117	123	44.36	44.30	0.00	0.00	0.05		590	33				29	285	292
										66	26.7	3.5			294
135	134	43.77	43.85	0.00	0.00	0.09		590	61				14	193	486
										68	27.6	2.6			488
162	154	43.66	43.66	0.00	0.00	0.05		560	35				45	448	729
										70	27.9	3.3			731
168	170	43.29	43.29	0.00	0.00	0.12		470	54				19	250	972
										53	20.9	2.5			974
175	181	43.36	43.42	0.00	0.00	0.12		490	37	59			21	345	1192
										53	20.0	1.9			1194
187	180	42.63	42.58	0.00	0.00	0.10			80				38	427	1430
											22.4	2.5			1432
182	190	42.00	41.95	0.00	0.00	0.17		570	43	30			30	323	1670
										27	14.3	1.2			1672
185	180	41.06	41.06	0.00	0.00	0.13		640	34				25	240	1909
										68	23.5	2.3			1911
180	182	39.75	39.70	0.00	0.00	0.11		620	48	43			39	376	2291
										54	20.1	1.3			2293
184	179	38.60	38.55	0.00	0.00	0.05		430					43	375	2676
											49.3	4.1			2678
179	179	37.60	37.71	0.00	0.00	0.12		460	40				33	270	3068
										191	61.6	4.7			3070
173	174	36.87	36.92	0.00	0.00	0.12		430	34	49			12	301	3451
										74	31.5	2.7			3453
172	175	36.40	36.40	0.00	0.00	0.10		570	54	51			30	426	3833
										61	23.9	2.0			3835
164	168	36.09	36.04	0.00	0.00	0.07		510	46	62			18	375	4217
										88	12.9	1.0			4219
173	161	35.88	35.94	0.00	0.00	0.07		550	35	37			12	246	4602
										50	12.5	1.1			4604
	166	35.78	35.68	0.00	0.00	0.03		570	41				21	357	4987
										213	31.6	3.2			4989

Table 6. Summary of hydrographic data at Station 4.

Date	Time	Lat.	Long.	Depth	Transparency
15, Jul., 1978	0324-0740	53°35.2'-53°33.6'N	177°06.9'-177°12.2'E	3920m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
0700	NE-8.5m/s	1007.6mb	cloudy	3	6.2°C	5	1	10

D	T	S	σt	DO		O_2sat.		AOU		pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ		%		mℓ/ℓ				mequ./ℓ		μg atoms/ℓ	
0	7.2	32.954	25.81	7.257	7.252	106.4	106.4	-0.439	-0.434	8.000	7.981	2.277	2.282	1.40	1.53
10	7.21	32.950	25.80	7.266	7.270	106.6	106.6	-0.449	-0.453	8.003	7.978	2.274	2.281	1.40	1.46
12		32.947													
20	7.20	32.951	25.80	7.267	7.278	106.6	106.7	-0.448	-0.459	8.017	7.984	2.275	2.280	1.42	1.50
22		32.951													
29	6.99	32.962	25.84	7.293	7.307	106.4	106.6	-0.442	-0.455	8.012	7.984	2.272	2.281	1.44	1.51
31		32.963													
48	6.22	33.062	26.02	7.054	7.064	101.2	101.3	-0.082	-0.092	7.941	7.927	2.281	2.284	1.66	1.76
50		33.057													
72	4.28	33.170	26.33	6.647	6.635	91.0	90.9	0.653	0.665	7.853	7.823	2.283	2.287	1.98	2.07
74		33.184													
96	3.66	33.252	26.45	6.129	6.128	82.7	82.7	1.280	1.281	7.772	7.746	2.311	2.291	2.16	2.22
98		33.256													
120	3.59	33.289	26.49	5.815	5.805	78.4	78.2	1.605	1.615	7.756	7.732	2.291	2.292	2.23	2.25
122		33.298													
144	3.46	33.306	26.52	5.897	5.902	79.2	79.3	1.546	1.541	7.760	7.738	2.305	2.295	2.22	2.31
146		33.308													
169	3.57	33.387	26.57	5.084	5.089	68.5	68.6	2.335	2.330	7.716	7.744	2.295	2.300	2.35	2.39
171		33.396													
190	3.60	33.457	26.62	4.505	4.509	60.8	60.8	2.905	2.901	7.688	7.664	2.322	2.307	2.45	2.44
192		33.460													
286	3.57	33.680	26.80	2.851	2.864	38.5	38.7	4.554	4.540	7.594	7.538	2.336	2.324	2.72	2.80
288		33.671													
478	3.76	34.001	27.04	0.809	0.793	11.0	10.8	6.545	6.561	7.477	7.429	2.357	2.357	3.05	3.09
480		34.007													
718	3.48	34.174	27.20	0.512	0.476	6.9	6.4	6.885	6.921	7.487	7.436	2.385	2.386	3.14	3.13
720		34.174													
959	3.09	34.310	27.35	0.429	0.463	5.8	6.2	7.033	6.999	7.473	7.439	2.402	2.405	3.16	3.16
961		34.312													
1201	2.79	34.395	27.44	0.485	0.473	6.5	6.3	7.029	7.041	7.500	7.455	2.418	2.420	3.13	3.14
1203		34.396													
1442	2.46	34.474	27.54	0.663	0.654	8.8	8.6	6.910	6.919	7.501	7.470	2.435	2.435	3.12	3.06
1444		34.475													
1661	2.20	34.526	27.60	0.884	0.857	11.6	11.2	6.737	6.763	7.537	7.489	2.448	2.446	3.08	3.07
1663		34.529													
1895	1.97	34.570	27.65	1.217	1.193	15.9	15.6	6.446	6.470	7.550	7.508	2.457	2.456	3.01	2.96
1897		34.573													
2271	1.80	34.614	27.70	1.566	1.538	20.4	20.0	6.128	6.156	7.591	7.563	2.465	2.464	2.95	2.92
2273		34.616													
2650	1.68	34.638	27.73	1.890	1.871	24.5	24.2	5.827	5.846	7.617	7.570	2.471	2.469	2.91	2.87
2652		34.639													
3031	1.63	34.650	27.74	2.202	2.200	28.5	28.5	5.524	5.526	7.625	7.612	2.472	2.470	2.84	2.85
3033		34.653													
3416	1.60	34.661	27.75	2.402	2.403	31.1	31.1	5.329	5.328	7.639	7.610	2.472	2.473	2.81	2.79
3418		34.659													

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
40.9	36.8	15.63	15.69	0.23	0.22	0.44	0.835	1380	311	586	125	25.6	213	2122	0
40.1	32.9	15.63	15.62	0.22	0.23	0.44	1.159	870	275				133	1923	10
										423					12
44.2	46.3	15.56	15.50	0.24	0.24	0.42	0.744	920	307				122	1840	20
										529	110	25			22
30.9	38.3	15.77	15.77	0.24	0.24	0.64	1.190	870	400				133	1376	29
										599	104	24			31
55.5	43.3	20.24	20.23	0.29	0.30	0.71	1.330	910	176				92	913	48
										480	67.5	14			50
63.2		25.89	25.84	0.42	0.41	0.36	0.803	840	140				51	672	72
										317	58.2	9.8			74
67.7	78.0	29.34	29.34	0.02	0.02	0.03	0.181	870	79				25	449	96
										194	37.3	5.3			98
86.4		30.32	30.38	0.02	0.01	0.05	0.111	840	190				26	323	120
										119	32.4	3.9			122
77.4	80.1	30.54	30.60	0.01	0.01	0.05	0.149	880	70				18	394	144
										252	37.4	5.2			146
	81.0	32.28	32.28	0.01	0.01	0.02	0.115	880	93				14	336	169
										171	44.8	5.6			171
83.1	84.6	33.52	33.52	0.03	0.02	0.16	0.097	730	105				32	489	190
										258	49.7	5.5			192
92.3	100.6	38.28	38.28	0.00	0.00	0.05		600	73				22	344	286
										333	53.1	6.7			288
120	127	43.19	43.08	0.00	0.00	0.05		780	59	63			7.8	124	478
										169	23.2	2.4			480
178		43.46	43.95	0.00	0.00	0.07		550	30				17	192	718
										184	29.4	2.8			720
157	169	43.62	43.67	0.00	0.00	0.05		770	49				6.8	137	959
										259	32.2	3.3			961
182	191	43.51	43.51	0.00	0.00	0.09		670	23	44			7.9	112	1201
										135	21.1	1.9			1203
201	193		42.90	0.00	0.00	0.02		720	43				22	140	1442
										229	23.8	2.3			1444
197	211	42.41	42.36	0.00	0.00	0.13		750	22				23	281	1661
										109	18.8	1.8			1663
215	220	41.27	41.48	0.00	0.00	0.09		740	25				20	192	1895
															1897
229	229	40.23	40.23	0.00	0.00	0.09		790	77	42			27	186	2271
										147	18.4	2.2			2273
229	237	39.35	39.41	0.00	0.00	0.10		760	46				18	220	2650
										180	18.4	2.8			2652
231	238	38.48	38.53	0.00	0.00	0.08		670	40	70			15	116	3031
										180	16.1	1.8			3033
228		37.99	37.88	0.00	0.00	0.07		730	56	90			8	101	3416
										118	19.8	1.9			3418

Table 7. Summary of hydrographic data at Station 6.

Date	Time	Lat.	Long.	Depth	Transparency
17, Jul., 1978	0705-1056	56°58.8'-56°58.3'N	177°00.3'-177°01.4'W	3640m	5.5m

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
1000	N-5.0m/s	1014.4mb	drizzle	3	6.4°C	6	1	10

D	T	S	σt	DO		O_2sat		AOU		pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ		%		mℓ/ℓ				mequ./ℓ		µg atoms/ℓ	
0	8.25	32.664	25.43	7.770	7.803	116.5	117.0	-1.101	-1.135	8.080	8.080	2.265	2.265	0.92	0.91
10	7.09	32.661	25.59	7.842	7.809	114.5	114.0	-0.993	-0.960	8.071	8.071	2.264	2.265	0.98	0.99
12		32.666													
20	7.27	32.748	25.63	7.216	7.225	105.9	106.0	-0.400	-0.408	7.998	7.995	2.264	2.266	1.42	1.49
22		32.735													
29	6.80	32.748	25.70	7.132	7.147	103.5	103.7	-0.240	-0.255	7.974	7.965	2.263	2.264	1.52	1.60
31		32.774													
48	3.50	33.053	26.31	7.003	7.015	94.0	94.2	0.445	0.433	7.812	7.806	2.274	2.279	2.17	2.17
50		33.072													
72	3.10	33.170	26.44	6.778	6.754	90.2	89.8	0.739	0.763	7.765	7.758	2.284	2.285	2.26	2.32
74		33.170													
96	3.00	33.222	26.49	6.706	6.707	89.0	89.0	0.827	0.827	7.762	7.758	2.290	2.290	2.34	2.39
98		33.224													
121	3.02	33.267	26.53	6.324	6.327	84.0	84.0	1.203	1.201	7.743	7.738	2.294	2.293	2.42	2.40
123		33.273													
145	3.31	33.351	26.57	5.462	5.466	73.1	73.2	2.007	2.003	7.699	7.696	2.300	2.298	2.54	2.60
147		33.353													
169	3.51	33.437	26.62	4.642	4.655	62.5	62.7	2.786	2.772	7.647	7.641	2.307	2.308	2.60	2.65
171		33.445													
193	3.48	33.501	26.67	4.228	4.227	56.9	56.9	3.202	3.203	7.606	7.607	2.314	2.313	2.71	2.71
195		33.500													
290	3.62	33.740	26.85	2.520	2.513	34.1	34.0	4.872	4.879	7.510	7.507	2.336	2.335	2.99	2.98
292		33.745													
482	3.49	34.034	27.09	0.940	0.903	12.7	12.2	6.461	6.498	7.429	7.429	2.365	2.364	3.19	3.11
484		34.035													
723	3.18	34.221	27.27	0.577	0.555	7.7	7.5	6.873	6.895	7.435	7.432	2.392	2.394	3.40	3.38
725		34.222													
965	2.81	34.352	27.41	0.569	0.570	7.6	7.6	6.944	6.943	7.440	7.443	2.413	2.414	3.34	3.34
967		34.352													
1208	2.53	34.436	27.50	0.647	0.664	8.6	8.8	6.915	6.897	7.448	7.450	2.427	2.429	3.30	3.30
1210		34.436													
1451	2.26	34.504	27.58	0.884	0.880	11.6	11.6	6.725	6.730	7.477	7.475	2.441	2.440	3.30	3.31
1453		34.504													
1678	2.06	34.553	27.63	1.049	1.039	13.7	13.6	6.597	6.607	7.496	7.495	2.451	2.451	3.22	3.25
1680		34.552													
1916	1.90	34.591	27.67	1.294	1.312	16.9	17.1	6.381	6.363	7.523	7.526	2.456	2.456	3.17	3.21
1918		34.590													
2300	1.76	34.624	27.71	1.665	1.631	21.6	21.2	6.037	6.071	7.554	7.553	2.463	2.464	3.14	3.11
2302		34.625													
2686	1.67	34.648	27.74	1.926	1.927	25.0	25.0	5.792	5.791	7.566	7.573	2.470	2.470	3.09	3.10
2688		34.647													
3074	1.61	34.661	27.75	2.180	2.187	28.2	28.3	5.550	5.543	7.595	7.602	2.470	2.472	3.06	3.04
3076		34.662													
3463	1.60	34.669	27.76	2.359	2.355	30.5	30.5	5.372	5.376	7.616	7.641	2.476	2.474	3.07	3.02
3465		34.671													

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
11.0	13.5	8.08	8.09	0.20	0.19	0.13	3.073	1070	1480	982	190	37	468	2406	0
13.4	18.2	8.21	8.20	0.18	0.18	0.23	5.256	1080	733				444	2353	10
										1700	242	50			12
31.0	32.6	12.93	12.82	0.19	0.19	0.73	1.002	960					153	1299	20
										725	103	19			22
		13.84	13.78	0.25	0.25	1.49	3.778	900	450				152	1059	29
										901	115	22			31
44.2	45.2	23.99	23.82	1.06	1.06	0.33	0.985	760	82				39	478	48
										189	48.4	8.7			50
60.8	64.0	26.90	26.78	0.03	0.03	0.05	0.116	780	62				17	423	72
										318	26.3	4.9			74
63.1	63.7	27.38	27.26	0.00	0.00	0.03	0.060	830					24	370	96
															98
66.5	66.8	31.66	31.77	0.00	0.00	0.00	0.039	860	56				21	296	121
										252	17.3	3.9			123
69.9	70.5	30.05	30.05	0.00	0.00	0.09	0.062	550	159				24	346	145
										176	29.3	5.5			147
74.2	77.2	31.82	32.22	0.00	0.00	0.10	0.057		148				20	327	169
										135	21.9	3.7			171
79.6	78.5	33.41	33.47	0.00	0.00	0.13	0.037	550	93				35	398	193
										178	23.4	3.7			195
97.4	98.2	41.31	41.43	0.00	0.00	0.13		630	67				53	544	290
										205	30.9	4.5			292
124	121	42.31	42.54	0.00	0.00	0.13		480					30	259	482
										324	57.4	8.0			484
145	148	43.28	43.05	0.00	0.00	0.09		550	56				31	252	723
										167	13.3	1.4			725
167	164	42.81	42.81	0.00	0.00	0.06		500	28	26			18	243	965
										144	34.2	3.9			967
178	177	42.52	42.52	0.00	0.00	0.08			25				24	214	1208
										184	26.3	3.1			1210
194	198	41.66	41.65	0.00	0.00	0.07		450	17				36	309	1451
										139	20.9	2.3			1453
206	200	41.19	41.35	0.00	0.00	0.13		440	23				17	183	1678
										207	23.6	2.5			1680
213	210	40.38	40.32	0.00	0.00	0.13		440	39				39	546	1916
										126	20.1	2.9			1918
230	223	39.17	39.11	0.00	0.00	0.12		450	32				19	274	2300
										157	19.0	2.3			2302
238	237	38.14	38.13	0.00	0.00	0.15			5	31			18	203	2686
										160	20.1	2.5			2688
236	235	37.38	37.33	0.00	0.00	0.09		440	37				18	230	3074
										159	22.8	2.8			3076
243	243	36.92	36.98	0.00	0.00	0.12		460	51				16	317	3463
										185	28.9	4.3			3465

Table 8. Summary of hydrographic data at Station 8.

Date	Time	Lat.	Long.	Depth	Transparency
18, Jul., 1978	0248-0610	57°59.9'-58°00.3'N	175°04.8'-175°07.8'W	3010m	4m

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
0500	ENE-4.5m/s	1010.4mb	cloudy	2	8.2°C	7	1	10

D	T	S	σt	DO	O_2sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	8.4	32.690	25.43	7.866	118.4	-1.222	8.161	8.172	2.274	2.285	0.81	0.82
10	8.41	32.703	25.43	7.873	118.5	-1.231	8.169	8.155	2.269	2.280	0.83	0.89
12	8.08	32.702	25.48									
19	7.85	32.700	25.51	7.798	115.9	-1.070	8.169	8.142	2.269	2.280	0.87	0.91
21		32.700										
29	6.88	32.662	25.62	7.057	102.5	-0.175	8.046	8.021	2.261	2.272	1.31	1.46
31		32.747										
48	4.60	33.099	26.24	6.847	94.5	0.400	7.860	7.851	2.277	2.285	2.19	2.05
50		33.111										
73	3.65	33.184	26.40	6.806	91.8	0.608	7.818	7.820	2.283	2.292	2.29	2.32
75		33.192										
97	3.24	33.216	26.47	6.935	92.6	0.554	7.809	7.814	2.289	2.291	2.32	2.33
99		33.220										
121	3.06	33.258	26.51	6.532	86.9	0.988	7.789	7.766	2.289	2.295	2.44	2.43
123		33.258										
143	3.26	33.318	26.54	5.810	77.7	1.670	7.736	7.731	2.293	2.302	2.53	2.53
145		33.318										
167	3.31	33.376	26.59	5.331	71.4	2.136	7.694	7.693	2.301	2.308	2.55	2.54
169		33.381										
190	3.38	33.435	26.63	4.833	64.9	2.618	7.677	7.657	2.304	2.310	2.58	
192		33.435										
286	3.33	33.623	26.78	3.413	45.8	4.038	7.578	7.551	2.318	2.325	2.93	
288		33.669										
478	3.48	34.004	27.07	1.219	16.5	6.185	7.471	7.459	2.361	2.366	3.25	
480		34.003										
721	3.18	34.213	27.26	0.630	8.5	6.820	7.450	7.443	2.392	2.395	3.26	
723		34.227										
965	2.81	34.344	27.40	0.539	7.2	6.974	7.443	7.467	2.412	2.418	3.38	3.30
967		34.349										
1205	2.51	34.434	27.50	0.659	8.7	6.906	7.462	7.474	2.427	2.437	3.38	3.35
1207		34.435										
1444	2.28	34.493	27.57	0.849	11.2	6.757	7.486	7.502	2.440	2.446	3.32	3.32
1446		34.493										
1683	2.09	34.535	27.61	1.088	14.2	6.553	7.505	7.524	2.446	2.456	3.28	3.33
1685		34.536										
1922	1.92	34.572	27.66	1.353	17.6	6.320	7.540	7.531	2.458	2.463	3.28	3.32
1924		34.573										
2304	1.75	34.621	27.71	1.669	21.7	6.035	7.566	7.579	2.467	2.471	3.25	3.22
2306		34.621										
2690	1.67	34.641	27.73	1.897	24.6	5.822	7.575	7.579	2.473	2.476	3.15	3.20
2692		34.639										

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
35.6	37.6	2.49	2.49	0.05	0.05	0.34	1.397	940		2020	457	82	418	14265	0
39.5	37.3	3.23	3.12	0.05	0.04	0.19	1.752	860	495				473	15545	10
										1600	353	61			12
41.6	39.9	3.93	3.87	0.08	0.08	0.49	1.520	890	1830				589	13728	19
										1850	394	68			21
43.1	36.9	8.84	8.90	0.20	0.20	2.65	2.326	890	590				320	4829	29
										602	116	19			31
64.8	63.1	24.74	24.91	0.51	0.51	0.68	0.597	770	138				51	853	48
										176	49.8	8.0			50
73.0	68.6	28.28	28.38	0.08	0.09	0.15	0.183	810	97				68	1136	73
										95	29.9	4.6			75
80.8	67.6	29.03	29.19	0.01	0.02	0.05	0.178	760	69				26	355	97
											11.8	1.7			99
76.9	70.3	30.52	30.63	0.00	0.00	0.07	0.157	780	98						121
										77	21.9	3.3			123
87.9	79.4	32.16	32.22	0.00	0.00	0.08	0.116	700	111				24	296	143
										126	28.9	4.3			145
84.0	70.9	33.35	33.41	0.00	0.00	0.07	0.123	750	169				29	331	167
										160	25.2	4.2			169
79.7	78.1	34.77	34.60	0.00	0.00	0.07	0.118	710	95				32	301	190
										247	37.3	5.4			192
103	98.0	39.02	39.13	0.00	0.00	0.08		700	62				25	256	286
										141	23.4	3.6			288
137	126	43.84	43.67	0.00	0.00	0.05			58				12	186	478
										135	22.3	3.3			480
168	148	44.69	44.80	0.00	0.00	0.07		760	35				12	218	721
										199	24.9	3.0			723
180	182	44.57	44.52	0.00	0.00	0.08		660	41				12	276	965
										112	32.0	4.2			967
198	187	43.89	43.95	0.00	0.00	0.05		600	37				20	248	1205
										153	18.5	2.6			1207
221	207	43.09	43.09	0.00	0.00	0.05			64				30	189	1444
										255	39.6	4.7			1446
221	219	42.13	42.13	0.00	0.00	0.08		620	59				24	548	1683
										157	20.0	2.5			1685
243	232	41.33	41.44	0.00	0.00	0.10		630	38	183			21	207	1922
										296	46.3	6.7			1924
258	251	40.08	40.02	0.00	0.00	0.10		650	67				33	248	2304
										233	22.2	2.5			2306
271	274	39.23	39.17	0.00	0.00	0.09		620	104	126			39	357	2690
										383	62.7	8.9			2692

Table 9. Summary of hydrographic data at Station 9.

Date	Time	Lat.	Long.	Depth	Transparency
18. Jul., 1978	2140-2308	58°15.1'-58°14.6'N	174°30.4'-174°31.1'W	1650m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
2200	E-4.5m/s	1010.4mb	cloudy	2	8.3°C	7	1	10

D	T	S	σt	DO	O_2sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		µg atoms/ℓ	
0	8.4	32.397	25.20	7.703	115.7	-1.046	8.177	8.199	2.258	2.256	0.45	0.44
10	8.13	32.421	25.26	7.926	118.4	-1.229	8.185	8.191	2.256	2.256	0.41	0.44
12		32.449										
19	6.83	32.561	25.55	7.227	104.8	-0.332	8.049	8.076	2.259	2.262	1.05	1.09
21		32.561										
29	6.72	32.610	25.60	7.305	105.7	-0.394	8.034	8.054	2.259	2.259	1.18	1.14
31		32.621										
48	4.63	32.844	26.03	6.465	89.1	0.789	7.843	7.864	2.263	2.263	1.84	1.95
50		32.899										
72	4.04	33.031	26.24	6.288	85.6	1.062	7.769	7.806	2.277	2.277	2.07	2.16
74		33.033										
96	3.70	33.143	26.36	6.164	83.2	1.243	7.757	7.795	2.283	2.284	2.18	2.16
98		33.130										
120	3.54	33.179	26.41	6.124	82.4	1.311	7.757	7.776	2.288	2.290	2.13	2.27
122		33.180										
144	3.38	33.226	26.46	6.207	83.2	1.255	7.756	7.765	2.296	2.292	2.26	2.28
146		33.228										
168	3.09	33.241	26.50	6.684	88.9	0.832	7.782	7.776	2.297	2.292	2.12	2.19
170		33.241										
192		33.263	26.52	6.435	85.5	1.087	7.776	7.764	2.297	2.294	2.26	2.30
194		33.278										
289	3.37	33.573	26.74	3.849	51.7	3.598	7.618	7.608	2.322	2.320	2.65	2.67
291		33.583										
481	3.51	33.981	27.05	1.266	17.1	6.134	7.473	7.479	2.363	2.363	3.04	3.04
483		33.986										
722	3.17	34.216	27.27	0.639	8.6	6.813	7.476	7.460	2.396	2.394	3.17	3.15
724		34.219										
962	2.86	34.338	27.39	0.585	7.8	6.918	7.483	7.475	2.414	2.415	3.12	3.12
964		34.338										

Table 10. Summary of hydrographic data at Station 10.

Date	Time	Lat.	Long.	Depth	Transparency
19. Jul., 1978	0219-0250	58°30.3'-58°30.5'N	174°00.3'-174°00.0'W	125m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
0200	E-1.0m/s	1011.1mb	cloudy	2	8.0°C	7	1	10

D	T	S	σt	DO	O_2sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		µg atoms/ℓ	
0	8.15	32.502	25.32	6.578	113.5	-0.904	8.192	8.187	2.270	2.267	0.58	0.67
10	7.90	32.498	25.35	6.852	115.1	-1.014	8.188	8.183	2.267	2.265	0.58	0.62
12		32.498										
19	7.27	32.522	25.46	6.917	112.2	-0.835	8.135	8.144	2.266	2.268	0.81	0.82
21		32.523										
29	6.47	32.566	25.60	6.575	102.3	-0.159	8.052	8.052	2.265	2.264	1.05	1.13
31												
48	4.80	32.723	25.92	5.913	92.4	0.553	7.870	7.857	2.262	2.257	1.79	1.78
50		32.728										
72	4.17	32.889	26.12	5.527	85.7	1.047	7.796	7.795	2.269	2.268	2.05	1.98
74		32.905										
97	3.60	33.022	26.28	5.323	80.2	1.473	7.735	7.746	2.276	2.276	2.18	2.26
99		33.019										
111	3.61	33.025	26.28	5.197	79.9	1.497	7.738	7.745	2.278	2.280	2.15	2.22
113		33.019										

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
21.0	18.1	0.36	0.36	0.02	0.02	0.24	1.501	1310	1690	1530	277	55	346	2985	0
23.6	25.7			0.00	0.00	0.26	1.770	1190	960				415	5829	10
										1160	221	43			12
37.2	39.5	6.63	6.63	0.20	0.20	0.64	0.755	960	422				121	2149	19
										760	122	25			21
41.7	42.7	9.52	9.33	0.20	0.20	1.42	0.812	930	247				110	1917	29
										365	122	22			31
55.7	55.0	23.10	23.17	0.32	0.31	0.35	0.509	940	200				61	920	48
										289	68.6	11			50
64.4	63.8	27.24	27.24	0.07	0.07	0.06	0.216	900	125				40	571	72
										159	30.9	4.9			74
72.5	70.9	28.86	28.85	0.08	0.09	0.14	0.179	730	128				23	369	96
										383	38.9	6.9			98
73.1	70.6	29.63	29.68	0.06	0.07	0.10	0.171	770	177				22	389	120
										153	17.6	2.0			122
72.2	73.8	30.02	30.09	0.04	0.03	0.21	0.171	780	121				14	318	144
										224	29.6	4.0			146
67.3	65.0	29.84	29.47	0.02	0.01	0.17	0.121	710	124				13	191	168
										130	26.9	3.2			170
70.6	68.0	30.03	29.96	0.01	0.02	0.05	0.100	770	72				14	192	192
										173	36.1	3.9			194
97.1	103	35.69	35.87	0.01	0.01	0.00		780	81				19	201	289
										165	23.3	2.8			291
124	124	41.79		0.00	0.00	0.00		690	52				14	126	481
										126	18.7	1.9			483
151	150	42.79	42.79	0.00	0.00	0.07		710	59				7.3	143	722
										116	18.4	1.6			724
168	163	42.79	42.66	0.00	0.00	0.00		600	27				5.9	106	962
										82	16.7	1.7			964

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
28.8	33.3	0.12	0.05	0.01	0.01	0.52	1.285	1170	505	905	238	47	217	4994	0
35.6	32.0	0.05	0.04	0.01	0.02	0.47	0.630	1060	525				207	4762	10
										893	218	48			12
39.2	36.2	1.87	1.94	0.09	0.08	1.41	1.931	1030	662				142	4395	19
										837	246	37			21
37.5	41.7	7.36	7.36	0.22	0.22	2.05	1.274	950	400				123	2266	29
										580	141	28			31
56.0	47.6	20.43	20.49	0.49	0.49	0.51	1.203	880	147				78	1333	48
										304	79.1	13			50
56.0	53.4	25.20	25.20	0.14	0.13	0.17	0.366	890	150				76	944	72
										209	51.8	9.2			74
68.6	69.3	28.36	28.35	0.14	0.15	0.05	0.139	770	386				133	1122	97
										698	105	18			99
63.1	61.8	28.23	28.17	0.14	0.14	0.12	0.133	760	246				136	1312	111
										664	47.3	8.3			113

Table 11. Summary of hydrographic data at Station 11.

Date	Time	Lat.	Long.	Depth	Transparency
19, Jul., 1978	0602-0635	58°44.2'-58°44.2'N	173°30.1'-173°30.5'W	123m	4m

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
0600	NNW-2.5m/s	1012.0mb	cloudy	2	8.1°C	7	1	10

D	T	S	σt	DO	O_2 sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	8.1	32.449	25.28	8.138	121.5	-1.438	8.136	8.128	2.263	2.260	0.56	0.58
10	7.98	32.444	25.30	8.171	121.6	-1.452	8.131	8.122	2.262	2.259	0.58	0.63
12		32.445										
19	7.92	32.448	25.31	8.079	120.1	-1.351	8.102	8.111	2.263	2.262	0.64	0.69
21		32.458										
29	6.68	32.453	25.48	7.017	101.3	-0.093	8.000	8.008	2.252	2.251	1.32	1.34
31		32.455										
48	3.77	32.663	25.98	6.934	93.5	0.484	7.832	7.830	2.255	2.252	1.80	1.89
50		32.684										
72	3.21	32.724	26.08	6.657	88.5	0.862	7.781	7.798	2.256	2.258	2.05	2.04
74		32.727										
97	3.34	32.805	26.13	6.311	84.3	1.179	7.762	7.763	2.261	2.263	2.13	2.19
99		32.805										
111	3.38	32.825	26.14	6.183	82.6	1.299	7.750	7.754	2.264	2.264	2.06	2.15
113		32.826										

Table 12. Summary of hydrographic data at Station 13.

Date	Time	Lat.	Long.	Depth	Transparency
19, Jul., 1978	1744-1825	59°59.5'-59°59.7'N	170°55.8'-170°53.5'W	67m	12m

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
1800	W-4.5m/s	1012.6mb	cloudy	3	6.9°C	7	1	10

D	T	S	σt	DO	O_2 sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	7.1	31.549	24.72	7.316	106.1	-0.419	8.076	8.069	2.204	2.201	0.25	0.31
10	7.07	31.552	24.72	7.349	106.5	-0.447	8.082	8.063	2.206	2.204	0.31	0.32
12		31.555										
20	6.03	31.553	24.85	7.581	107.2	-0.509	8.084	8.065	2.202	2.203	0.32	0.32
22		31.543										
29	4.98	31.551	24.97	7.551	104.1	-0.297	8.058	8.049	2.203	2.205	0.31	0.46
31		31.557										
48	-0.11	31.675	25.46	7.082	85.8	1.170	7.803	7.818	2.213	2.213	1.64	1.80
50		31.674										
58	-0.13	31.677	25.46	7.033	85.2	1.223	7.808	7.807	2.213	2.310	1.71	1.71
60		31.678										

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
	14.6	3.14	3.06	0.04	0.06	0.00	2.651	1150	977	1930	297	59	378	3489	0
	10.7	3.12	3.12	0.06	0.06	0.07	3.696	1010	988				313	3363	10
										2260	364	80			12
9.4	10.4	3.76	3.75	0.06	0.05	0.24	4.728	950	1060				324	3801	19
										2750	452	96			21
45.0	37.5	11.90	11.98	0.20	0.19	1.17	0.831	930	375				70	835	29
										666	112	20			31
55.3	49.2	23.32	23.49	0.18	0.14	0.07	0.581	800	193				48	818	48
										433	86.6	18			50
58.6	60.8	25.87	25.82	0.05	0.04	0.09	0.152	810	489				84	1351	72
										610	79.3	13			74
60.5	60.5	26.71	26.32	0.11	0.11	0.12		850	793				176	2285	97
										1250	127	22			99
60.2	60.5	26.31	26.29	0.12	0.12	0.21	0.164	940	1260				190	2556	111
										1230	89.9	17			113

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
27.0		0.00	0.00	0.00	0.00	0.03	0.630	970	338	316	109	20	97	623	0
28.9	23.5	0.00	0.00	0.00	0.00	0.03	0.415	930	467				94	642	10
										360	123	23			12
	36.2	0.00	0.00	0.00	0.00	0.05	0.682	950	230				96	522	20
										289	65.4	13			22
16.8		0.00	0.00	0.00	0.00	0.05	0.759	1020	410				98	578	29
										346	112	23			31
32.7		5.53	5.53	0.31	0.31	5.17	0.606	880	1980				117	3117	48
										1570	90.6	19			50
31.4	30.2	5.53	5.53	0.31	0.31	5.17	0.365		2380				86	2953	58
								940		1500	120	24			60

Table 13. Summary of hydrographic data at Station 14.

Date	Time	Lat.	Long.	Depth	Transparency
20, Jul., 1978	0520-0550	60°59.7'-60°59.7'N	168°59.9'-168°59.3'W	38m	11m

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
0600	SW-6.0m/s	1013.6mb	cloudy	3	6.2°C	7	1	9

D m	T °C	S ‰	σt	DO mℓ/ℓ	O_2sat. %	AOU mℓ/ℓ	pH		Alk mequ./ℓ		PO_4^3-P µg atoms/ℓ	
0	6.8	30.804	24.17	7.282	104.3	-0.303	7.948	7.930	2.162	2.165	0.06	0.17
10	6.86	30.802	24.16	7.254	104.1	-0.284	7.958	7.944	2.163	2.165	0.08	0.11
12		30.802										
20	4.79	30.878	24.46	7.403	101.1	-0.083	7.911	7.903	2.165	2.165	0.21	0.16
22		30.884										
30	4.72	30.887	24.48	7.393	100.8	-0.061	7.913	7.919	2.169	2.168	0.12	0.22
32		30.886										

Table 14. Summary of hydrographic data at Station 16.

Date	Time	Lat.	Long.	Depth	Transparency
20, Jul., 1978	1932-1945	63°00.1'-63°00.2'N	166°59.0'-166°58.2'W	27m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
2000	SW-6.5m/s	1014.7mb	fog	3	9.3°C	3	1	10

D m	T °C	S ‰	σt	DO mℓ/ℓ	O_2sat. %	AOU mℓ/ℓ	pH		Alk mequ./ℓ		PO_4^3-P µg atoms/ℓ	
0	11.0	29.181	22.28	6.719	104.8	-0.307	7.944	7.936	2.166	2.169	0.16	0.17
10	7.70	31.018	24.22	7.088	103.9	-0.263	7.911	7.922	2.236	2.235	0.26	0.32
12		31.055										
20	5.59	31.087	24.54	6.918	96.5	0.251	7.883	7.880	2.247	2.247	0.26	0.26
22		31.087										

Table 15. Summary of hydrographic data at Station 18.

Date	Time	Lat.	Long.	Depth	Transparency
23, Jul., 1978	2048-2110	64°59.9'-64°59.7'N	168°34.9'-168°34.1'W	49m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
2100	N-10.0m/s	1014.1mb	cloudy	4	7.2°C	7	1	10

D m	T °C	S ‰	σt	DO mℓ/ℓ		O_2sat. %		AOU mℓ/ℓ		pH		Alk mequ./ℓ		PO_4^3-P µg atoms/ℓ	
0	8.2	31.084	24.20	7.896	7.919	117.1	117.4	-1.152	-1.175	8.169	8.181	2.177	2.174	0.36	0.41
10	8.11	31.094	24.22	8.002		118.4		-1.245		8.175	8.194	2.175	2.178	0.40	0.42
12		31.224													
20	2.53	32.031	25.58	8.103		105.4		-0.418		8.101	8.092	2.235	2.231	0.92	0.92
22		32.033													
29	2.30	32.069	25.63	8.108		104.9		-0.380		8.089	8.087	2.239	2.236	0.91	0.97
31		32.124													
39	2.12	32.110	25.68	8.027		103.4		-0.266		8.080	8.073	2.243	2.240	1.02	1.03
41		32.133													

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS	POC		PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
18.4	24.1	0.00	0.00	0.00	0.00	0.08	0.402	1100	1290	398	85.7	16	73	1076	0
24.4		0.00	0.00	0.00	0.00	0.10	0.390	1090	1650				53	908	10
										428	74.4	14			12
23.2	22.9	0.01	0.01	0.00	0.00	0.07	0.680	1160	51				61	1159	20
										480	106	21			22
	19.4	0.02	0.02	0.00	0.00	0.14	0.722	1110	110				80	988	30
										875	86.2	20			32

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS	POC		PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
10.5	8.9	0.00	0.00	0.00	0.00	0.07	0.446	1330	261	524	92.9	16	96	1425	0
4.1	2.2	0.00	0.00	0.00	0.00	0.07	0.414	1090	176				66	845	10
										545	103	20			12
6.0	7.0	0.07	0.07	0.00	0.00	0.25	0.604	1080	1660				143	2199	20
										1190	99.9	20			22

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS	POC		PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
28.1	25.5	0.99	0.96	0.01	0.01	0.11	2.362	930	568	557	167	36	365	1533	0
29.7		0.95	1.00	0.02	0.02	0.11	2.540	790	474				391	1378	10
										703	222	44			12
28.4	28.1	5.09	5.09	0.05	0.05	0.96	1.862	850	762				265	3010	20
										776	95.5	18			22
30.6	31.0	5.66	5.62	0.06	0.06	1.16	2.207	760	753				233	3209	29
										810	119	22			31
39.7		6.58	6.58	0.07	0.07	1.11	2.890	630	1210				384	3077	39
										1360	138	26			41

Table 16. Summary of hydrographic data at Station 21.

Date	Time	Lat.	Long.	Depth	Transparency
24, Jul., 1978	1215-1235	67°40.3'-67°40.2'N	168°33.5'-168°33.3'W	50m	8m

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
1200	NNW-6.0m/s	1015.5mb	cloudy	3	6.6°C	7	1	10

D	T	S	σt	DO	O_2sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	4.0	32.311	25.67	9.052	122.4	-1.660	8.151	8.122	2.256	2.254	0.86	0.80
10		32.347	25.77	9.524	126.6	-2.003	8.179	8.181	2.263	2.262	0.54	0.58
12		32.330										
20	2.02	32.426	25.94	7.884	101.5	-0.119	7.974	7.971	2.254	2.258	1.43	1.48
22		32.472										
29	1.91	32.547	26.04	7.407	95.2	0.373	7.898	7.910	2.267	2.265	1.78	1.78
31		32.547										
41		32.550										
43	1.74	32.551	26.06	7.188	92.0	0.626	7.850	7.852	2.264	2.267	1.93	1.97

Table 17. Summary of hydrographic data at Station 22.

Date	Time	Lat.	Long.	Depth	Transparency
24, Jul., 1978	2209-2225	69°10.1'-69°10.2'N	168°36.2'-168°36.5'W	52m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
2200	ESE-3.9m/s	1015.0mb	fine	2	7.6°C	7	1	3

D	T	S	σt	DO	O_2sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	10.2	28.938	22.23	6.743	103.2	-0.207	8.000	7.993	2.141	2.146	0.60	0.60
10	7.43	30.035	23.49	7.361	106.5	-0.449	7.982	7.985	2.187	2.189	0.71	0.66
12		30.235										
20	3.04	30.797	24.56	8.152	106.6	-0.504	7.983	7.984	2.198	2.202	0.79	0.81
22		30.835										
29	2.77	31.136	24.85	7.997	104.1	-0.314	7.997	7.983	2.212	2.211	0.86	0.85
31		31.187										
43		31.587										
45	1.78			7.724	98.3	0.113	8.008	8.021	2.231	2.233	1.14	1.02

Table 18. Summary of hydrographic data Station 23.

Date	Time	Lat.	Long.	Depth	Transparency
25, Jul., 1978	1848-1910	65°47.3'-65°47.6'N	168°34.8'-168°34.6'W	56m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
1900	SSW-9.0m/s	1014.9mb	fog	4	4.2°C	2	2	10

D	T	S	σt	DO	O_2sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	5.3	31.772	25.11	8.325	115.8	-1.138	8.177	8.181	2.220	2.222	0.56	0.52
10	4.56	31.795	25.21	8.379	114.5	-1.063	8.176	8.175	2.220	2.224	0.60	0.59
12												
19	2.82	31.964	25.51	8.264	108.3	-0.632	8.125	8.134	2.230	2.232	0.80	0.81
21		31.957										
29	2.78	31.957	25.50	7.978	104.4	-0.338	8.118	8.127	2.229	2.235	0.80	0.81
31		31.963										
46		31.969										
48	2.79	31.964	25.51	8.238	107.9	-0.601	8.119	8.115	2.230	2.234	0.82	0.81

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
32.6	31.0	1.46		0.04	0.04	0.08	3.954	1060	1140	1990	418	80	589	3560	0
28.4	30.3	0.48	0.56	0.01	0.02	0.08	3.003	990	794				538	3568	10
										1290	294	57			12
	39.7	11.19	11.16	0.13	0.14	1.72	3.020	700	968				276	3437	20
										2110	291	61			22
44.8	49.7	13.26	13.20	0.11	0.15	3.28	6.446	770	1650				486	6804	29
										2470	268	51			31
										2680	329	64			41
62.9	54.8	14.85	14.88	0.17	0.16	3.60	4.168	820	2470				677	9067	43

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
25.2	23.5	0.00	0.00	0.00	0.00		0.376	1180	219	457	124	22	139	1787	0
22.9	20.0	0.00	0.00	0.00	0.00		0.536	1070	230				140	1811	10
										435	94.6	17			12
19.0	25.5	0.00	0.00	0.00	0.00		0.577	960	356				140	2218	20
										866	151	27			22
25.2	25.8	0.00	0.00	0.00	0.00		1.075	950	565				193	2809	29
										684	91.4	18			31
										2030	196	34			43
37.4		1.18	1.21	0.06	0.06		0.413	890	1990				372	6426	45

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
21.6	21.9	0.88	0.88	0.02	0.02	0.46	2.404	880	753	1180	240	41	456	2690	0
22.9	24.2	0.95	0.81	0.02	0.02	0.32	2.026	890	769				467	3397	10
										1640	199	38			12
26.8	29.0	2.16	2.18	0.03	0.03	0.88	1.976	870	986				393	3117	19
										1670	257	50			21
27.4		2.27	2.27	0.03	0.03	1.05	2.757	810	1140				376	3818	29
										1620	212	45			31
										1620	214	40			46
	24.5		2.41	0.03	0.03	1.05	2.445	840	1520				399	3519	48

Table 19. Summary of hydrographic data at Station 25.

Date	Time	Lat.	Long.	Depth	Transparency
26, Jul., 1978	1540-1606	64°01.2'-64°01.4'N	172°03.3'-172°01.9'W	52m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
1600	SW-6.0m/s	1016.0mb	cloudy	3	8.5°C	7	1	10

D	T	S	σt	DO	O_2sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	9.5	28.989	22.38	7.448	112.2	-0.811	8.267	8.280	2.042	2.031	0.06	0.19
10	2.71	32.834	26.21	7.041	92.5	0.568	7.895	7.888	2.280	2.277	1.76	1.63
12		32.855										
19	2.31	32.862	26.26	6.908	89.9	0.777	7.852	7.852	2.280	2.276	1.79	1.64
21		32.862										
29	2.21	32.857	26.27	6.864	89.1	0.841	7.843	7.843	2.278	2.278	1.79	1.76
31		32.859										
43	2.17	32.858	26.27	6.839	88.7	0.874	7.838	7.842	2.278	2.278	1.91	1.77
45		32.858										

Table 20. Summary of hydrographic data at Station 26.

Date	Time	Lat.	Long.	Depth	Transparency
26, Jul., 1978	2250-2316	63°00.6'-63°00.6'N	173°00.8'-173°00.5'W	68m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
2300	S-7.0m/s	1017.4mb	cloudy	3	8.4°C	7	3	10

D	T	S	σt	DO	O_2sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	8.2	31.058	24.18	7.115	105.5	-0.370	8.177	8.178	2.167	2.165	0.66	0.75
10	8.08	31.043	24.19	7.128	105.4	-0.364	8.176	8.177	2.165	2.172	0.70	
12		31.050										
19	4.76	31.166	24.69	7.896	108.0	-0.584	8.202	8.202	2.173	2.173	0.74	0.75
21		31.172										
29	2.51	31.461	25.13	8.707	112.8	-0.989	8.167	8.166	2.194	2.195	0.81	0.85
31												
48	-1.51	32.128	25.87	5.351	62.6	3.193	7.560	7.494	2.233	2.233	1.99	2.05
50		32.134										

Table 21. Summary of hydrographic data at Station 28.

Date	Time	Lat.	Long.	Depth	Transparency
27, Jul., 1978	1114-1133	61°00.3'-61°00.4'N	173°00.1'-173°00.0'W	68m	13m

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
1100	SSE-9.7m/s	1018.1mb	cloudy	3	7.8°C	7	3	10

D	T	S	σt	DO	O_2sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	7.8	31.664	24.71	7.201	106.2	-0.420	8.073	8.074	2.206	2.209	0.11	
10	7.74	31.651	24.71	7.244	106.7	-0.453	8.075	8.032	2.205	2.206	0.41	0.44
12		31.639										
19	4.81	31.643	25.06	8.069	110.8	-0.789	8.083	8.086	2.204	2.205	0.41	
21		31.655										
29	4.12	31.716	25.19	7.783	105.2	-0.383	8.043	8.051	2.209	2.209	0.47	0.50
31		31.727										
48	0.86	31.908	25.60	6.554	81.6	1.475	7.782	7.808	2.217	2.215	1.70	1.72
50		31.906										

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
	15.4	0.04	0.04	0.00	0.00	0.14	0.870	1050	444	663	139	25	230	1638	0
40.9	46.2	18.64	18.75	0.09	0.09	0.91	0.926	600	844				261	2422	10
										1300	105	19			12
48.4	43.7	19.94	19.90	0.11	0.10	1.06	0.575	670	935				346	2757	19
										1220	110	19			21
	52.7	20.33	20.36	0.11	0.10	1.08	0.606	630	820				365	3228	29
										1310	108	17			31
57.0	50.5	20.62	20.61	0.10	0.11	1.12	0.783			1400	120	19	487	2378	43
									976						45

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
15.8	18.6	0.00	0.00	0.00	0.00	0.27	0.376	880	176	271	103	18	162	1045	0
15.1	17.9	0.00	0.00	0.00	0.00	0.27	0.349	730	163				145	959	10
										176	80.7	14			12
	13.6	0.00	0.00	0.00	0.00	0.27	0.667	680	146				128	1264	19
										166	82.4	14			21
11.5	14.7	0.00	0.00	0.00	0.00	0.23	1.642	790	137				205	1058	29
										397	93.8	19			31
57.3	65.6	15.16	15.25	0.48	0.48	1.08	0.549	670	1850				366	7411	48
										1970	132	24			50

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
9.0	11.5	0.26	0.23	0.00	0.00	0.24	0.341	930	148	352	95.9	19	94	778	0
11.8	9.3	0.00	0.00	0.00	0.00	0.19	0.313	910	119				86	553	10
										622	161	33			12
7.9	11.5	0.00	0.00	0.00	0.00	0.04	0.672	1000	225				152	627	19
										581	170	32			21
3.9	7.2	0.14	0.14	0.00	0.00	0.44	0.977	910	122				90	602	29
										558	148	29			31
29.7	37.6	8.89	8.94	0.19	0.19	6.32	0.560	870	1510				419	4075	48
										2070	156	22			50

Table 22. Summary of hydrographic data at Station 30.

Date	Time	Lat.	Long.	Depth	Transparency
28, Jul., 1978	0335-0402	58°59.3'-58°59.5'N	173°00.3'-173°00.9'W	108m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
0400	SE-15.0m/s	1013.6mb	cloudy	4	8.1°C	6	3	10

D	T	S	σt	DO	O_2 sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	8.6	32.498	25.25	7.882	119.0	-1.259	8.148	8.151	2.266	2.271	0.46	0.46
10	8.50	32.497	25.26	7.930	119.5	-1.293	8.150	8.153	2.265	2.269	0.59	0.59
12		32.499										
19	8.48	32.497	25.26	7.930	119.4	-1.289	8.145	8.150	2.269	2.270	0.50	0.51
21		32.497										
29	6.62	32.495	25.52	7.028	101.4	-0.096	8.006	7.998	2.254	2.254	1.41	1.35
31		32.500										
49	3.01	32.634	26.02	6.493	85.9	1.069	7.782	7.769	2.249	2.251	2.16	2.16
51		32.634										
73	2.90	32.637	26.03	6.498	85.7	1.084	7.754	7.754	2.251	2.250	2.16	2.17
75		32.635										
97		32.635										
99	2.88	32.638	26.04	6.507	85.8	1.079	7.749	7.743	2.249	2.251	2.17	2.18

Table 23. Summary of hydrographic data at Station 32.

Date	Time	Lat.	Long.	Depth	Transparency
28, Jul., 1978	1940-2011	56°59.9'-57°00.0'N	173°04.8'-173°05.9'W	128m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
2000	SSW-8.5m/s	1007.5mb	fog	4	8.6°C	3	4	10

D	T	S	σt	DO	O_2 sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	7.8	32.703	25.52	7.199	106.9	-0.464	8.061	8.043	2.274	2.273	1.02	0.91
10	7.51	32.712	25.57	7.094	104.6	-0.314	8.038	8.042	2.273	2.272	1.03	1.76
12		32.712										
19	7.48	32.714	25.58	7.097	104.6	-0.312	8.052	8.043	2.274	2.273	1.05	1.07
21		32.714										
29	7.29	32.722	25.61	7.018	103.0	-0.204	8.024	8.019	2.272	2.273	1.02	1.22
31		32.731										
49	5.76	32.850	25.91	6.445	91.3	0.613	7.889	7.891	2.274	2.273	1.72	1.81
51		32.856										
73	4.42	33.016	26.19	5.898	81.0	1.384	7.765	7.768	2.277	2.278	2.12	2.13
75		33.030										
97	3.92	33.118	26.32	5.783	78.5	1.585	7.730	7.736	2.285	2.283	2.32	2.32
99		33.125										
116	3.81	33.144	26.35	5.653	76.5	1.734	7.716	7.715	2.285	2.287	2.38	2.44
118		33.144										

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
4.3	6.1	0.20	0.20	0.02	0.02	0.05	5.754	940	1630	4380	819	157			0
7.5		0.20	0.21	0.02	0.01	0.15	6.117	880	3610						10
										4260	803	143			12
8.2		0.22	0.20	0.02	0.02	0.16	8.621	880	1640						19
										3180	594	107			21
39.4	40.5	12.13	12.23	0.21	0.20	0.83	0.520	820	203				119	1315	29
										809	140	31			31
74.2	63.8	25.96	26.05	0.12	0.12	0.03	0.384	820	657				129	3137	49
										1360	101	15			51
64.5	65.2	26.15	26.13	0.11	0.09	0.00	0.129	810	945				176	3408	73
										1290	73	14			75
68.5	67.4	26.13	26.16	0.09	0.10					1020	72	15			97
						0.00	0.197	840	1020				227	3932	99

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
16.8	18.1	8.35	8.37	0.23	0.21	0.19	2.165	900	1360	1830	265	54			0
15.4		9.07	9.07	0.21	0.21	0.31	2.931	760	1740	2060					10
											256	53			12
16.1		9.06	9.07	0.22	0.21	0.33	2.888	720	1160	1950					19
											259	55			21
22.9	23.5	9.95	9.91	0.21	0.21	0.45	3.055	720	1360	1750			224	1516	29
											219	46			31
47.3	45.8	19.39	19.33	0.19	0.21	0.40	1.272	650	514	1010			109	1073	49
											134	27			51
64.2	67.9	27.27	27.32	0.06	0.06	0.09	0.206	570	160	386			31	469	73
											52.5	8.9			75
68.1	71.1	29.54	29.49	0.07	0.07	0.00	0.206	590	230	452			40	793	97
											49.6	8.1			99
76.0	72.6	30.73	30.68	0.08	0.09	0.00	0.348	590	675	807			79	1840	116
											67.4	11			118

Table 24. Summary of hydrographic data at Station 33.

Date	Time	Lat.	Long.	Depth	Transparency
28, Jul., 1978	2346-0055	56°35.0'-56°35.1'N	172°59.7'-173°00.2'W	800m	

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
0000	SSW-6.0m/s	1008.0mb	drizzle	4	8.9°C	5	4	10

D	T	S	σt	DO	O_2 sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	8.3	32.682	25.43	7.197	108.1	-0.537	8.086	8.087	2.273	2.271	0.91	0.92
10	8.27	32.680	25.44	7.215	108.3	-0.551	8.096	8.086	2.273	2.269	0.97	1.00
12		32.680										
19	8.26	32.683	25.44	7.244	108.7	-0.578	8.097	8.087	2.271	2.272	0.97	1.01
21		32.688										
29	6.33	32.883	25.86	6.734	96.7	0.229	7.951	7.927	2.278	2.274	1.65	1.72
31		32.902										
49	5.04	33.010	26.12	6.160	85.9	1.014	7.847	7.827	2.278	2.278	2.00	2.01
51		33.036										
73	4.09	33.142	26.32	5.929	80.8	1.407	7.757	7.746	2.287	2.288	2.26	2.30
75		33.165										
97	3.77	33.206	26.41	5.899	79.8	1.491	7.745	7.739	2.291	2.295	2.33	2.33
99		33.207										
121	3.69	33.237	26.44	5.727	77.3	1.677	7.731	7.722	2.293	2.295	2.36	2.41
123		33.231										
146	3.64	33.243	26.45	5.744	77.5	1.669	7.721	7.725	2.295	2.296	2.35	2.44
148		33.242										
170	3.57	33.262	26.47	5.801	78.1	1.624	7.719	7.725	2.295	2.297	2.43	2.42
172		33.260										
194	3.47	33.275	26.49	5.783	77.7	1.660	7.714	7.710	2.297	2.297	2.42	2.39
196		33.278										
291	3.24	33.449	26.65	4.755	63.6	2.722	7.652	7.653	2.311	2.311	2.57	2.73
293		33.460										
485	3.56	33.972	27.04	1.111	15.0	6.280	7.449	7.439	2.362	2.360	3.28	3.24
487												

Si_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
9.3	12.6	5.42	5.35	0.17	0.14	0.19	2.254	900	930	1240	176	36	225	1132	0
14.0	15.9	5.44	5.40	0.15	0.14	0.27	2.104	800	824				222	1278	10
										1610	307	63			12
14.3		5.16	5.11	0.14	0.14	0.34	2.270	850	836				256	1543	19
										1790	202	43			21
40.1	43.0	16.79	16.92	0.27	0.28	1.48	0.768	790	322				68	876	29
										565	81.3	17			31
51.6	56.3	24.43	24.42	0.20	0.21	0.40	0.422	750	148				45	493	49
										487	63.5	10			51
62.7	63.5	29.23	29.30	0.07	0.05	0.15	0.165	680	87				24	377	73
										304	38.5	5.1			75
69.2	72.6	30.41	30.36	0.05	0.05	0.07	0.096	790	105				20	398	97
										391	27.1	4.6			99
70.3	68.6	31.39	31.23	0.03	0.05	0.21	0.112	770	125				59	1112	121
										337	37.4	5.5			123
68.1	72.9	31.21	31.12	0.07	0.06	0.07	0.088	750	162				26	473	146
										251	30.6	4.7			148
71.0	71.8	31.27	31.21	0.06	0.07	0.07	0.084	690	220				28	520	170
											31.0	4.0			172
68.1	69.0	31.54	31.59	0.07		0.06	0.099	690					33	733	194
										251	35.8	5.1			196
81.7	80.9	35.11	35.16	0.07	0.07	0.07		710	79				20	482	291
										213	20.5	2.6			293
127	127	44.27	44.23	0.07	0.06	0.12		700	47				8.1	174	485
										1220	21.3	3.0			487

Table 25. Summary of hydrographic data at Station 34.

Date	Time	Lat.	Long.	Depth	Transparency
29, Jul., 1978	0657-0955	56°08.1'-56°07.5'N	173°02.6'-173°02.8'W	3030m	9m

Time	Wind	Atm. pressure	Weather	Sea	Air temp.	Visibility	Swell	Cloud amount
0900	SW-3.8m/s	1011.6mb	cloudy	2	8.9°C	7	3	10

D	T	S	σt	DO	O_2 sat.	AOU	pH		Alk		PO_4^{3-}-P	
m	°C	‰		mℓ/ℓ	%	mℓ/ℓ			mequ./ℓ		μg atoms/ℓ	
0	8.5	32.666	25.39	7.133	107.6	-0.502	8.048	8.057	2.265	2.265	1.08	1.08
10	8.35	32.665	25.41	7.166	107.7	-0.513	8.072	8.072	2.269	2.264	1.12	1.12
12		32.661										
19	8.29	32.704	25.45	7.101	106.6	-0.440	8.051	8.056	2.268	2.265	1.21	1.21
21		32.702										
29	8.26	32.706	25.46	7.073	106.1	-0.408	8.044	8.037	2.268	2.264	1.25	1.21
31		32.711										
48	5.83	32.979	26.00	6.822	96.9	0.219	7.904	7.904	2.279	2.275	1.86	1.91
50		32.982										
71	4.68	33.131	26.25	6.939	96.0	0.293	7.842	7.847	2.288	2.282	2.11	2.15
73		33.137										
95	3.56	33.207	26.43	7.025	94.6	0.404	7.816	7.817	2.297	2.289	2.32	2.28
97		33.207										
119	3.05	33.233	26.50	6.890	91.6	0.633	7.780	7.789	2.290	2.291	2.36	2.38
121		33.229										
145	2.85	33.219	26.50	7.124	94.2	0.438	7.802	7.796	2.288	2.289	2.27	2.33
147		33.219										
169	2.63	33.226	26.53	7.042	93.6	0.490	7.789	7.788	2.289	2.290	2.29	2.30
171		33.225										
193	2.78	33.301	26.57	6.337	83.7	1.235	7.738	7.730	2.293	2.291	2.37	2.48
195		33.303										
290	3.17	33.601	26.78	3.568	47.7	3.914	7.587	7.553	2.317	2.317	3.00	2.86
292		33.609										
483	3.56	33.958	27.02	1.218	16.5	6.174	7.454	7.438	2.352	2.356	3.32	3.24
485		33.960										
725	3.24	34.207	27.25	0.620	8.3	6.819	7.446	7.439	2.392	2.387	3.35	3.35
727		34.212										
966	2.87	34.346	27.40	0.465	6.2	7.036	7.444	7.453	2.413	2.412	3.34	3.33
968		34.341										
1204	2.54	34.437	27.50	0.638	8.4	6.921	7.467	7.472	2.430	2.427	3.36	3.36
1206		34.436										
1443	2.24	34.510	27.58	0.864	11.4	6.749	7.493	7.492	2.442	2.443	3.31	3.33
1445		34.509										
1682	2.04	34.559	27.64	1.093	14.3	6.557	7.505	7.518	2.452	2.451	3.27	3.15
1684		34.556										
1921	1.90	34.591	27.67	1.275	16.6	6.401	7.530	7.524	2.459	2.458	3.31	3.25
1923		34.587										
2304	1.78	34.625	27.71	1.627	21.1	6.070	7.543	7.570	2.466	2.462	3.17	3.13
2306		34.623										
2687	1.64	34.651	27.74	1.902	24.6	5.822	7.585	7.586	2.470	2.470	3.09	3.15
2689		34.651										

SiO_2-Si		NO_3^--N		NO_2^--N		NH_4^+-N	chl-a	DOC	SS		POC	PON	P.Vol.	P.No.	D
μg atoms/ℓ							μg/ℓ						nℓ/ℓ	N/mℓ	m
18.0	20.6	7.09	7.09	0.20	0.20	0.71	1.401	990	441	688	132	28	259	1698	0
	23.1	7.09	7.08	0.20	0.20	0.58	1.475	870	600				243	2131	10
										607	125	26			12
25.9	22.8	9.23	9.23	0.19	0.18	0.61	1.010	870	309				216	1619	19
										423	125	26			21
32.6	29.7	20.15	20.23	0.34	0.34	1.19	1.003	860	310				165	1379	29
										361	105	22			31
54.1	49.1	20.28	20.27	0.34	0.34	1.16	0.413	780	215				49	611	48
										160	43.8	6.9			50
57.0	53.5	24.30	24.32	0.49	0.47	0.75	0.310	750	105				39	446	71
										107	28.7	4.9			73
62.3	61.1	27.25	27.19	0.56	0.56	0.13	0.229	740	70				28	401	95
										75	21.8	3.1			97
64.2	63.0	29.42	29.37	0.03	0.03	0.17	0.126	720	63				29	326	119
										71	20.2	2.7			121
65.5	61.4	28.97	28.98	0.03	0.02	0.07	0.124	710	109				24	273	145
										116	35.9	4.6			147
65.2	62.7	29.12		0.01	0.01	0.07	0.075	730	64				22	219	169
										80	24.6	3.3			171
71.2	74.4	30.89	30.98	0.01	0.00	0.00	0.071	700	79				18	215	193
										113	36.7	5.8			195
92.7	89.9	37.61	37.61	0.00	0.00	0.00		620	36	33			32	259	290
										82	27.9	3.3			292
121	122	42.51	42.51	0.00	0.00	0.00		710	29	26			17	141	483
										226	23.8	3.4			485
148	148	43.38	43.38	0.00	0.00	0.03		700	31	59			23	199	725
										116	22.1	2.3			727
162	163	43.51	43.55	0.00	0.00	0.07		650	32	29			14	117	966
										157	28.0	2.3			968
184	182	42.83	43.01	0.00	0.00	0.07		660	42	45			7.2	175	1204
										165	17.1	1.9			1206
201	200	42.21	42.29	0.00	0.00	0.00		630	57	35			9.2	114	1443
										250	27.7	3.7			1445
212	211	41.49	41.49	0.00	0.00	0.07		590	67	60			18	251	1682
										167	17.3	2.2			1684
221	221	40.92	40.72	0.00	0.00	0.07		590	47	42			14	149	1921
										215	24.1	4.2			1923
231	231	39.83	39.96	0.00	0.00	0.14		590	17	43			27	220	2304
										249	18.3	2.6			2306
241	237	38.94	38.93	0.00	0.00	0.31		670	34	58			9.6	188	2687
										211	21.0	3.2			2689

Table 26. Summary of data at surface stations.

No.	Date	Time	Lat.	Long.	T °C	S ‰	Wind m/s	pH		Alk meq/ℓ		PO_4^{3-}-P µg atoms/ℓ		SiO_2-Si		SS µg/ℓ		P.Vol. nℓ/ℓ	P.No. N/mℓ
S 1	7/6	06	36°09.0'N	142°09.8'E	25.9	34.523	NE - 7.0	8.264	8.270	2.320	2.318	0.02	0.02	7.8	1.6	194		45	3041
S 2		12	36°57.1'N	143°35.6'E	26.6		NE - 4.5	8.133	8.275	2.325	2.320	0.01	0.01	3.3	4.0	97		65	3166
S 3		18	37°33.7'N	144°58.1'E	25.4	34.555	SE - 3.5	8.225	8.227	2.328	2.321	0.05	0.07	4.8	3.3	82		79	3174
S 4	7/7	00	38°04.6'N	145°59.0'E	22.6	34.122	ESE- 1.7	8.183	8.192	2.320	2.315	0.03	0.04	2.5	1.1	250		78	708
S 5		06	38°48.5'N	147°03.2'E	20.9	34.223	SE - 2.5	8.284	8.197	2.322	2.318	0.06	0.04		2.5	171		145	2596
S 6		12	39°21.2'N	148°19.2'E	22.2	34.218	S - 2.8	8.219		2.316	2.318	0.09	0.10	4.0	3.2	215		109	898
S 7		18	40°00.6'N	149°34.3'E	21.2	33.855	SE - 4.0	8.195		2.312	2.314	0.06	0.09	2.4		180		129	2372
S 8	7/8	00	40°38.8'N	150°53.2'E	20.7	34.213	SE - 2.6	8.192		2.325	2.324	0.06	0.12	2.9	3.0	228		142	1838
S 9		06	41°11.0'N	152°11.7'E	19.3	34.123	S - 5.0	8.153	8.177	2.317	2.315	0.06	0.09	1.7	1.6	300		172	1675
S10		12	41°43.8'N	153°28.0'E	18.8	33.907	S - 5.0	8.175		2.310	2.310	0.08	0.07	0	0.3	307		229	2077
S11		18	42°15.3'N	154°47.0'E	17.1	33.881	SW - 6.0	8.162		2.309	2.308	0.10	0.12	2.4	1.2	890		677	2833
S12	7/9	00	42°47.0'N	156°10.7'E	16.5	34.029	SW - 6.5	8.154	8.168	2.319	2.316	0.06	0.11		0.2	276		205	1348
S13		06	43°16.8'N	157°36.2'E	15.6	33.682	WSW- 6.0	8.180	8.180	2.301	2.300	0.10	0.07	2.9	0	290		279	1072
S14		12	43°46.5'N	159°05.9'E	14.8	33.160	WNW- 7.8	8.175	8.173	2.286	2.286	0.16	0.17	3.9	0	390		334	1562
S15		18	44°15.2'N	160°34.8'E	13.1	33.004	N - 6.0	8.067	8.076	2.287	2.287	0.70	0.72	0	4.6	360		183	1439
S16	7/10	00	44°38.4'N	161°48.8'E	12.3	33.375	NE -10.7	8.059	8.063	2.303	2.302	0.75	0.69	9.7	9.5	195		187	1341
S17		06	45°03.2'N	163°02.9'E	8.9	33.064	ENE- 9.3	7.986	7.995	2.287	2.285	1.14	1.13	16.8	16.1	181		73	648
S18		18	45°39.6'N	165°21.7'E	8.7	33.078	E - 5.0	7.993	7.998	2.291	2.289	1.20	1.27	15.4	10.3	100		57	485
S19	7/11	00	46°02.0'N	166°52.0'E	8.1	32.918	E - 5.0	8.040	8.041	2.288	2.287	1.25	1.24	12.1	10.6	581		240	1698
S20		06	46°27.2'N	168°24.1'E	7.9	32.952	E - 2.5	8.057	8.073	2.293	2.285	1.50	1.24	17.8		1025		546	2764
S21		12	46°48.9'N	169°57.2'E	8.9	33.030	S - 0.5	8.006	8.017	2.290	2.287	1.25	1.50	43.5		492		520	3058
S22		18	47°12.6'N	171°30.1'E	7.6	33.004	W - 4.0	8.019	7.991	2.287	2.285	1.67	1.75	44.4	58.3	512		371	2119
S23	7/11'	00	47°33.1'N	172°51.4'E	7.5	33.019	WNW- 3.2	7.985	7.973	2.285	2.284	1.78	1.94	45.0	40.5	359		340	2163
S24	.	06	47°53.9'N	174°30.8'E	7.6	33.946	W - 6.5	8.033	7.483	2.282	2.278	1.61	1.66	36.6	36.0	340		272	2839
S25	8/10	12	54°49.8'N	162°43.6'W	10.2		NW -15.2	8.128	7.117	2.180	2.179	0.38	0.36	11.3	4.4	412	370	310	2363
S26		18	54°11.8'N	164°24.8'W	10.3	31.708	SW - 7.0	8.116	7.109	2.222	2.222	0.04	0.03	7.5	2.6	459	373	230	1288
S27	8/11	00	53°36.9'N	166°05.8'W	9.8	31.878	SSE-12.2	8.095	7.090	2.217	2.215	0.53	0.53	16.2	8.6	320	443	227	1855
S28		06	53°07.2'N	167°46.4'W	9.5	31.952	SSW-13.5	8.065	7.073	2.220	2.224	0.62	0.62	26.6	13.6	265	296	150	1762
S29		12	52°44.0'N	169°03.5'W	8.7	32.068	W -15.8	8.035	7.036	2.224	2.223	0.79	0.79	17.9	18.5	440	383	143	1064
S30		18	52°22.5'N	170°31.6'W	7.5	32.252	W -12.8	7.963	7.964	2.230	2.228	1.24	1.10	22.2	22.1	236	358	187	2036
S31	8/12	00	51°51.1'N	172°20.3'W	6.4	32.846	W -10.1	7.869	7.856	2.269	2.269	1.79	1.65	46.0	47.2	268	225	156	786
S32		06	51°22.0'N	174°02.5'W	10.0	32.337	WNW-11.8	8.061	8.071	2.241	2.240	0.77	0.76	8.9	11.8	303	263	218	1962
S33		12	50°51.1'N	175°44.5'W	9.9	32.234	WNW- 9.0	8.086	8.085	2.238	2.239	0.72	0.64	5.2	5.5	246	411	230	1549
S34		18	50°20.1'N	177°24.5'W	9.5	32.548	WNW-10.0	8.010	8.018	2.258	2.257	1.06	1.06	24.0	24.0	514	505	208	1717
S35	8/14	00	49°44.4'N	179°00.7'W		32.501	WSW- 3.0	8.022	8.026	2.253	2.252	1.07	1.11	17.6	20.3	166	198	107	1396
S36	8/14'	06	49°08.4'N	179°20.4'E	9.9	32.735	SE - 2.0	8.013	8.008	2.267	2.267	1.40	1.33	20.8	20.9	227	159	128	2760
S37		12	48°31.4'N	177°44.5'E	10.2	32.770	E - 6.9	8.000	8.005	2.269	2.269	1.52	1.58	35.4	36.5	247	200	147	2488
S38		20	47°55.7'N	176°19.9'E	10.1	32.819	NE - 9.5	7.990	7.998	2.274	2.272	1.46	1.57	26.3	27.6	215	183	74	1483
S39	8/15	06	47°35.7'N	174°12.0'E	10.4	32.989	N - 9.5	8.006	8.008	2.273	2.271	1.47	1.46	18.2	18.5	117	166	101	1504
S40		12	47°19.5'N	172°26.6'E	11.4	32.808	WSW- 6.7	8.006	8.012	2.269	2.269	1.43	1.43	51.3	53.5	275	211	142	1725

No.	Date	Time	Lat.	Long.	T °C	S ‰	Wind m/s	pH		Alk meq/ℓ		PO_4^{3-}-P µg atoms/ℓ		SiO_2-Si		SS µg/ℓ		P.Vol. nℓ/ℓ	P.No. N/mℓ
S41	8/15	18	47°02.3'N	170°50.9'E	11.2	32.812	SW - 8.5	7.989	7.994	2.273	2.269	1.42	1.48	45.5	50.5	155	258	113	1662
S42	8/16	09	46°14.9'N	167°06.6'E	10.4	32.764	SSW-13.4	7.996	8.011	2.271	2.271	1.18	1.19	23.7	22.3	196	166	74	1139
S43		18	45°47.0'N	165°01.4'E	12.7	32.896	WNW-14.0	8.060	8.082	2.281	2.278	0.70	0.68	10.2	12.7	369	355	193	1196
S44	8/17	00	45°23.7'N	163°40.0'E	14.1	33.091	W - 9.1	8.111	8.121	2.283	2.283	0.48	0.48	15.7	18.9			193	1654
S45		06	45°05.2'N	162°18.1'E	14.9	33.051	WNW- 7.0	8.131	8.126	2:283	2.280	0.46	0.48	20.0	17.4	189	200	152	2296
S46		12	44°43.4'N	160°50.2'E	15.6	32.790	SSW- 8.5	8.122	8.131	2.265	2.269	0.47	0.41	21.9	10.2	179	221	99	1352
S47		18	44°17.8'N	159°19.5'E	16.7	32.945	S - 9.5	8.147	8.148	2.278	2.281	0.29	0.36	17.3	18.2	196	186	114	743
S48	8/18	00	43°45.0'N	157°45.1'E	16.3	32.348	SE -12.0	8.131	8.138	2.251	2.251	0.44	0.49	16.5	14.5	126	192	81	1353
S49		06	43°17.8'N	156°26.7'E	18.4	33.006	NW -10.0	8.162	8.163	2.278	2.275	0.18	0.16	13.5	13.9	112	175	98	1039
S50		12	42°45.7'N	154°57.6'E	20.8	33.589	N - 9.8	8.172	8.173	2.290	2.288	0.06	0.07	17.7	17.0	94	174	35	439
S51		18	42°19.4'N	153°32.6'E	20.1	33.018	NNW- 7.5	8.133	8.150	2.278	2.280	0.14	0.10	19.6	14.8	75	71	90	890
S52	8/19	00	41°45.4'N	152°13.0'E	19.2	32.812	W - 4.0	8.145	8.153	2.271	2.270	0.17	0.13	14.0	17.3	101	126	79	1235
S53		06	41°12.2'N	150°48.6'E	22.9	33.895	SE - 3.0	8.168	8.178	2.230	2.300	0.14	0.15	17.1	16.9	128	65	40	541
S54		12	40°38.1'N	149°23.5'E	21.5	33.116	SE - 8.1	8.153	8.167	2.283	2.285	0.13	0.11	11.5	16.9	78	28	41	688
S55		18	40°00.3'N	148°04.3'E	25.1	34.108	SE - 9.0	8.179	8.185	2.307	2.307	0.09	0.05	20.1	17.8	94	115	39	515
S56	8/20	00	39°19.7'N	146°35.2'E	23.2	33.359	SW - 8.0	8.130	8.174	2.279	2.278	0.16	0.16	13.9	14.8	96	109	44	450
S57		06	38°40.8'N	145°20.2'E	23.9	34.111	SW - 8.0	8.184	8.191	2.308	2.309	0.12	0.15	16.2	20.3	77	95	45	551

Table 27. Biomass (mg dry weight) of plankton collected with a twin Norpac net*.

Stations	Date and Time		Depth of haul m	GG54 mg/haul	GG54 mg/m³	XX13 mg/haul	XX13 mg/m³
1	10 July 78	1112-1120	0-150	586	29	294	15
3	12	0837-0849	0-150	250	13	472	25
4	15	0855-0905	0-150	1910	95	2012	114
6	17	1324-1334	0-150	832	46	1256	91
8	18	0610-0625	0-150	2938	141	1574	94
9	18	2310-2326	0-150	2144	117	1192	79
10	19	0258-0305	0-110	1376	104	892	103
11	19	0717-0726	0-110	4272	324	2536	251
13	19	1810-1820	0- 62	466	54	654	85
14	20	0551-0553	0- 30	118		196	44
15	20	1254-1256	0- 25	206	52	114	32
16	20	1946-1948	0- 27	114	29	192	52
18	23	2117-2122	0- 45	350	32	750	95
21	24	1330-1334	0- 47	578	77	1384	282
22	24	2252-2303	0- 49	812	121	894	160
23	25	1914-1918	0- 51	528	75	714	135
25	26	1622-1625	0- 49	2204	302	1512	252
26	26	2320-2324	0- 60	194	25	236	35
28	27	1147-1152	0- 65	972	110	1472	180
30	28	0252-0300	0-100	4028	270	6028	482
32	28	1850-1857	0-126	1836	119	2584	219
33	29	0055-0106	0-150	868	44	936	49
34	29	1033-1044	0-150	1036	50	1394	76
35	30	0343-0352	0-151	544	27	890	55

* Mesh size: GG54, 0.33mm; XX13, 0.10mm.

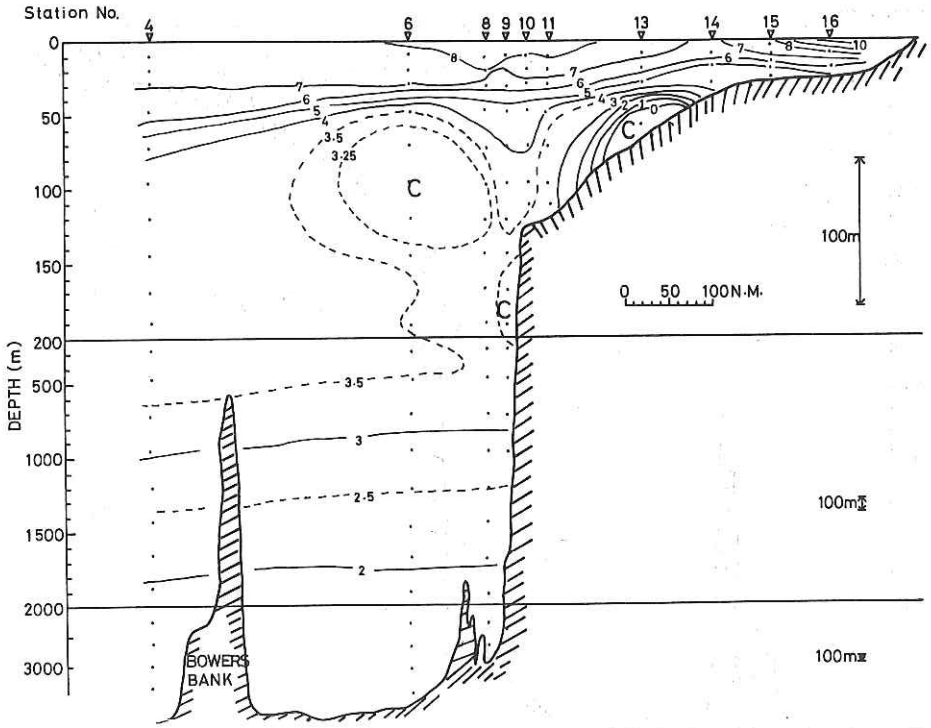

Fig. 2. Cross section of temperature (°C) in the Bering Sea from leg 1.

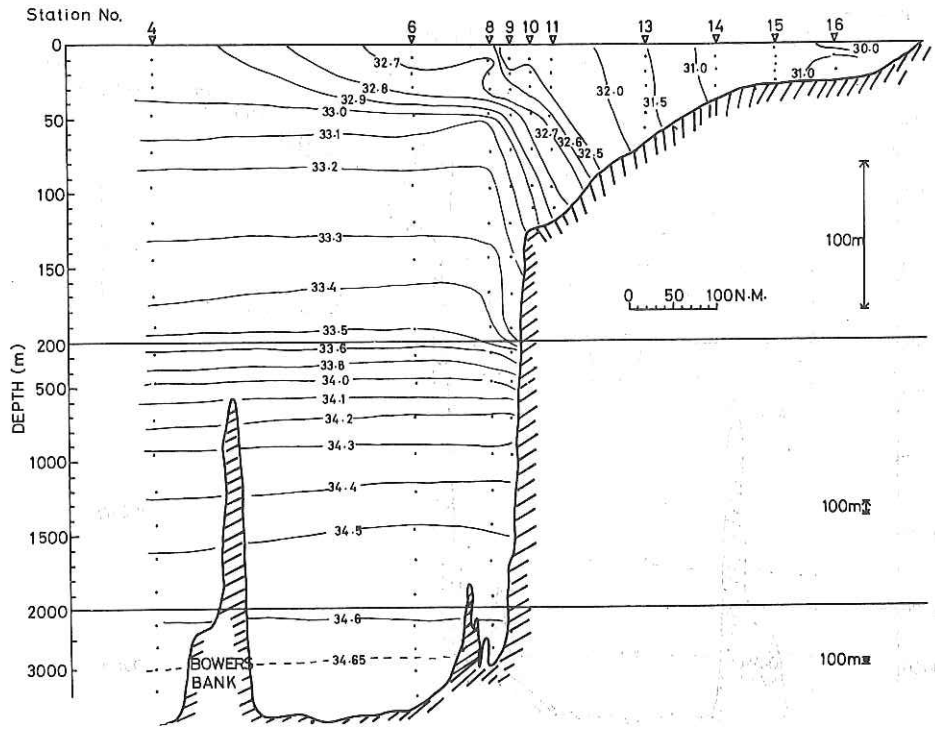

Fig. 3. Cross section of salinity (‰) in the Bering Sea from leg 1.

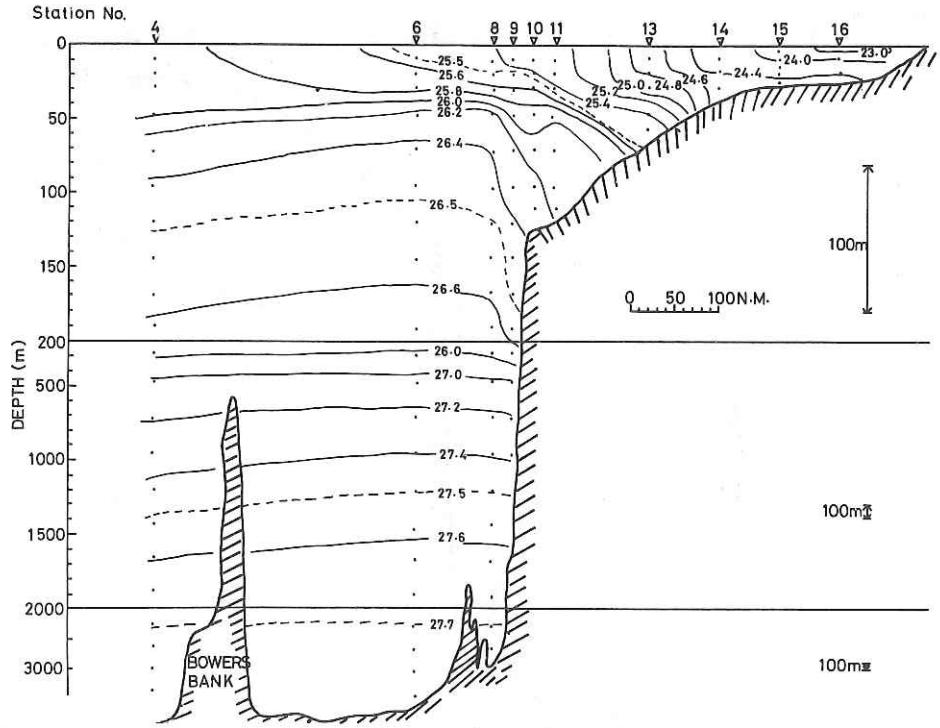

Fig. 4. Cross section of density (σ_t) in the Bering Sea from leg 1.

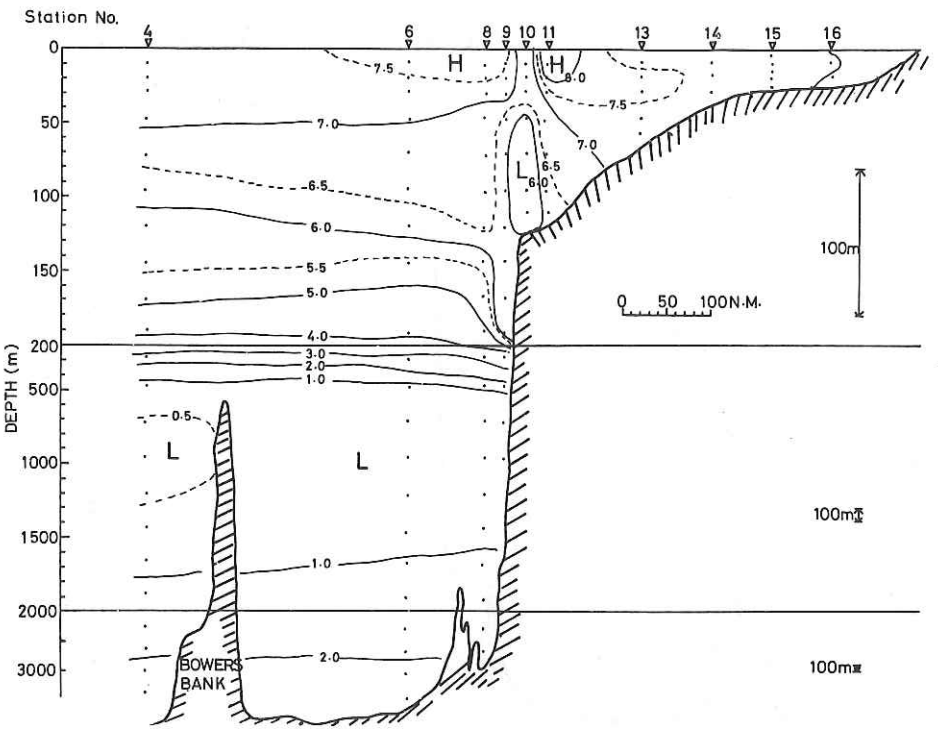

Fig. 5. Cross section of dissolved oxygen (mℓ/ℓ) in the Bering Sea from leg 1.

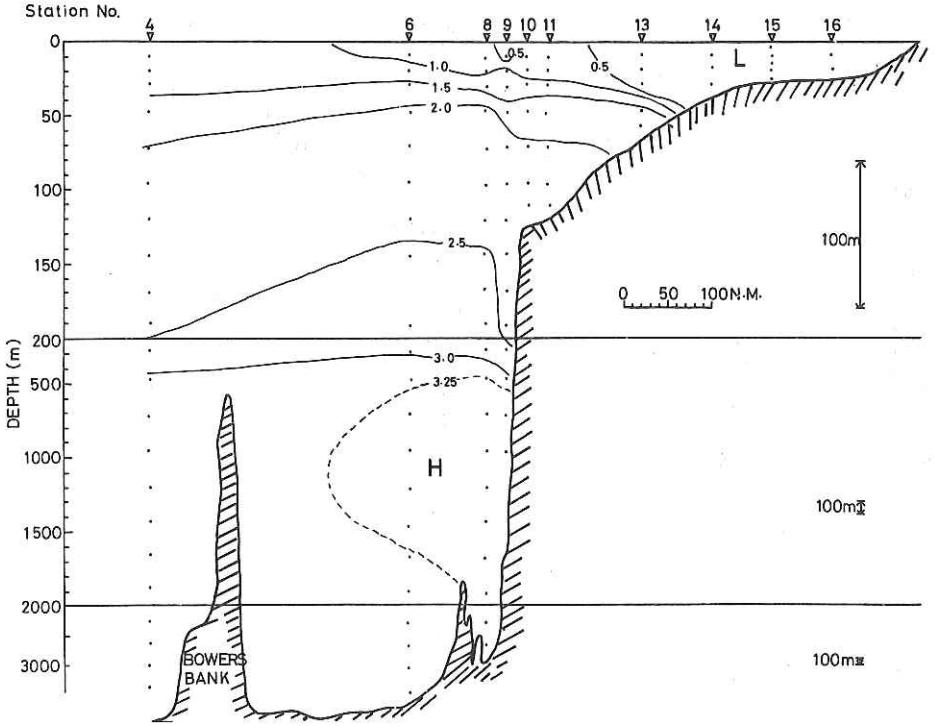

Fig. 6. Cross section of phosphate (μg atoms P/ℓ) in the Bering Sea from leg 1.

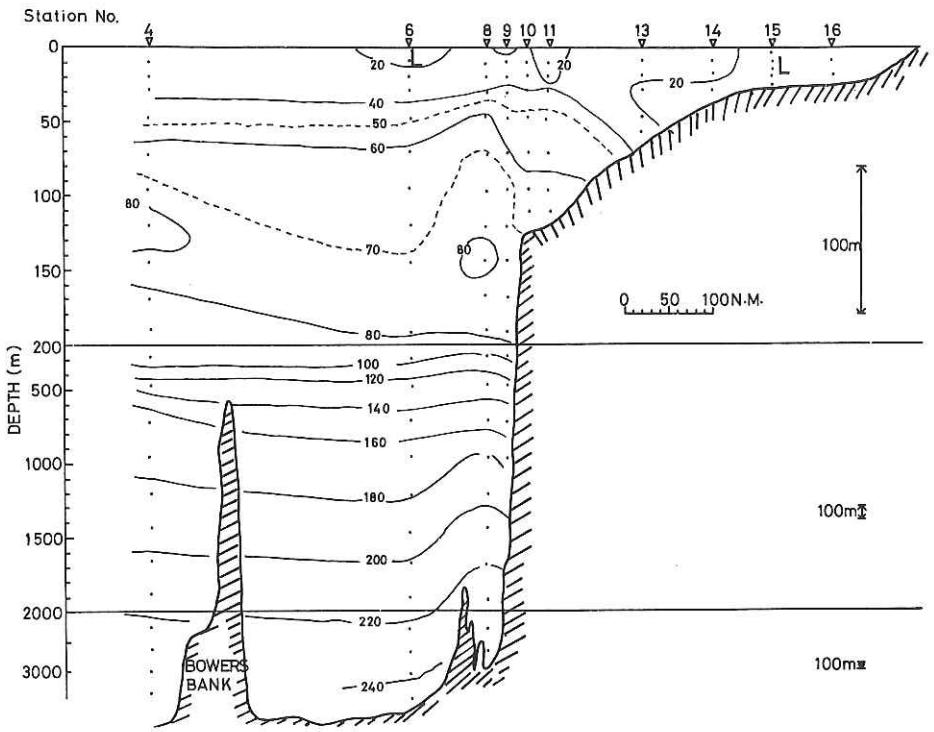

Fig. 7. Cross section of silicate (μg atoms Si/ℓ) in the Bering Sea from leg 1.

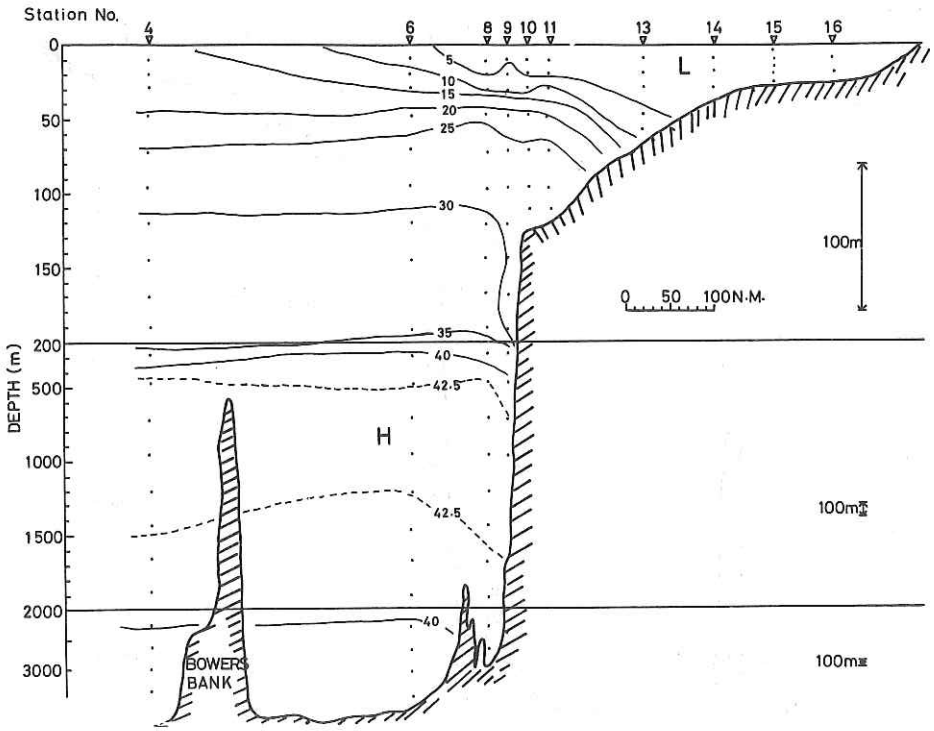

Fig. 8. Cross section of nitrate (μg atoms N/ℓ) in the Bering Sea from leg 1.

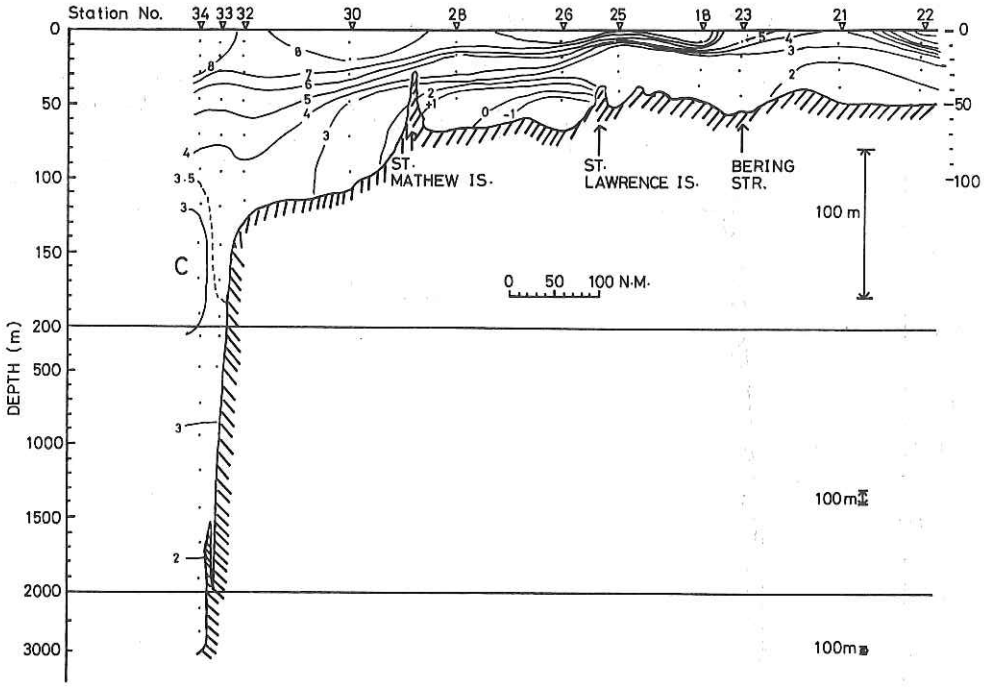

Fig. 9. Cross section of temperature (°C) in the Bering and Chukchi seas from leg 2.

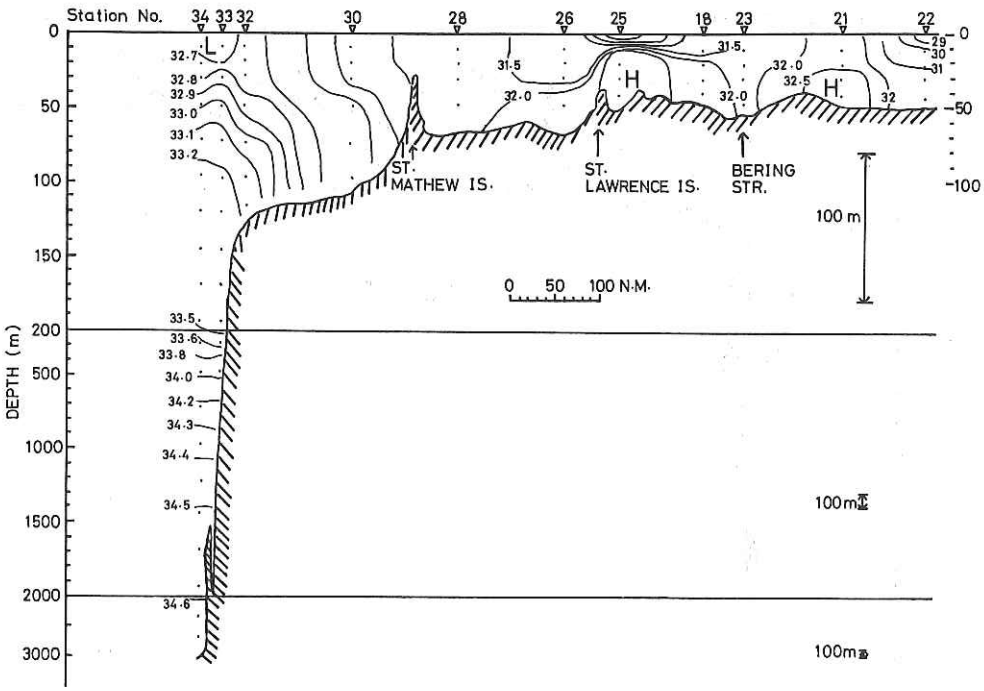

Fig. 10. Cross section of salinity (‰) in the Bering and Chukchi seas from leg 2.

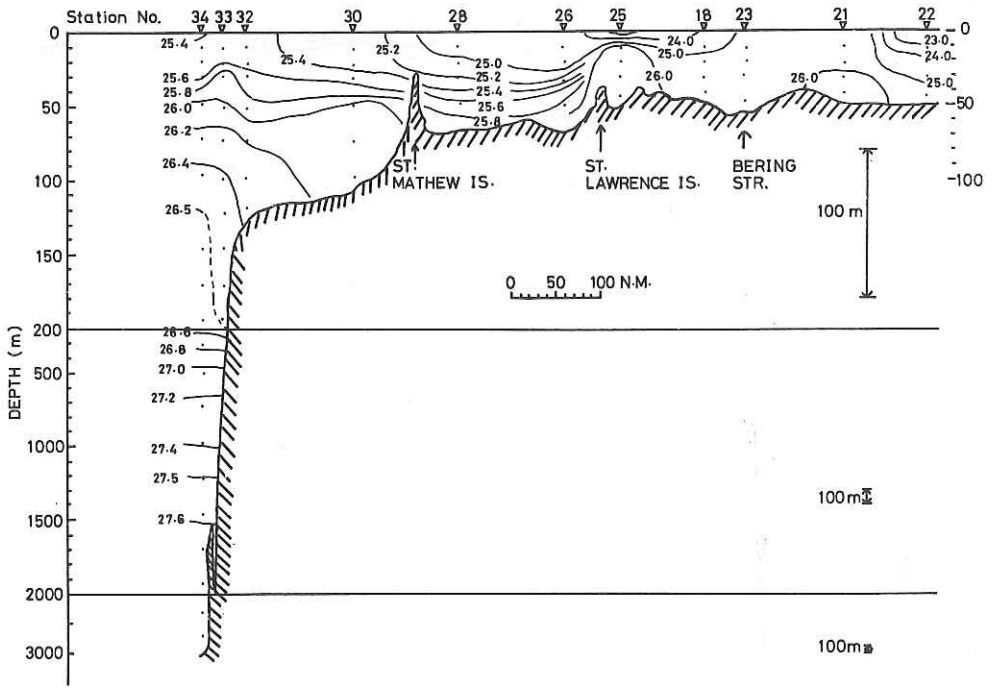

Fig. 11. Cross section of density (σ_t) in the Bering and Chukchi seas from leg 2.

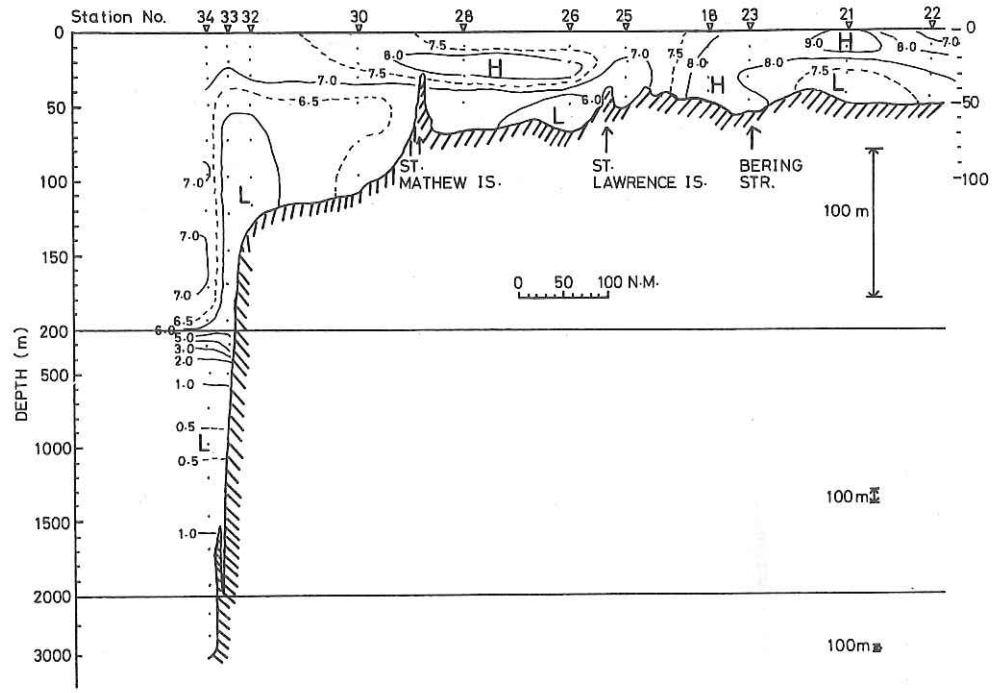

Fig. 12. Cross section of dissolved oxygen (mℓ/ℓ) in the Bering and Chukchi seas from leg 2.

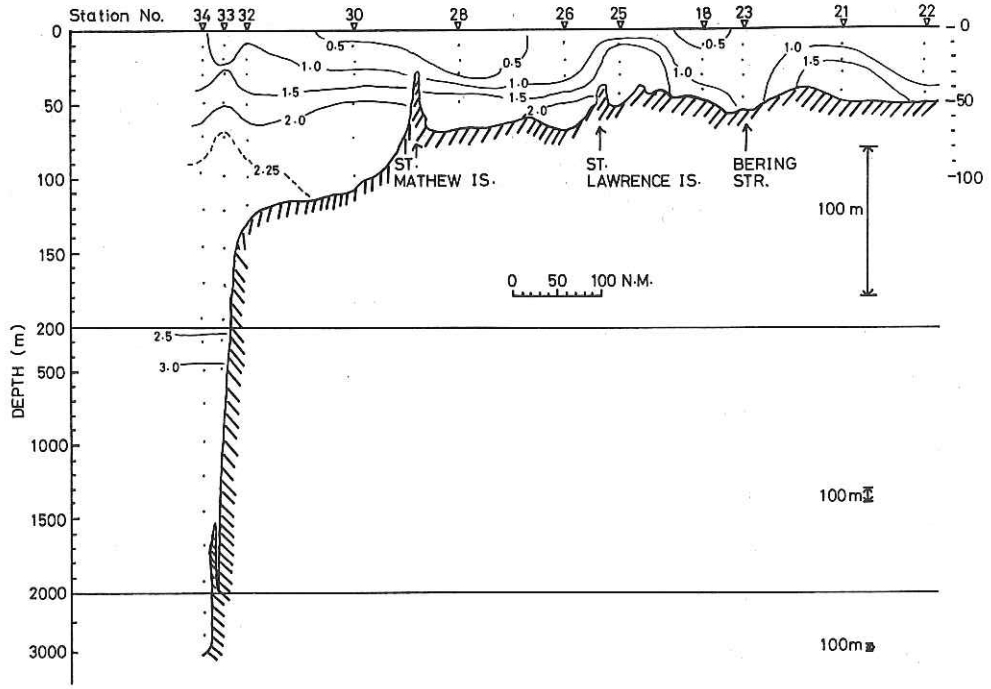

Fig. 13. Cross section of phosphate (μg atoms P/ℓ) in the Bering and Chukchi seas from leg 2.

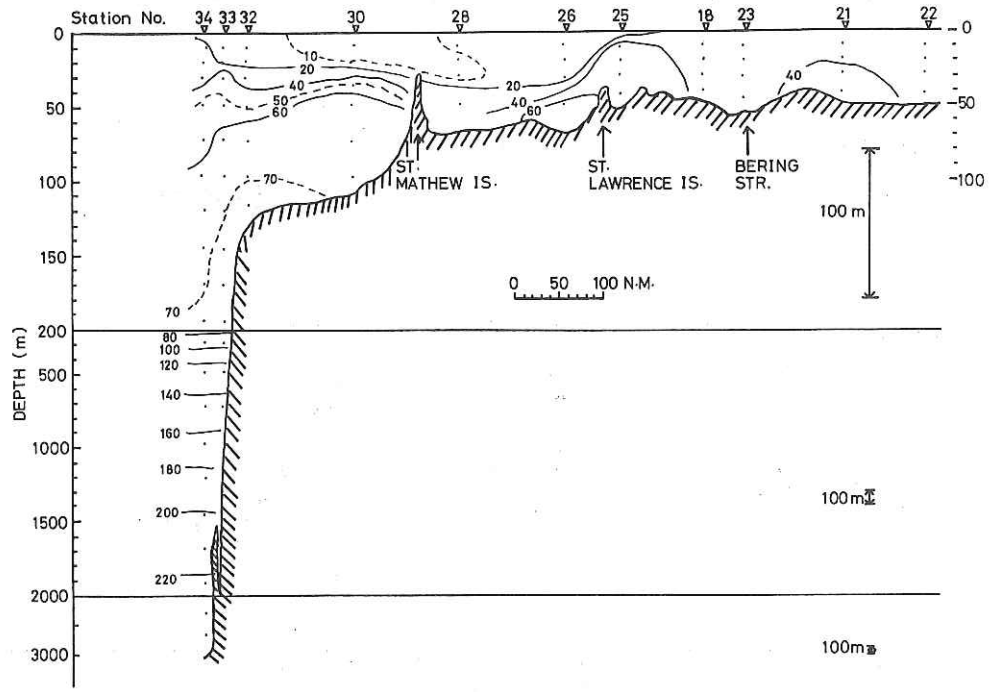

Fig. 14. Cross section of silicate (μg atoms Si/ℓ) in the Bering and Chukchi seas from leg 2.

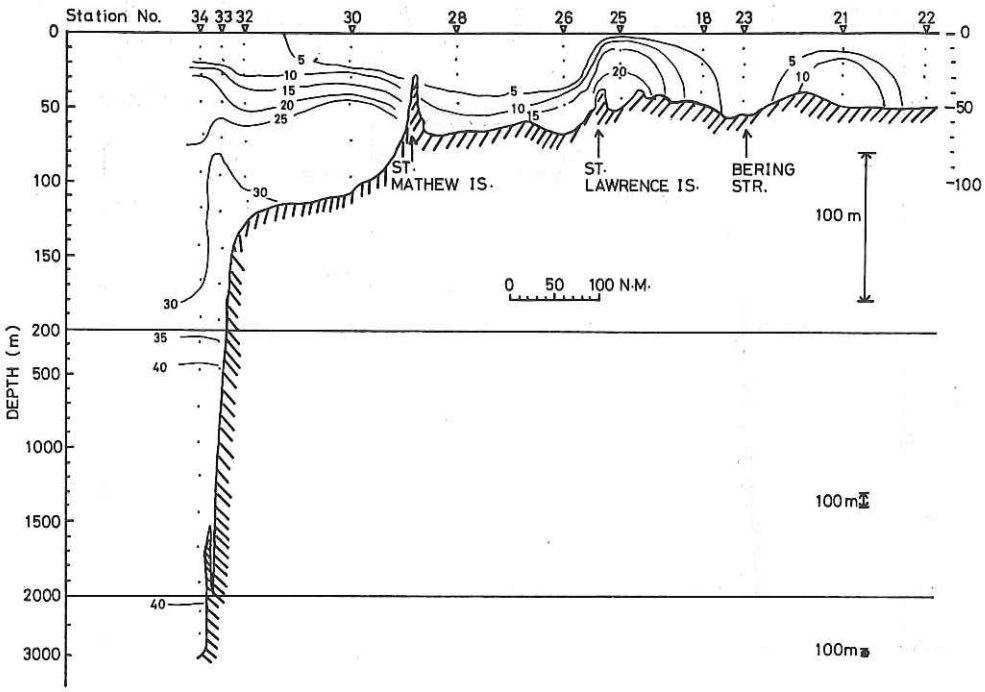

Fig. 15. Cross section of nitrate (μg atoms N/ℓ) in the Bering and Chukchi seas from leg 2.

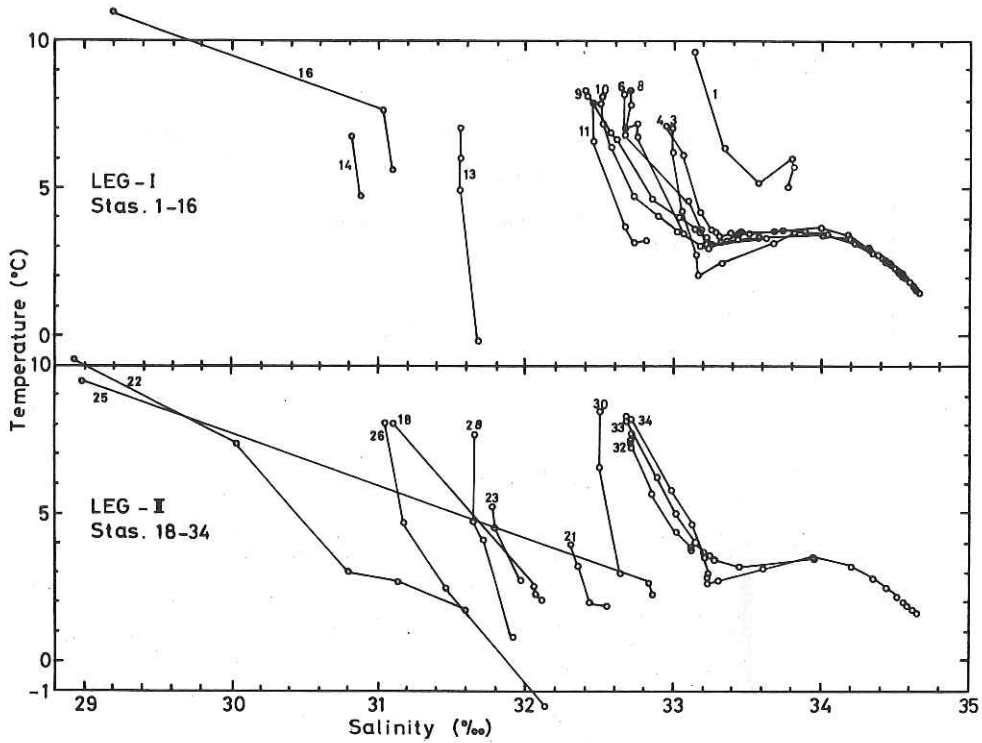

Fig. 16. T-S diagrams at hydrographic stations in the Bering and Chukchi seas and the northern North Pacific.

Sampling of bottom sediments

Core samples of sediments were obtained at Stations 3, 4 and 6 using a piston core sampler and at eight stations using a tripodal Phleger core sampler. Additional sediment samples were collected at nine stations with an Okean grab sampler (cf. Table 3).

Records of the piston core samples are given in Table 28, and core descriptions by N. Suzuki are displayed in Figs. 17-19.

Table 28. Records of sediment sampling by piston core sampler.

Stations	3	4	6
Latitude	47°56.9'N	53°32.4'N	56°59.1'N
Longitude	176°24.6'E	177°15.8'E	177°02.2'E
Date	12 Jul '78	15 Jul '78	17 Jul '78
Time lowered	1406	0941	1104
Time hit	1532	1058	1219
Time surfaced	1659	1208	1317
Core length (cm)	1128	1022	1030
Water depth (m)	5350	3930	3650

The core collected at Station 3 consists of diatomaceous ooze and appears almost homogeneous. Some disturbance by slumping is observed. Tills of metamorphic rocks, probably derived from the northern metamorphic regions, are included.

The core at Station 4 also consists of diatomaceous ooze. Six turbidite-like layers characterized by graded bedding and sole mark are intercalated. These layers are mineralogically characterized by brown volcanic glasses and heavy minerals, involve poor diatom fossils and lack the clay matrix. The thickness of these tufaceous layers ranges from 3 to 20cm.

The presence of a well developed sliding structure in the core at Station 6 suggests that the sea bottom at this station is unstable. Some of the coarser layers are characterized by turbidite-like faces,

and involve graded bedding and sole mark. Lacking of the clay matrix and less abundance of diatom fossils in sandy layers are the same as observed in the core at Station 4.

Figs. 17-19. Descriptions of visual properties of core samples collected at Stations 3 (Fig. 17), 4 (Fig. 18) and 6 (Fig. 19). Following abbreviations are used: a, angular; bl, blue or blueish; br, brown or brownish; c, clay or clayey; d, dark; gr, green or greenish; gr, grey or greyish; h, hole; i, inclusion; l, light; m, mottle; p, pale; r, red or reddish; rk, rock; rs, roundness; s, silt or silty; sd, sand or sandy; st, streak; y, yellow or yellowish.

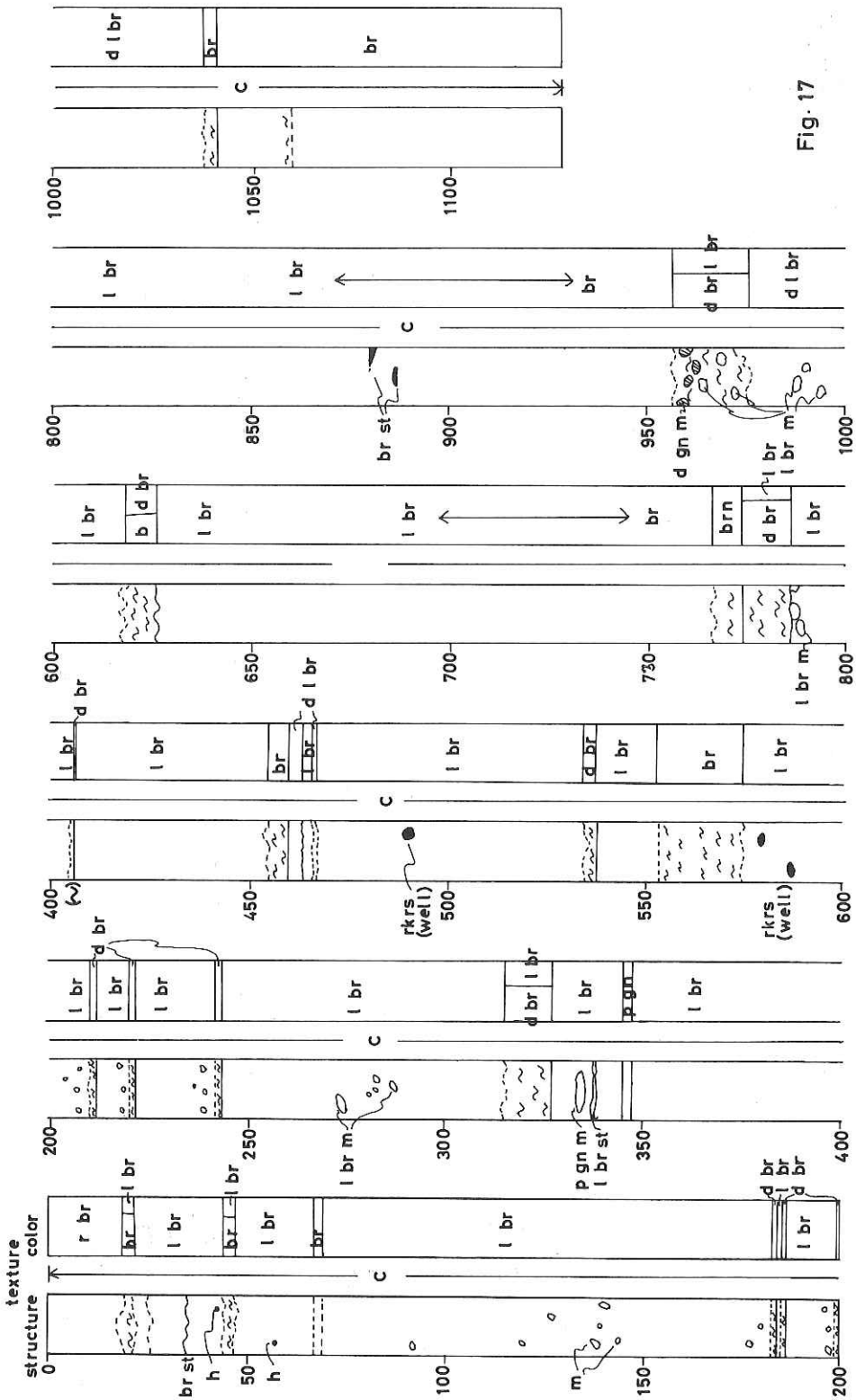
texture
color
structure
r br
l br
br
d br
d l br
c
br st
h
m
l br m
p gn m
l br st
rkrs (well)
d gn m
brn
p gn
b
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
730
800
850
900
950
1000
1050
1100

Fig. 17

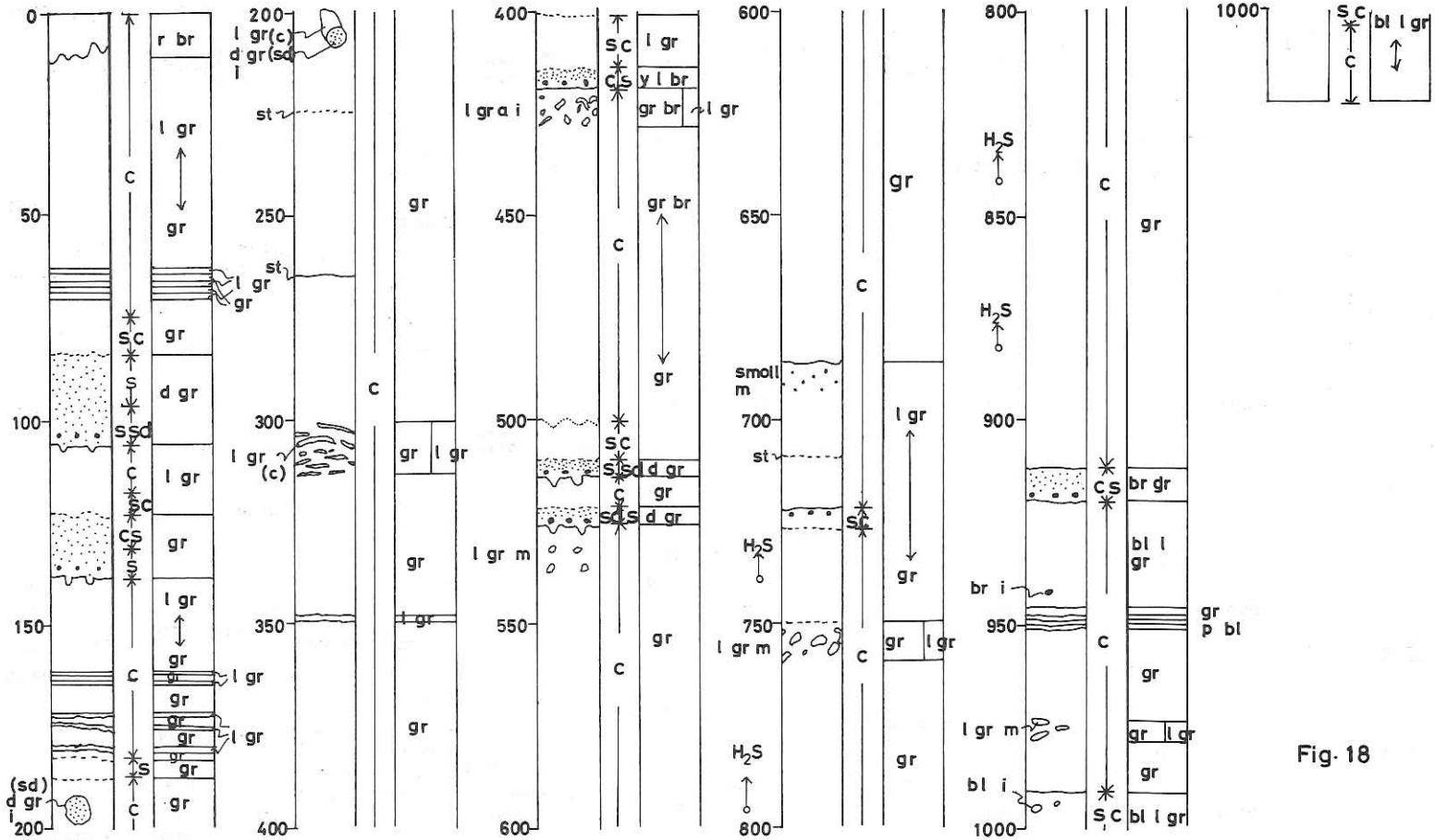
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
r br
l gr
gr
d gr
l gr(c)
d gr(sd)
l
st
(c)
(sd)
smoll
m
l gr m
br i
bl i
y l br
gr br
br gr
bl l gr
p bl
H2S
S C
C S
S
C

Fig. 18

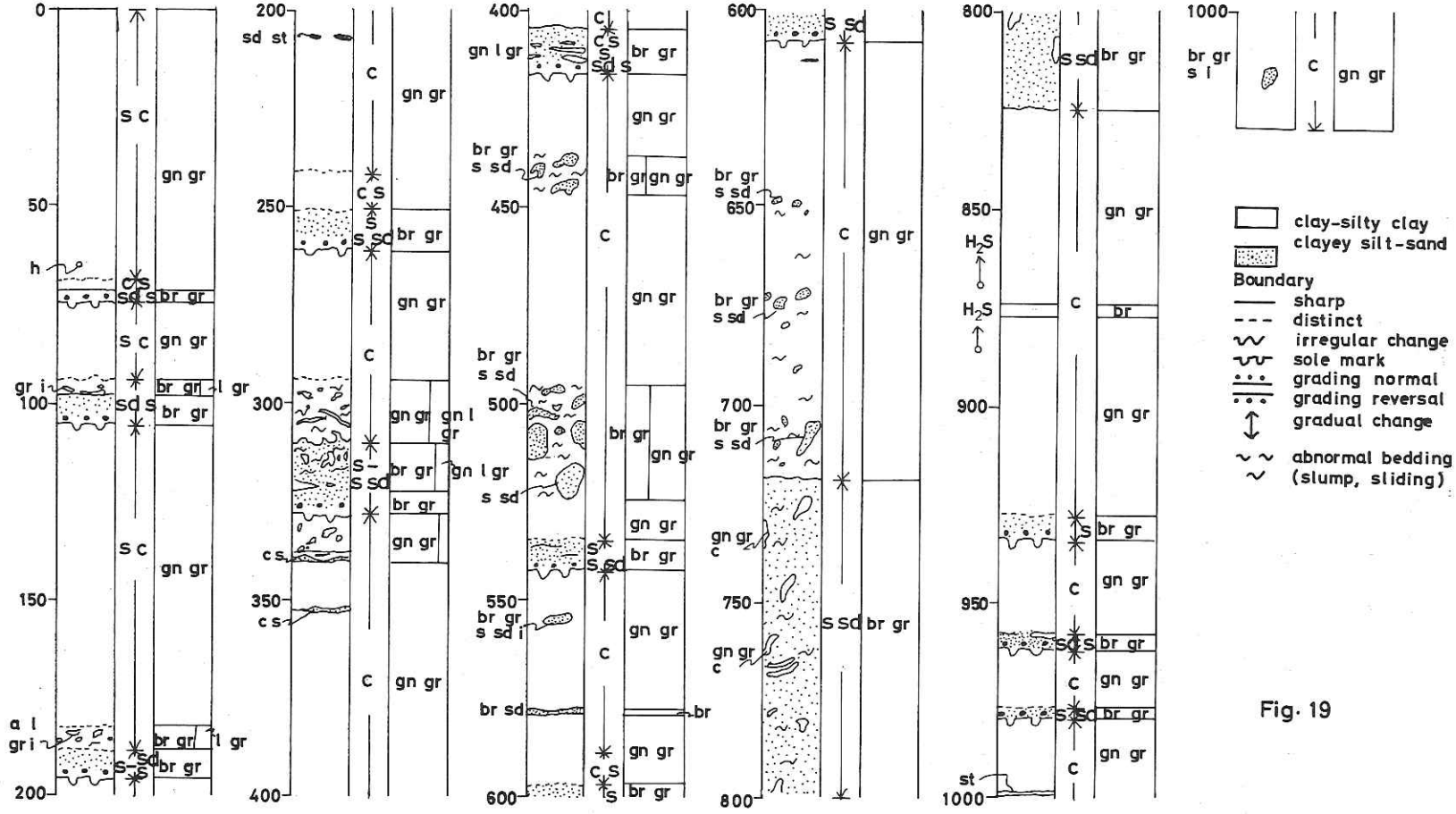
clay-silty clay
clayey silt-sand
Boundary
sharp
distinct
irregular change
sole mark
grading normal
grading reversal
gradual change
abnormal bedding
(slump, sliding)

Fig. 19

Hydrographic characteristics

T. Nakai, H. Otobe and A. Hattori

1. Section 1 (Stations 4-16; see Figs. 2-8)

Ten hydrographic stations were occupied from the vicinity of Rat Island to the entrance of Norton Sound (Fig. 1). Station 4 was in the basin surrounded by Bowers Bank, Station 6 was in the eastern Aleutian Basin, Station 8 to 11 were near the shelf break, and the other stations were on the continental shelf of the Bering Sea.

In the basin area, the horizontal distribution of temperature was comparatively uniform. Judging from T-S diagrams (Fig. 16) and other data, the water masses in this area were apparently influenced by the Alaskan Stream. The surface water with temperatures above 7°C extended to about 30m with the thermocline between 40 and 60m. The cold water below 3.5°C lay between 50 and 150m and formed the dichothermal layer. A weak temperature maximum was observed at ca. 350m. In the shelf break area, the surface temperature was slightly higher than that in other areas. The thermocline was vertically extended, and the temperature gradient was relatively small. Upwelling in this area was suggested. At Station 13 on the continental shelf, the cold water below 3°C lay near the bottom. The thermocline became shallower toward the coast, and the center of the thermocline was at a depth of ca. 10m. Warm surface water with temperatures over 10°C was found in Norton Sound.

The distribution of salinity was uniform horizontally in the basin area. There was neither a maximum nor a minimum layer, and the salinity increased unidirectionally from the surface to the bottom. In the continental shelf region, Stations 10 to 16, the surface salinity decreased northward, from 32.5‰ on the edge of the continental shelf (Station 10) to below 30‰ in the inner part (Station 16). Dilution by runoff of the Yukon River was evident.

The dissolved oxygen in the surface layer ranged from 7 to 8 mℓ/ℓ and was invariably oversaturated. The distribution of dissolved

oxygen at the edge of the continental shelf was complicated. There was a discontinuity layer between the deep water and the continental shelf water, and both water masses were distinctly different.

2. Section 2 (Stations 18-34; see Figs. 9-15)

This section extended southward from the Chukchi Sea (Stations 21 and 22) to the margin of the continental slope (Station 34), through Bering Strait (Station 23) along the western sides of St. Lawrence and St. Mathew islands (Fig. 1).

Warm water with salinities lower than 32‰ was found along the northeastern coast of the Bering Sea; this water mass continued to the Chukchi Sea across Bering Strait. The surface temperature of the Chukchi Sea was comparatively high, probably because of long solar heating in summer, and a sharp thermocline was observed at 15m. In the strait and along its northern side, vertical gradients of temperature, salinity, dissolved oxygen and nutrients were relatively small because of the vertical mixing by the strong current or the tidal water movement, or both.

Between Bering Strait and St. Lawrence Island (Stations 18 and 25), the depth of the thermocline was most shallow, and the vertical gradient of temperature in the thermocline was largest. The bottom cold water extended from south of St. Lawrence Island to St. Mathew Island (Stations 26 and 28). This cold water probably continued to Station 13 of the section 1.

In the area of the continental slope (Stations 32, 33 and 34), the distributions of temperature, salinity and dissolved oxygen were similar to those of the section 1. It is suggested that the surface water of the Bering Sea basin flows parallel to the shelf edge to form an anticyclonic circulation.

Continuous measurements of temperature and conductivity of surface waters and meteorological variables

T. Nakai and H. Otobe

Temperature and conductivity of surface seawater and meteorological variables (air temperature, wind speed, wind direction, atmospheric pressure, solar radiation, dew point and orientation of the vessel) were continuously measured during the cruise. The temperature and conductivity data were digitally recorded at 10-min intervals and meteorological variables at 30-min intervals on magnetic tapes. Except for dew point measurements, sensors and data loggers of Aanderaa Instruments Co., Bergen, Norway, were used. Dew point was determined using a Dew Cell sensor of Yokokawa Electric Works, Japan.

Measurement of insolation, submarine irradiance, and beam transmittance

K. Matsuike and M. Haga

1. Insolation

Total and spectral insolation were continuously measured by an Epply actinograph and a spectral actinograph, respectively (Fig. 20). The sensors were installed on the wing near the top of the stern mast and connected to a CDR 12A high sensitive recorder. The sensing unit of the spectral actinograph consisted of a lens system, five interference filters, and five silicon photocells. The wavelengths and half-band widths of the filters used were 358 and 21 nm, 451 and 10 nm, 538 and 9 nm, 630 and 10 nm, and 720 and 11 nm.

2. Submarine irradiance

The spectral underwater irradiance was measured at Stations 3, 4, 6, 8, 11, 14, 21, 25, 28 and 34, using an underwater spectral irradiance meter fitted with eight interference filters (Table 29). The wavelengths and half-band widths of the filters used were 375 and

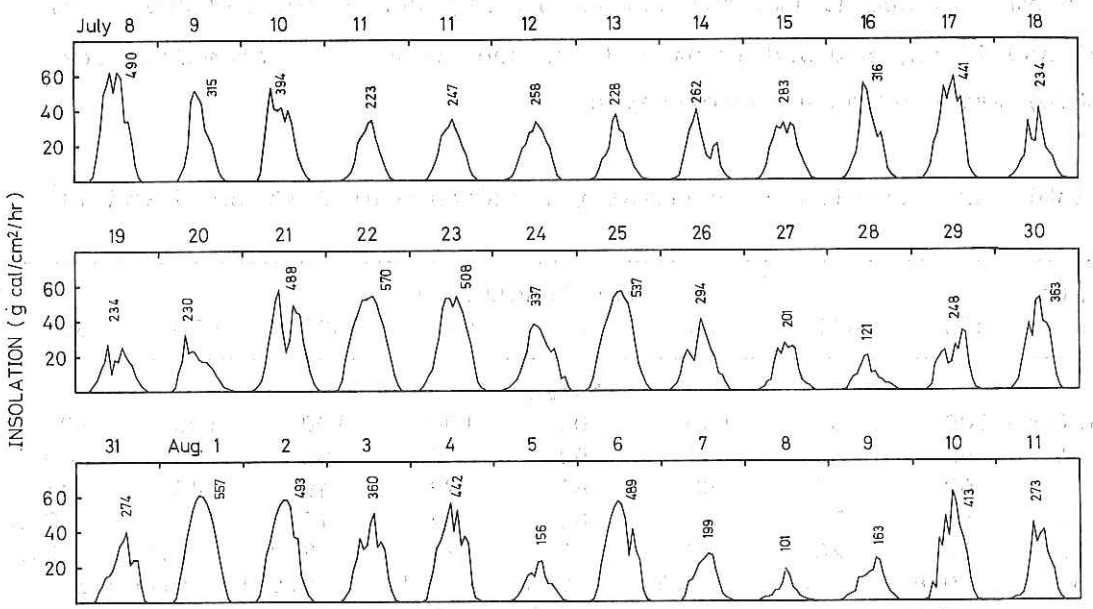

Fig. 20. Total insolation during the cruise. Numerical figures refer to daily insolation estimated by numerical integration.

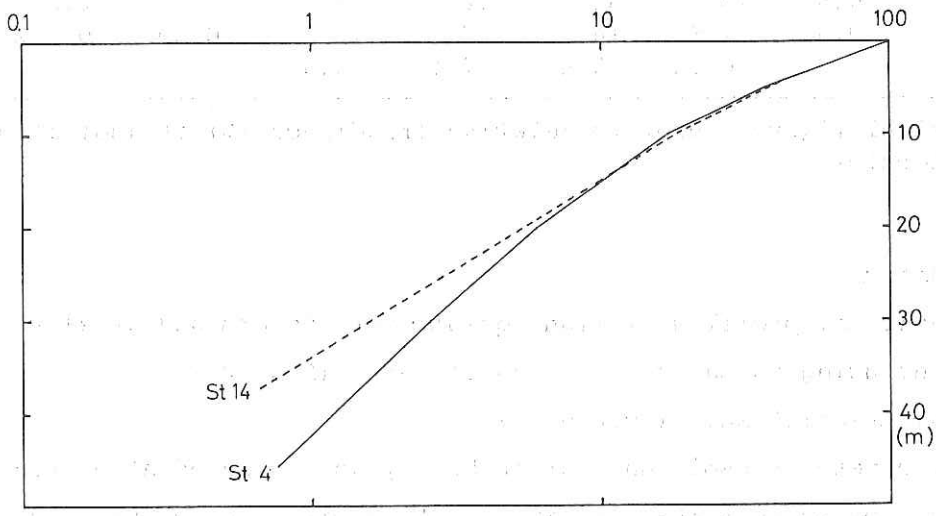

Fig. 21. Relative underwater irradiance at Stations 4 and 14 as measured in terms of light quanta.

19.5 nm, 427 and 11 nm, 484 and 11 nm, 513 and 10 nm, 572 and 12 nm, 622 and 11 nm, 650 and 12 nm and 681 and 10 nm. A photomultiplier (R636) was used as a photoreceptor.

Table 29. Spectra of underwater irradiance at Stations 4 and 14.*

Depth m	Wavelengths nm 375	427	484	513	572	622	650	681
				Station 4				
Surface	100	100	100	100	100	100	100	100
1	85	88	94	92	89	68	65	60
2	69	77	88	83	78	48	43	35
5	42	50	69	61	54	15	13	7.3
10	17	26	47	37	29	2.3	1.6	0.5
30	0.85	1.7	9.6	5.3	2.1	0.0012	0.00032	
50	0.045	0.10	2.0	0.73	0.16			
70	0.0024	0.0065	0.41	0.10				
				Station 14				
Surface	100	100	100	100	100	100	100	100
1	77	80	91	92	89	76	68	67
2	57	55	83	85	82	54	47	41
5	23	39	62	64	60	23	16	12
10	5.5	13	38	42	37	5.3	2.8	1.5
20	0.30	1.8	14	17	13	0.29	0.082	0.024
30		0.24	5.4	7.1	4.5			

*Numerical figures refer to relative irradiance (%) at indicated wavelengths.

3. Quantum

Vertical profiles of light quanta were determined at eleven stations using an underwater quantum meter (Fig. 21).

4. Beam transmittance (Turbidity)

The beam transmittance or turbidity was measured at eleven stations by using Martek XMS in situ transmissometers (Fig. 22). Blue (centroid wavelength, 486 nm) and red (centroid wavelength, 610 nm) filters were applied. The length of light pass was 1 m.

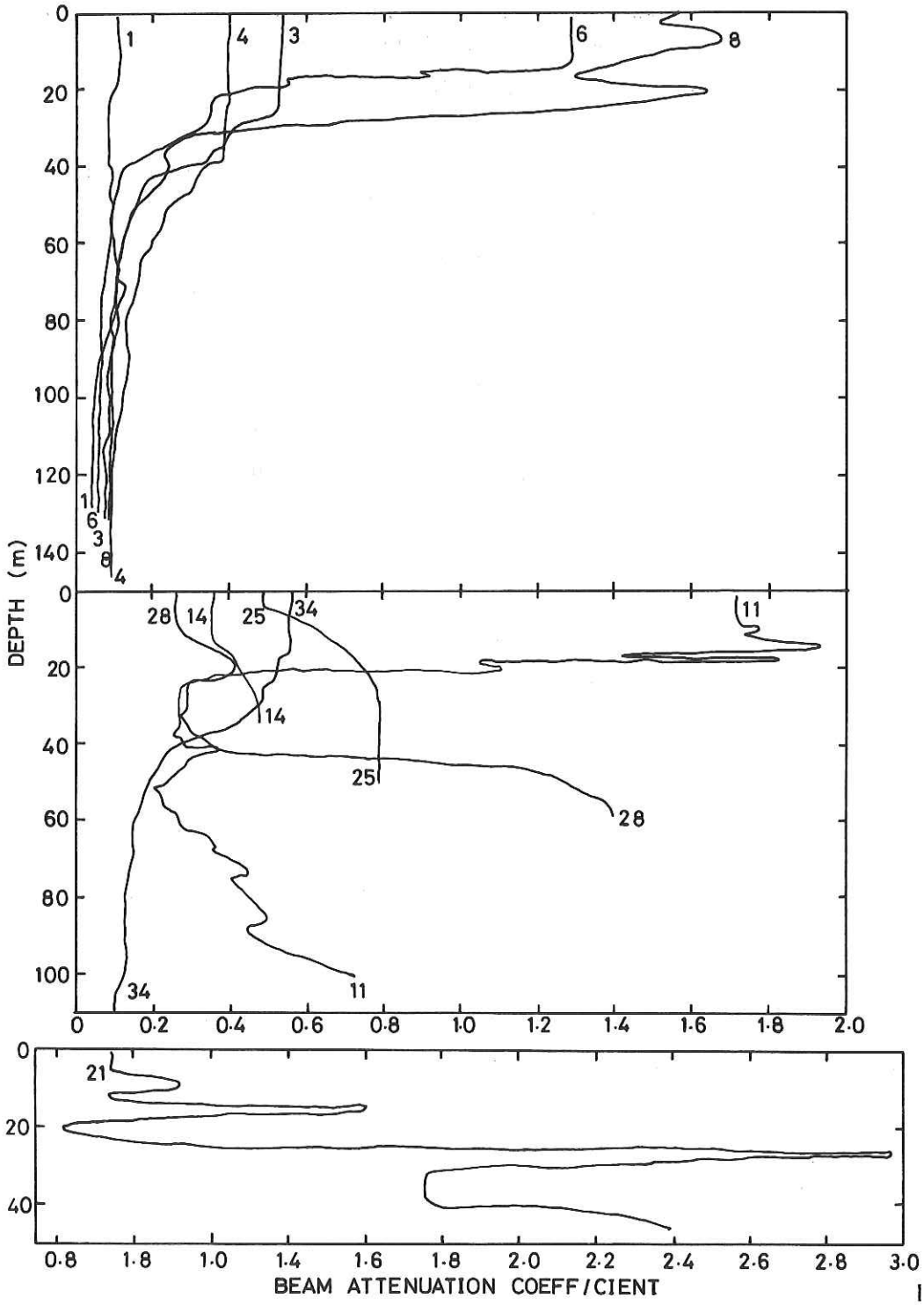

Fig. 22. Vertical distribution of beam attenuation coefficient (α) at hydrographic stations in the Bering and Chukchi seas and the northern North Pacific. A blue filter (centroid wavelength, 486 nm) was used. Numerical figures refer to station numbers.

Measurements of radiation fluxes

H. Otobe

Fluxes of short- and long-wave radiation were continuously measured to assess the heat budget on the sea surface. A short wavelength sensor with upward and downward components (Neopyranometer Model MS 41, Eko-Seiki-Sangyo Co., Tokyo) was used to measure the solar radiation and the light reflected at the sea surface and scattered from underwater. A long wavelength sensor with upward and downward components (Mole type radiometer, Eko-Seiki-Sangyo Co., Tokyo) was used for atmospheric and sea surface radiations. Routine meteorological data were collected simultaneously.

Chemical studies of the northern North Pacific and the Bering Sea*

S. Tsunogai, M. Uematsu, K. Harada and Y. Watanabe

1. Chemical composition of particulate matter in seawater

Seawater samples collected from various depths at all of the hydrographic stations (Fig. 1) and the surface stations were filtered through a Nuclepore filter (pore size, 0.6 μm). The dry weight of particulate matter (Tables 4-26) was determined by the method of Uematsu et al.(1978). The concentrations of Na, K, Mg, Ca, Si, Fe, Al and Mn were determined by atomic absorption spectrophotometry and other methods.

2. Size distribution of particulate matter in seawater

The numbers of particles larger than 2 μm and smaller than 40 μm in diameter in 2 mℓ of sample water were counted with a Model TA-II

*This work was conducted in collaboration with N. Nishimura, S. Noriki, M. Kusakabe, T. Shinagawa, N. Masuda, M. Yamada and T. Yamada, Laboratory of Analytical Chemistry, Faculty of Fisheries, Hokkaido University.

Coulter counter. The size range was divided into 13 fractions. The total volume of particles in this range and the numbers of particles between 2.00 and 2.54 μm in diameter are given in Tables 4-26.

3. ^{234}Th, ^{226}Ra, ^{210}Pb and ^{210}Po in seawater

Seawater samples (about 20 ℓ) were obtained from various depths at Stations 2 (22 samples) and 4 (20 samples) with Niskin bottles. The surface samples (40) were collected at various locations (cf. Table 26) with a plastic bucket. The radionuclides and yield tracers added were coprecipitated with carbonates and hydroxides, and ^{234}Th, ^{226}Ra, ^{210}Pb and ^{210}Po were separated from each other by an ion exchange technique. The α activity from Po (^{210}Po and its yield tracer ^{208}Po) and the β activity from ^{234}Th were counted on board the ship. Further chemical treatment and the counting were carried out ashore.

4. ^{232}Th, ^{230}Th, ^{228}Ra and ^{7}Be in the surface water

A large volume of water, about 500 ℓ for each sample, was collected using a suction pump and an 180-m long plastic hose. At Stations 4, 8, 27 and 33, eight samples were obtained from various depths between 0 to 162m. The radionuclides were coprecipitated with ferric hydroxide and further fractionated by passing through anion and cation exchange columns. An α ray pulse-height analyzer was used for counting the activities of Th isotopes and the γ activity of ^{7}Be was determined by a usual scintillation method.

5. Ca and its relation to alkalinity in seawater

Calcium and alkalinity were determined on the same water samples. The method of Tsunogai et al.(1968) was used to determine calcium.

6. Fe, Mn, Al, Cu, Co and Ni in seawater

The seawater samples (20) collected at Stations 3 and 4 were filtered through Nuclepore filters and acidified. The metals were determined by colorimetric or atomic absorption methods ashore. Samples for the determination of metals in suspended and settling particles were also obtained.

7. ^{226}Ra, ^{210}Pb and Th isotopes in plankton

Zooplankton and phytoplankton samples were collected for

Table 30. Concentrations of silicate, phosphate and Mn in interstitial water.

Station 3

D cm	SiO_2-Si	PO_4^{3-}-P	Mn
	µg atoms/ℓ		ppm
0- 3	475	2.06	0.00
3- 6	563	2.71	0.00
6- 9	639	3.56	0.00
9- 12	542	3.03	0.00
20- 30	593	2.81	0.00
30- 40	609	3.78	0.00
40- 50	589	3.67	0.00
50- 60	609	4.53	0.00
60- 70	933	5.18	0.09
80- 90	685	4.43	0.46
90- 98	626	2.16	0.70
105- 115	693	4.97	1.08
115- 125	589	3.99	1.03
125- 135	630	5.50	1.39
135- 145	618	4.75	1.53
145- 155	681	4.32	1.98
155- 165	693	14.2	2.42
165- 175	765	5.40	2.35
175- 185	644	5.50	2.44
185- 195	601	4.43	2.16
195- 205	672	4.64	2.36
262- 272	748	5.72	3.12
322- 332	690	6.91	3.36
411- 421	799	7.67	4.24
471- 481	714	8.43	4.78
562- 572	693	9.19	5.76
632- 642	139	11.0	6.08
726- 736	122	9.39	6.71
776- 786	622	11.0	7.19
848- 858	635	10.5	7.84
918- 928	621	9.30	8.28
1014-1024	723	9.93	9.24
1118-1128	605	10.9	9.63

Station 4

D cm	SiO_2-Si	PO_4^{3-}-P	Mn
	µg atoms/ℓ		ppm
0- 10	773	5.29	0.03
10- 20	773	6.22	0.05
20- 30	756	15.5	2.73
30- 40	782	16.6	2.58
50- 60	726	15.9	2.40
60- 70	735	18.3	2.34
70- 80	695	19.8	1.84
80- 90	730	17.8	1.84
90- 100	708	18.6	1.66
112- 120	722	26.9	1.55
120- 130	622	27.0	1.71
160- 170	578	25.9	1.63
170- 180	657	30.5	2.26
180- 190	708	32.2	1.75
190- 200			1.34
235- 245	586	32.8	2.22
266- 276	521	38.2	2.22
327- 337	526	58.5	1.79
398- 408	835	81.4	2.15
487- 497	682	79.2	1.59
547- 557	661	88.0	1.70
639- 649			1.19
722- 732	630	108	0.54
804- 814	657	102	0.14
922- 932	639	135	0.23
962- 972	652	175	0.23
1001-1008	617	165	0.24

determining these radionuclides. The analytical methods are the same as those used for seawater.

8. Compositions of interstitial waters

Samples of interstitial water were obtained by squeezing the sediments collected with a piston core sampler at Stations 3 and 4 (cf. Figs. 17 and 18) at near in situ temperatures. The samples were analyzed for P, Si, Mn, Fe, Zn, Co, Ni, Ba, Cu and Pb by colorimetric or atomic absorption methods. The reactive phosphate, and silicate results are shown in Table 30.

9. Chemical studies of sediments

The sediment samples described in Figs. 17 and 18 were used. Their water content, ignition loss, carbonate content, and radionuclides (Th, U, ^{226}Ra and ^{210}Pb) were determined. The sediments were divided into various fractions by treating with redox reagents, and metals such as Fe, Mn, Al, Zn, Co, Ni, Ba, Cu and Pb were determined in each fraction. The data will be used to study sedimentation rates, diffusive losses from the sediments and other phenomena.

10. ^{210}Pb in aerosols over the ocean

Aerosols in maritime air were collected by parallel filtration through Millipore RA (pore size, 1.2 μm) and GS (pore size, 0.22 μm) filters. The collectors were set on the compass bridge deck about 10m above the sea surface. The sampling was conducted for 50-150 hours at a flow rate of ca. 3 ℓ/min. Twelve samples for GS filter and eight samples for RA filter were obtained.

11. Fe, Mn and Al in maritime air

Aerosols containing Fe, Mn and Al were collected on a Nuclepore filter (pore size, 0.4 μm, diameter, 96 mm) by passing air for 3 to 4 hours at a rate of ca. 500 ℓ/min through the filter. The sampling device was set on the compass bridge deck. Twenty-two samples were obtained and analyzed by a flameless atomic absorption method.

12. A sediment trap experiment in the northern North Pacific

An array of sediment traps (Fig. 23) was deployed on 13 July 1978 at Station 3 (47°51.1'N, 176°20.6'E) and retrieved on 14 August 1978.

Table 31. Flux, ignition loss and concentrations of Mn, Fe and Al of particulate matter collected by sediment trap in the northern North Pacific.

Depth Km		Part. flux* mg dw/m^2·day	IL* %	Mn µg/g Total	Mn µg/g Sol.*	Mn µg/g Res.*	Fe mg/g Total	Fe mg/g Sol.	Fe mg/g Res.	Al mg/g Total	Al mg/g Sol.	Al mg/g Res.
0.1	>58µ	34	20	740	1.8	740	37.3	0.41	36.9	54.0	1.36	52.6
	<58µ	21	16	58	6.1	52	4.6	0.83	3.7	1.0	0.34	0.7
	Total	55 ± 24†	18	490	3.4	480	25.2	0.57	24.7	34.3	0.97	33.3
1.1	>58µ	58	22	50	24	25	5.3	0.94	4.4	1.4	0.41	1.0
	<58µ	150	15	74	24	50	1.6	0.42	1.1	2.0	0.32	1.6
	Total	208 ± 59†	19	67	24	43	2.6	0.57	2.1	1.8	0.35	1.4
2.2	>58µ	62	19	140	49	95	16.3	2.08	14.2	2.0	0.39	1.6
	<58µ	134	13	170	43	120	2.9	0.61	2.3	2.3	0.40	1.9
	Total	196 ± 22†	15	160	45	110	7.1	1.07	6.1	2.2	0.40	1.8
4.4	>58µ	24	17	87	50	36	4.0	1.03	3.0	2.1	0.68	1.4
	<58µ	124	11	460	64	390	5.9	1.10	4.8	6.6	1.27	5.3
	Total	148 ± 40†	12	400	62	340	5.6	1.09	4.5	5.9	1.18	4.7
5.25	>58µ	12	26	1500	270	1220	23.5	3.83	19.6	4.2	1.28	2.9
	<58µ	22	12	2100	1300	770	23.4	5.99	17.4	18.8	3.37	15.5
	Total	34 ± 8†	17	1900	930	930	23.4	5.22	18.2	13.6	2.63	11.1

*Part. flux; particle flux; IL: ignition loss; Sol: soluble fraction in 0.1N HCl.
†A half of the range of total dry weight obtained from 4 cylinders.

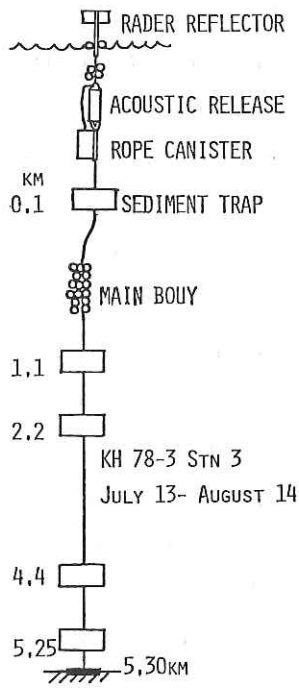

Fig. 23. Mooring system used.

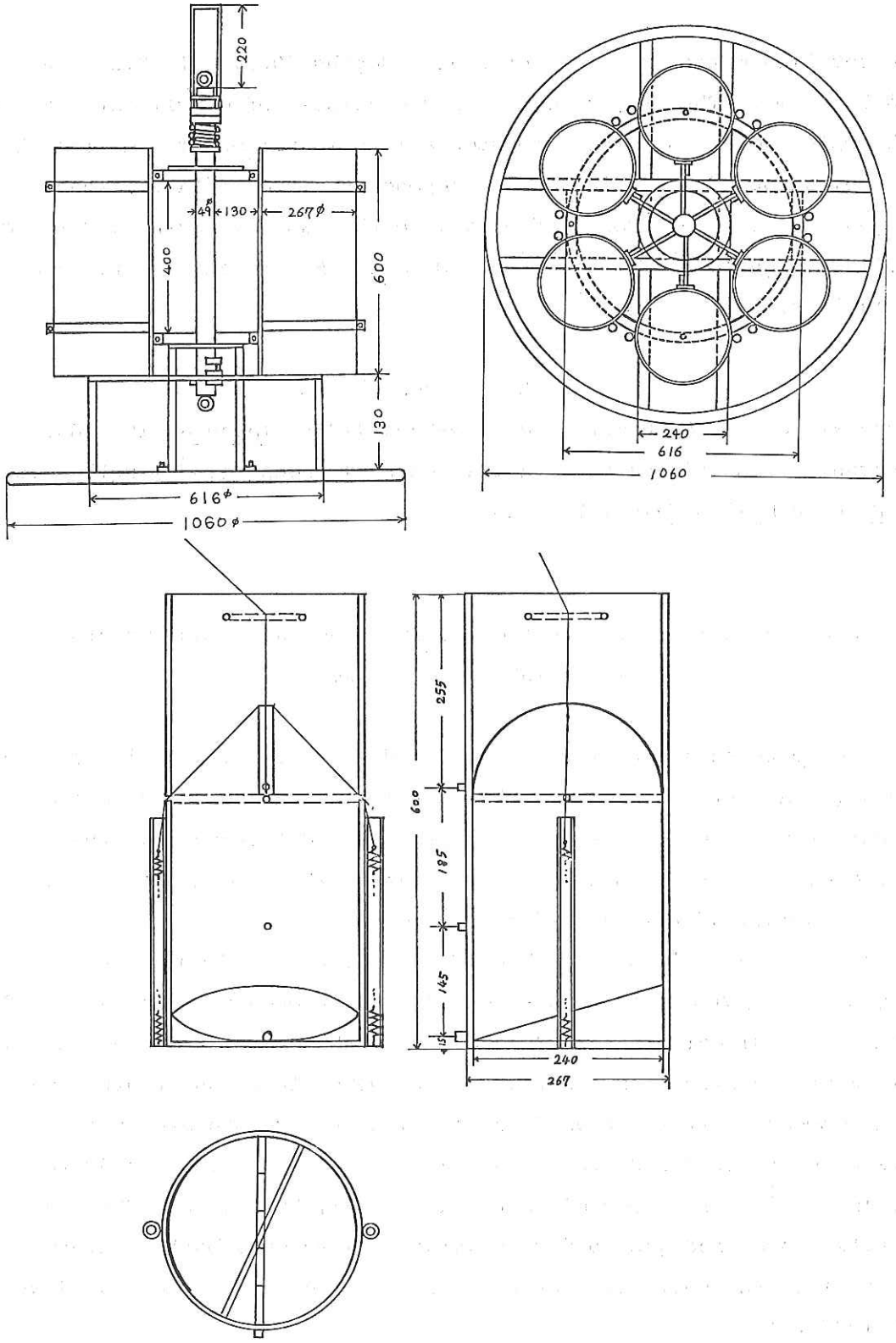

Fig. 24. Sediment trap used. Design of a cylinder of the sediment trap is shown in bottom figure.

The settling matter was collected at 5 depths (0.1, 1.1, 2.2, 4.4 and 5.25 km). The trap at each depth consisted of 6 cylinders (Fig.24). Subsamples were distributed to specialists in various fields for the determination of major inorganic components, trace metals, organic compounds, stable isotopes of organic carbon and nitrogen, and radionuclides such as ^{234}Th and ^{210}Pb. Data for Mn, Fe and Al are given in Table 31.

References

Tsunogai, S., M. Nishimura and S. Nakaya (1968) Talanta, 15: 385.

Uematsu, M., M. Minagawa, H. Arita and S. Tsunogai (1978) Bull. Fac. Fish. Hokkaido Univ., 29: 164.

Study on air-sea carbon dioxide exchange in surface waters

T. Gosink and J. J. Kelley

The purpose of our work was to study air-sea carbon dioxide exchange in surface water. We are particularly interested in the effect of sea ice on this exchange process. Unfortunately, the Hakuho Maru's northernmost station (Station 22) encountered no ice.

A summary of the data is as follows:

(i) Air concentrations of carbon dioxide decreased from north to south. It was 330±1 ppm at latitutdes 64-69°N and dropped to 323±2 near 60°N with an occasional high of 325-328 ppm as the cruise proceeded to 55°N.

(ii) With one exception, surface waters were always undersaturated with respect to free carbon dioxide. The average seawater values were between 180 and 250 ppm (pH~8.4). A few low values of 80-160 ppm (pH 8.5^{+}) were recorded near Stations 23, 25 and 30. The one exception occurred just before Station 25 when cold bottom waters had come to the surface. The P_{CO_2} was erratic in the range of 340-420 (pH<8.2).

(iii) In the beginning of Leg 2, the weather was unusually clear and

sunny for several days. This factor and the relatively calm wind probably had a bearing on the low surface values. Thermoclines were at 20 to 30m. High P_{CO_2} values were generally encountered at 40m (≥400 ppm). At Station 34 (deep slope area) the very high P_{CO_2} was deeper than 50m. Station 18 (40m) showed essentially the same concentration at the surface and bottom (~280 ppm).

(iv) In our limited attempt (Koike and Gosink) to compare continuous nitrate and P_{CO_2} data, there seemed to be a fairly good positive correlation.

Trace metals in seawater

M. Maeda

During the previous Bering Sea cruise of the Hakuho Maru, Maeda (1977) found that unreactive copper in 12 seawater samples collected in the Bering Sea ranges from 0.11 to 0.26 µg/ℓ. During the present cruise, 208 seawater samples (60 from the surface and 148 from various depths at 17 stations) were collected in the eastern Bering Sea and the northern North Pacific to obtain detailed information on the distribution of trace metals (Cu, Zn and Cd) and their chemical forms in seawater.

The samples collected with Niskin bottles or a plastic bucket were filtered through membrane filters (pore size, 0.45 µm) on board ship as soon as possible. The filtrates were acidified with nitric acid or frozen at -20°C. The concentrations of total dissolved, dissolved reactive, and particulate metals will be determined in a clean laboratory on land by a chelate extraction followed by flameless atomic absorption spectrophotometry.

Reference

Maeda, M. (1977) Proc. Ann. Meet. Geochem. Soc. Japan, Oct. 1977, Tokyo.

Radium and plutonium isotopes in seawater

T. Nakanishi

Thirty-four water samples (720 to 900 ℓ) were collected from the surface of the Bering and Chukchi seas and the northern North Pacific Ocean. Plutonium and radium isotopes were successively coprecipitated with ferric hydroxide and barium sulfate. The precipitates were collected and saved for later determination of ^{226}Ra, ^{228}Ra, ^{238}Pu and ^{239}Pu plus ^{240}Pu.

Seven plankton samples (mixture of phytoplankton and zooplankton) were collected by filtering large volumes of surface seawater (2,400-7,200 ℓ) through a 0.1-mm mesh net. The abundance of radium and plutonium in plankton will be determined and compared with that in surface water to obtain insight into the concentration of these elements through biological processes.

Chemical and geochemical studies of the northern North Pacific and the Bering Sea

N. Handa, E. Tanoue and T. Hama

1. Chemical composition of particulate organic matter

Particulate matter was collected by filtering 2 to 10 ℓ of seawater through a preweighed Whatman type C glass fibre filter (GF/C, 47 mm in diameter). The filters were washed with 3.5% ammonium carbonate and stored frozen at -20°C. The filters with residues were later dried at 105°C for 3 hours and weighed.

A large volume (200 to 500 ℓ) of seawater was collected from the surface, subsurface and deep layers at Station 3 in the northern North Pacific and at Stations 4, 6, 13 and 33 in the Bering Sea. The samples were filtered using a specially designed filtration device (filter area: 285 x 420 mm). Precombusted GF/C filter were used. The particulate organic matter collected on the filter was saved for

later analysis.

Organic carbon and nitrogen were determined using a Yanaco CHN analyzer. Carbohydrate, amino acid, protein, lipid and plant pigments were determined by colorimetric or spectrophotometric methods. Monosaccharides, fatty acids and other chemical constituents were determined by gas chromatography combined with mass spectrometry. Data on dry weight, organic carbon and organic nitrogen are entered in Tables 4-25.

2. Chemical composition of dissolved organic matter

Two hundred to five hudred ℓ of seawater collected from various depths at Stations 3 and 4 were filtered through GF/C. The filtrates were stored frozen at -20°C until use.

Dissolved organic matter was later concentrated by reverse osmosis, and individual chemical forms (groups) were separated from each other by Sephadex column chromatography. The molecular weight and monosaccharide, amino acid and organic acid compositions were determined. Detailed investigations were also conducted for humic materials.

3. Chemical characterization of organic material collected by a sediment trap in the northern North Pacific

Settling materials collected by the sediment trap (see p.59) were concentrated on a GF/C (47-mm diameter) filter and stored frozen at -20°C. Gravimetric and chemical analyses were later conducted ashore. The vertical fluxes ranged from 0.2 to 0.9 g(wet weight)/m^2·day.

The settling materials were analyzed for organic carbon and nitrogen, carbohydrate, amino acid, lipid and stable carbon isotopes. Fatty acids, fatty alcohols and monosaccharides were also determined. In order to obtain some insight into the mechanism of the vertical transport of organic matter from the surface to the ocean floor, the chemical composition of the settling material was compared with that of the suspended particulate matter and of the sedimentary organic matter.

4. Geochemical study of organic matter in deep-sea sediments

Deep-sea sediments were collected by a piston core sampler at Stations 3 and 4 (see p.45). Their water content, grain size and

organic constituents such as carbohydrate, amino acid, lipid and plant pigments were determined.

To pursue early diagenetic processes of organic matter in the sediments, monosaccharides and fatty acids were determined. Humic materials were extracted and their chemical properties were investigated by gas chromatography combined with mass spectrometry.

5. Geochemical studies on the origin of organic matter in marine sediments

Surface sediments were collected with a Phleger corer or an Okean grab sampler at ten stations (see p.45). Horizontal distributions of various organic constituents such as lignin oxidation products, fatty acids and chlorophyll derivatives and their $^{13}C/^{12}C$ ratios were investigated to assess the contribution of land-derived organic matter to sedimentary organic matter and the origin and transport of the sedimentary organic matter.

DDT residues in the northern Pacific Ocean and the Bering Sea

K. Miyata

The insecticidal value of DDT was first discovered in the 1940's and its use was accelerated greatly in the 1950's. In the late 1960's, hazards associated with indiscriminate use of DDT were pointed out. Since 1973, the use of DDT has been restricted in most countries in the northern hemisphere, but some countries in Africa and South America still its use. At least 50,000 tons of DDT are assumed to be released into the environment every year even now. It has been estimated that more than 2,000,000 tons of DDT have been disseminated into the surrounding environment on the earth since its original dispersion.

DDT and its derivatives are persistent and easily dissipated into the atmosphere; numerous studies have shown their world wide distribution. Much information has been accumulated on the distribution of DDT residues in the marine environment. However, our under-

standing of the total picture of DDT residues in the marine environment is incomplete. One of the reasons for this is that only a few investigations have been made in relatively remote ocean area. Especially lacking is the measurement of DDT residues in open seawater. This is because the concentrations in remote ocean areas are very low, often below present day detection limits, and contamination during sampling and analysis is a serious problem.

The purpose of this study is to determine the concentrations of DDT residues in the northern North Pacific and the Bering Sea. Preliminary determinations were also made with sediments and plankton.

Water samples were collected from the surface using 10-ℓ stainless steel buckets at 17 stations and from various depths by a pumping system at 3 strations, and stored in 200-ℓ stainless steel tanks. DDT and its derivatives were selectively collected by passing the samples through absorbent columns (250-mm long, 55-mm diameter) packed with a commercial porous polyurethane foam (TL-25, Bridgestone Co.) at a flow rate of about 300 mℓ/min (Uthe et al., 1972; Musty and Nickless, 1974; Risebrough et al., 1976). Plankton samples were collected from the surface at 4 stations using nets (XX13 and GG 54). Sediment samples were collected at 3 stations using an Okean grab sampler. The top 5cm of each sediment was taken. All of these samples were kept frozen and brought back to the laboratory for analysis.

The samples were subjected to successive extraction with acetone and n-hexane. The extracts were transferred to a separatory funnel and shaken vigorously with distilled water. The hexane fraction was collected and passed through a forisil column. DDT and its derivatives were then gently concentrated and determined by a gas-liquid chromatography.

References

Uthe, J. F., J. Reinke and H. Gesser (1972) Environ. Let., 6: 103

Musty, P. R. and G. Nickless (1974) J. Chromatogr., 100: 83.

Risebrough, R. W., B. W. deLappe and W. Walker (1976) In Marine

Pollutant Transfer (H. Windom and R. Duce, Eds.), D. C. Health, Lexington, Mass.

Primary productivity measured by a ^{14}C technique

T. Saino, K. Miyata and A. Hattori

Primary productivity was measured by a standard ^{14}C technique in the northern North Pacific and the Bering and Chukchi seas. Water samples were collected with Niskin bottles from depths of 100, 48, 22, 11, 5, 1 and 0.1% light penetration. The subsamples (100 mℓ) were placed in glass bottles and incubated together with 10 μCi of $NaH^{14}CO_3$ at temperatures of the surface water for 2 hours. The bottles were exposed to artificial light of daylight fluorescent lamps at about 10,000 lux. For the subsurface samples, light intensities were reduced to simulate natural light conditions using neutral filters. The incubation was terminated by the addition of 1 mℓ of neutral formalin. The samples were filtered through Reeve Angel 984H glass fibre filters without delay, and the radioactivity of the particles collected on the filters was counted with a Beckman DPM-100 liquid scintillation counter using a toluene-based scintillant cocktail.

The total carbonate concentration was calculated from interpolated temperature, salinity, pH and total alkalinity. It varied from 1.75 to 2.18 mM.

Aliquots of the water samples (250 mℓ) were filtered through Reeve Angel 984H filters, and chlorophyll *a* was determined by the fluorescent method of Yentsch and Menzel (1963).

Results are summarized in Table 32.

Reference

Yentsch, C. S. and D. W. Menzel (1963) Deep-Sea Res., 10: 221.

Table 32. Primary production in the Bering and Chukchi Seas and the northern North Pacific.

	Station 1 10, Jul., 1978 1042 45°14.7'N 163°45.5'E			Station 3 12, Jul., 1978 0912 47°56.8'N 176°23.0'E			Station 4 15, Jul., 1978 0914 53°33.1'N 177°13.9'E			Station 6 17, Jul., 1978 1240 56°59.0'N 177°02.6'W		
% Light intensity	D m	Primary production mg C/m³/h	mg/chl-a/m³	D m	Primary production mg C/m³/h	mg/chl-a/m³	D m	Primary production mg C/m³/h	mg/chl-a/m³	D m	Primary production mg C/m³/h	mg/chl-a/m³
100	0	1.07	0.140	0	1.57	1.035	0	2.03	0.174	0	3.37	2.154
48	12	0.53	0.140	4	1.47	0.727	9	1.34	0.434			
22	34	0.10	0.100	12	0.92	0.713	18	0.83	0.674			
11	53	0.08	0.156	19	0.29	0.663	28	0.33	0.779			
5	75	0.07	0.205	27	0.17	0.674	37	0.10	0.522			
1	120	0.00	0.017	42	0.02	0.456	55	0.00	0.206			
0.1	185	0.00	0.004	80	0.00	0.112	93	0.00				
	Integrated production	19.1 mg C/m²/h		Integrated production	23.2 mg C/m²/h		Integrated production	34.4 mg C/m²/h				

	Station 8 18, Jul., 1978 0630 58°00.1'N 175°08.4'W			Station 11 19, Jul., 1978 0756 58°43.8'N 173°31.8'W			Station 14 20, Jul., 1978 0632 60°59.7'N 168°58.0'W			Station 21 24, Jul., 1978 1241 67°40.1'N 168°33.3'W		
% Light intensity	D m	Primary production mg C/m³/h	mg/chl-a/m³	D m	Primary production mg C/m³/h	mg/chl-a/m³	D m	Primary production mg C/m³/h	mg/chl-a/m³	D m	Primary production mg C/m³/h	mg/chl-a/m³
100	0	9.65	3.234	0	12.18	1.791	0	1.07	0.111	0	5.06	1.467
48	4	7.66	3.360	3	5.24	1.782	7	0.68	0.107	4	4.95	0.881
22	8	5.34	3.209	6	2.72	2.046	15	0.18	0.107	8	4.35	0.848
11	12	2.00	2.009	9	1.07	2.422	22	0.15	0.144	12	1.58	0.979
5	16	0.58	2.717	12	0.49	3.508	28	0.04	0.274	16	0.89	2.610
1	23	0.00	3.399	18	0.00	2.068				24	0.10	1.044
0.1	43	0.00	0.339	41	0.00	1.705				38	0.00	1.403
	Integrated production	80.2 mg C/m²/h		Integrated production	43.7 mg C/m²/h		Integrated production	11.6 mg C/m²/h		Integrated production	60.4 mg C/m²/h	

Table 32. (Continued)

Station 25
26, Jul., 1978
1613
64°01.7'N
172°01.5'W

% Light intensity	D m	Primary production mg C/m³/h	mg/chl-a/m³
100	0	3.11	0.489
48	6	1.84	0.555
22	12	0.48	0.359
11	17	0.24	0.359
5	23	0.15	0.359
1	33	0.01	0.359
0.1	48	0.00	0.408

Integrated production 25.0 mg C/m²/h

Station 28
27, Jul., 1978
1138
61°00.5'N
172°59.9'W

D m	Primary production mg C/m³/h	mg/chl-a/m³
0	0.82	0.229
8	0.67	0.303
17	0.28	0.405
26	0.24	0.606
33	0.11	0.564
43	0.01	0.271
55	0.01	0.376

Integraged production 14.1 mg C/m²/h

Station 34
29, Jul., 1978
1009
56°07.5'N
173°02.8'W

D m	Primary production mg C/m³/h	mg/chl-a/m³
0	3.93	0.758
7	2.89	0.837
14	1.40	0.600
21	0.50	0.837
28	0.17	0.695
43	0.00	0.114
74	0.00	0.087

Integrated production 48.3 mg C/m²/h

Station 22
24, Jul., 1978
2327
69°09.9'N
168°37.2'W

D m	Primary production mg C/m³/h	mg/chl-a/m³
0	0.78	0.207

Station 23
25, Jul., 1978
1919
65°47.9'N
168°34.5'W

% Light intensity	D m	Primary production mg C/m³/h	mg/chl-a/m³
100	0	2.38	1.009
48			
22			
11			
5			
1			
0.1			

Ammonium and nitrate uptake

A. Hattori, H. Iizumi and T. Saino

Ammonium and nitrate uptakes were measured in the euphotic zone at 3 stations in the northern North Pacific and at 9 stations in the Bering and Chukchi seas using a ^{15}N technique. Water samples were collected with Niskin bottles from the 100, 11 and 1% light depths. One-ℓ subsamples were placed in glass bottles wrapped with neutral density screens to simulate the above light levels. Incubation was conducted at near in situ temperatures under illumination with daylight fluorescent lamps at 10,000 lux in the presence of small amounts (less than half of ambient concentration) of added ^{15}N-ammonium or nitrate for 3 to 4 hours. The incubation was terminated by introduction of 1 mℓ of 0.1 M $HgCl_2$. Particulate materials were collected on Reeve Angel 984H filters and their ^{15}N content was determined as described elsewhere (Wada et al., 1977). At several stations the effects of ammonium or nitrate concentrations on uptake rates were also examined.

Reference

Wada, E., T. Tsuji, T. Saino and A. Hattori (1977) Anal. Biochem., 80: 312.

The oceanographic fine structure of the seasonal thermocline in the shelf break of the Bering Sea

T. Saino, H. Otobe and A. Hattori

Vertical profiles of ammonium distribution in the northern North Pacific and the Bering Sea often show a peak near the seasonal thermocline (Preliminary Report of the Hakuho Maru Cruise KH-75-4, Ocean Research Institute, University of Tokyo, 1977). To obtain further insight into the mechanism of its formation and maintenance, water

samples were collected with 2.7-ℓ Niskin bottles from 10 depths near the thermocline at Stations 8, 9, 10, 11, 32, 33 and 34 located on the shelf break of the Bering Sea.

Salinity, ammonium, nitrite, nitrate, phosphate and silicate were determined. Total volumes of particulate materials with average diameter of 1.6 to 25 μm were also determined with a Coulter counter. Particulate materials were collected by filtering through a Reeve Angel 984H glass fibre filter and their POC, PON, chlorophyll *a* and ATP contents were determined. Subsamples of the water were preserved for later examination of phytoplankton [Furuya] and microzooplankton [Taniguchi].

Serial water samples were collected within 10 to 15 seconds, so the effect of the internal waves on the vertical distribution of the variables can be disregarded. A short period variation of the thermocline was simultaneously monitored by repeated BT observations made at 3- to 5-min intervals during the Niskin casts.

Inorganic nitrogenous compounds in interstitial waters

I. Koike, H. Iizumi and A. Hattori

Vertical profiles of nitrate, nitrite and ammonium in interstitial waters were determined. Sediment samples were collected with a Phleger core sampler at Stations 8, 11, 14, 15, 16, 21 and 30, and with a pilot corer attached to a piston core sampler at Stations 3, 4 and 6. Sediment cores were sectioned to 3-cm thick segments. The segments were placed in metal filter holders fitted to centrifuge tubes. Reeve Angel 984H glass fibre filters were used. Insterstitial waters were extracted by centrifugation at 2,000 *g* for 20 min. Nitrate, nitrite and ammonium were determined with a Technicon AutoAnalyzer as described previously.

Ammonium regeneration in shallow waters of the Bering Sea and the northern North Pacific

I. Koike and A. Hattori

Seawater samples were collected from the surface at Station 3, from the surface and 28m at Station 8, and from 55m at Station 28. Duplicate samples (4.5 ℓ) were placed in 5-ℓ glass bottles and incubated at ca. 10°C together with 0.5 to 2.0 μg atoms of ^{15}N-ammonium (10% ^{15}N excess). At intervals, 1-ℓ aliquots were filtered through a Reeve Angel 984H filter. Ammonium concentration and ^{15}N content of ammonium in the filtrate were determined by the indophenol method and mass spectrometry, respectively. PON and ^{15}N content in PON were also determined by mass spectrometry. Some samples were prefiltered through a 40-μm mesh net to eliminate large phytoplankton and zooplankton. The rate of ammonium regeneration was calculated following the method of Hattori et al.(1976).

Reference

Hattori, A., I. Koike, M. Ohtsu and J. J. Goering (1976) Proc. 1976 Spring Meet. Oceanogr. Soc. Japan, 124.

Continous measurements of inorganic nitrogenous compounds and chlorophyll *a*

I. Koike, K. Furuya and A. Hattori

Depth profiles of inorganic nitrogenous compounds and chlorophyll *a* were determined by continuous measurement of their concentrations from the surface to about 140m at Stations 4, 8, 13 and 33. Seawater was pumped up at a rate of ca. 20 ℓ/min using a suction pump and an 180-m long plastic hose. During the pumping the sampling hose was lowered or raised at a constant rate of 10 m/min. After the removal of air bubbles by passing through two funnels, the water sample was

separately introduced to a Turner fluorometer fitted with a flow cell and to a Technicon AutoAnalyzer. Nitrate, nitrite and ammonium were determined by the methods described by Strickland and Parsons (1972) with some modifications. An ammonium maximum appeared in the pycnocline associated with a subsurface chlorophyll maximum.

Horizontal distributions of inorganic nitrogenous compounds and chlorophyll *a* near the sea surface were also continuously measured in Bering Strait and Unimack Pass. Seawater pumped up from 4m were fed to the analyzers.

Reference

Strickland, J. D. H. and T. R. Parsons (1972) A Practical Handbook of Seawater Analysis. Fisheries Research Board of Canada, Ottawa.

Nitrate reduction and ammonium regeneration in deep-sea and continental shelf sediments of the Bering and Chukchi seas and the northern North Pacific

H. Iizumi and A. Hattori

During the KH-75-4 Cruise of the Hakuho Maru we found that nitrate concentrations in the interstitial waters of sediments of the Bering Sea were, irrespective of the water depth, far less than those of the water just above the sediments. In contrast, nitrate concentrations in the deep-sea sediments of the northern North Pacific were nearly the same as those of the bottom water. This suggests that the sediments of the Bering Sea serve as a sink for nitrate.

Biological nitrate reduction and ammonium regeneration in sediments were investigated by shipboard experiments. Subsamples of the sediments collected using an Okean grab sampler at Stations 3, 4, 21, 22 and 30 were used.

Potential activity for nitrate reduction was estimated from the increase in nitrite with time in media enriched with nitrate. The

numbers of nitrate reducing bacteria were simultaneously determined using an MPN method and ZoBell's 2216-E medium supplemented with nitrate. ATP content was measured by the method of Hodson et al. (1976), and redox potential of the sediments was determined using an Au electrode.

Ammonium regeneration was measured by an isotope dilution technique described by Iizumi and Hattori (1977).

References

Hodson, R. E., O. Holm-Hansen and F. Azam (1976) Mar. Biol., 34: 143.

Iizumi, H. and A. Hattori (1977) Preliminary Report of the Hakuho Maru Cruise KH-75-4, 70.

Phytoplankton distribution

K. Furuya, Y. Hirota and T. Nemoto

The community structure and distribution of phytoplankton were studied at all stations. Phytoplankton were collected by vertical haul of a NORPAC net (0.1-mm mesh) from 150m to the surface or from near the bottom to the surface at shallow stations. Phytoplankton were also collected with Niskin bottles from predetermined depths between 0 and 200m. The net-collected samples were fixed with 2% neutral formalin. Part of the water samples was treated with 1% glutalaldehyde, and phytoplankton were collected by filtering through a Gelman TCM450 filter after the method of Tsuji et al.(1976). The filters were mounted on slide glasses with glycelin jelly and kept in a desiccator to facilitate fluorescent microscopic inspection of naked flagellates and coccoid forms. Another portion of the sample was treated with 1% Utermöhl's fixative. Phytoplankton were settled by standing for more than 24 hours and examined with an inverted microscope.

Diatoms accounted for more than 70% of the phytoplankton standing

Table 33. Distribution of diatoms, dinoflagellates and silicoflagellates (numbers of individuals per mℓ).

	Sta.3				Sta.4				Sta.8				Sta.9			
	0 m	20 m	50 m	100 m	0 m	20 m	50 m	100 m	0 m	20 m	50 m	100 m	0 m	20 m	50 m	100 m
Diatoms																
Achnanthes sp.	-	-	-	-	-	-	-	-	5.6	-	-	-	-	-	-	-
Asteromphalus heptactis	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
A. robustus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A. sp.	0.1	-	-	-	0.1	0.1	0.1	+	-	-	-	-	-	-	-	-
Chaetoceros atlanticus	-	-	-	-	-	-	-	-	-	0.3	0.2	-	-	-	-	-
C. borealis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. brevis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. compressus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. concavicornis	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
C. constrictus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. convoltus	-	+	-	-	-	-	-	-	0.3	0.6	0.2	0.1	+	4.0	5.0	-
C. decipiens	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. dichaeta	-	-	-	-	-	-	-	-	0.6	-	-	0.1	-	-	-	-
C. didymus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. spp.	1.0	+	+	3.0	6.0	12.0	-	-	0.1	2.2	-	+	1.0	-	-	-
Corethron histrix	+	+	-	-	0.5	0.6	0.8	-	0.5	10.3	0.4	0.4	2.6	0.1	0.1	+
Coscinodiscus asteromphalus	-	-	-	-	-	-	-	-	-	0.3	-	-	+	-	-	-
C. marginatus	-	-	-	-	+	0.1	+	-	0.1	0.3	-	-	+	+	+	-
C. oculus-iridis	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-
C. spp.	-	-	-	-	-	2.0	2.0	-	0.1	-	-	-	-	1.0	+	-
Denticula seminae	1.0	+	-	16.0	-	-	-	-	8.3	87.1	5.4	1.1	9.0	3.0	4.0	-
Eucampia zoodiacus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fragilaria spp.	-	-	-	-	-	-	-	-	-	-	0.1	0.2	-	-	-	-
Leptocylindrus danicus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Melosira sulcata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M. spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Navicula granii	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N. spp.	-	-	-	-	-	-	-	-	1.2	2.2	-	-	-	-	-	-
Nitzschia closterium	0.6	0.2	-	+	0.3	0.3	2.2	1.0	2.0	10.0	2.9	0.2	6.1	0.1	0.1	+
N. delicatissima	-	-	-	-	-	-	-	-	0.1	-	-	+	-	-	-	-
N. frigida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N. longissima var. reversa	+	+	-	-	-	-	-	-	0.3	-	+	-	-	-	-	-
N. pungens var. atlantica	-	-	-	-	-	-	-	-	3.1	2.1	-	-	-	-	-	-
N. seriata	-	+	-	-	+	-	-	-	2.2	1.5	-	-	-	-	-	-
N. sigma	-	+	-	-	-	-	-	-	-	2.2	-	-	-	-	-	-
N. spp.	-	-	-	-	-	-	-	-	0.8	1.1	-	-	-	-	-	-
Pleurosigma spp.	-	-	-	-	-	-	-	-	0.2	1.1	+	-	-	-	-	-
Rhizosolenia alata	-	-	-	-	-	-	-	-	0.1	-	0.1	0.1	+	-	-	-
R. hebetata f. hiemalis	+	-	-	-	0.2	0.2	0.1	-	-	2.0	0.1	+	0.2	0.1	+	-
R. hebetata f. semispina	0.1	-	-	+	0.1	+	0.1	-	-	-	-	+	0.1	+	-	+

Table 33. (continued)

	Sta.3				Sta.4				Sta.8				Sta.9			
	0 m	20 m	50 m	100 m	0 m	20 m	50 m	100 m	0 m	20 m	50 m	100 m	0 m	20 m	50 m	100 m
Rhizosolenia imbricata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. fragilissima	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. styliformis	-	-	-	-	-	-	-	-	-	-	-	-	0.2	0.1	-	-
R. spp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Skeletonema costatum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thelassiosira decipiens	-	+	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-
T. eccentrica	-	-	-	-	-	2.0	-	-	-	-	-	-	-	-	-	-
T. lineata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. polycorda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. subtilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. spp.	2.0	0.6	-	-	-	-	-	-	11.1	5.3	2.4	1.3	-	-	-	-
Thalassionema nitzschioides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thalassiothrix longissima	-	-	-	-	0.3	0.3	0.2	-	0.1	-	+	-	-	-	-	-
T. frauenfeldii		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tropidoneis spp.	0.1	-	-	-	0.1	0.1	0.2	-	0.7	7.8	+	-	0.3	+	+	-
Other pennatae	8.5	1.5	+	4.0	23.9	59.4	9.4	5.0	21.5	60.0	0.8	+	12.3	17.1	4.4	2.1
Total number of diatoms	13.4	2.3	0.1	23.0	31.7	77.1	15.0	6.0	58.6	196.9	12.6	4.1	31.9	25.6	13.7	2.2
Dinoflagellates																
Amphidinium spp.	3.0	5.4	5.6	1.0	-	-	-	-	11.0	0.3	+	0.4	-	12.0	6.0	-
Ceratium fusus	+	-	-	-	0.1	-	-	-	-	-	-	-	-	+	-	-
C. furca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. longipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. spp.	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-
Dinophysis spp.	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-
Gonyaulax spp.	2.0	3.6	+	-	-	-	-	-	2.8	0.3	-	-	-	-	-	-
Gymnodinium spp.	16.0	9.4	4.8	1.0	-	-	-	-	17.9	48.7	5.0	0.2	1.0	12.0	9.0	-
Oxytoxum spp.	21.0	5.6	5.4	1.0	-	1.0	-	-	5.5	1.1	3.9	0.4	-	-	-	-
Peridinium spp.	-	-	0.4	1.0	-	+	-	-	-	1.7	+	-	-	-	-	+
Prorocentrum spp.	3.0	8.7	1.6	-	-	-	-	-	6.9	-	-	-	-	-	-	-
Other armoured dinoflagellates	9.0	3.1	1.6	+	+	-	-	-	5.5	+	+	0.2	10.2	1.0	+	3.0
Other unarmoured dinoglagellates	147.3	3.6	1.6	11.0	5.0	5.0	4.0	4.0	15.2	+	-	0.2	14.2	30.2	12.0	1.0
Total number of dinoflagellates	201.4	39.4	21.0	15.0	5.1	6.1	4.0	4.0	64.8	52.0	9.0	1.5	25.4	55.2	27.0	4.0
Silicoflagellates																
Dictyocha fibra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Distephanus speculum	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 33. (continued)

	Sta.10				Sta.11				Sta.13			Sta.18		Sta.21	
	0 m	20 m	50 m	100 m	0 m	20 m	50 m	100 m	0 m	20 m	50 m	0 m	20 m	0 m	20 m
Diatoms															
Achnanthes sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Asteromphalus heptactis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. robustus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. sp.	–	–	–	–	–	–	–	–	–	–	–	–	–	0.1	–
Chaetoceros atlanticus	0.2	0.1	+	+	4.6	5.0	0.1	–	–	–	–	1.3	–	–	–
C. borealis	–	–	–	–	0.2	0.5	+	–	–	–	–	–	–	–	–
C. brevis	–	–	–	–	–	–	–	–	–	–	–	28.2	2.0	–	–
C. compressus	–	–	–	–	–	–	–	–	–	–	–	3.1	–	–	–
C. concavicornis	–	–	+	–	0.8	0.2	–	–	–	–	–	2.0	6.8	–	–
C. constrictus	–	–	–	–	–	–	–	–	–	–	–	–	1.5	–	–
C. convoltus	6.3	+	0.1	0.1	5.1	3.4	0.2	–	–	4.0	–	2.2	3.9	2.0	2.0
C. decipiens	–	–	–	–	–	0.2	–	–	–	–	–	5.1	1.6	–	–
C. dichaeta	–	–	–	–	0.2	–	–	–	–	–	–	–	–	–	–
C. didymus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. spp.	0.5	+	+	+	0.6	2.6	+	+	–	–	1.0	13.6	2.1	2.0	–
Corethron histrix	+	+	+	+	–	–	–	–	–	–	–	–	–	+	+
Coscinodiscus astermophalus	–	0.1	–	–	–	–	–	–	–	–	+	+	0.2	0.4	0.3
C. marginatus	–	–	–	+	0.1	0.5	0.1	–	–	–	–	–	–	–	–
C. oculus-iridis	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. spp.	0.1	–	–	+	–	–	–	+	–	–	0.1	+	–	+	0.1
Denticula seminae	2.9	20.0	1.4	2.1	3.8	2.9	0.6	–	–	–	–	–	–	–	–
Eucampia zoodiacus	–	–	–	–	–	–	–	–	–	–	–	6.1	–	–	–
Fragilaria spp.	–	–	+	0.3	0.2	–	–	0.1	–	–	–	–	–	–	–
Leptocylindrus danicus	–	–	–	–	–	–	–	–	–	–	–	32.4	71.3	–	–
Melosira sulcata	–	–	–	–	–	–	–	–	–	–	–	0.6	1.5	–	–
M. spp.	–	+	–	0.2	–	0.1	–	0.1	–	–	2.0	–	–	–	–
Navicula granii	0.2	–	–	–	0.7	–	–	–	–	–	–	–	–	–	–
N. spp.	0.5	+	+	+	3.5	0.3	+	–	–	–	–	–	0.1	–	–
Nitzschia closterium	17.3	17.8	+	0.4	32.2	5.1	7.0	–	13.8	29.3	+	3.2	+	3.5	5.2
N. delicatissima	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N. frigida	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N. longissima var. reversa	–	+	–	+	–	0.6	–	–	–	–	–	+	2.1	+	+
N. pungens var. atlantica	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N. seriata	–	–	–	–	–	–	–	–	–	–	–	0.4	–	–	–
N. sigma	–	+	–	–	–	0.6	0.2	–	–	–	–	–	0.5	–	–
N. spp.	–	–	–	–	2.8	0.1	0.1	–	–	–	–	–	–	–	–
Pleurosigma spp.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhizosolenia alata	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R. hebetata f. hiemalis	+	0.1	–	+	5.2	8.1	0.8	–	–	–	–	–	–	–	–
R. hebetata f. semispina	0.2	–	–	+	0.3	–	+	–	+	+	+	–	–	–	+

Table 33. (continued)

	Sta.10				Sta.11				Sta.13			Sta.18		Sta.21	
	0 m	20 m	50 m	100 m	0 m	20 m	50 m	100 m	0 m	20 m	50 m	0 m	20 m	0 m	20 m
Rhizosolenia imbricata	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-
R. fragilissima	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
R. styliformis	-	+	-	-	-	-	-	-	+	+	-	-	-	-	-
R. spp.	-	-	-	-	-	-	-	-	-	-	-	1.8	-	-	-
Skeletonema costatum	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thelassiosira decipiens	0.4	+	-	0.1	-	-	-	+	-	-	-	-	1.3	-	-
T. eccentrica	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-
T. lineata	-	-	-	-	-	-	-	-	-	-	-	-	0.1	-	-
T. polycorda	-	-	-	-	-	-	-	-	-	-	-	-	3.7	-	-
T. subtilis	-	-	-	-	-	11.3	-	-	-	-	-	-	-	-	-
T. spp.	11.4	0.1	+	0.5	0.1	1.9	+	0.1	2.0	4.0	2.0	-	-	202.0	59.0
Thalassionema nitzschioides	-	-	-	-	-	-	-	-	0.1	+	+	-	-	-	-
Thalassiothrix longissima	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. frauenfeldii	0.2	-	-	-	-	-	-	-	-	-	-	-	0.5	-	-
Tropidoneis spp.	0.1	0.2	-	+	0.1	0.3	-	-	-	-	-	-	-	-	-
Other pennatae	10.0	5.5	0.1	0.6	22.2	8.9	2.4	0.6	5.3	2.4	4.1	+	0.5	9.4	13.3
Total number of diatoms	51.1	44.1	1.7	4.3	82.8	52.9	11.7	0.9	21.2	39.7	9.3	100.2	99.6	219.4	79.9
Dinoflagellates															
Amphidinium spp.	36.0	5.4	0.1	0.5	5.7	-	1.7	0.6	-	-	-	4.5	1.5	3.0	1.0
Ceratium fusus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. furca	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-	-
C. longipes	+	-	-	-	-	-	-	-	-	-	-	0.3	-	-	-
C. spp.	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-
Dinophysis spp.	-	-	-	-	-	-	+	-	+	+	-	-	-	0.1	-
Gonyaulax spp.	0.2	-	+	-	-	-	-	-	2.0	-	-	0.2	0.7	-	5.0
Gymnodinium spp.	58.0	10.3	0.1	0.8	39.7	7.0	3.1	0.9	-	-	-	3.0	0.7	-	-
Oxytoxum spp.	9.1	0.1	0.1	0.2	13.3	5.2	1.7	-	-	-	-	0.6	1.6	-	-
Peridinium spp.	0.3	+	0.1	-	-	-	-	-	-	-	-	0.4	-	0.2	-
Prorocentrum spp.	5.8	0.1	+	-	11.4	4.1	-	-	-	-	-	1.0	3.1	-	-
Other armoured dinoflagellates	5.5	+	+	-	13.2	1.8	0.3	-	14.0	18.0	+	+	0.5	17.8	6.2
Other unarmoured dinoflagellates	21.9	+	+	0.1	22.8	2.3	-	-	15.0	15.0	+	+	-	81.7	12.4
Total number of dinoflagellates	136.9	15.9	0.4	1.7	106.2	20.4	6.7	1.5	31.1	33.1	0.1	10.0	8.1	102.8	23.6
Silicoflagellates															
Dictyocha fibra	0.3	-	+	-	0.4	-	-	-	-	-	-	-	-	-	-
Distephanus speculum	-	-	-	-	-	0.3	-	-	-	-	-	-	-	-	-

Table 33. (continued)

	Sta.22		Sta.26			Sta.32				Sta.33			
	0 m	20 m	0 m	20 m	50 m	0 m	20 m	50 m	100 m	0 m	20 m	50 m	100 m
Diatoms													
Achnanthes sp.	–	–	–	–	–	–	–	+	–	–	–	–	–
Asteromphalus heptactis	–	–	–	–	–	–	–	–	–	–	–	–	–
A. robustus	–	–	–	–	–	0.1	–	–	+	–	–	–	–
A. sp.	–	–	–	–	–	–	–	–	–	0.1	+	+	–
Chaetoceros atlanticus	–	–	–	–	–	4.1	4.5	0.3	+	–	–	–	–
C. borealis	–	–	–	–	–	0.2	0.4	0.1	–	–	–	–	–
C. brevis	–	–	–	–	–	–	–	–	–	–	–	–	–
C. compressus	–	–	–	–	–	–	0.8	–	–	–	–	–	–
C. concavicornis	–	–	–	–	–	0.2	0.8	–	+	–	–	–	–
C. constrictus	–	–	–	–	–	–	–	–	–	–	–	–	–
C. convoltus	–	–	3.0	–	–	3.1	11.7	0.1	0.2	–	–	–	–
C. decipiens	–	–	–	–	–	–	0.7	+	–	–	–	–	–
C. dichaeta	–	–	–	–	–	–	0.2	–	–	–	–	–	–
C. didymus	–	–	–	–	–	0.1	0.4	–	+	–	–	–	–
C. spp.	–	+	–	–	–	0.8	–	0.3	–	169.0	151.0	63.0	–
Corethron histrix	–	–	–	–	–	4.8	2.8	0.6	+	9.7	9.7	3.6	0.1
Coscinodiscus asteromphalus	–	–	–	–	–	+	–	–	–	–	–	–	+
C. marginatus	–	–	–	–	–	–	–	+	–	+	+	+	–
C. oculus-iridis	–	–	–	–	–	–	–	–	–	–	–	–	–
C. spp.	–	–	–	–	–	–	0.1	–	–	+	+	+	–
Denticula seminae	–	1.5	–	–	–	2.4	33.2	0.2	7.2	20.0	21.0	16.0	3.0
Eucampia zoodiacus	–	–	–	–	–	–	–	–	–	–	–	–	–
Fragilaria spp.	–	–	–	–	–	–	–	–	–	–	–	–	–
Leptocylindrus danicus	–	–	–	–	–	–	–	–	–	1.0	–	–	–
Melosira sulcata	–	–	–	–	–	–	–	–	–	–	–	–	–
M. spp.	–	–	–	–	–	–	–	–	–	–	–	–	–
Navicula granii	–	–	–	–	–	–	–	–	–	–	–	–	–
N. spp.	+	–	–	–	–	0.4	0.2	–	–	–	–	–	–
Nitzschia closterium	0.2	0.5	+	0.1	+	9.7	–	+	10.1	–	0.1	–	–
N. delicatissima	–	–	–	–	–	–	–	–	–	–	–	–	–
N. frigida	–	–	–	–	–	0.7	–	–	–	–	–	–	–
N. longissima var. reversa	–	–	–	–	–	0.1	–	–	+	–	–	–	–
N. pungens var. atlantica	–	–	–	–	–	–	–	–	–	–	–	–	–
N. seriata	–	–	–	–	–	–	–	–	–	–	–	–	+
N. sigma	–	1.0	–	–	–	–	0.1	–	–	–	–	–	–
N. spp.	+	–	–	–	–	–	–	–	–	–	–	–	–
Pleurosigma spp.	–	–	–	–	–	0.1	–	–	+	–	–	–	–
Rhizosolenia alata	–	–	–	–	–	–	–	–	–	0.1	0.1	+	–
R. hebetata f. hiemalis	–	–	–	–	–	2.0	+	0.1	0.1	1.2	1.4	0.6	+
R. hebetata f. semispina	–	–	–	–	–	0.8	+	0.1	+	2.8	3.6	1.0	–

Table 33. (continued)

	Sta.22		Sta.26			Sta.32				Sta.33			
	0 m	20 m	0 m	20 m	50 m	0 m	20 m	50 m	100 m	0 m	20 m	50 m	100 m
Rhizosolenia imbricata													
R. fragilissima	-	-	-	-	-	0.1	0.6	-	-	-	+	-	-
R. styliformis	-	-	-	-	-	-	-	-	-	-	-	-	-
R. spp.	-	-	-	-	-	-	0.1	+	-	-	-	-	-
Skeletonema costatum	-	-	-	-	-	-	-	-	-	-	-	-	-
Thelassiosira decipiens	-	-	-	-	-	1.4	-	+	+	-	-	-	-
T. eccentrica	-	-	-	-	-	0.1	0.1	+	+	-	-	-	-
T. lineata	-	-	-	-	-	0.1	0.1	-	-	-	-	-	-
T. polycorda	-	-	-	-	-	-	-	-	-	-	-	-	-
T. subtilis	-	-	-	-	-	-	-	-	-	-	-	-	-
T. spp.	-	+	-	-	-	5.8	+	0.1	0.1	3.0	3.0	3.0	-
Thalassionema nitzschioides	-	-	-	-	-	0.6	-	-	-	-	-	-	-
Thalassiothrix longissima	-	0.8	-	-	-	-	-	-	-	-	-	-	-
T. frauenfeldii	+	20.5	-	-	-	0.2	1.0	+	+	-	-	-	-
Tropidoneis spp.	-	-	-	-	-	-	0.4	-	+	3.7	2.5	0.6	-
Other pennatae	0.2	0.1	4.3	6.1	6.3	12.9	6.8	0.2	1.2	25.9	24.4	14.9	0.2
Total number of diatoms	0.5	24.4	7.3	6.2	6.3	51.9	64.7	2.1	19.0	236.5	216.7	102.8	3.4
Dinoflagellates													
Amphidinium spp.	11.5	0.3	-	6.0	1.0	2.7	0.1	+	4.5	-	-	-	-
Ceratium fusus	-	-	-	-	-	-	-	-	-	-	-	-	-
C. furca	-	-	-	-	-	-	-	-	-	-	-	-	-
C. longipes	0.3	-	-	-	-	0.1	+	-	-	-	-	-	-
C. spp.	0.1	-	0.1	0.1	-	-	+	-	-	+	+	+	-
Dinophysis spp.	0.2	-	0.2	-	-	0.1	-	+	-	+	-	+	-
Gonyaulax spp.	2.6	+	1.0	-	-	1.7	0.1	+	-	-	-	-	-
Gymnodinium spp.	10.0	0.4	15.0	13.0	3.0	1.5	0.8	+	7.2	-	-	-	-
Oxytoxum spp.	11.9	0.3	-	-	-	7.0	1.7	0.1	0.8	-	-	-	-
Peridinium spp.	0.2	-	0.1	+	-	-	0.1	+	-	-	-	-	-
Prorocentrum spp.	-	1.2	-	-	-	5.5	1.6	+	0.1	-	-	1.0	-
Other armoured dinoflagellates	1.4	+	10.2	14.2	6.0	+	+	-	1.1	2.3	1.1	-	-
Other unarmoured dinoflagellates	2.0	0.2	25.8	82.9	8.0	+	-	+	-	18.2	14.1	6.0	9.0
Total number of dinoflagellates	40.1	2.3	52.4	116.3	18.0	18.6	4.3	0.2	9.1	20.6	15.2	7.0	9.0
Silicoflagellages													
Dictyocha fibra	-	-	-	-	-	0.4	0.1	-	-	-	-	-	-
Distephanus speculum	-	-	-	-	-	-	-	-	-	-	-	-	-

stock. The cell numbers of diatoms, dinoflagellates and silicoflagellates are shown in Table 33. The species composition of diatoms was similar to that observed in the previous Bering Sea cruise of the Hakuho Maru. High populations of naked flagellates and coccoid forms were found at several stations. Their taxonomic study is now in progress.

Reference

Tsuji, T., Y. Yokota and T. Yanagita (1976) Proc. 1976 Spring Meet. Oceanogr. Soc. Japan, 96.

Plankton and micronekton abundance in the Bering and Chukchi seas

T. Nemoto, Y. Hirota and K. Furuya

Macrozooplankton were collected by a NORPAC net with a 0.3-mm mesh filtering part and microzooplankton by the same net with a 0.1-mm mesh filtering part. In general, plankton biomasses, expressed in terms of dry weight, were large in the Bering and Chukchi seas and somewhat smaller in the waters of the Alaskan continental shelf and in the waters outside of the Bering Sea. Copepods were predominant. Details of species composition are now under examination.

Micronekton were collected by an IKMT or ORI net and their biomasses are given in Table 34. Although sampling was limited, micronekton were abundant in the middle part of the Bering Sea. Pisces micronekton were generally abundant at all stations. *Stenobrachius leucopsarus* and *S. nonnachir* formed two dominant species of myctophids. Food and feeding structures of micronekton were examined on board ship. The results were similar to those obtained in the previous cruise (KH-75-4). Euphausiid micronekton composed of *Thysanoessa longipes*, *T. inermis* and *Euphausia pacifica* were dominant at Stations 4 and 35 and in the shallow water of Station 41. Shrimp micronekton

Table 34. Composition of IKMT catches

Station	4		6		8		35		41			
Date	15, July		17, July		18, July		29, July		14, Aug.		14, Aug.	
Time	0035-0210		1635-1743		1650-1800		2145-2307		2040-2220		2246-2316	
Wire out (m)	2000		2000		2000		2000		2000		300	
Depth of haul (m)	0-490		0-570		0-500				0-520			
Water volume filtered (m^3)	45381		28709		24777		33813				14627	
	Wet wt. (g) per haul	Ind.No. Per haul	Wet wt. (g) per haul	Ind.No. per haul	Wet wt. (g) per haul	Ind.No. per haul	Wet wt. (g) per haul	Ind.No. Per haul	Wet wt. (g) per haul	Ind.No. per haul	Wet wt. (g) per haul	Ind.No. per haul
Polychaetes					0.20	1	1.14	44	0.40	3		
Chaetognaths	25.00	193	5.31	77	6.74	312	12.95	247	18.20	163	8.00	207
Copepods	2.56	160	2.89	154	2.61	179	2.42	134	0.56	36		
Amphipods	5.42	124	2.27	48	2.68	66	1.86	45	1.56	30	0.39	9
Mysids	13.80	140	7.67	78	5.71	159	6.39	147	5.98	36		
Euphausiids	71.00	934	33.42	752	8.03	147	126.04	1652	27.30	489	199.91	4109
Decapods	22.85	159	58.20	106	44.66	138	19.68	88	19.83	53	1.29	5
Shrimps			0.10	3	0.20	11	2.28	98				
Crab larvae												
Anomuran larvae	0.10	1										
Cephalopods	1.86	4	2.25	7	50.68	7	2.21	14	15.02	34	11.75	51
Pisces	365.02	185	102.28	53	244.52	78	211.38	145	324.02	130	294.20	73
Total	507.61	1900	214.39	1278	366.03	1098	386.35	2614	412.87	974	515.54	4454

were dominant within the Bering Sea but poor in the waters south of the Bering Sea. A similar trend was observed during the KH-75-4 cruise.

Vertical distribution of euphausiids

Y. Hirota and T. Nemoto

In order to investigate the vertical distribution of euphausiids, they were collected using Motoda horizontal nets (MTD nets) with 0.1-mm or 0.3-mm mesh filtering part at Station 3 in the northern North Pacific and at Stations 4, 6, 8, 30 and 35 in the Bering Sea. At each station, horizontal hauls at 11 or 12 depths from the surface to 500m were conducted.

The dominant species of euphausiids were as follows:

Station 3	*Euphausia pacifica, Thysanoessa inermis*
Station 4	*E. pacifica, T. longipes*
Station 6	*T. longipes*
Station 8	*E. pacifica, T. longipes*
Station 30	*T. inermis*
Station 35	*T. longipes*

These species distributed mainly in the upper 150m layer during the night. During the day, juveniles of these species were mainly found in the waters below 50m and adults in the waters below 100m.

Distribution and biomass of microzooplankton

A. Taniguchi

One-ℓ samples of seawater collected with Niskin bottles from various depths at 13 stations in the shelf region of the Bering and Chukchi seas and at 8 stations in the oceanic region were preserved by adding 10 mℓ of neutral formalin. After standing, plankton were

concentrated ca. 100-fold by gently withdrawing the supernatant with a siphon and then examined under an inverted microscope. Identification and examination of the numbers of individuals and body size of microzooplankters are under way.

On the basis of the data obtained, regional differences in standing biomass, vertical distribution and species diversity of the microzooplanktonic communities will be investigated.

Zooplankton collected by a Longhurst-Hardy plankton recorder

Y. Endo and K. Hirano

A Longhurst-Hardy plankton recorder (LHPR) of Benthos Inc., Type 315, was fixed to a 1.22-m long cylindrical stainless steel frame (Fig. 25B). This was called LHPR-P unit and was used for phytoplankton sampling. For zooplankton sampling, another frame, 1.40m long, was connected to an LHPR-P unit and a conical Pylen No.60 net was set as shown in Fig. 25A. This was called LHPR-Z unit. Pylen No.200 (0.1-mm mesh) was used as sampling-rolling gauze for phytoplankton sampling and Pylen No.60 (0.35-mm mesh) for zooplankton sampling.

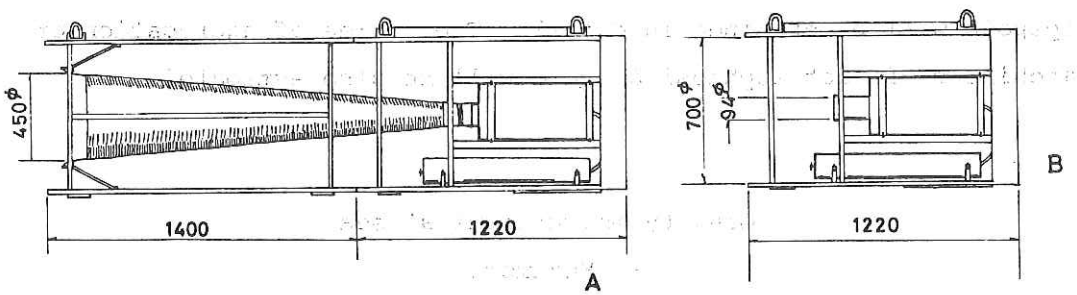

Fig. 25. Longhurst-Hardy plankton recorder used.

Six oblique tows were made at Stations 3, 4, 6, 8 and 28 and two oblique-horizontal tows at Stations 8 and 35. Roll-up interval of sampling-rolling gauze was 30 seconds. Records of the sampling are summarized in Table 35. During sampling series LHPR-Z IV and

Table 35. Records of plankton sampling by LHPR-P and LHPR-Z.

Sta.	Date and time	LHPR-unit and Ser. No.	Towing method and depth	Gause used	Sample Nos.
3	12 July 1978 2034-2145	LHPR-Z I	Oblique 0-350m	Pylen No.60	1-109
3	13 July 1978 1500-1605	LHPR-Z II	Oblique 0-310m	Pylen No.60	1-116
4	15 July 1978 0210-0312	LHPR-P I	Oblique 0-300m	Pylen No.200	1-116
6	17 July 1978 1341-1440	LHPR-Z III	Oblique 0-470m	Pylen No.60	1-111
8	18 July 1978 1336-1416	LHPR-Z IV	Oblique 0-610m	Pylen No.60	1-?
8	18 July 1978 1523-1606	LHPR-Z V	Oblique 0-120m -horizontal	Pylen No.60	1-78
28	27 July 1978 1252-1324	LHPR-P II	Oblique 0-52m	Pylen N.200	1-?
35	30 July 1978 0035-0137	LHPR-Z VI	Oblique 0->500m -horizontal	Pylen No.60	1-96

LHPR-P II, the machine did not work well.

Microstructure of vertical distribution of euphausiids and copepods will be examined in detail. The degree of aggregation or patchiness of each euphausiid stage will be also estimated.

Gravity measurement at sea

H. Fujimoto

Observed period: 5 July 1978 0000 to 22 August 1978 1400

Gravity meter system: T.S.S.G.

Gravity meter: Model Z-68-7-14 (string type)

Vertical gyro: Model 72-A (a pair of single freedom gyros)

Data processing system: Model 76-1 (0.05 sec. sampling rate)

Trouble with gravity meter: Vertical gyro (after 4 August 1978)

Stopped period: 28 July 1556 to 30 July 1524, trouble with the MG of gyro

4 August 1356 to 7 August 2014, no data processing

Position fixing: Loran A and C, dead reckoned navigation, NNSS

Out of order time of NNSS: 16 update fixes were not good.