Preliminary Report
of
The Hakuhō Maru Cruise KH-88-4

September 22-October 31, 1988

The Japan Trench, Japan Sea,
Ryukyu Trench and Philippine Sea
(WESTPAC)

Ocean Research Institute
University of Tokyo
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By
The Scientific Members of the Cruise

Edited by
Suguru OHTA

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CONTENTS

I. INTRODUCTORY REMARKS

The seas encircling Japanese islands are diverse and characterized by many aspects. Northwestern Pacific and the Philippine Sea are open oceans, and the Japan Sea and the East China Sea including the Okinawa Trough are semi-closed marginal seas. Pacific and Philippine Plates subduct beneath Japan forming trench systems (the Japan Trench, Kurile Trench, Izu-Bonin Trench and Nankai Trough) along the eastern side of the island arc, and deep marginal seas open behind the arc. Cold Oyashio bathes the northeastern half of Honshu, warm Kuroshio washes the southwestern part of Japan, and the Japan Sea embraces its own water mass. So the submarine climates around Japan encompass tropical, subtropical, temperate and sub-boreal ones. Vast continental shelf is found in the East China Sea, and very steep coastal deep-sea system can be found within embayments such as Suruga Bay. Various oceanographic regimes, ecological systems and biological processes are developed and evolving there, and comparative biological oceanography and ecological studies have been highly expected.

The main objectives of this cruise involve ecological studies of deep-sea benthos, physiology of the midwater and deep-sea microbes, studies of plankton and micronekton from surface to bathypelagic realms, chemistry of organic compounds, chemical approach to the circulation of natural and anthropogenic substances in the ocean and within bottom sediments, general hydrographic observations using CTD and hydrocasts, and deep-sea current measurement using mooring systems. Twenty-five Japanese scientists from eight institutions and a foreign scientist participated in the cruise for those study items collaborating with each other. Main study fields were established east off Sanriku crossing the Japan Trench, in the cold water masses of the Oyashio region and the Japan Sea, at the periphery of the East China Sea, along the transect crossing the Ryukyu Trench, in the middle of the Philippine Sea, and within the Kuroshio Current. The cruise was composed of two legs; Leg 1 from Tokyo to Shimonoseki during Sept. 22 - Oct. 10, and Leg 2 from Shimonoseki to Tokyo during Oct. 16 - Oct. 31, taking the anti-clockwise course around Japanese islands.

The cruise was not always so blessed one. We experienced the harsh effects of four typhoons and/or tropical low pressures and many migratory low pressures, and further, monsoons. Due to senile degeneration of the equipments of the R.V. Hakuho

Maru I, a part of the gear operations was severely restricted or must be abandoned. An unexpected call at a port intervened the second leg. Nevertheless, we did our best at all times, fulfilling the research schedule elaborated beforehand. All the samples and data are now being analyzed and processed in detail in every laboratories of the participants for future synthesis and publication. Although the era of 'expedition' has already past, several new findings were also brought to light. One of the episodes is the finding of a kind of tiny bivalve from the trench floor may harbor symbiotic bacteria within their gill tissue. If this is the case, it will be the deepest record of the symbiotic strategy in the hadal reducing environment.

This volume contains the fundamental data of the sampling operations (track chart - Fig. 1; station data - Tables 1 to 11), raw data of routine hydrographic works (CTD observations, the data of salinity, dissolved oxygen and nutrients through the analysis of hydrocasts - appendices), brief summaries of aims and sample treatment procedure of each study item. Sometimes preliminary ecological data such as trawl catch list are involved. It is our understanding that these data obtained by the scientists aboard the cruise are fundamentally common property of the cruise party, and the chief scientist will manage and claim coordination as the representative of the party. Anyone who will cite and publish these data before formal publication of the data book must inform him and receive permission beforehand.

Participation of a scientist from the State Oceanic Administration, Peoples Republic of China as a part of the WESTPAC Program was realized through the courtesy of the Intergovernmental Oceanographic Commission (IOC), UNESCO and the Ministry of Education, Science and Culture, Japan.

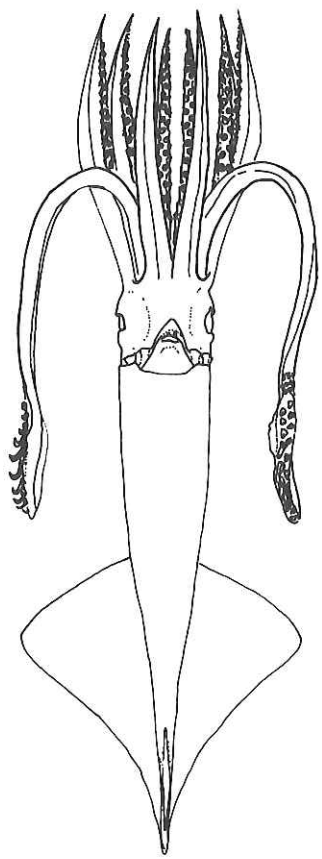
On behalf of the scientists on board, the chief scientist wishes to express his sincere gratitude to Captain Hideji Shimamune, the Chief Officer Yoichi Jinno (vicarious captain between the leg from Naha to Tokyo), to the other officers and the crew members of the Hakuho Maru for their cooperation and skillful assistance throughout the cruise. His special thanks are extended to Drs. Tomoyuki Miura of the Kagoshima University, and Tsunemi Kubodera of the National Science Museum, Tokyo for filling the 'Banto' (head secretary) during each leg.

October, 1989

Suguru OHTA

Chief scientist
R.V. Hakuho Maru KH-88-4 Cruise

Ocean Research Institute
University of Tokyo



nail squid *Onychoteuthis banksii*
[drawn by Dr. T. Kubodera]

II. Scientists aboard the KH-88-4 Cruise of the R.V. Hakuho Maru

OHTA, Suguru*1 [chief scientist]
Ocean Research Institute, University of Tokyo : Assoc. Professor#1
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 351
Fax. 03-377-3395 & 03-375-6716, Telex J25607 [ORIUT]
Suwahara-danchi 1-8-401, Wako-shi, Saitama 351-01

OHWADA, Kouichi*1 [vice-chief sci.]
Ocean Research Institute, University of Tokyo : Assoc. Professor
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 240
Kamitakada 4-chome 8-1-405, Nakano-ku, Tokyo 164

OHWADA, Takashi*1
Ocean Research Institute, University of Tokyo : JSPS Jr. Res. Fel.
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 354
SK Haimu #103, Minamidai 1-chome 7-14, Nakano-ku, Tokyo 164

KIKUCHI, Tomohiko*3
Ocean Research Institute, University of Tokyo : Research Student#2
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 248
Kikuna 3-chome 15-21, Kohoku-ku, Yokohama 222

FUJITA, Toshihiko*2
Ocean Research Institute, University of Tokyo : grad. student (D3)
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 354
Hirai 4-chome 2-18, Edogawa-ku, Tokyo 132

KOJIMA, Shigeaki*1
Ocean Research Institute, University of Tokyo : grad. student (D2)
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 354
Sakae-cho 5-chome 58-1, Tachikawa-shi, Tokyo 190

TODA, Tatsuki*3
Ocean Research Institute, University of Tokyo : grad. student (D2)
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 331
Higashigotanda 5-chome 4-15, Shinagawa-ku, Tokyo 141

OH, Suwan*1
Ocean Research Institute, University of Tokyo : grad. student (D2)
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 247
Minamidai 3-chome 44-3, Nakano-ku, Tokyo 164 (c/o Tsutano)

SUGISAKI, Hiroya*1
Ocean Research Institute, University of Tokyo : grad. student (D1)
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 331
Sonan 1-chome 24-33-2, Sagamihara-shi, Kanagawa 228

TSUKAMOTO, Youichi*1
Ocean Research Institute, University of Tokyo : grad. student (D1)
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 246
Nainhaitsu #1, Yayoi-cho 3-chome 3-9, Nakano-ku, Tokyo 164

OH, Bong-Cheol*1
Ocean Research Institute, University of Tokyo : for. res. student
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 331
Maeda-so #205, Minamidai 2-chome 42-9, Nakano-ku, Tokyo 164

NAKAOKA, Masahiro*1
Ocean Research Institute, University of Tokyo : grad. student (M2)
Minamidai 1-chome 15-1, Nakano-ku, Tokyo 164 : 03-376-1251 ex 354
Hirata 3-chome 16-7, Ichikawa-shi, Chiba 272

GAMÔ, Sigeo*1
Faculty of Education, Yokohama National University: Professor
Tokiwadai 156, Hodogaya-ku, Yokohama 240 : 045-335-1451 ex 2256
Kohinata 2-chome 10-26-303, Bunkyo-ku, Tokyo 112

MONTANI, Shigeru*2
Faculty of Agriculture, Kagawa University : Assoc. Professor
Ikenobe, Miki-cho, Kita-gun, Kagawa 761-07 : 0878-98-1411 ex 312
Mure-jutaku #6-104, Mure 1440, Mure-cho, Kita-gun, Kagawa 761-01

MISHIMA, Yasufumi*1
Uni. Grad. School of Agr., Ehime University : grad. student (D1)
Ikenobe, Miki-cho, Kita-gun, Kagawa 761-07 : 0878-98-1411 ex 312
Daini-Saji-so, Hiraki 496-5, Miki-cho, Kita-gun, Kagawa 761-07

YOSHIDA, Mitsuyoshi*1
Grad. School of Agriculture, Kagawa University : grad. student (M1)
Ikenobe, Miki-cho, Kita-gun, Kagawa 761-07 : 0878-98-1411 ex 312
Kumano-so #16, Ikenobe 2723-3, Miki-cho, Kita-gun, Kagawa 761-07

Remarks: Titles and affiliations are at the time of the cruise, if otherwise specified.

*1: Tokyo - Tokyo
*2: Tokyo - Shimonoseki
*3: Shimonoseki - Tokyo
#1: present title -> Professor
#2: present tile & affiliation ->
Faculty of Education, Yokohama National University: Lecturer
Tokiwadai 156, Hodogaya-ku, Yokohama 240 : 045-335-1451 ex 2297

HAYASHI, Isao[*2]
Faculty of Agriculture, Kyoto University : Lecturer
Oiwake-cho, Kitashirakawa, Sakyo-ku, Kyoto 606 : 075-753-6222
Masamune 44-4, Momoyama-cho, Fushimi-ku, Kyoto 612

MAEKAWA, Nobuyuki[*1]
Grad. School of Agriculture, Kyoto University : grad. student (M1)
Oiwake-cho, Kitashirakawa, Sakyo-ku, Kyoto 606 : 075-753-6222
Matsubara-agaru, Kiyamachi-dori, Shimogyo-ku, Kyoto 600

MIURA, Tomoyuki[*2]
Faculty of Fisheries, Kagoshima University : Lecturer
Shimoarata 4-chome 50-20, Kagoshima 890 : 0992-54-2181 ex 478
Shimoarata 4-chome 50-6-24, Kagoshima 890

HARADA, Koh[*3]
Faculty of Fisheries, Hokkaido University : Research Associate
Minato-cho 3-chome 1-1, Hakodate 041 : 0138-41-0131 ex 311
Yanagawa-cho 13-501-44, Hakodate 040

NAGAO, Seiya[*2]
Grad. School of Fisheries, Hokkaido University : grad. student (D3)
Minato-cho 3-chome 1-1, Hakodate 041 : 0138-41-0131 ex 311
Wakaba-so #6, Minato-cho 3-chome 15-4, Hakodate 041

WATANABE, Yutaka[*1]
Grad. School of Fisheries, Hokkaido University : grad. student (D1)
Minato-cho 3-chome 1-1, Hakodate 041 : 0138-41-0131 ex 311
Kameda-cho 48-10, Hakodate 041 (c/o Kidaoka)

SAITO, Shimei[*1]
Grad. School of Fisheries, Hokkaido University : grad. student (M2)
Minato-cho 3-chome 1-1, Hakodate 041 : 0138-41-0131 ex 311
Kitahama-cho 10-chome 9-310, Hakodate 040

MINAKAWA, Masayuki[*1]
Grad. School of Fisheries, Hokkaido University : grad. student (M1)
Minato-cho 3-chome 1-1, Hakodate 041 : 0138-41-0131 ex 311
Minato-cho 3-chome 11-13, Hakodate 041 (c/o Matsuda)

KUBODERA, Tsunemi[*1]
National Science Museum, Tokyo : Curator
Hyakunin-cho 3-chome 23-1, Shinjuku, Tokyo 160 : 03-364-2311 ex 532
Arai 5-chome 12-5, Nakano-ku, Tokyo 165

ZHOU, Zheng[*1]
[WESTPAC scientist]
State Oceanic Administration, Peoples Republic of China
1, Fuxingmenwai Avenue, Beijing, P.R.C. : P.R.C. 867283
Qin Derun 1, Fuxingmenwai Avenue, Beijing, P.R.C.

III. TRACK CHART OF THE HAKUHO MARU KH-88-4 CRUISE

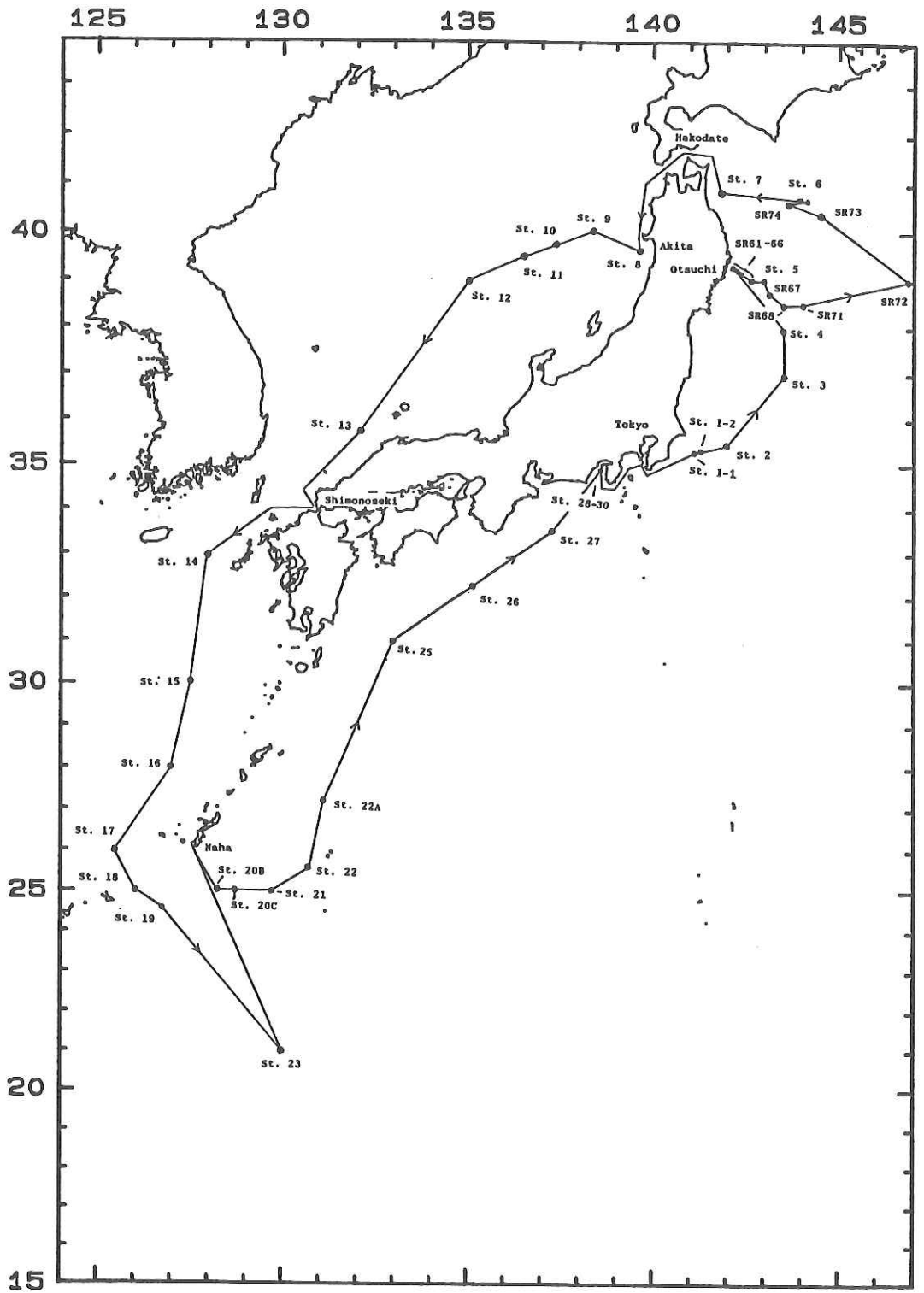


Fig. 1. Track chart of the Hakuho Maru KH-88-4 Cruise.

IV. STATION LISTS

Table 1. Station list of beam trawl operations.

St.No.	Area	Date	Time of operation (on bottom)	Ship position	Depth range cor'ed (PDR rdg)	Type of gear (Wire out)	Remarks
SR61	SE off Otsuchi NW Pacific	'88.09.24	18:03-18:51 18:14-18:40	39 18.6' N - 39 19.0' N 142 08.7' E 142 08.9' E	247-250m (250-253m)	2m S-A BT*1 450m	
SR62	SE off Otsuchi NW Pacific	'88.09.24	19:24-20:17 19:34-20:04	39 16.5' N - 39 16.8' N 142 10.8' E 142 11.1' E	348-350m (353-355m)	2m S-A BT 600m	
SR63	SE off Otsuchi NW Pacific	'88.09.24	20:55-21:43 21:03-21:30	39 15.2' N - 39 15.4' N 142 13.2' E 142 13.3' E	456-467m (463-474m)	2m S-A BT 710m	
SR65	SE off Otsuchi NW Pacific	'88.09.25	06:06-08:55 06:36-08:15	39 07.8' N - 39 08.7' N 142 23.8' E 142 24.2' E	984-988m (1,000-1,005m)	3m ORE BT*2 2,050m	
SR66	SE off Otsuchi NW Pacific	'88.09.25	16:55-20:00 17:33-19:16	38 57.1' N - 38 59.8' N 142 41.6' E 142 41.3' E	1,235-1,284m (1,255-1,305m)	2m S-A BT 2,550m	
SR67	SE off Otsuchi NW Pacific	'88.09.26	06:17-10:07 07:19-09:21	38 42.1' N - 38 44.1' N 143 08.9' E 143 07.0' E	1,735-1,942m (1,760-1,970m)	2m S-A BT 4,000m	
SR68	SE off Otsuchi NW Pacific	'88.09.27	09:44-14:23 11:22-12:48	38 27.4' N - 38 31.1' N 143 31.5' E 143 32.4' E	2,815-2,995m (2,840-3,020m)	4m ORE BT*3 5,160m	
SR71	SE off Otsuchi NW Pacific	'88.09.28	08:48-16:10 11:43-13:47	38 36.45'N - 38 38.71'N 144 04.32'E 144 05.17'E	7,500-7,570m (7,390-7,460m)	4m ORE BT 9,900m	blue gray mud
SR72A	SE off Otsuchi NW Pacific	'88.09.30	08:25-13:29 -	39 00.8' N - 39 09.5' N 147 00.4' E 147 04.5' E	5,370-5,380m (5,330-5,340m)	3m ORE BT 7,500m	didn't touch bottom
SR72B	SE off Otsuchi NW Pacific	'88.10.01	07:50-13:44 10:24-11:39	39 06.09'N - 39 08.05'N 147 02.91'E 147 04.28'E	5,375-5,375m (5,335-5,335m)	4m ORE BT 8,500m	red clay with pumice & ice-rafted cobbles
SR75	E off Hachinohe NW Pacific	'88.10.04	09:57-13:02 10:40-12:24	40 45.7' N - 40 46.7' N 144 05.0' E 144 05.6' E	4,873-5,033m (4,870-5,030m)	4m ORE BT 5,600m	2 rattails escaped at the surface
7	E off Jusanko NW Pacific	'88.10.4-5	23:35-00:23 23:43-00:12	40 49.6' N - 40 49.1' N 141 52.2' E 141 52.6' E	226-228m (225-227m)	2m S-A BT 480m	sand
8	W off Akita Japan Sea	'88.10.05	20:52-21:47 21:05-21:30	39 36.8' N - 39 36.0' N 139 42.4' E 139 42.7' E	250-265m (255-270m)	2m S-A BT 560m	sandy mud
13	off Hinomisaki Japan Sea	'88.10.09	04:55-05:45 05:07-05:32	35 43.0' N - 35 42.7' N 132 03.7' E 132 03.0' E	243-248m (245-250m)	2m S-A BT 500m	tremendous amount of *Ophiura sarsi*
17	W off Okinawa East China Sea	'88.10.17	17:55-20:30 18:36-19:46	26 05.7' N - 26 04.4' N 125 34.6' E 125 34.1' E	2,050-2,055m (2,060-2,065m)	2m S-A BT 2,845m	bizarre black sediment
18	Miyako Sone East China Sea	'88.10.18	08:00-09:07 08:13-08:55	25 12.3' N - 25 10.4' N 125 58.5' E 125 56.1' E	138-158m (135-155m)	2m S-A BT 500m	algal ball boulders; net sligtly torn

*1: Sigsby-Agassiz type beam trawl of 2m span; *2 : ORE type beam trawl of 3m span; *3 : ORE type beam trawl of 4m span

Table 2. Station list of USNEL box corers and OKEAN-40 grab operations [1/3].

St.No.	Area	Date & Time of operation	Time of hit bot.	Position	Depth corrected (PDR rgd)	Type of gear	Sample size for each study item[*3] (unit : cm^2)	Remarks
SR64-1	SE off Otsuchi NW Pacific	'88.09.24 22:11-22:38	22:25	35 12.2'N 142 13.7'E	522m (530m)	USNEL-S[*1]	A(979.6),B(20.4)	
-2		'88.09.24 22:58-23:25	23:12	39 14.1'N 142 13.8'E	500m (508m)	USNEL-S	C(196+residue),D(10), E(14.5)	
-3		'88.09.24 23:41-00:04	23:54	39 13.8'N 142 13.6'E	487m (495m)	USNEL-S	A(754.6),B(20.4),F(225)	
SR65-1	SE off Otsuchi NW Pacific	'88.09.25 09:45-10:35	10:14	39 06.6'N 142 23.8'E	988m (1,005m)	USNEL-L[*2]	A(2254.6),B(20.4),F(225)	RMT attached
-2		'88.09.25 10:50-11:48	11:25	39 05.5'N 142 23.5'E	993m (1,010m)	USNEL-L	A(400),B(20.4),C(196+res.) D(40.6),E(14.5)	RMT attached
SR66-1	SE off Otsuchi NW Pacific	'88.09.25 13:27-13:24	13:55	38 58.6'N 142 41.8'E	1,270m (1,290m)	USNEL-L	A(2254.6),B(20.4),F(225)	RMT attached
-2		'88.09.25 14:35-16:36	14:59	38 58.0'N 142 41.5'E	1,280m (1,300m)	USNEL-L	C(196+res.),D(small), E(small)	winch trouble
SR67-1	SE off Otsuchi NW Pacific	'88.09.26 11:45-12:55	12:24	38 42.2'N 143 04.3'E	1,715m (1,740m)	USNEL-L	A(400),B(20.4),C(196+res.) D(40),E(14),G(128),H(20)	
-2		'88.09.26 13:16-14:19	13:50	38 41.6'N 143 03.3'E	1,715m (1,740m)	USNEL-L		failed

- (to be continued) - - -

*1 USNEL-S : 1/10m^2 USNEL spade corer (sampling area; 32cm x 32cm) with 40kg weight
*2 USNEL-L : 1/4m^2 USNEL spade corer (sampling area; 50cm x 50cm)
*3 study items;
A: Ecological study of macrobenthos - - - - - - - - - - - - - - - - Kojima, S. and S. Ohta
B: Analysis of sediment characteristics - - - - - - - - - - - - - - Kojima, S. and S. Ohta
C: Ecological and taxonomical studies of small-size polychaetes - Ohwada, T.
D: Analysis of nitrogen compounds and phytopigments - - - - - - - Montani, S. *et al.*
E: Microbiolical study of deep-sea sediments - - - - - - - - - - Ohwada, K.
F: Vertical distribution of macrobenthos in sediments - - - - - - - Hayashi, I. and N. Maekawa
G: Chemical analysis of pore water in the sediment - - - - - - - - Harada, K. *et al.*
H: Ecological study of meiobenthos - - - - - - - - - - - - - - - - Shirayama, Y. and S. Kojima
I: Ecological study of *Limopsis* - - - - - - - - - - - - - - - - - - Nakaoka, M.

Table 2. Station list of USNEL box corers and OKEAN-40 grab operations (continued [2/3]).

St.No.	Area	Date & Time of operation	Time of hit bot.	Position	Depth corrected (PDR rgd)	Type of gear	Sample size for each study item (unit : cm^2)	Remarks
SR68-1	SE off Otsuchi NW Pacific	'88.09.26 16:53-18:52	17:59	38 29.7'N 143 31.0'E	2,875m (2,900m)	USNEL-L		failed
-2		'88.09.27 04:24-06:15	05:21	38 29.4'N 143 31.2'E	2,895m (2,920m)	USNEL-S	A(754.6),B(20.4),F(225)	
SR68-3	SE off Otsuchi NW Pacific	'88.09.27 06:35-08:38	07:38	38 29.9'N 143 28.4'E	2,775m (2,800m)	USNEL-S	A(200),B(10.2),C(196+res.) D(40.6),E(14.5),G(128.3)	
SR72-1	E off Sanriku NW Pacific	'88.09.30 14:00-17:04	15:41	39 11.4'N 147 06.2'E	5,360m (5,320m)	USNEL-L+*4	A(1675.6),B(20.4),C(196), D(40.6),E(14.5),F(225) G(328.3)	
SR73-1	E off Hachinohe NW Pacific	'88.10.02 06:53-11:55	09:53	40 26.7'N 144 26.2'E	7,560m (7,450m)	USNEL-L+	A(1900.6),B(20.4),C(196), D(40.6),E(14.5),G(328.3)	
-2		'88.10.02 12:15-16:54				USNEL-L+		failed (winch trouble)
SR74-1	E off Hachinohe NW Pacific	'88.10.02 19:53-21:26	20:42	40 38.9'N 143 41.5'E	2,590m (2,610m)	USNEL-S	A(754.6),B(20.4),F(225)	RMT attached
-2		'88.10.03 19:35-21:11	20:27	40 39.1'N 143 41.9'E	2,600m (2,620m)	USNEL-S	A(628.5),B(20.4),C(196), D(40.6),E(14.5),G(100)	
SR75-1	E off Hachinohe NW Pacific	'88.10.03 14:41-17:49	16:18	40 44.7'N 144 03.7'E	4,685m (4,680m)	USNEL-S	A(607.6),B(20.4),C(147) F(225)	RMT attached
17-1	W off Okinawa	'88.10.18-19 23:21-00:43	20:42	26 03.6'N 125 36.6'E	2,050m (2,060m)	USNEL-S		failed
-2		'88.10.19 01:25-03:03	02:20	26 05.2'N 125 35.2'E	2,045m (2,055m)	USNEL-S		failed; triggered but water only
18-1	E off Miyakojima Philippine Sea	'88.10.19 12:48-13:38	13:16	25 06.7'N 126 11.4'E	625m (620m)	USNEL-L+		failed; not triggered

- (to be continued) - - -

*4 USNEL-L+: USNEL-L with 4 extra-weights (100kg) attached to the frame
*5 OKEAN-40: Okean-40 type grab sampler (sampling area: 40 x 40cm)

Table 2. Station list of USNEL box corers and OKEAN-40 grab operations (continued [3/3]).

St.No.	Area	Date & Time of operation	Time of hit bot.	Position	Depth corrected (PDR rgd)	Type of gear	Sample size for each study item (unit : cm^2)	Remarks
18-2	E off Miyakojima Philippine Sea	'88.10.19 13:48-14:25	14:08	25 07.0'N 126 10.6'E	471m (465m)	USNEL-L+	C(196+res.),E(small), G(small)	not penetrated well
20C-1	landward wall of Ryukyu Trench	'88.10.25 10:00-13:10	11:33	25 00.8'N 128 45.1'E	5,485m (5,450m)	USNEL-L+	C(196+1/2 res.),D(40.6), E(14.5),F(1/2 res.),G(100)	
-2		'88.10.25 13:20-16:13	15:02	25 02.3'N 128 45.3'E	5,460m (5,425m)	USNEL-L+	A(2449),B(20.4),H(30.6)	
21-1	W off Daitojima Philippine Sea	'88.10.26 03:07-05:09	04:03	25 02.4'N 129 44.6'E	4,530m (4,520m)	OKEAN-40*5	C(196+res.),D(small), E(small),G(small)	
21-2		'88.10.26 05:25-07:29	06:31	25 02.5'N 129 43.9'E	4,530m (4,520m)	OKEAN-40	A(500),B(20.4)	
22-1	W off Daitojima Philippine Sea	'88.10.26 15:06-17:38	16:33	25 35.2'N 130 45.3'E	4,315m (4,305m)	USNEL-L+	A(600),B(20.4),C(196+res.) D(40),E(14),G(100),H(30)	
30-1	N off Osezaki Suruga Bay	'88.10.30 00:20-00:40	00:30	35 03.6'N 138 46.9'E	281m (280m)	USNEL-S-*6	I(979.6),B(20.4)	RMT and water sampler attached
-2		'88.10.30 00:50-01:08	01:00	35 03.8'N 138 46.8'E	312m (310m)	USNEL-S-	I(979.6),B(10.2),H(10.2)	RMT and water sampler attached
-3		'88.10.30 01:17-01:39	01:29	35 03.8'N 138 46.8'E	302m (300m)	USNEL-S-	I(979.6),B(10.2),H(10.2)	RMT and water sampler attached
-4		'88.10.30 01:46-02:04	01:55	35 03.7'N 138 46.7'E	302m (300m)	USNEL-S-	I(979.6),B(10.2),H(10.2)	RMT and water sampler attached
-5		'88.10.30 02:26-02:43	02:35	35 03.7'N 138 46.8'E	286m (285m)	USNEL-S-	I(979.6),B(10.2),H(10.2)	RMT and water sampler attached
-6		'88.10.30 02:58-03:17	03:08	35 03.7'N 138 46.9'E	281m (280m)	USNEL-S-	I(979.6),B(10.2),H(10.2)	RMT and water sampler attached

*6 USNEL-S-: USNEL-S removed the additional 40kg weights

Table 3. Station list of underwater photography.

St.No.	Area	Date	Time of operation (on bottom)	Ship position	Depth range cor'ed (PDR rdg)	Type of film* (length)	Remarks
						[I] [O]	
SR67	SE off Otsuchi NW Pacific	'88.09.26	03:43-06:05 04:24-05:35	38 41.6'N - 38 41.2'N 143 10.5'E 143 10.6'E	2,000-2,015m (2,030-2,044m)	P-X + T-X 100f	
SR68	SE off Otsuchi NW Pacific	'88.09.26	19:15-22:04 20:00-21:15	38 30.8'N - 38 31.3'N 143 29.3'E 143 28.9'E	2,790-2,700m (2,820-2,730m)	P-X + T-X 100f	compass lost
SR71	SE off Otsuchi NW Pacific	'88.09.28	03:33-08:28 05:51-07:03	38 31.0'N - 38 31.2'N 144 05.0'E 144 04.9'E	7,530-7,540m (7,420-7,430m)	E-C + T-X 100f	compass lost
SR72	SE off Otsuchi NW Pacific	'88.09.30	17:19-21:29 18:53-20:00	39 13.0'N - 39 13.4'N 147 08.6'E 147 08.8'E	5,410-5,410m (5,370-5,370m)	T-X + T-X 100f	
SR75	E off Hachinohe NW Pacific	'88.10.3-4	23:00-02:36 00:20-01:31	40 44.4'N - 40 44.5'N 144 04.5'E 144 05.3'E	4,665-4,705m (4,665-4,705m)	E-C + T-X 100f	
7	E off Jusanko NW Pacific	'88.10.04	22:50-23:25 22:58-23:20	40 50.6'N - 40 50.2'N 141 51.4'E 141 51.7'E	249-241m (248-240m)	T-X + T-X 33f	RMT(S)
8	W off Akita Japan Sea	'88.10.05	20:04-20:39 20:12-20:32	39 36.8'N - 39 36.8'N 139 42.2'E 139 41.4'E	245-267m (250-272m)	T-X + T-X 33f	RMT(S)
13	off Hinomisaki Japan Sea	'88.10.09	04:05-04:46 04:11-04:40	35 43.3'N - 35 43.2'N 132 03.6'E 132 03.9'E	247-247m (250-250m)	T-X + T-X 33f	RMT(S)
17	Okinawa Trough East China Sea	'88.10.18	20:36-23:05 21:19-22:30	26 03.3'N - 26 03.5'N 125 34.7'E 125 35.5'E	2,035-2,035m (2,060-2,060m)	P-X + T-X 100f	RMT(D) system stopped at 1/3
18	E off Miyakojima Philippine Sea	'88.10.19	09:15-10:40 09:20-10:35	25 09.5'N - 25 07.8'N 125 54.9'E 125 52.8'E	128-123m (125-120m)	P-X + T-X 100f	RMT(S) system stopped at 2/3
19	E off Miyakojima Philippine Sea	'88.10.20	03:28-05:34 04:05-05:25	24 35.1'N - 24 35.0'N 126 41.0'E 126 40.3'E	1,905-1,915m (1,910-1,920m)	P-X + T-X 100f	RMT(D): wire broken and camera system lost !

* P-X : Kodak Plus-X Pan BW film; T-X : Kodak Tri-X Pan BW film; E-C : Eastman Color 5294 nega-color film

Table 4. Station list of NORPAC-twin net hauls.

St.No.	Location	Date	Time	Mesh size (mm)	Towing method	Wire out (m)	Sampling layer (m)	Volume of water filterd (m^3)	Remarks
17N1	26°03.3'N 125°34.2'E	Oct.18 1988	20:53 21:03	0.33 0.10	Vert.	160	0-150	44.2	failed
17N2	26°03.3'N 125°34.7'E	Oct.18 1988	21:08 21:18	0.33 0.10	Vert.	150	0-150	39.7	
18	25°09.5'N 125-59.2'E	Oct.19 1988	09:21 09:32	0.33 0.10	Vert.	150	0-125	49.1	depth 125m
19	25°35.8'N 126°43.3'E	Oct.19 1988	19:05 19:15	0.33 0.10	Vert.	167	0-150	53.0	
23	20°58.5'N 129°54.7'E	Oct.21 1988	19:33 19:45	0.33 0.10	Vert.	150	0-150	41.3	
20B	25°02.4'N 128°08.7'E	Oct.24 1988	19:58 20:10	0.33 0.10	Vert.	155	0-150	45.4	
20C	25°01.7'N 128°45.1'E	Oct.25 1988	12:28 12:41	0.33 0.10	Vert.	162	0-150	49.8	
21	25°00.1'N 129°44.4'E	Oct.26 1988	00:24 00:44	0.33 0.10	Vert.	170	0-150	52.8	
22	25°33.7'N 130°43.8'E	Oct.26 1988	19:40 19:51	0.33 0.10	Vert.	152	0-150	41.2	

Table 5. Station list of MTD (GG 54) net horizontal tows [1/2].

St.No.	Location			Date	Time	Wire out	Sampling layer	Volume of water	Remarks
	Mid. point	Net in	Net out			(m)	(m)	filt'ed(m^3)	
SR-64	39-10.8 N	39-11.7 N	39-10.0 N	09.25	02:37	0	Surface	149.2	Kagawa Univ.
	142-12.8 E	142-13.2 E	142-12.2 E	1988	03:40	250	177		
						500	354	431.3	
SR-68	38-32.6 N	38-32.2 N	38-32.9 N	09.27	01:59	0	Surface	142.2	Kagawa Univ.
	143-25.2 E	143-26.2 E	143-24.2 E	1988	03:19	500	357	358.0	
						1000	714		
SR-71	38-35.6 N	38-33.9 N	38-37.5 N	09.29	05:07	0	Surface	339.1	Kagawa Univ.
	143-58.9 E	143-59.6 E	143-57.9 E	1988	06:30	500	357		
						1000	714	1099.1	
SR-72	39-15.1 N	39-14.0 N	39-15.7 N	09.30	21:44	0	Surface	234.4	Kagawa Univ.
	147-10.8 E	147-09.5 E	147-11.9 E	1988	23:00	500	357		failed
						1000	714		
6-1	40-41.9 N	40-40.9 N	40-42.6 N	10.03	00:39		0	233.2	
	143-59.2 E	143-59.2 E	143-59.5 E	1988	02:30		10		
							25		
							50	302.3	
							75	254.0	
							100	322.1	
							150	404.5	
							200	322.1	
							250	326.9	
							300	370.4	
							500		
							600	285.7	
							750	492.4	
6-2	40-40.5 N	40-40.8 N	40-40.1 N	10.03	04:05		0	275.3	
	143-59.0 E	143-58.1 E	143-59.5 E	1988	06:00		10	394.6	
							25	396.4	
							50	410.5	
							75		mes. failed
							100		
							150	54.2	
							200		
							250	44.3	
							300		
							500	93.4	
							600	84.1	
							750	83.9	
6-3	40-39.6 N	40-40.1 N	40-39.3 N	10.03	06:04		0	225.0	
	144-00.2 E	143-59.5 E	144-00.7 E	1988	07:53		10	270.1	
							25	359.9	
							50	348.8	
							75	368.3	
							100		
							150		
							200	259.6	
							250		
							300		
							500	377.8	
							600	312.5	
							750	230.7	
6-4	40-40.8 N	40-40.4 N	40-44.1 N	10.03	11:08		0	199.5	
	143-57.0 E	143-58.2 E	143-55.8 E	1988	12:52		10	270.1	
							25	290.7	
							50	254.1	failed
							75		
							100	464.5	
							150		
							200	396.6	
							250	378.8	
							500		
							600	475.7	
							750	413.7	

(to be continued)

Table 5. Station list of MTD (GG 54) net horizontal tows (continued: [2/2]).

St.No.	Location			Date	Time	Wire out (m)	Sampling layer (m)	Volume of water filt'ed(m^3)	Remarks
	Mid. point	Net in	Net out						
9-1	40-02.1 N 138-29.0 E	40-01.0 N 138-29.7 E	40-03.6 N 138-26.9 E	10.06 1988	04:05 06:51		0 10 25 50 75 100 150 250 750 1000 1250 1500	24.5 418.5 328.0 299.7 246.2 371.3 224.2 27.2 74.8	 failed
9-2	40-03.6 N 138-26.2 E	40-03.8 N 138-25.1 E	40-03.0 N 138-27.4 E	10.06 1988	09:34 11:48		0 10 25 50 75 100 150 250 500 750 1000 1250 1500	241.7 268.0 299.5 162.1 164.6 174.2 147.7 731.4 677.9	 not closed not closed failed net lost not closed not closed failed net lost
9-3	40-00.2 N 138-29.2 E	40-00.7 N 138-29.6 E	39-59.2 N 138-28.8 E	10.06 1988	14:34 16:42		0 10 25 50 75 100 150 250 500 750 1000	331.8 374.5 532.1 632.6 571.2 189.6 366.5 342.5 333.8	
9-4	39-57.7 N 138-34.6 E	39-57.2 N 138-34.4 E	39-58.5 N 138-31.7 E	10.07 1988	00:49 02:56		0 10 25 50 100 150 250 500 750 1000	301.0 445.9 288.4 348.9 218.9 398.5 430.1 443.8 413.8	
19	24-35.0 N 126-42.1 E	24-34.6 N 126-42.2 E	24-35.4 N 126-41.9 E	10.20 1988	01:45 03:13	0 500 990 1000	Surface 350-359 705-782 712-789	482.6 945.8 538.4	Kagawa Univ. net lost
20B	25-05.3 N 128-06.6 E	25-04.3 N 128-07.7 E	25-06.3 N 128-06.4 E	10.24- 25,1988	23:50 01:08	0 500 1000	Surface 279-346 559-692	158.6 379.8 592.0	Kagawa Univ.
21	25-01.1 N 129-44.5 E	25-00.3 N 129-44.0 E	25-01.9 N 129-44.9 E	10.26 1988	01:36 02:45	0 500 1000	Surface 303-350 606-700	314.1 337.2 367.3	Kagawa Univ.
22	25-33.8 N 130-43.6 E	25-33.0 N 130-43.3 E	25-34.6 N 130-43.9 E	10.26 1988	20:41 21:59	0 500 1000	Surface 308-350 606-701	353.4 391.9 315.5	Kagawa Univ. net broken

Table 6. Station list of ORI-69 net hauls [1/2].

St.No.	Location: Mid. Point	Location: Net in	Location: Net out	Date	Time	Mesh size (mm)	Towing method	Wire out	Sampling layer(m)	Volume of water filtered(m^3)	Remarks
1-1	35-20.8'N 141-09.9'E	35-20.7'N 141-09.8'E	35-20.9'N 141-10.1'E	Sept.23 1988	01:25 01:35	0.69	Hor.	-	Surface		
1-2	35-20.6'N 141-19.0'E	35-20.3'N 141-18.9'E	35-20.8'N 141-19.0'E	Sept.23 1988	03:02 03:13	0.69	Hor.	-	Surface	3,278.7	
2	35-33.2'N 142-03.8'E	35-32.7'N 142-03.3'E	35-33.7'N 142-04.3'E	Sept.23 1988	08:24 08:44	0.69	Hor.	-	Surface	3,262.5	
4	37-58.7'N 143-31.9'E	37-58.4'N 143-31.7'E	37-58.9'N 143-32.2'E	Sept.24 1988	06:12 06:30	0.69	Hor.	-	Surface	2,667.8	
SR71	38-35.8'N 144-04.0'E	38-36.0'N 144-04.6'E	38-35.5'N 144-03.8'E	Sept.29 1988	02:34 02:54	0.69	Hor.	-	Surface	2,713.2	
SR72	39-14.0'N 147-10.5'E	39-14.1'N 147-10.7'E	39-13.9'N 147-09.9'E	Oct.01 1988	01:20 01:40	0.69	Hor.	-	Surface	2,938.0	
6-1	40-41.7'N 143-58.6'E	40-42.6'N 143-59.3'E	40-40.9'N 143-58.2'E	Oct.03 1988	02:43 03:55	0.69	Obl.	1,500		7,836.7	
6-4	40-39.5'N 143-59.0'E	40-39.4'N 144-00.6'E	40-39.6'N 143-57.4'E	Oct.03 1988	09:13 10:26	0.69	Obl.	1,500		8,354.8	
SR75-A	40-45.3'N 144-02.6'E	40-45.2'N 144-02.8'E	40-45.3'N 144-02.4'E	Oct.04 1988	03:52 03:57	0.69	Hor.	-	Surface	563.8	
SR75-B	40-45.5'N 144-02.2'E	40-45.4'N 144-02.3'E	40-45.5'N 144-02.1'E	Oct.04 1988	04:02 04:07	0.69	Hor.	-	Surface	562.0	
SR75	40-46.1'N 144-00.9'E	40-46.4'N 144-00.0'E	40-45.5'N 144-01.8'E	Oct.04 1988	05:50 06:45	0.69	Obl.	1,000		6,447.9	
9-2	40-02.8'N 138-28.3'E	40-03.1'N 138-27.4'E	40-02.5'N 138-29.1'E	Oct.06 1988	11:55 13:22	0.69	Obl.	2,500	0-1,936	8,306.4	
9-4	39-58.5'N 138-35.9'E	39-59.7'N 138-37.0'E	39-57.2'N 138-34.7'E	Oct.6-7 1988	23:18 00.40	0.69	Obl.	2,500	0-1,643	10,617.5	
13	35-42.2'N 132-02.1'E	35-42.3'N 132-02.7'E	35-42.1'N 132-01.4'E	Oct.09 1988	06:02 06:47	0.69	Obl.	300		3,945.5	
14	33-00.2'N 127-59.9'E	33-00.1'N 128-00.1'E	33-00.3'N 127-59.7'E	Oct.17 1988	00:49 01:00	0.69	Hor.	-	Surface	977.5	

(to be continued)

Table 6. Station list of ORI-69 net hauls (continued [2/2]).

St.No.	Location			Date	Time	Mesh size (mm)	Towing method	Wire out	Sampling layer(m)	Volume of water filtered(m^3)	Remarks
	Mid. Point	Net in	Net out								
15	29-59.8'N 127-30.1'E	29-59.9'N 127-30.2'E	29-59.6'N 127-30.0'E	Oct.17 1988	16:25 16:35	0.69	Hor.	-	Surface	995.3	
16	28-00.2'N 127-00.3'E	28-00.2'N 127-00.4'E	28-00.2'N 127-00.1'E	Oct.18 1988	04:50 05:00	0.69	Hor.	-	Surface	1,081.9	
17	26-05.4'N 125-34.6'E	26-05.5'N 125-34.6'E	26-05.3'N 125-34.5'E	Oct.18 1988	18:43 18:53	0.69	Hor.	-	Surface	1,275.9	
18	25-11.9'N 125-58.1'E	25-12.2'N 125-58.4'E	25-11.6'N 125-57.7'E	Oct.19 1988	08:17 08:27	0.69	Hor.	-	Surface	1,013.0	
19	24-34.8'N 126-44.1'E	24-34.8'N 126-44.0'E	24-34.8'N 126-44.1'E	Oct.19 1988	21:44 21:54	0.69	Hor.	-	Surface	1,235.4	
23	20-58.5'N 129-53.9'E	20-58.3'N 129-54.1'E	20-58.6'N 129-53.7'E	Oct.21 1988	21:53 22:03	0.69	Hor.	-	Surface	1,239.2	with surface MTD
20B-1	25-05.5'N 128-06.6'E	25-05.3'N 128-06.8'E	25-05.7'N 128-06.3'E	Oct.25 1988	00:20 00:33	0.69	Hor.	-	Surface	204.9	inadequate tow
20B-2	25-07.0'N 128-05.2'E	25-06.6'N 128-05.2'E	25-07.3'N 128-05.1'E	Oct.25 1988	01:24 01:34	0.69	Hor.	-	Surface	1,283.6	
21	25-01.1'N 129-44.4'E	25-01.0'N 129-44.3'E	25-01.1'N 129-44.5'E	Oct.26 1988	01:58 02:08	0.69	Hor.	-	Surface	1,181.5	
22	25-33.6'N 130-43.2'E	25-33.4'N 130-43.1'E	25-33.7'N 130-43.3'E	Oct.26 1988	21:06 21:16	0.69	Hor.	-	Surface	1,134.1	
22A	27-12.8'N 131-08.9'E	27-12.8'N 131-08.6'E	27-12.7'N 131-09.1'E	Oct.27 1988	09:23 09:33	0.69	Hor.	-	Surface	1,490.8	
25	31-01.6'N 133-04.1'E	31-01.4'N 133-03.8'E	31-01.7'N 133-04.3'E	Oct.28 1988	08:21 08:31	0.69	Hor.	-	Surface	1,860.4	
26-1	32-21.0'N 135-09.6'E	32-20.7'N 135-09.4'E	32-21.2'N 135-09.8'E	Oct.28 1988	22:26 22:36	0.69	Hor.	-	Surface	1,231.4	
26-2	32-21.5'N 135-10.0'E	32-21.2'N 135-09.8'E	32-21.8'N 135-10.1'E	Oct.28 1988	22:39 22:49	0.69	Hor.	-	Surface	1,146.1	Kubodera
27	33-39.9'N 137-10.0'E	33-39.6'N 137-10.0'E	33-40.1'N 137-09.9'E	Oct.29 1988	11:42 11:52	0.69	Hor.	-	Surface	1,049.2	

Table 7. Station list of 10-foot IKMT and IKPT net hauls.

St.No.	Location			Date	Time	Net	Mesh size	Towing	Wire	Sampling layer	Volume of waters
	Mid. Point	Net in	Net out			type	(mm)	method	out	(m)	filtered(m^3)
1-1	35-20.6'N 141-09.8'E	35-20.0'N 141-09.2'E	35-21.3'N 141-10.4'E	Sept.23 1988	01:03 02:01	10-foot IKMT*1	5.0	Oblique	750	0-325	9,371.8
1-2	35-21.5'N 141-19.0'E	35-20.2'N 141-18.9'E	35-22.7'N 141-19.0'E	Sept.23 1988	02:59 04:15	10-foot IKMT	5.0	Oblique	1,800	0-625	13,662.6
2	35-35.0'N 142-03.6'E	30-30.3'N 142-00.2'E	35-39.7'N 142-07.1'E	Sept.23 1988	07:29 10:21	10-foot IKMT	5.0	Oblique+ 1 hr Hor.	3,000	0-780 730-700	46,124.5
4	38-00.4'N 143-33.0'E	37-58.2'N 143-31.5'E	38-02.6'N 143-34.4'E	Sept.24 1988	06:05 08:58	10-foot IKMT	5.0	Oblique+ 1 hr Hor.	3,000	0-1,200 1,200-1,125	29,715.0
SR71	38-36.6'N 144-02.6'E	38-40.0'N 144-05.3'E	38-33.2'N 143-59.9'E	Sept.29 1988	01:00 04:44	10-foot IKMT	5.0	Oblique+ 1 hr Hor.	5,000	0-2,000 2,000-2,100	49,392.3
SR72	39-14.1'N 147-09.9'E	39-15.7'N 147-11.9'E	39-12.9'N 147-07.9'E	Sept.30 Oct.01	23:20 02:32	10-foot IKMT	5.0	Oblique+ 1 hr Hor.	3,000	0-1,400 1,400-1,100	20,147.4
SR75	40-45.6'N 144-02.8'E	40-44.4'N 144-05.8'E	40-46.8'N 143-59.9'E	Oct.04 1988	02:50 05:40	10-foot IKMT	5.0	Oblique+ 1 hr Hor.	3,000	0-1,200 1,200-1,300	29,082.7
19	24-34.9'N 126-42.9'E	24-34.1'N 126-41.9'E	24-35.6'N 126-43.8'E	Oct.19 1988	20:40 23:47	10-foot IKPT*2	1.0	Oblique+ 0.5 hr Hor.	3,000	0-1,050 1,050-1,596	20,579.3
23	20-59.5'N 129-52.7'E	20-57.9'N 129-54.4'E	21-00.9'N 129-50.9'E	Oct.21 1988	21:40 24:22	10-foot IKPT	1.0	Oblique	3,000	0-1,329	20,313.9
22A	27-12.6'N 131-08.6'E	27-12.8'N 131-05.4'E	27-12.3'N 131-12.7'E	Oct.27 1988	08:17 10:55	10-foot IKMT	5.0	Oblique	3,000	0-1,009	50,158.3
25	31-03.0'N 133-07.5'E	31-01.1'N 133-03.4'E	31-04.9'N 133-11.6'E	Oct.28 1988	08:13 11:08	10-foot IKMT-EMPS*3	5.0	Oblique+ 0.5 hr Hor. 0.5 hr Obl. 0.5 hr Obl. rest Obl.	3,000	0-744 744-862 862-750 750-422 422-0	57,812.1
26	32-20.7'N 135-09.5'E	32-16.3'N 135-07.4'E	32-25.0'N 135-11.6'E	Oct.28 1988	21:02 23:58	10-foot IKMT-EMPS	5.0	Oblique+ 0.5 hr Hor. 0.5 hr Obl. 0.5 hr Obl. rest Obl.	3,000	0-840 840-871 871-656 656-317 317-0	57,231.7
27	33-39.3'N 137-10.2'E	33-34.6'N 137-13.2'E	33-44.0'N 137-07.2'E	Oct.29 1988	10:00 13:16	10-foot IKMT	5.0	Oblique+ 0.5 hr Hor.	3,000	0-808	70,335.7

*1: Isaacs-Kidd Midwater Trawl; *2: Isaacs-Kidd Plankton Trawl; *3: Electrical Multilayer Plankton Sampler attached to IKMT

Table 8. Summary of operations of PRS (Pressure Retaining Sampler) for microbiological study.

St.No.	Date	Time	Location	Depth	Wire out	Remarks
SR66	'88.09.25	20:00-21:10	39° 00.6'N 142° 40.9'E	1,250m	500m	non-sterile test operation pressure held: 4 kg/cm^2 working duration of pump: 30 min vol. of water filtered: 2,700 ml
SR71	'88.09.28	16:22-20:31	38° 40.8'N 144° 07.1'E	7,500m	6,000m	sterilization: 120° C, 30 min pressure held: 410 kg/cm^2 working duration of pump: 60 min vol. of water filtered: 4,000 ml
20B	'88.10.25	01:46-06:08	25° 07.7'N 128° 04.8'E	6,200m	5,000m	sterilization: 120° C, 30 min pressure held: 0 kg/cm^2 working duration of pump: 60 min vol. of water filtered: uncertain leak from a valve for water intake

Table 9. Station list of CTD observations [1/2].

St.No.	Area	Date & Time of operation (deepest)	Ship position Initiation	Deepest p.	Retrieval	Totl. w.o. & max. pres.	Type of accesory gear(s)	Remarks: (water sampling layers)
			depth in m ([corrected])					
3	E off Inubozaki NW Pacific	'88.09.23 20:53-22:30 21:31	37 00.1'N 143 26.9'E 7,300m	36 59.9'N 143 26.2'E 7,360m	36 59.9'N 143 25.5'E 7,300m	2,110 m 2,000db	5-liter Niskin 24bot. rosette	50,100,200,300,400,500, 600,750,1k,1250,1500, 2kdb
4	E off Shioyazaki NW Pacific	'88.09.24 04:18-05:55 05:00	37 59.7'N 143 30.1'E 4,370m	37 59.1'N 143 30.7'E 4,370m	37 58.3'N 143 31.3'E 4,370m	2,087 m 2,004db	5-liter Niskin 24bot. rosette	50,100,200,300,400,500, 600,700,800,900,1300, 2kdb
5	E off Kinkasan NW Pacific	'88.09.25-26 22:45-00:04 23:16	38 59.9'N 143 00.0'E [1,620m]	38 59.0'N 143 00.6'E [1,615m]	38 58.9'N 143 00.6'E [1,620m]	1,612 m 1,550db	5-liter Niskin 24bot. rosette	50,100,250,500,600,700, 800,1k,1250,1400,1500, 1550db
SR68	SE off Otsuchi NW Pacific	'88.09.26 22:04-23:59 22:58	38 31.7'N 143 28.3'E [2,670m]	38 32.0'N 143 27.7'E [2,600m]	38 32.2'N 143 27.0'E [2,550m]	2,566 m 2,500db	5-liter Niskin 24bot. rosette	100,250,500,750,1k, 1250,1500,2k,2100, 2300,2400,2500db
SR71	SE off Otsuchi NW Pacific	'88.09.28-29 20:35-00:48 20:55	38 40.0'N 144 06.4'E [7,615m]	38 40.2'N 144 06.0'E [7,530m]	38 40.2'N 144 05.7'E [7,520m]	5,974 m 6,004db	5-liter Niskin 24bot. rosette	250,500,750,1k,1500, 2k,3k,4k,4500,5k, 5500,6kdb
SR72	E off Sanriku NW Pacific	'88.09.29-30 22:40-02:41 00:31	38 59.9'N 146 59.9'E [5,410m]	39 00.8'N 147 00.2'E [5,390m]	39 00.3'N 146 59.9'E [5,350m]	5,520 m 5,471db	5-liter Niskin 24bot. rosette with pinger	500,750,1k,1500,2k, 3k,4k,4500,5k,5370, 5424,5470db
6	E off Hachinohe NW Pacific	'88.10.02-03 22:53-00:28 23:34	40 40.2'N 144 00.0'E [4,320m]	40 40.4'N 144 59.3'E [4,360m]	40 40.8'N 144 59.2'E [4,390m]	2,034 m 2,010db	5-liter Niskin 24bot. rosette	100,200,300,400,500, 600,700,800,900,1k, 1500,2kdb
9	W off Oga Pen. Japan Sea	'88.10.06 18:30-20:34 19:21	39 58.9'N 138 29.4'E [2,515m]	39 59.2'N 138 29.8'E [2,505m]	39 59.3'N 138 30.3'E 4,500m	2,330 m 2,306db	5-liter Niskin 24bot. rosette Niskin but-fly	50,100,200,300,400,500, 600,800,1k,1250,1500, 2300db
11	E of Yamato Bk. Japan Sea	'88.10.07 20:35-22:48 21:44	39 29.8'N 136 30.7'E [2,630m]	39 29.6'N 136 30.7'E [2,630m]	39 29.5'N 136 31.6'E [2,630m]	2,478 m 2,524db	5-liter Niskin 24bot. rosette	50,100,200,300,400,500, 600,800,1k,1250,1500, 2520db

- - - (to be continued) - - -

Table 9. Station list of CTD observations (continued [2/2]).

St.No.	Area	Date & Time of operation (deepest)	Ship position Initiation depth	Deepest p. in m ([corrected])	Retrieval	Totl. w.o. & max. pres.	Type of accesory gear(s)	Remarks: (water sampling layers)
12	S of Yamato Bk. Japan Sea	'88.10.08 06:19-08:08 07:08	38 59.8'N 135 00.1'E [2,935m]	38 59.6'N 135 00.3'E [2,935m]	38 59.5'N 135 00.5'E [2,955m]	2,500 m 2,518db	5-liter Niskin 24bot. rosette	50,100,200,300,400,500, 600,800,1k,1250,1500, 2500db
13	NW off Hinomisaki Japan Sea	'88.10.09 07:01-07:25 07:06	35 41.9'N 132 01.3'E [232m]	35 41.9'N 132 01.3'E [232m]	35 41.8'N 132 01.4'E [232m]	220 m 223db	5-liter Niskin 24bot. rosette	25,50,100,150,200,225db
14	W off Goto Is. East China Sea	'88.10.17 00:18-00:48 00:25	32 59.8'N 128 00.2'E [153m]	32 59.9'N 128 00.2'E [153m]	33 00.0'N 128 00.1'E [153m]	145 m 144db	5-liter Niskin 24bot. rosette with pinger	10,25,50,75,100,138, 144db
15	W off Tokara Is. East China Sea	'88.10.17 15:57-16:24 16:03	30 00.0'N 127 30.0'E [138m]	30 00.0'N 127 30.0'E [138m]	30 00.0'N 127 30.2'E [138m]	139 m 138db	5-liter Niskin 24bot. rosette with pinger	10,25,50,75,100,132, 138db
16	W off Amami East China Sea	'88.10.18 03:43-04:46 04:10	27 59.8'N 126 59.8'E [1,095m]	28 00.0'N 127 00.4'E [1,095m]	28 00.2'N 127 00.4'E [1,095m]	1,110 m 1,096db	5-liter Niskin 24bot. rosette with pinger	50,100,200,300,400,500, 600,700,800,900,1k, 1100db
19	E off Miyakojima Philippine Sea	'88.10.19 18:49-19:17 19:02	24 36.1'N 126 43.6'E [1,940m]	24 35.8'N 126 43.3'E [1,940m]	24 35.6'N 126 43.1'E	1,935 m 1,945db	5-liter Niskin 24bot. rosette with pinger	50,100,200,400,600,800, 800,1k,1200,1400,1600, 1800,1945db
23	Philippine Basin	'88.10.21 18:13-21:35 20:03	20 58.8'N 129 54.7'E [5,720m]	20 58.4'N 129 54.7'E [5,910m]	20 57.9'N 129 54.4'E [5,870m]	5,948 m 5,900db	with pinger	
30	NW off Osezaki Suruga Bay	'88.10.29-30 23:52-00:07 23:58	35 03.8'N 138 47.0'E [312m]	35 03.7'N 138 47.1'E [280m]	35 03.8'N 138 47.1'E [271m]	291 m 281db	5-liter Niskin 24bot. rosette with pinger	280dbx4
28	W off Osezaki Suruga Bay	'88.10.30 08:56-09:55 09:29	35 01.2'N 138 38.6'E [1,325m]	35 01.2'N 138 38.5'E [1,325m]	35 01.4'N 138 38.3'E [1,318m]	1,350 m 1,347db	with pinger	
29	SW off Toi Suruga Bay	'88.10.30 11:38-12:47 12:20	34 54.7'N 138 38.6'E [1,567m]	34 54.1'N 138 38.5'E [1,570m]	34 54.1'N 138 38.4'E [1,570m]	1,609 m 1,590db	with pinger	

Table 10. Station list of Niskin-23 and Niskin butterfly hydrocasts [1/2].

St.No.	Area	Date & Time of operation mess.;haul-up	Ship position Initiation depth in m ([corrected])	Messenger	Retrieval	Total wire out	Type of accesory gear(s)	Remarks: (water sampling layers) [in db]
SR64-1	SE off Otsuchi NW Pacific	'88.09.25 00:48- 01:11;	39 13.0'N 142 13.2'E 490m	39 12.7'N 142 13.2'E 495m		400m	23-lit. Niskin	25,50,75,100,125,150, [200,400: failed]
SR64-2	SE off Otsuchi NW Pacific	'88.09.25 -02:20 02:09;		39 12.0'N 142 13.3'E 510m	39 11.9'N 142 13.3'E 480m	400m	23-lit. Niskin	200,400
5	S off Kinkasan NW Pacific	'88.09.26 22:45-00:04 00:45;00:56	38 58.9'N 143 00.6'E [1,620m]	38 58.6'N 143 00.9'E [1,640m]	38 58.4'N 143 01.4'E [1,645m]	1,500m	23-lit. Niskin	25,50,75,100,125,150, 200,400,600,800,1k,1500
SR68	SE off Otsuchi NW Pacific	'88.09.27 00:10-01:46 00:55;01:10	38 32.2'N 143 26.7'E [2,522m]	38 32.2'N 143 26.5'E [2,512m]	38 32.2'N 143 26.3'E [2,512m]	2,000m	23-lit. Niskin	25,50,75,100,125,150, 200,400,600,800,1k,2k
SR71-1	SE off Otsuchi NW Pacific	'88.09.27 17:28- 19:26;20:35	38 31.3'N 144 04.6'E [7,470m]	38 40.2'N 144 06.0'E		7,141m	23-lit. Niskin Niskin but-fly with pinger	1k,2k,3k,4k,5k, [6k,7k: failed] NB:3kx3,5kx3,7kx3
SR71-2	SE off Otsuchi NW Pacific	'88.09.27-28 -02:44 23:35;00:23		38 31.8'N 144 04.3'E [7,490m]	38 31.3'N 144 03.1'E [7,360m]	7,000m	23-lit. Niskin Niskin but-fly with pinger	50,75,100,125,150,200, 400,800,5700,7k NB:5700,7k
SR72-1	E off Sanriku NW Pacific	'88.09.30 00:46-07:22 04:45;05:25	39 02.4'N 146 59.9'E [5,350m]	39 03.5'N 147 00.5'E [5,360m]	39 04.7'N 147 00.9'E [5,360m]	4,950m	23-lit. Niskin Niskin but-fly	25,50,75,100,125,150, 350 350,550,750,950, 1950,2950 [3950,4950:failed]
SR72-2	E off Sanriku NW Pacific	'88.10.01 02:47-04:23	39 12.9'N 147 07.7'E [5,390m]		39 13.7'N 147 08.6'E [5,390m]		23-lit. Niskin	abandoned due to bad sea condition
SR72-3	E off Sanriku NW Pacific	'88.10.01 14:03-18:08 15:51;	39 12.1'N 147 06.5'E [5,365m]	39 12.6'N 147 06.9'E [5,360m]	39 12.9'N 144 05.9'E [5,360m]	5,313m	23-lit. Niskin Niskin but-fly with pinger	4k,5k,5300 NB:3kx3,5kx3 7m above the bottom

(to be continued)

Table 10. Station list of Niskin-23 and Niskin butterfly hydrocasts (continued [2/2]).

St.No.	Area	Date & Time of operation mess.;haul-up	Ship position Initiation depth in m ([corrected])	Messenger	Retrieval	Total wire out	Type of accesory gear(s)	Remarks: (water sampling layers)
9	W off Oga Pen. Japan Sea	'88.10.06 20:38-21:02 20:50;20:52	39 59.3'N 138 30.3'E [2,480m]	39 59.3'N 138 30.4'E [2,480m]	39 59.2'N 138 30.5'E [2,480m]	150m	23-lit. Niskin	25,75,125,150
11	E of Yamato Bk. Japan Sea	'88.10.07 22:50-23:15 23:05;23:07	39 29.5'N 136 31.6'E [2,630m]	39 29.6'N 136 31.9'E [2,630m]	39 29.7'1 136 32.0'E [2,630m]	150m	23-lit. Niskin	25,75,125,150
12	S of Yamato Bk. Japan Sea	'88.10.08 08:10-08:31 08:21;08:23	38 59.5'N 135 00.5'E [2,945m]	38 59.5'N 135 00.5'E [2,945m]	38 59.4'N 135 00.5'E [2,945m]	150m	23-lit. Niskin	25,75,125,150
19	E off Miyakojima Philippine Sea	'88.10.19-20 23:55-01:23 00:39;00:50	24 35.2'N 126 43.5'E [1,942m]	24 34.8'N 126 42.9'E [1,942m]	24 34.5'N 126 42.6'E [1,992m]	1,700m	23-lit. Niskin	25,50,75,100,125,150 200,400,800,600,1k,1700
20B-S	axis of Ryukyu Tr. Philippine Sea	'88.10.24 17:30-18:45 18:11;18:21	25 00.7'N 128 09.6'E 6,940m	25 01.3'N 128 09.6'E 6,940m	25 01.7'N 128 09.1'E 6,535m	1,000m	23-lit. Niskin	25,50,75,100,125,150, 200,400,600,800,1k
20B-D	axis of Ryukyu Tr. Philippine Sea	'88.10.24 18:45-23:38 20:40;21:30	25 01.7'N 128 09.1'E 6,935m	25 02.8'N 128 08.3'E 7,000m	25 04.0'N 128 07.9'E 7,110m	6,003m	23-lit. Niskin Niskin but-fly	2k,3k,3970,5k,5970 NB:3980,3990,4k, NB:5980,5990,6k
21	NW off Oki-Daito Philippine Sea	'88.10.25-26 21:40-01:23 23:15;23:55	25 00.0'N 129 45.1'E 4,490m	25 00.0'N 129 44.5'E 4,460m	25 00.1'1 129 44.0'E 4,430m	4,000m	23-lit. Niskin Niskin but-fly	25,50,75,100,125,150, 200,400,600,800,1k,2k, 3k,3970 NB:3980,3990,4k
22	SW off Min.-Daito Philippine Sea	'88.10.26 17:50-20:30 19:05;19:25	25 34.8'N 130 44.7'E 4,280m	25 34.0'N 130 44.1'E 4,260m	25 33.3'N 130 43.5'E 4,180m	4,000m	23-lit. Niskin	25,50,75,100,125,150, 200,400,600,800,1k,2k, 3k,4k

Table 11. Station list of 200-liter van Dorn water samplings.

St.No.	Area	Date & Time of operation mess.;haul-up	Ship position Initiation depth	Messenger in m ([corrected])	Retrieval	Total wire out	Type of gear	Remarks: (water sampling layer)
23-1	Philippine Basin	'88.10.21 08:56-09:19 09:02;	20 59.9'N 129 59.8'E [5,650m]	20 59.9'N 129 59.7'E [5,650m]	20 59.9'N 129 59.6'E [5,650m]	250m	200-liter van Dorn	250m failed: air bubbling occurred
23-2	Philippine Basin	'88.10.21 09:20-11:52 10:25;	20 59.9'N 129 59.6'E [5,650m]	20 59.9'N 129 58.5'E [5,650m]	20 59.6'N 129 58.3'E [5,540m]	5,500m	200-liter van Dorn	5,500m
23-3	Philippine Basin	'88.10.21 11:53-12:48 12:20;	20 59.6'N 129 58.3'E [5,540m]	20 59.8'N 129 58.3'E [5,550m]	20 59.7'N 129 58.0'E [5,560m]	2,000m	200-liter van Dorn	2,000m
23-4	Philippine Basin	'88.10.21 12:56-14:42 13:46;	20 59.6'N 129 57.9'E [5,570m]	20 59.5'N 129 57.4'E [5,600m]	20 59.4'N 129 57.0'E [5,610m]	4,000m	200-liter van Dorn	4,000m
23-5	Philippine Basin	'88.10.21 14:50-15:24 15:08;	20 59.4'N 129 56.9'E [5,610m]	20 59.3'N 129 56.7'E [5,620m]	20 59.3'N 129 56.5'E [5,610m]	1,000m	200-liter van Dorn	1,000m
23-6	Philippine Basin	'88.10.21 15:33-15:50 15:40;	20 59.3'N 129 56.5'E [5,580m]	20 59.2'N 129 56.3'E [5,580m]	20 59.1'N 129 56.2'E [5,580m]	500m	200-liter van Dorn	500m
23-7	Philippine Basin	'88.10.21 16:00-17:35 16:40;	20 59.1'N 129 56.1'E [5,620m]	20 59.0'N 129 55.7'E [5,620m]	20 58.9'N 129 55.4'E [5,640m]	3,000m	200-liter van Dorn	3,000m
23-8	Philippine Basin	'88.10.21 17:47-18:00 17:52;	20 58.8'N 129 55.3'E [5,620m]	20 58.8'N 129 55.2'E [5,620m]	20 58.8'N 129 55.1'E [5,620m]	250m	200-liter van Dorn	250m

V. STUDY ITEMS AND PRELIMINARY REPORTS

5-1. Studies of Megabenthos and Bottom Environments

5-1-1. Collection of megabenthos and macrobenthos with beam trawls and tentative list of the trawl catch

Suguru OHTA, Takashi OHWADA, Toshihiko FUJITA,
Masahiro NAKAOKA (Ocean Research Institute, Univ. Tokyo),
Sigeo GAMÔ (Yokohama Natl. Univ.),
Tomoyuki MIURA (Kagoshima Univ.),
Tsunemi KUBODERA (Natl. Sci. Mus., Tokyo)
and Zheng ZHOU (State Oceanic Administration, P.R.C.)

Megabenthos and macrobenthos of the bathyal and hadal zones were collected at fifteen stations using three kinds of beam trawls in the Northwestern Pacific off Sanriku (Sts. SR61, SR62, SR63, SR65, SR66, SR67, SR68, SR72A, SR72B, SR75 and 7), in the Japan Sea (Sts. 8 and 13), in the Okinawa Trough (St. 13) and in the Philippine Sea (St. 18) (see Station List: Table 1). The bathymetry ranged from about 130m to 7,500m, hence, covering the shelf edge and the trench axis. The stations off Sanriku were arranged roughly on a transect beginning from the depth of 250m on the upper continental slope, crossing the Japan Trench of the depth of 7,570m and to the floor of the Pacific Ocean of the depth of 5,335m.

The beam trawls consisted of three types - two ORE-type beam trawls of 3m and 4m spans, and a Sigsby-Agassiz type beam trawl of 2m span. The nets of the beam trawls were constructed from knotless synthetic webbing of 48mm stretched mesh, and were furnished with inner liners of 4mm square mesh in the codends to retain smaller organisms. One or two small conical nets ("Gamo's net" of 1mm square mesh, and sometimes "juvenile net" with GG54 mesh) were rigged within every trawl to retain small macrobenthic taxa and juveniles. Towing velocity was maintained between 1 and 2 knots. The duration of the two on the bottom was set in accordance with the depth, from half an hour when the depth was shallower than 1,000m, to one hour for depths greater than 1,000m, if otherwise permitted. None of these types of gears were fished with the intention of quantifying the results, but well-operated standard towing affords semi-

quantitative information.

Catches were washed on 1.0mm mesh sieves, sorted out on board, identified preliminarily, counted and preserved in 10% seawater formalin buffered with borax (some taxa were transferred to 70% ethanol afterwards). A part of the samples were stored in a deep freezer and in liquid nitrogen for physiological and analytical purposes, and several bivalve species were fixed in TEM preservative for the observation of symbiotic bacteria.

Many scientists collaborated in the preparation and operation of the gears and sorting. In the preparation of the list of the trawl catch, the following scientists were mainly responsible for the identification of each taxon. However, identification and counting were done preliminarily, so that the list remains to be a rather tentative one, and should be confirmed and supplemented by further studies. These samples should be utilized for morphological nd taxonomical studies, bathymetrical and zoogeographical distribution analysis, species composition analysis, size and age structure analysis, reproductive ecology, food-chain analysis, and physiological studies. A part of dominant benthic organisms of the trawl catches were donated to microbiological studies, inorganic chemical studies and organic chemical analysis.

Pisces: S. Ohta [benthic] and Y. Tsukamoto [pelagic]
Holothurioidea and Echinoidea: S. Ohta
Ophiuroidea and Asteroidea: T. Fujita and S. Ohta
decapod Crustacea: S. Ohta
small Crustacea: S. Gamô
Cephalopoda: T. Kubodera
Mollusca other than Cephalopoda: S. Ohta and M. Nakaoka
Polychaeta: T. Miura
remaining taxa: S. Ohta

Table 12. Tentative catch lists of the beam trawl operations [1/16].

STATION SR61 Location: southeast off Otsuchi, Northwest Pacific
39°18.6'N, 142°08.7'E - 39°19.0'E, 142°08.9'E
Date: September 24, 1988
Time on bottom: 18H14M - 18H40M
Depth range: 247-250m [PDR rdg: 250-253m]
Type of gear: 2m Sigsby-Agassiz beam trawl

Polychaeta		
Syllidae	x	1
Polynoidae	x	1
Onuphidae	x	1
Gastropoda		
Buccinum isaotakii Kira, 1959 シライトマキボラ	x	1
Tectonatica russa (Gould, 1859) キタタマガイ	x	1
Pycnogonida		
+gen. sp.	x	2
Ostracoda		
+*Cypridina* spp.	x	ca.20
Nebaliacea		
+*Nebalia* ? sp.	x	5
Cumacea		
+*Leucon* spp.	x	many
+*Eudorella* spp.	x	many
+*Campylaspis* sp. a	x	many
+*Campylaspis* sp. b	x	1
+*Hemilamprops* sp.	x	1
+*Diastylis bidentata* ?	x	ca.60
+*Diastylis* sp.	x	2
+*Leptostylis* sp.	x	many
Tanaidacea		
+*Tanais* ? sp.	x	5
Isopoda		
+*Munna* sp.	x	4
+*Munnopsis* ? sp.	x	1
+*Ilyarachna* sp.	x	4
Amphipoda		
+*Orchoneme* ? spp.	x	ca.28
+*Harpinia* ? sp.	x	7
+*Monoculodes* ? sp.	x	ca.30
+*Podocerus* ? sp.	x	6
+gen. spp.	x	many
Macrura		
Spirontocaris mororani Rathbun, 1903	x	5
Spirontocaris sp.	x	4

+ denotes that the specimens were caught in Gamo's net installed in trawl net.
* denotes that the species must be pelagic.

Crangon dalli Rathbun, 1902 ミゾエビジャコ	x 10
Asteroidea	
Dipsacaster sp.	x 1
Henricia kinkasana Hayashi, 1940	x 1
Ophiuroidea	
Ophiura sarsi Lütken, 1854 キタノクシノハクモヒトデ	x 568
Ophiura leptoctenia H.L. Clark, 1911	x 272
Ophiura sp.	x 3

Table 12. Tentative catch lists of the beam trawl operations (continued [2/16]).

STATION SR62 Location: southeast off Otsuchi, Northwest Pacific
39° 16.5'N, 142° 10.8'E - 39° 16.8'N, 142° 11.1'E
Date: September 24, 1988
Time on bottom: 19H34M-20H04M
Depth range: 348-350m [PDR rdg: 353-355m]
Type of gear: 2m Sigsby-Agassiz beam trawl

Polychaeta		
Polynoidae	x	9
Glyceridae	x	1
Lumbrineridae	x	2
Onuphidae	x	1
Goniadidae	x	1
Spionidae	x	2
Opheliidae	x	1
Orbiniidae	x	2
Sphaerodoridae	x	8
Sternaspidae	x	15
Oweniidae	x	2
Pectinariidae	x	2
Gastropoda		
Fusitriton oregonensis (Redfield, 1846) アヤボラ	x	4
Buccinum isaotakii Kira, 1959 シライトマキボラ	x	1
Bivalvia		
Limopsis uwadokoi Oyama ミノシラスナガイ	x	2
Polynemamussium intuscostatum (Yokoyama, 1920)	x	25
Cephalopoda		
Octopus sp. (sp. nov.?)	x	3
Pycnogonida		
Nymphon-type gen. sp.a	x	1
Nymphon-type gen. sp.b	x	3
+gen. sp.	x	6
Harpacticoida		
+gen. spp.	x	3
Ostracoda		
+*Cypridina* sp.	x	ca.100
Cumacea		
+*Leucon* spp.	x	32
+*Eudorella* spp.	x	ca.100
+*Eudorellopsis* sp.	x	ca.47
+*Campylaspis* sp.	x	1
+*Cumella* sp.	x	1
+*Paralamprops* ? sp.	x	1
+*Diastylis bidentata* ?	x	1
+*Leptostylis* sp.	x	15
Tanaidacea		
+*Tanais* spp.	x	ca.108
Isopoda		

†Anthuridae gen. sp.	x 3
†*Desmosoma* sp.	x 13
†*Munna* sp.	x 7
†*Ilyarachna* spp.	x ca.120
Macrura	
Pandalus borealis Krøyer, 1838 ホッコクアカエビ	x 9
Spirontocaris brevidigitata Kobjakova, 1935	x 3
? *Eualus* sp.	x 1
Crangon communis Rathbun, 1899 フタトゲエビジャコ	x 51
Anomura	
Parapaguridae gen. sp.	x 1
Ophiuroidea	
Ophiura sarsi Lütken, 1854 キタノクシノハクモヒトデ	x 977
Ophiura leptoctenia H.L. Clark, 1911	x8826
Ophiura flagellata (Lyman, 1878) キヌクシノハクモヒトデ	x 1
Asteroidea	
Pedicellaster magister ezoensis Hayashi,1943	x 1

Table 12. Tentative catch lists of the beam trawl operations (continued [3/16]).

STATION SR63 Location: southeast off Otsuchi, Northwest Pacific
39°15.2'N, 142°13.2'E - 39°15.4'N, 142°13.3'E
Date: September 24, 1988
Time on bottom: 21H03M-21H30M
Depth range: 456-467m [PDR rdg: 463-474m]
Type of gear: 2m Sigsby-Agassiz beam trawl

Coelenterata		
sea anemone gen. sp. a	x	1
sea anemone gen. sp. b	x	1
Polychaeta		
Aphroditidae	x	3
Polynoidae	x	53
Onuphidae (tubes)	x	45
Pectinariidae	x	5
Ampharetidae	x	8
Terebellidae	x	1
Polychaete tubes	x	6
Gastropoda		
Machaeroplax sp.	x	3
Tectonatica clausa (Brod. & Sow., 1829) ハイイロタマガイ	x	3
Admete couthouyi (Jay, 1838) エゾコロモ	x	2
Rectiplanes sp.		
Obesotoma simplex (Middendorff, 1849) アズキイロフタマンジ	x	2
turrid gen. sp.	x	1
Microglyphis japonica (Habe, 1952) ワラベマメウラシマ	x	1
Cylichna consobrina Gould, 1859 イトコカイコガイ	x	3
Philine sp.	x	8
Scaphopoda		
Cadulus (Polyschides) sp.	x	18
Bivalvia		
Ennucula mirifica (Dall, 1907) オオクルミガイ	x	1
Portlandiella beringii (Dall, 1916) ベーリングソデガイ	x	2+1/2
Nuculana (Thestyleda) pernula radiata (Krause, 1885)	x	1
Neilonella sp.	x	23
Limopsis uwadokoi Oyama ミノシラスナガイ	x	1
Lyonsiella sp.	x	1
Solamen spectabilis A. Adams キサガイモドキ	x	1/2 d.
Tellinidae gen. sp.	x	1
Kelliella sp.	x	1
Liocyma aniwana Dall エゾハマグリ	x	1
Galeommatidae gen. sp.	x	1
Cuspidaria sp.	x	1
Cardiomya ? *sagamiana* Okutani & Sakurai, 1964	x	1
Ostracoda		
+ *Cypridina* spp.	x	14
+ *Cythereis* spp.	x	7
Cumacea		

+*Leucon* spp.	x many
+*Eudorella* sp.	x 31
+*Eudorellopsis* sp.	x 2
+*Diastylis* spp.	x 5
+*Leptostylis* sp.	x 2
Tanaidacea	
+*Tanais* ? spp.	x many
Isopoda	
+Anthuridae gen. sp.	x 2
+*Desmosoma* ? spp.	x ca.27
+*Munna* sp.	x 3
+*Ilyarachna* spp.	x 22
Macrura	
Crangon (Neocrangon) communis Rathbun フタトゲエビジャコ	x 7
Anomura	
Parapagurus sp.a	x 2
Parapagurus sp.b	x 12
Asteroidea	
Dipsacaster laetmophilus Fisher, 1910	x 9
Ctenodiscus crispatus (Retzius, 1805) スナイトマキ	x 4
Ceramaster japonicus (Sladen, 1889) ゴカクヒトデ	x 2
Pseudarchaster parelii (Düben & Koren, 1846) アカモミジ	x 1
Crossaster borealis Fisher, 1906	x 1
Dipropteraster multipes (M. Sars, 1865)	x 2
Pedicellaster magister ezoensis Hayashi, 1943	x 1
Ophiuroidea	
Ophiura sarsi Lütken, 1854 キタノクシノハクモヒトデ	x1218*10
Ophiura leptoctenia H.L. Clark, 1911	x2648*10
Ophiura flagellata (Lyman, 1878) キヌクシノハクモヒトデ	x 4*10
Ophiura quadrispina H.L. Clark, 1911	x 10*10
Holothurioidea	
gen. sp.	x 6
Pisces	
angler fish	x 1

Table 12. Tentative catch lists of the beam trawl operations (continued [4/16]).

STATION SR65 Location: southeast off Otsuchi, Northwest Pacific
39°07.8'N, 142°23.8'E - 39°08.7'N, 142°24.2'E
Date: September 25, 1988
Time on bottom: 06H36M-08H15M
Depth range: 984-988m [PDR rdg: 1,000-1,005m]
Type of gear: 3m ORE beam trawl

Coelenterata	
Actinostola carlgreni Wassilieff セトモノイソギンチャク	x 15
small, white sea anemone	x 2
small, orange sea anemone	x 2
Radicipes pleurocristatus Stearns	x ca.500
Polychaeta	
Aphroditidae	x 16
Polynoidae	x 11
Phyllodocidae	x 4
Goniadidae	x 3
Lumbrineridae	x 1
Opheliidae	x 4
Orbiniidae	x 1
Pectinariidae	x 19
Ampharetidae	x 99
Maldanidae	x 3
Terebellidae	x 5
Gastropoda	
Trochidae gen. sp. near *Machaeroplax*	x 1+1d
Eunatica pallida (Broderip & Sowerby, 1829)	x 4+2d
Boreotrophon alaskanus Dall, 1902 アラスカツノオリイレ	x 1
Neptunea intersculpta (Sowerby, 1899) エゾボラモドキ	x 2
Mathildidae gen. sp.	x 3+3
Aforia diomedea Bartsch, 1945 ヤゲンイグチガイ	x 1
Admete globularia (Smith, 1875) ウスカワコロモ	x 3+1d
Rectiplanes ? sp.	x 1d
Riuguhdrillia engonia (Watson) ヤゲンクダマキ	x 1
Taranis corneus Okutani, 1966	x 3
Microglyphis japonica (Habe, 1952) ワラベマメウラシマ	x 8+4d
Cylichna consobrina Gould, 1859 イトコカイコガイ	x 1d
Scaphopoda	
Laevidentarium toyamaense (Kuroda & Kikuchi) トヤマツノガイ	x 17
Cadulus (Polyschides) sp.	x 4+3d
Bivalvia	
Nuculana (Thestyleda) sagamiensis Okutani, 1962	x 1+2d
Malletia (Bathymalletia) takaii (Okutani) タカイソデガイ	x 3
Limopsis uwadokoi Oyama ミノシラスナガイ	x ca.300
Solamen spectabilis (A. Adams, 1862) キサガイモドキ	x 6
Abra sp.	x1+1/2d
Abrina sp.	x 76
Cuspidaria mitis Prashad, 1932 ヨワシャクシガイ	x 2

Cuspidaria obtusirostris Okutani, 1962 ワタゾコシャクシガイ	x	7
Cardiomya behringensis Leche, 1883 テングシャクシガイ	x	5
Cephalopoda		
Benthoctopus fuscus Taki, 1964 クロダコ	x	2
Pycnogonida		
Ascorhynchus japonicum Ives, 1892 ヤマトトックリウミグモ	x	4
+gen. sp.	x	2
Ostracoda		
+*Cypridina* spp.	x	8
Cypridina sp.	x	1
Cumacea		
+*Leucon* sp. b	x	11
+*Leucon* sp. c	x	2
+*Eudorella* sp.	x	5
+*Campylaspis* sp.	x	1
+*Diastylis* sp.	x	1
Diastylis 2 spp.	x	2
Tanaidacea		
+*Tanais* ? sp.	x	3
Isopoda		
+Anthuridae gen. sp.	x	1
+*Janillopsis* sp.	x	3
+*Eurycope* ? sp.	x	1
Amphipoda		
+*Metaphoxus* ? sp.	x	1
+*Monoculodes* ? sp.	x	2
+gen. spp.	x	ca.20
Macrura		
Eualus biunguis (Rathbun, 1902) ハサミモエビ	x	1
gen. sp.	x	2
Brachyura		
Chionoecetes sp. [only one leg]	x	1
Anomura		
Paralomis multispina (Benedict, 1895) エゾイバラガニ	x	2
Asteroidea		
Thrissacanthias penicillatus (Fisher, 1905)	x	12
Ctenodiscus crispatus (Retzius, 1805) スナイトマキ	x	19
Benthopecten spinosus (Verrill, 1884)	x	2
Nearchaster aciculosus (Fisher, 1910)	x	1
Nearchaster cf. *aciculosus* (Fisher, 1910)	x	1
Ceramaster japonicus (Sladen, 1889)	x	10
Pseudarchaster parelli (Düben & Koren) アカモミジ	x	2
Diplopteraster multipes (M. Sars, 1865)	x	1
Brisingella pannychia Fisher, 1928	x	13
Ophiuroidea		
Asteronyx loveni Müller & Troschel, 1842 キヌガサモズル	x	ca.500
Amphiophiura penichra (H.L. Clark, 1911)	x	ca.500
Amphiura sp.	x	
Ophiolimna ? bairdi (Lyman, 1883)	x	
Holothurioidea		
Synallactes multivesiculatus Ohshima, 1915	x	22
Gephyrothuriidae gen. sp.	x	4

Laetmogone ? sp.	x	2
Pannychia moseleyi Theel, 1882 ムラサキハゲナマコ	x	27
Pisces		
Antimora microlepis Bean, 1891 カナダダラ	x	1
Coryphaenoides cinereus (Gilbert, 1893) カラフトソコダラ	x	8
Coryphaenoides ? nasutus Günther, 1877 [huge] ハナソコダラ	x	2
Coryphaenoides pectoralis Gilbert, 1891 ムネダラ	x	2
Coryphaenoides ? sp.	x	1
Coryphaenoides ? sp.	x	1
Nezumia ? sp.	x	2
Ventrifossa sp.	x	2

Table 12. Tentative catch lists of the beam trawl operations (continued [5/16]).

STATION SR66 Location: southeast off Otsuchi, Northwest Pacific
38°57.1'N, 142°41.6'E - 38°59.8'N, 142°41.3'E
Date: September 25, 1988
Time on bottom: 17H33M-19H14M
Depth range: 1,235-1,284m [PDR rdg: 1,255-1,305m]
Type of gear: 2m Sigsby-Agassiz beam trawl

Coelenterata		
Actinostola carlgreni Wassilieff セトモノイソギンチャク	x	2
Polychaeta		
Aphroditidae	x	25
Polynoidae	x	22
Goniadidae	x	2
Lumbrineridae	x	1
Onuphidae	x	2
Opheliidae	x	4
Sternaspidae	x	35
Ampharetidae	x	14
Maldanidae [including 41 tubes]	x	1
Sabellidae [including 15 tubes]	x	3
Gastropoda		
Trochidae gen. sp. near *Machaeroplax*	x	1+3d
Neptunea intersculpta (Sowerby, 1899) エゾボラモドキ	x	8
Buccinidae gen. sp. [juvenile]	x	2
Admete globularia (Smith, 1875) ウスカワコロモ	x	3
Admete couthouyi (Jay, 1838) エゾコロモ	x	2d
Rectiplanes (Rectiplanes) kawamurai Habe, 1958	x	21
Rectiplanes sp.	x	14
Mathildidae gen. sp.	x	1
Taranis corneus Okutani, 1966	x	8+6d
Turridae gen. sp.	x	3+2d
Obesotoma sp.	x	1d
Obesotoma sp. [? *simplex*]	x	4
other gastropods ca. 10 spp.	x	22
Scaphopoda		
Fissidentarium sp.	x	1+2d
Laevidentarium toyamaense (Kuroda & Kikuchi) トヤマツノガイ	x	7+7d
Cadulus (Polyschides) sp.	x	1d
Bivalvia		
Portlandiella beringii (Dall, 1916) ベーリングソデガイ	x	6
Nuculana (Thestyleda) sagamiensis Okutani, 1962	x	2
Malletia (Bathymalletia) takaii (Okutani) タカイソデガイ	x	1
Limopsis sp. [cf. *L. itrupica*]	x	ca.300
Policordia pilula (Prashad, 1932) ムスメコロガイ	x	3
Abra or *Macoma* sp.	x	2
Cuspidaria dubia Prashad, 1932 コウモリシャクシガイ	x	1
Cuspidaria mitis Prashad, 1932 ヨワシャクシガイ	x	27
Cuspidaria obtusirostris Okutani, 1962 ワタゾコシャクシガイ	x	1

Pycnogonida		
Ascorhynchus sp.	x	2
Ostracoda		
+*Cypridina* spp.	x	8
Cumacea		
+*Eudorella* sp.	x	4
+*Campylaspis* sp.	x	2
+*Diastylis* sp.	x	2
+*Leptostylis* sp.	x	1
Isopoda		
+*Eurycope* ? sp.	x	1
Amphipoda		
+*Orchoneme* ? sp.	x	1
+*Metaphoxus* ? sp.	x	1
+gen. spp.	x	4
Macrura		
Eualus biunguis Rathbun, 1902 ハサミモエビ	x	2
Anomura		
Parapagurus pilosimanus scaber Henderson, 1888	x	3
Paralomis multispina (Benedict, 1895) エゾイバラガニ	x	1
Brachyura		
Ethusina sp.	x	1
Asteroidea		
Thrissacanthias penicillatus (Fisher, 1905)	x	6
Ctenodiscus crispatus (Retzius, 1805) スナイトマキ	x	6
Ceramaster japonicus (Sladen, 1889)	x	1
Pseudarchaster parelii (Düben & Koren, 1846)	x	1
Benthopecten spinosus (Verrill, 1884)	x	10
Crossaster borealis Fisher, 1906	x	1
Hymenaster glaucus Sladen, 1889	x	22
Pteraster ? *jordani* Fisher, 1905	x	1
Brisingella pannychia Fisher, 1928	x	1
Ophiuroidea		
Asteronyx loveni Müller & Troschel, 1842 キヌガサモズル	x	15 liters
Amphiophiura penichra (H.L. Clark, 1911)	x	30
Holothurioidea		
Pseudostichopus ? *nudus* Ohshima, 1915	x	6
Pannychia moseleyi Theel, 1882 ムラサキハゲナマコ	x	6
Molpadia sp.	x	1
Tunicata		
Morgula ?	x	2
Pisces		
Coryphaenoides acrolepis (Bean, 1883) イバラヒゲ	x	2
Coryphaenoides cinereus (Gilbert, 1893) カラフトソコダラ	x	4
Coryphaenoides longifilis Günther, 1877 ヒモダラ	x	1
Coryphaenoides pectoralis Gilbert, 1891 ムネダラ	x	1

Table 12. Tentative catch lists of the beam trawl operations (continued [6/16]).

STATION SR67 Location: southeast off Otsuchi, Northwest Pacific
38°42.1'N, 143°08.9'E - 38°44.1'N, 143°07.0'E
Date: September 26, 1988
Time on bottom: 07H19M-09H21M
Depth range: 1,735-1,942m [PDR rdg: 1,760-1,970m]
Type of gear: 2m Sigsby-Agassiz beam trawl

Coelenterata		
orange-colored small sea anemone	x	5
whitish sea anemone	x	
Polychaeta		
Aphroditidae	x	25
Polynoidae	x	10
Sigalionidae	x	4
Lumbrineridae	x	1
Opheliidae	x	4
Maldanidae	x	2
Sabellidae [15 tubes]	x	2
Gastropoda		
Machaeroplax sp.	x	17
Margarites (?) sp.	x	1
Hazuregyra sp.	x	3+1d
Tectonatica clausa (Broderip & Sowerby) ハイイロタマガイ	x	4+2d
Eunatica pallida (Broderip & Sowerby, 1829) ウスイロタマガイ	x	4+2d
Latisipho pulcius (Dall, 1919) クリイロツムバイ	x	1
Mohnia multicostata Habe & Ito, 1965 シワミトゞリホソバイ	x	3
Aforia diomedea Bartsch, 1945 ヤゲンイグチ	x	1
Rectiplanes sanctioannis (Smith, 1875) エゾイグチ	x	4
Riuguhdrillia engonia (Watson, 1881) ヤゲンクダマキガイ	x	3+1d
Elaeocyma ? sp.	x	1
"*Turritoma*" sp.	x	1d
Microglyphis japonica (Habe, 1952) ワラベマメウラシマ	x	2
Ringicula (Ringiculina) pilula Habe, 1950 シラタママメウラシマ	x	1
Cylichna consobrina Gould, 1859 イトコカイコガイ	x	2
Philine sp.	x	3
Scaphopoda		
Antalis sp.	x	10+1d
Laevidentarium sp.	x	1
Cadulus (Polyschides) sp.	x	10+1d
Polyplacophora		
Lepidopleurus diomedeae (Berry, 1971) フカヅメヒザラガイ	x	10
Bivalvia		
Acharax ? *tokunagai* (Yokoyama, 1925)	x	fragm.
Limopsis sp.	x	ca.500
Portlandiella beringii (Dall, 1916) ベーリングソデガイ	x	15
Brachiopoda		
Brachiopoda gen. sp. [attached to arenaceous foram.]	x	1
Pycnogonida		

Colossendeis colossea Wilson, 1881 ﾍﾞﾆｵｵｳﾐｸﾞﾓ	x	1
Ascorhynchus japonicum Ives, 1892 ﾔﾏﾄﾄｯｸﾘｳﾐｸﾞﾓ	x	13
+gen. sp.	x	1
Cirripedia		
Scalpellum sp.	x	6
Cumacea		
+*Eudorella* sp.	x	1
+*Campylaspis* sp. a	x	2
+*Campylaspis* sp. c	x	1
+*Diastylis* sp.	x	1
Tanaidacea		
+*Tanais* sp.	x	4
Isopoda		
+*Cymodoce* ? sp.	x	1
+*Janirellopsis* sp.	x	1
Amphipoda		
+*Cyphocaris* sp.	x	1
+*Cyphocaris* 2 spp.	x	2
Macrura		
Crangon abyssorum Rathbun, 1902	x	2
Anomura		
Parapagurus pilosimanus scaber Henderson, 1888	x	5
Brachyura		
Ethusina sp.	x	1
Chionoecetes ? *angulatus* Rathbun, 1924 ﾄｹﾞｽﾞﾜｲｶﾞﾆ	x	4
Crinoidea		
crinoid gen. sp.	x	1
comatulid gen. sp.	x	4
Asteroidea		
Thrissacanthias penicillatus (Fisher, 1905)	x	4
Ctenodiscus crispatus (Retzius, 1805) ｽﾅｲﾄﾏｷ	x	18
Eremicaster sp.	x	17
Pseudarchaster parelii (Düben & Koren, 1846)	x	1
Crossaster borealis Fisher, 1906	x	9
Hymenaster ?glaucus Sladen, 1889 ﾏｸﾋﾄﾃﾞ	x	14
Pteraster sp.	x	1
Henricia leviuscula (Stimpson, 1857)	x	2
Ophiuroidea		
Amphiura koreae Duncan, 1879 ﾁｮｳｾﾝｸﾓﾋﾄﾃﾞ	x	ca.100
Amphiophiura penichra H.L. Clark, 1911	x	ca.50
gen. sp.	x	ca.200
gen. sp.	x	ca.300
Echinoidea		
Brisaster latifrons A. Agassiz, 1898 ｷﾂﾈﾌﾞﾝﾌﾞｸ	x	63
Holothurioidea		
Paelopatides sp. [purple]	x	1
Pseudostichopus sp. a [with sand grains]	x	4
Pseudostichopus sp. b [without sand grains]	x	6
? *Echinocucumis* sp.	x	1
Psolidium vitreum Ohshima, 1915 "ﾊﾘｼﾞｲｶﾞｾｷﾝｺ"	x	167

Table 12. Tentative catch lists of the beam trawl operations (continued [7/16]).

STATION SR68 Location: southeast off Otsuchi, Northwest Pacific
38°27.4'N, 143°31.5'E - 38°31.1'N, 143°32.4'E
Date: September 27, 1988
Time on bottom: 11H22M-12H48M
Depth range: 2,815-2,995m [PDR rdg: 2,840-3,100m]
Type of gear: 4m ORE beam trawl

Polychaeta	
Aphroditidae	x 6
Onuphidae	x 7
tubes of Onuphidae	x 29
Ampharetidae	x 4
tubes of Ampharetidae	x 41
Gastropoda	
Machaeroplax delicatus (Dall, 1919) ウバシタダミ	x 2
Naticidae gen. sp.	x 5
Boreotrophon sp.	x 1
Ancistrolepis sp. [dead]	x 1
Mohnia sp. a	x 1
Neptunea intersculpta (Sowerby, 1899) エゾボラモドキ	x 7
Neptunea vinosa (Dall, 1919)	x 1+1d
Neptunea constricta (Dall, 1907) チヂミエゾボラ	x 3
Neptunea sp. 1	x 1
Neptunea sp. 2	x 1
Buccinum rausanum Shikama, 1952 ラウスバイ	x 4+1d
Aforia diomedea Bartsch, 1945 [round type]	x 1
Rectiplanes ? sp.	x 7+2d
? *Rhodopetema erosa* (Schrenck)	x14+4d
? *Merria* sp.	x 3
? *Turritoma* sp.	x 3
Bivalvia	
Portlandiella beringii (Dall, 1916) ベーリングソデガイ	x4+34d
Cuspidaria sp.	x 2
Cephalopoda	
Benthoctopus violescens Taki, 1964 スミレダコ	x 1
Benthoctopus sp.	x 1
Pycnogonida	
Colossendeis colossea Wilson, 1881 ベニオオウミグモ	x 2
+gen. sp(p).	x 5
Cirripedia	
Scalpellum sp.	x 2
Ostracoda	
+*Cypridina* spp.	x 5
Cumacea	
+*Leucon* sp. a	x 5
+*Leucon* sp. b	x 1
+*Campylaspis* sp. d	x 2
+*Campylaspis* sp. e	x 3

+*Diastylis* spp.	x	5
Isopoda		
+*Astacilla* ? spp. [see front cover]	x	4
+*Janirella* sp.	x	2
+*Munnopsis* sp.	x	3
+*Eurycope* sp.	x	3
+*Ilyarachna* ? sp.	x	1
+gen. ? [near *Eurycope*] sp.	x	4
Amphipoda		
+*Cyphocaris* sp.	x	5
+*Orchoneme* ? sp.	x	2
+gen. spp.	x	ca.30
Macrura		
**Bentheogennema borealis* (Rathbun, 1902)	x	15
**Oplophorus spinosus* (Brulle, 1839) オキヒオトゞシエビ	x	1
**Acanthephyra quadrispinosa* Kemp, 1939 サガミヒオトゞシエビ	x	2
**Acanthephyra* sp.	x	1
**Sergestes* and/or *Sergia* spp.	several	
Nematocarcinus ensifer f. *productus* Bate, 1888 イトアシエビ	x	6
Nematocarcinus ensifer f. *longirostris* Bate, 1888	x	3
Crangon abyssorum Rathbun, 1902	x	28
Brachyura		
Ethusina sp.	x	1
Asteroidea		
Eremicaster sp.	x	2
Benthopecten spinosus (Verrill, 1884)	x	5
Hymenaster quadrispinosus Fisher, 1905	x	4
Hymenaster nobilis Wyville Thomson	x	3
Holothurioidea		
Mesothuria (Zygothuria) lactea (Theel, 1886)	x	11
Pseudostichopus sp.	x	
Benthodytes typica Theel, 1882	x	1
Scotoplanes globosa (Theel, 1879) センジュナマコ	x	4
Ypsilothuria bitentaculata (Ludwig, 1893) イガグリキンコ	x	1
Molpadia musculus Risso, 1825	x	3
Molpadia intermedia (Ludwig, 1893)	x	2
Pisces		
**Cyclothone* sp.	x	1
**Gonostoma gracile* Günther, 1878 ヨコエソ	x	8
**Lampanyctus regalis* Gilbert, 1891 ミカドハダカ	x	3
**Lampanyctus* spp.	x	8
**Melamphaes* sp.	x	3
**Diaphus* spp.	x	8
**Myctophum* sp.	x	1
Bathyraja sp.	x	1
?*Lycodes esmarki* Collett ヨコスジクロゲンゲ	x	1
Synaphobranchus spp.	x	4
?*Spectrunculus grandis* Günther, 1877 ソコボウズ	x	2
Ophidiiformes gen. sp.	x	1

Table 12. Tentative catch lists of the beam trawl operations (continued [8/16]).

STATION SR71 Location: southeast off Otsuchi, Northwest Pacific
38°36.5'N, 144°04.3'E - 38°38.7'N, 144°05.2'E
Date: September 28, 1988
Time on bottom: 11H43M-13H47M
Depth range: 7,500-7,570m [PDR rdg: 7,390-7,460m]
Type of gear: 4m ORE beam trawl

Coelenterata	
Galatheanthemum sp.	x 2
Echiura	
Jacobia birsteini Zenkevich, 1958	x several
Polychaeta	
Polynoidae	x 1
Lumbrineridae	x 9
Opheliidae	x 20
tube of ?	x 10
Gastropoda	
Lepeta ? sp.	x 1
Hazuregyra sp.	x 1
large gastropod gen. sp.	x 1
Bivalvia	
Spinula vityazi Filatova, 1964 ナラクトゲソデガイ	x 610
Kelliella sp.	x1607
Neilonella sp.a [tiny]	x 710
Neilonella sp.b [large: or *Bathymalletia* ?]	x 269
Nuculanidae gen. sp.	x 95
Pycnogonida	
+gen. sp.	x 1
Tanaidacea	
+*Tanais* sp.	x 3
Isopoda	
Storthyngula sp.	x ca.50
Amphipoda	
+*Lepechinella* sp.	x 3
+gen. spp.	x 2
Macrura	
**Notostomus japonicus* Bate, 1888 アタマエビ	x 1
**Acanthephyra quadrispinosa* Kemp, 1939 サガミヒオトシエビ	x 2
Holothurioidea	
Elpidia gracialis kurilensis Baranova & Belyaev, 1971	x ca.100
? *Mesothuria* sp.	x
Peniagone azorica von Marenzeller, 1894	
Pisces	
Careproctus amblystomopsis Andriashev, 1955	x 2
**Melamphaes* sp.	x 1
**Rondeletia loricata* Abe & Hotta, 1963 アカチョッキクジラウオ	x 1
**Lampanyctus* sp.	x 1
**Gonostoma gracile* Günther, 1878 ヨコエソ	x 1

Table 12. Tentative catch lists of the beam trawl operations (continued [9/16]).

STATION SR72A Location: off Sanriku, Northwest Pacific Ocean floor
39°06.09'N, 147°02.91'E - 39°08.05'N, 147°04.28'E
Date: October 1, 1988
Time on bottom: 10H24M-11H39M
Depth range: 5,370-5,380m [PDR rdg: 5,330-5,340m]
Type of gear: 3m ORE beam trawl
Remarks: Did not touch bottom. Midwater trawling!

Macrura		
**Notostomus japonicus* Bate, 1888 アタマエビ	x	1
**Acanthephyra quadrispinosa* Kemp, 1939 サガミヒオドシエビ	x	1
Pisces		
**Lampanyctus regalis* Gilbert, 1891 ミカドハダカ	x	1
**Chauliodus* sp.	x	1

Table 12. Tentative catch lists of the beam trawl operations (continued [10/16]).

STATION SR72B Location: off Sanriku, Northwest Pacific Ocean floor
39°06.09'N, 147°02.91'E - 39°08.05'N, 147°04.28'E
Date: October 1, 1988
Time on bottom: 10H24M-11H39M
Depth range: 5,375-5,375m [PDR rdg: 5,335-5,335m]
Type of gear: 4m ORE beam trawl

Coelenterata		
Antipatharian coral	x	1
white and tough sea anemone [medium-sized]	x	4
Porifera		
Euplectella sp.	x	1
Echiura		
Bonellid gen. sp. [? *Jacobia birsteini*]	x	7
Polychaeta		
Polynoidae	x	1
Opheliidae	x	2
tubes of ?	x	30
Gastropoda		
Scaphander sp.	x	22
Neptunea sp.	x	1
Turridae gen. sp. [hitachiobi-type]	x	1
trochid gen. sp. a [like *Bathybembix*]	x	2
trochid gen. sp. b [like *Machaeroplax*]	x	1
trochid gen. sp. c [like *Margarites*]	x	1
cocculinid limpet	x	1
Scaphopoda		
Laevidentarium sp.	x	2
Bivalvia		
Spinula oceanica Filatova, 1958 ワダツミソデガイ	x	36
Neilonella sp. [large: or *Bathymalletia* sp.]	x	31
Tindaria sp. [rounded nuculanid]	x	5
Nuculanidae gen. sp. [very thin]	x	2
Harpacticoid Copepoda		
†*Cervinia* ? sp.	x	1
Cumacea		
†*Leucon* sp. [with long siphon]	x	1
†*Diastylis* sp.	x	1
†*Leptostylis* sp.	x	1
Tanaidacea		
†*Tanais* sp.	x	8
Isopoda		
†*Ischnomesus* ? 2 spp.	x	2
†*Janirella* 2 spp.	x	3
Amphipoda		
†gen. 2 spp.	x	2
Macrura		
**Acanthephyra quadrispinosa* Kemp, 1939 サガミヒオドシエビ	x	1

Notostomus japonicus Bate, 1888 アタマエビ	x 1
Asteroidea	
Dytaster exilis Sladen, 1889	x 2
Eremicaster gracilis (Sladen, 1883)	x 12
Styracaster caroli Ludwig, 1907	x 2
Ampheraster sp.	x 9
Echinoidea	
Kamptosoma asterias A. Agassiz, 1881	x 2
spatangoids	x fragments
Holothurioidea	
Pseudostichopus sp. [small]	x 1
Pseudostichopus sp. [large: ca. 12cm]	x 1
Psychropotes longicauda Theel, 1882 エボシナマコ	x 5+1
Peniagone sp.	x
gelatinous elasipod	x 17
Molpadia sp.	x 2
Pisces	
Idiacanthus antrostomus Gilbert, 1890 ミツマタヤリウオ	x 1
Argyropelecus hemigymnus Cocco, 1829 テンガンムネエソ	x 1
Melamphaes sp.	x 1
Diaphus sp.	x 1
Cyclothone atraria Gilbert, 1905 オニハダカ	x 1
undetermined gen. sp.	x 2

Table 12. Tentative catch lists of the beam trawl operations (continued [11/16]).

STATION SR75 Location: east off Hachinohe, Northwest Pacific
40°45.7'N, 144°05.0'E - 40°46.7'N, 144°05.6'E
Date: October 4, 1988
Time on bottom: 10H41M-11H25M
Depth range: 4,873-5,033m [PDR rdg: 4,880-5,050m]
Type of gear: 4m ORE Beam Trawl

Porifera	
Demospongia ? gen. sp.	several fragments
Coelenterata	
Antipatharian coral	x 1
Polychaeta	
Polynoidae	x 1
Nereididae	x 4
Lumbrineridae	x 1
Opheliidae	x 17
Sternaspidae	x 1
Ampharetidae [including 5 tubes]	x 6
Serpulidae	x 5
Echiura	
Torbenwolffia ? sp.	x 1
urechid worms	x ca.5
Gastropoda	
Eunatica pallida (Broderip & Sowerby, 1829)	x 3+6d
Bathycocculina sp.	x 2
Latisipho ? *pulcius* (Dall, 1919) クリイロツムバイ	x 1
Buccinum sp. [aff. *B. isaotakii* Kira]	x 1
Neptunea sp. a	x 2
Neptunea sp. b [tumid]	x 3
other small gastropods [ca. 7 spp.]	x ca.25
Cylichna sp.	x 6+1d
Philine sp.	x 1
Bivalvia	
Axinulus sp.	x 20
Kelliella sp.	x456+49d
Neilonella sp.	x 33
Portlandiella beringii (Dall, 1916) ベーリングソデガイ	x 24
Tindaria ? sp.	x 1
Lyonsiella sp.	x 2
Cyclopecten sp.	x 1
Harpacticoid Copepoda	
†*Stratiotes* ? sp.	x 3
†gen. spp.	x 5
Cumacea	
†*Bathycuma* ? sp.	x 1
†*Campylaspis* sp.	x 1
†*Hemilamprops* sp.	x 4
†*Leptostylis* sp.	x 10

Tanaidacea		
+*Apseudes* sp.		x 1
+*Tanais* spp.		x 17
Isopoda		
+*Haploniscus* sp.		x 21
+*Desmosoma* sp.		x 1
+*Janirella* sp.		x 11
+*Ilyarachna* sp.		x 22
Amphipoda		
+*Lepechinella* sp.		x 4
+gen. spp.		x ca.30
Crinoidea		
Bathycrinus sp.		x 2+several calyces
Asteroidea		
Dytaster ? *exilis* (Sladen, 1889)		x 1
Styracaster caroli Ludwig, 1907		x 1
Ophiuroidea		
gen. sp.		2 liters
gen. sp.		x 1
Echinoidea		
spatangoids gen. sp.	many fragments (? 3 inds)	
Echinus ? sp.		x 1
Holothurioidea		
Scotoplanes globosa (Theel, 1879) センジュナマコ		x 6+2
Peniagone sp.		x ca.20
Molpadia spp.		x 7

#fallen timber
Bathycocculinid limpets
white sea anemone
Serpulid polychaetes

Table 12. Tentative catch lists of the beam trawl operations (continued [12/16]).

STATION 7 Location: east off Shimokita, Northwest Pacific
40°49.6'N, 141°52.2'E - 40°49.1'N, 141°52.6'E
Date: October 4, 1988
Time on bottom: 23H43M-00H12M
Depth range: 226-228m [PDR rdg: 225-227m]
Type of gear: 2m Sigsby-Agassiz Beam Trawl

Coelenterata		
Funiculina sp.	x	1
Nemertini		
nemertine worm gen. sp.		
Polychaeta		
Polynoidae	x	107
?	x	2
Gastropoda		
Fusitriton oregonensis (Redfield, 1846) アヤボラ	x	6
Buccinum isaotakii Kira, 1959 シライトマキボラ	x	1
Philine sp. [huge!]	x	2
Cephalopoda		
Octopus sp. (adolescent)	x	1
Pycnogonida		
Nymphon-type [red stripes]	x	ca.20
gen. sp.	x	1
gen. sp.	x	1
Cumacea		
+*Bodotria* ? sp.	x	1
+*Leucon* sp.	x	3
+*Campylaspis* sp.	x	4
+*Dimorphostylis* sp.	x	1
+*Diastylis bidentata* ?	x	10
+*Leptostylis* sp.	x	3
Tanaidacea		
+*Tanais* ? spp.	x	21
Isopoda		
+*Synidothea* ? sp.	x	1
+*Munna* ? sp.	x	12
+*Ilyarachna* sp.	x	2
Amphipoda		
+*Orchoneme* ? sp.	x	2
+Oedicerotidae gen. sp.	x	1
+gen. spp.	x	15
Macrura		
Eualus leptognathus (Stimpson, 1860) ヤマトモエビ	x	1
Spirontocaris mororani Rathbun, 1903	x	10
Crangon dalli Rathbun, 1933 ミゾエビジャコ	x	33
Paracrangon echinata Dana, 1852 カジワラエビ	x	23
Argis hozawai (Yokoya, 1939)	x	4
Brachyura		

Chorilia longipes japonica Miers, 1879 コツノガニ	x	9
Majiidae gen. sp.	x	9
Asteroidea		
Leptychaster sp.	x	2
Dipsacaster sp.	x	4
Henricia sp.	x	1
Ophiuroidea		
Asteronyx loveni Müller & Troschel, 1842 キヌガサモズル	x	5
Ophiura sarsi Lütken, 1854 キタクシノハクモヒトデ	x1863	
Echinoidea		
Glyptocidaris crenularis A. Agassiz, 1863 ツガルウニ	x	2
Pisces		
Gobiesocidae gen. sp.	x	1
Icelus spiniger Gilbert, 1896 コオリカジカ	x	2
Anoplagonus occidentalis Lindberg, 1950 ニセナメトクヒレ	x	2

Table 12. Tentative catch lists of the beam trawl operations (continued [13/16]).

STATION 8 Location: off Akita, Japan Sea
39° 36.8'N, 139° 42.4'E - 39° 36.0'N, 139° 42.7'E
Date: October 5, 1988
Time on bottom: 21H05M-21H30M
Depth range: 250-265m [PDR rdg: 255-270m]
Type of gear: 2m Sigsby-Agassiz Beam Trawl

Polychaeta	
Polynoidae	x 1
Lumbrineridae	x 10
Spionidae	x 2
Sternaspidae	x 1
tubes of ?	x 30
Gastropoda	
Trochidae gen. sp. near *Machaeroplax*	x 2
Naticidae gen. sp. [elongated in shell height]	x 4+1d
Tectonatica clausa (Broderip & Sowerby, 1929)	x 4+5d
Mohnia yanamii (Yokoyama, 1926) ヤナミシワバイ	x31+5d
Boreotrophon alaskanus Dall, 1902 アラスカツノオリイレ	x 2
Admete globularia (Smith, 1875) ウスカワコロモガイ	x 1
Rectiplanes sanctioannis (Smith, 1875) エゾイグチ	x 2
Naticid gen. sp. [dead]	x several
Scaphopoda	
Laevidentarium toyamaense (Kuroda & Kikuchi) トヤマツノガイ	x23+2d
Bivalvia	
Ennucula niponica (Smith, 1885) クルミガイ	x74+5d
Yoldia amygdalea (Valenciennes, 1846) スモモソデガイ	x 4+1d
Acila mirabilis (Adams & Reeve) オオキララガイ	x 464
Nuculana (Robaia) robai (Kuroda, 1929) チリロウバイ	x45+9d
Portlandiella toyamaensis Kuroda, 1929 トヤマソデガイ	x20+1d
Cardiomya behringensis Leche, 1916 ベーリングソデガイ	x 3
Macrura	
Crangon dalli Rathbun, 1933 ミゾエビジャコ	x 1
Brachyura	
Oregonia gracilis Dana, 1851 ケセンガニ	x 1
Asteroidea	
Leptychaster anomalus Fisher, 1906	x 14
Ctenodiscus crispatus (Retzius, 1805) スナイトマキ	x 118
Leptasterias ? hylodes Fisher, 1930	x 2
Ophiuroidea	
Ophiura sarsi Lutken, 1894 キタクシノハクモヒトデ	x ca.1500
Ophiura leptoctenia H.L. Clark, 1911	x ca. 200
Amphiodia craterodmeta H.L. Clark, 1911	x ca. 530
Amphiuridae gen. sp. [indeterminable]	x 2
Echinoidea	
Brisaster latifrons A. Agassiz, 1898 キツネブンブク	x 36
Pisces	
Dasycottus setiger Bean, 1890 ガンコ	x 1

Icelus gilberti Taranetz, 1936	ﾀﾞﾙﾏｺｵﾘｶｼﾞｶ	x	1
Anisarchus macrops (Matsubara & Ochiai,1952)	ﾒﾀﾞﾏｷﾞﾝﾎﾟ	x	1

Table 12. Tentative catch lists of the beam trawl operations (continued [14/16]).

STATION 13 Location: northwest off Hinomisaki, Japan Sea
35°43.0'N, 132°03.7'E - 35°42.7'N, 132°03.0'E
Date: October 9, 1988
Time on bottom: 05H07M-05H32M
Depth range: 243-248m [PDR rdg: 245-250m]
Type of gear: 2m Sigsby-Agassiz beam trawl

Coelenterata	
Liponema multicornis (Verrill) ダーリアイソギンチャク	x 1
white sea anemone	x 1
Nemertini	
nemertine worm gen. sp.	x 1
Polychaeta	
Aphrodita sp.	x 1
Ampharetidae gen. sp.	x 3
tubes of ?	x several
Gastropoda	
Volutopsius middendorffi furukawai Oyama, 1951	x 2
Neptunea constricta (Dall, 1907) チヂミエゾボラ	x 1
Buccinum bayani Jousseaume, 1883 カガバイ	x 5+3d
Helicofusus minor (Dall, 1925) ツムバイ	x 1
Turritella terebra (Linnaeus, 1758) キリガイダマシ	x 1d
Tectonatica clausa (Brod. & Sow., 1929) ハイイロタマガイ	x 4+3d
Admete globularia (Smith, 1875) ウスカワゴロモ	x 1
Admete sp. [? *A. couthouyi* (Jay)]	x 1
Admete sp. b	x 2
Rectiplanes sanctioannis (Smith, 1875) エゾイグチガイ	x 5d
Obesotoma sp. a	x 2+1d
Obesotoma sp. b	x 1
Elaeocyma (Sprendrillia) sp.	x 1
Cylichna consobrina Gould, 1859 イトコカイコガイ	x 7
gastropods 2 spp.	x 2
Scaphopoda	
Siphonodentarium isaotakii (Habe, 1953) クチキレツノガイ	x 5
Bivalvia	
Nuculana (Robaia) robai Kuroda, 1929	x1+3/2d
Acila divaricata (Hinds, 1843) オオキララガイ	x 1d
Portlandia (Portlandella) toyamaensis (Kuroda, 1929)	x 2
Polynemamussium intuscostatum (Yokoyama, 1920 モトリニシキ)	x 2/2d
Abra ? sp.	x 1
Myadora fluctuosa Gould, 1861 ミツカドカタビラガイ	x 1/2d
Poromya flexuosa Yokoyama, 1922 スナメガイ	x 8+4d
Cardiomya sp. [aff. *C. sagamiana* Okutani & Sakurai)	x 1
Cardiomya behringensis Leche, 1883 テングシャクシガイ	x 1
Cumacea	
†*Campylaspis* sp.	x 4
†*Leptostylis* sp.	x 4
Tanaidacea	

+*Tanais* sp.	x 1
Isopoda	
+*Munna* sp.	x 1
+*Eurycope* sp.	x 2
Amphipoda	
+*Monoculodes* ? sp.	x 1
+gen. spp.	x 9
Macrura	
Lebbeus groenlandicus (Fabricius, 1775) イバラモエビ	x 1
Crangon dalli Rathbun, 1903 ミゾエビジャコ	x 2
Anomura	
Pagurus trigonocheirus (Stimpson, 1858) ミツカドホンヤドカリ	x 15
Brachyura	
Chionoecetes opilio (O. Fabricius, 1788) ズワイガニ	x 6
Asteroidea	
Leptychaster anomalus Fisher, 1906	x 105
Ctenodiscus crispatus (Retzius, 1805) スナイトマキ	x 58
Crossaster papposus (Linnaeus, 1767)	x 2
Ophiuroidea	
Ophiura sarsi Lutken, 1894 キタクシノハクモヒトデ	35 litr.
Ophiura leptoctenia H.L. Clark, 1911	x ca. 6
Ophiacantha acanthinotata H.L. Clark, 1911	x ca.30
Amphiodia craterodmeta H.L. Clark, 1911	x ca.12
Pisces	
Allolepis hollandi Jordan & Hubbs, 1925 ノロゲンゲ	x 1

Table 12. Tentative catch lists of the beam trawl operations (continued [15/16]).

STATION 17 Location: Okinawa Trough, East China Sea
26°05.7'N, 125°34.6'E - 26°04.4'N, 125°34.1'E
Date: October 18, 1988
Time on bottom: 18H36M-19H46M
Depth range: 2,050-2,055m [PDR rdg: 2,060-2,065m]
Type of gear: 2m Sigsby-Agassiz beam trawl

Gastropoda		
Trochidae gen. sp. near *Machaeroplax*	x	1
Tectonatica ? *clausa* (Broderip & Sowerby, 1829)	x	2d
Elaeocyma sp.	x	2
Turridae gen. sp.	x	1
other gastropods 3 spp.	x	3d
Bivalvia		
Samacar strabo pacifica (Nomura & Hatai, 1940) ミノエガイ	x	12
Ennucula ? sp.	x2+12d	
Axinulus sp.	x	2
Cuspidaria ? *mitis* Prashad, 1932	x	1
Pteropoda		
Cavolinia gibbosa (d'Orbigny, 1836) シロカメガイ	x	1d
Cavolinia globulosa Gray, 1850 マルカメガイ	x	11d
Diacria trispinosa (Blainville, 1821) ヒラカメガイ	x	4d
Ostracoda		
gen. sp.	x	1
Harpacticoida		
+*Stratiotes* ? sp.	x	1
Cumacea		
+*Bathycuma* sp.	x	1
+*Hemilamprops* sp.	x	2
+*Procampylaspis* 2 spp.	x	2
Tanaidacea		
+*Tanais* ? spp.	x	8
+*Apseudes* 2 spp.	x	2
Isopoda		
+*Eurycope* ? sp.	x	2
+*Munna* ? sp.	x	1
+*Desmosoma* ? sp.	x	2
+*Haploniscus* sp.	x	1
+*Haploniscus* ? sp. [see back cover]	x	1
Amphipoda		
gen. ? spp.	x	3

Table 12. Tentative catch lists of the beam trawl operations (continued [16/16]).

STATION 18 Location: west off Miyakojima, East China Sea
25° 12.3'N, 125° 58.5'E - 25° 10.4'N, 125° 56.1'E
Date: October 19, 1988
Time of operation: 08H13M-08H55M
Depth range: 138-158m [PDR rdg: 245-250m]
Type of gear: 2m Sigsby-Agassiz beam trawl

Porifera		
yellow sponge [? *Callyspongia* sp.:like cucumber]	x	2
huge sponge	x	1
Coelenterata		
Sertularella sp. ウミシバ		
Aphanipathes sp. イバラウミカラマツ		
Antipathes dubia Brock カナアミカラマツ		
Cirripathes anguina (Dana) ムチカラマツ		
Dendronephtya sp. トゲトサカ		
Polychaeta		
Onuphidae gen. sp.	x	1
Gastropoda		
Phenacovolva birostris (Linnaeus, 1828) ツリフネキヌヅツミ	x	2
Siliquaria (Agathirses) cumingii (Morch, 1860) ミミズガイ	x	1d
Bivalvia		
Samacar strabo pacifica (Nomura & Hatai, 1940) ミノエガイ	x	1/2d
Spondylus sanguineus Dunker, 1852 メンガイモドキ	x	1/2*3
Spondylus anacanthus Mawe, 1823 オオナデシコガイ	x	1+1/2d
Lima tomlini Prashad, 1932 マルミノガイ	x	1/2d
Glans millegrana (Nomura & Zinbo, 1934) ハナフミガイ	x	1/2d
Pycnogonida		
+gen. 3 spp.	x	10
Ostracoda		
+*Cypridina* ?	x	many
+*Cythereis* ?	x	many
Cirripedia		
+*Scalpellum* sp.	x	1
+*Verruca* ? sp.	x	1
Harpacticoida		
+*Harpacticus* ? sp.	x	1
+*Peltidium* ? sp.	x	1
Nebaliacea		
+*Nebalia* sp.	x	2
Cumacea		
+*Bodotria* sp.	x	5
+*Campylaspis* 4 spp.	x	ca.60
+*Dimorphostylis* sp.	x	9
+*Gynodiastylis* sp.	x	1
Isopoda		
+*Gnathia* sp.	x	7
+*Antarcturus* sp.	x	2

†*Arcturus* ? sp.	x 2
†*Anthuridea* sp.	x 1
†*Munna* ? sp.	x 7
†*Jaeropsis* sp.	x 3
†*Janirella* ? 2 spp.	x 2
†Asellota gen. ? sp.	x 1
†*Cryptoniscus* larvae ?	x 2
Amphipoda	
†*Stegocephalus* spp.	x many
†*Cyphocaris* sp.	x many
†Podoceridae spp.	x many
†*Caprella* spp.	x many
Stomatopoda	
†*Gonodactylus* sp.	x 1
Anomura	
†Galatheidae gen. spp.	x ca.20
†*Porcellanella* sp.	x 1
Brachyura	
†*Dromia* sp.	x 1
†*Nursia* ? 2 spp.	x 5
†*Palicus* sp.	x 14
†*Achaeus* sp.	x 4
†*Genkaia gordonae* Miyake et Takeda, 1970	x 2
Crinoidea	
scarlet comatulid sea fern	x 6
yellowish comatulid sea fern	x 2
Asteroidea	
seven-armed asteroid	x 1
Stellaster equestris (Retzius) ホシヒトデ	x 1
Henricia sp.	x 1
Echinoidea	
Echinothuriidae gen. sp.	x 1
Ophiuroidea	
Gorgonocephalus sp. a [pinkish white]	x 5
Gorgonocephalus ? sp. b [tigrine spots]	x 1
Tunicata	
opal white tunicates	x 54
scarlet tunicates with peduncles	x ca.10
Pisces	
Synodus sp.a	x 1
Synodus sp.b	x 2
Plectranthias sp.	x 1
Pseudorhombus dupliciocellatus Regan, 1905 メガレイ	x 1

5-1-2. Systematic study on the deep-sea benthic crustaceans

Sigeo GAMÔ (Dept. Biol., Fac. of Education, Yokohama Natl. Univ.)

The samples were taken at stations of beam trawl operation during the cruise KH-88-4. The specimens were preliminarily identified, and listed in the preceding section, entitled *5-1-1. Collection of megabenthos and macrobenthos by beam trawls and tentative list of the trawl catch* (with *Table 12. Tentative catch lists of the beam trawl operations*)."

While working on the materials during the cruise, some characteristic cumaceans and isopods were found and illustrated herewith.

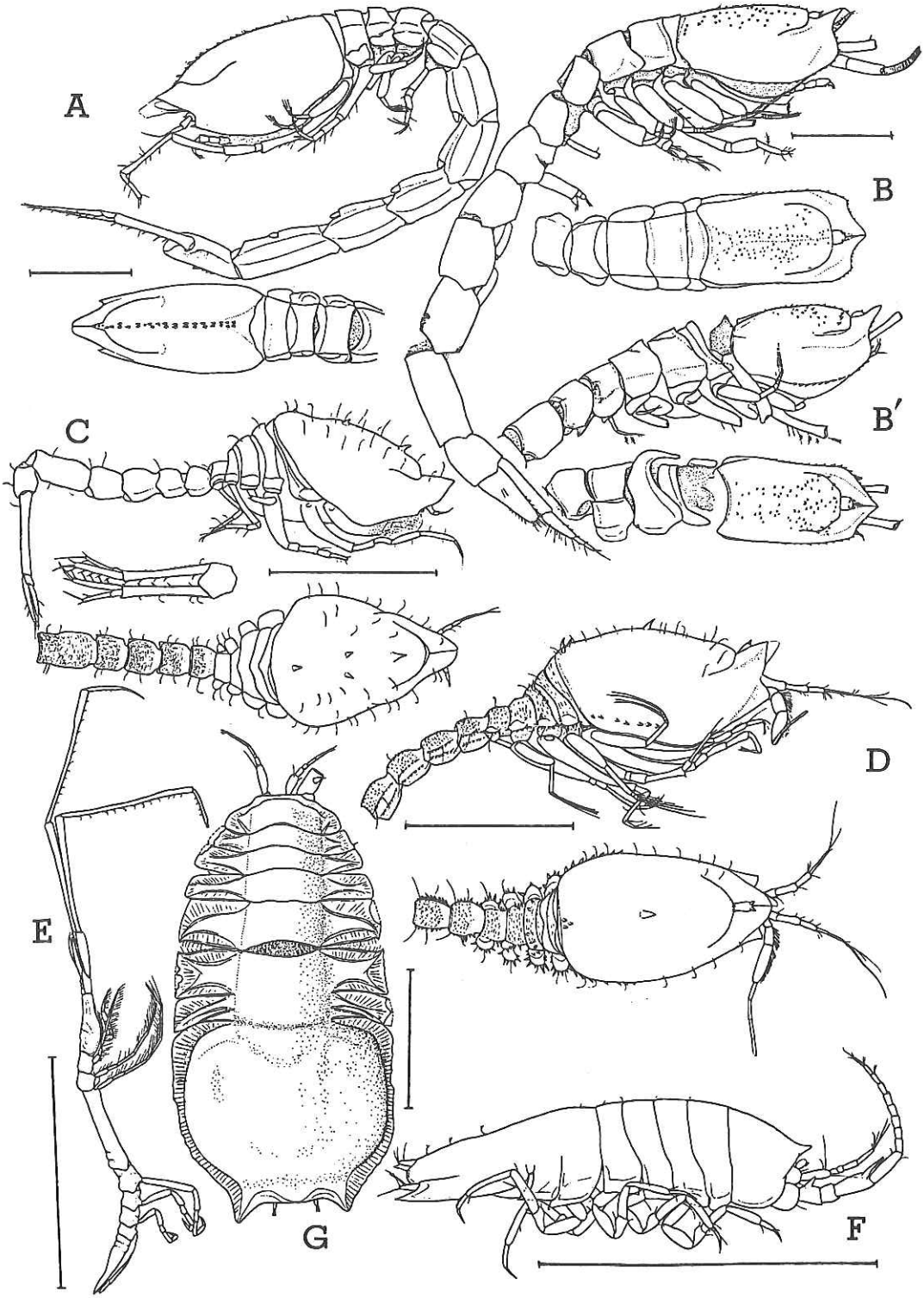
Order Cumacea

1. *Bathycuma* sp. (Fig. 2, A) (Bodotriidae)
   young male, St. 17.
2. *Procampylaspis* sp. (A). (Fig. 2, C) (Nannastacidae)
   ovigerous female, St. 17.
3. *Procampylaspis* sp. (B). (Fig. 2, D) (Nannastacidae)
   adult male, St. 17.
4. *Hemilamprops* (?) sp. (Fig. 2, B-B') (Lampropidae)
   adult male (B) and female (B'), St. 17.

Order Isopoda

5. *Astacilla* sp. (Fig. 2, E) (Arcturidae)
   St. SR68.
6. *Haploniscus* sp.a. (Fig. 2, F) (Haploniscidae)
   manca stage, St. 17.
7. *Haploniscus* sp.b. (Fig. 2, G) (Haploniscidae)
   male, St. 17.

Fig. 2. Some cumaceans and isopods from the bathyal depths during the cruise KH-88-4.
Cumacea: A. *Bathycuma* sp. young male (St. 17); B-B'. *Hemilamprops* (?) sp. adult male (B) and female (B') (St. 17); C. *Procampylaspis* sp.a ovigerous female (St. 17); D. *Procampylaspis* sp.b (St. 17).
Isopoda: E. *Astacilla* sp. (St. SR68); F. *Haploniscus* sp.a manca stage (St. 17); G. *Haploniscus* sp.b, male (St. 17).
Bar scales represent 1mm.


A
B
B′
C
D
E
F
G

5-1-3. Photographic observations of megabenthos and bottom environments

Suguru OHTA and Toshihiko FUJITA (ORI, Univ. Tokyo)

Underwater stereoscopic photography was carried out at eleven stations (Table 3) in order to observe and describe the life forms and behavior of large epibenthic and demersal organisms in their natural conditions, and bottom environments such as micro-topography, surface sediments, bottom currents as revealed by scours, dunes and lineations, etc. Precise quantitative estimation of density and biomass, analysis of spatial distribution of mega-epibenthic organisms can be done through geometrical analysis of stereo photographs and measurements of specimens collected with beam trawls and box corers, in the laboratory. Observations of traces made by living organisms are also the favorite items of bottom photography.

Specification of the camera system:

Underwater camera: two Benthos Model 372 standard cameras
two identical cameras with parallel optic axes separated a known distance and oriented perpendicular to the field of view.
28mm focal length lens (underwater corrected)
film capacity 100 feet for ca. 800 frames
BW films (Kodak Tri-X Pan and Kodak Plus-X Pan) and/or negacolor film (Eastman Color 5294) were loaded.

Underwater electronic flash: Benthos Model 382
100 watsec per flash

Acoustic pulse generator (pinger): Benthos Model 2216
pulse burst width - 0.5msec or 2msec

0.5 liter bottom water sampler
for DO and salinity measurement of near bottom water

Reversing thermometers or a memory thermometer

Operation Mode:

The camera system was suspended on a wire, and shot distance was monitored both on a storage synchroscope and a graphic precision depth recorder, keeping the altitude around 1 to 3 meters above the bottom. The cameras were triggered automatically by the programmable timer at ca. 6-second intervals. A part of the BW films were developed on board.

The sea conditions were rather bad throughout the cruise,

the resulting photographs were not always satisfactory ones, especially for the deeper stations.

Preliminary observations of representative megabenthos and some noteworthy objects are summarized in the followings;

STATION SR67: southeast off Otsuchi, ca. 2,000m
Silty bottom was dominated by ophiuroids belonging to the Ophiuridae and several kinds of sea anemones. *Cladorhiza* (Porifera), enteropneustid worms, *Philine* (Gastropoda) are also abundant. Macrourid fishes (*Coryphaenoides acrolepis*, *C. longifilis*) and holothurians (*Paelopatides* sp, *Peniagone* sp. and *Pseudostichopus* sp.) were representative free living megabenthic members. *Chionoecetes angulatus* (Brachyura), *Ascorhynchus japonicum* (Pycnogonida), buccinid gastropod, were occasionally seen.

STATION SR68: southeast off Otsuchi, ca. 2,750m
Silty mud bottom, on which onuphid polychaete tubes and sea anemones were dispersed. Representative megabenthos were *Colossendeis colossea* (Pycnogonida) and holothurians such as *Benthodytes typica*, *Mesothuria (Zygothuria) lactea* and *Paelopatides* sp. Errantian polychaetes, Enteropneusta gen. sp., comatulid sea ferns and nemertine worms were occasionally found.

STATION SR71: axis of the Japan Trench, ca. 7,500m
STATION SR72: Pacific Ocean floor, ca. 5,400m
Shot distance was too far, and no bottom figures were taken.

STATION SR75: east off Hachinohe, landward wall of the Japan Trench, ca. 4,700m
Bottom was smoothed with strong bottom current. Stalked and rooted coelenterata, *Pennatula* and *Umbellula* were bent in this current. Bottom surface was dominated by ophiurid (? *Ophiura bathybius*), ploughed by large cardioid spatangoids. Large elasipod holothurians, *Peniagone azorica* and *Scotoplanes globosa* were roaming on the bottom, where xenophyophores were dispersed. Actinians, comatulids, *Bathycrinus*, bonellid echiuran worms were other representative members. A macrourid fish of the genus *Coryphaenoides* (? *C. acrolepis*) followed the camera.

STATION 7: east off Jusanko, NW Pacific, ca. 250m
Bathyal ophiuroid, *Ophiura sarsi* were densely distributed on the sea floor. The density was estimated to be 440 inds/m2. Several individuals of an epizoic ophiuroid, *Asteronyx loveni* were observed clinging to slender pennatulids (? *Funiculina*). A crab *Erimacrus isenbeckii*, was one of the other representative benthic organisms.

STATION 8: west off Akita, the Japan Sea, ca. 250m
Ophiura sarsi was a dominant species whose density was estimated to be 27 inds/m2.

STATION 13: off Hinomisaki, the Japan Sea, ca. 250m
Ophiura sarsi was abundant (density 160 inds/m2). Flat fishes (such as *Hippoglossoides dubius*) were observed to be sitting on the sea floor. Large crabs (*Chionoecetes opilio*) and asteroids (*Solaster* sp. etc.) were also observed.

STATION 17: Okinawa Trough, ca. 2,000m
No noteworthy benthic organisms were recognized, and peculiarly depauperate considering the water depth. The bottom was smoothed, calm and bore rather bizarre atmosphere, speckled with enigmatic crusts.

STATION 18: east off Miyakojima, ca. 125m
The bottom was paved completely with white algal balls and coralline boulders, on which gorgonians and alcyonarians were attached.
The film was severely blurred by strong in situ ambient light.

5-1-4. Population biology of an ophiuroid, *Ophiura sarsi*

Toshihiko FUJITA (Ocean Research Institute, Univ. Tokyo)

A bathyal ophiuroid *Ophiura sarsi* Lutken is known to form "dense beds", i.e., high-density populations uniformly covering large area of the sea floor with scarcity of other organisms. In this cruise, three photographic stations and 6 trawling stations were established to investigate the ecological nature of dense beds of *O. sarsi*. Population densities were estimated by underwater photography, and size-frequency distributions were measured from trawled specimens.

Ophiura sarsi was very abundant in the upper bathyal zone off Otsuchi, Pacific coast of northeastern Japan (Sts. SR61, SR62, and SR63). The size-frequency distributions of *O. sarsi* were dominated by large individuals. With increasing depth, the mode of large individuals increased; 10.0mm in disc diameter at a depth of 250m, 12.1mm at 350m depth, and 13.8mm at 460m depth.

The population density of *O. sarsi* varied among three isobathic localities; 440 individuals/m^2 at St. 7 off Hachinohe, 27 inds/m^2 at St. 8 off Akita, and 160 inds/m^2 at St. 13 off Hinomisaki. The density was greater in Pacific coast than in the Japan Sea. The values of mean disc diameter were 5.8, 14.4 and 9.4mm at St. 7, St. 8 and St. 13, respectively. The maximum size, as well as the mean size, was greater where the population density was low. These suggests the density-dependent growth and/or survivorship.

My greatest interest is how the population structure of *O. sarsi* is related to the environment, the population density and other coexisting organisms. Detailed analysis about population biology of *O. sarsi* will be carried out from these samples with previously obtained samples.

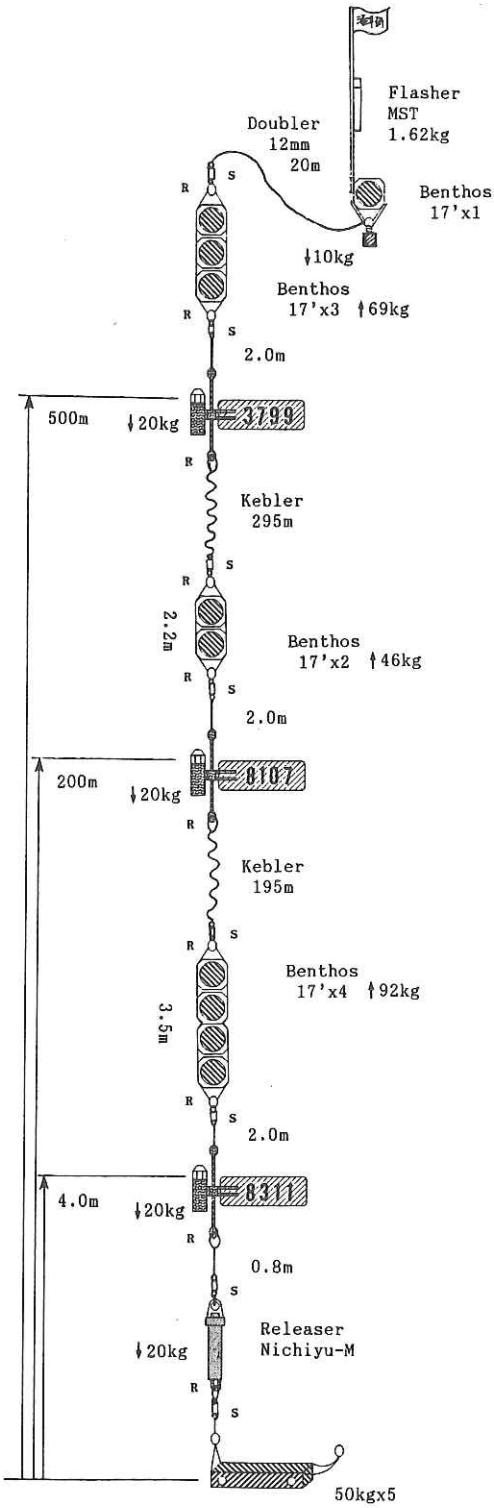
5-1-5. Current measurements with bottom-moored current meter systems in the axis of the Suruga Trough

Suguru OHTA (Ocean Research Institute, Univ. Tokyo)

Due to its geotectonic origin, Suruga Bay embraces a deep-sea trough-like structure or a deep-sea canyon along its axis called the Suruga Trough. The persistent density stratification of the water mass in the bay often introduce predominance of the baroclinic motions compared with the barotropic ones. Remarkable baroclinic tides have been frequently observed through the current and temperature measurements, and strong deep-sea bottom currents of the order of 40cm/sec induced by the semidiurnal internal tide were observed at a depth of several meters above the sea floor along the axis of the Suruga Trough (Ohta: unpublished). In order to clarify the bottom current regime in the steep bay (with special reference to the "beam transmission" of tidally induced internal wave into sloping deep embayment) and to correlate the life forms of the representative megabenthic organisms within Suruga Bay (see Ohta, 1983) to the bottom currents, two bottom-moored current meter systems (Fig. 3) consisting of 7 Aanderaa recorders were deployed at St. 28 (=St. BS16: 35° 00.53'N, 138° 38.68'E; 1,346m - 4m, 200m and 500m above the bottom) west off Osezaki and at St. 29 (=St. BS17: 34° 54.41'N, 138° 38.21'E; 1,571m - 4m, 200m, 500m and 800m above the bottom) west off Ugusu during preceding Tansei Maru KT-88-15 cruise. At the end of the KH-88-4 cruise, the two systems were retrieved successfully and CTD profiles were obtained at each station. Seven sets of current velocity, direction and temperature data recorded over 65 days at 10 min intervals on magnetic tapes are being analyzed in detail in the laboratory. Representative raw data and preliminarily processed data are shown in Figs. 4 to 10 together with current direction histogram, current velocity histogram, progressive vector plots, rotary power spectrum and harmonic analysis.

The data suggests, as a whole, the predominance of N-S M2 component along the long axis of the bay during the recording period. However, the direction itself and the E-W component also shows large fluctuations, suggesting complicate transmission and reflections of the internal waves in the enbayment.

This project was realized by the collaboration of the S. O., Dr. M. Matsuyama, Tokyo University of Fisheries and Dr. N. Hibiya, Earthquake Research Institute, the University of Tokyo.



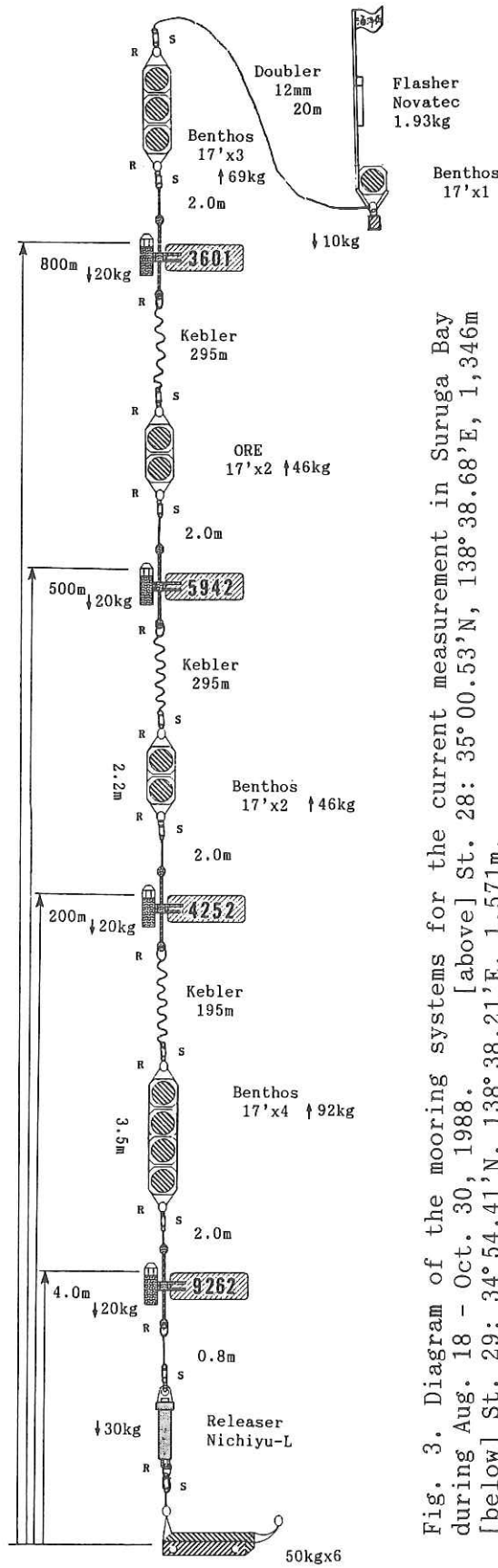
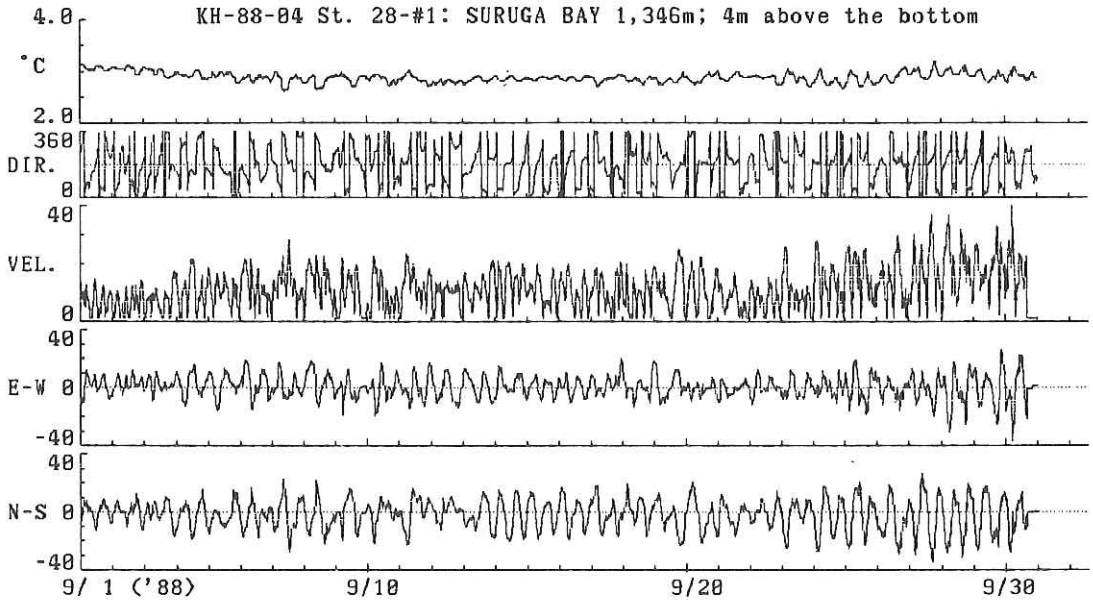


Fig. 3. Diagram of the mooring systems for the current measurement in Suruga Bay during Aug. 18 - Oct. 30, 1988. [above] St. 28: 35°00.53'N, 138°38.68'E, 1,346m [below] St. 29: 34°54.41'N, 138°38.21'E, 1,571m.



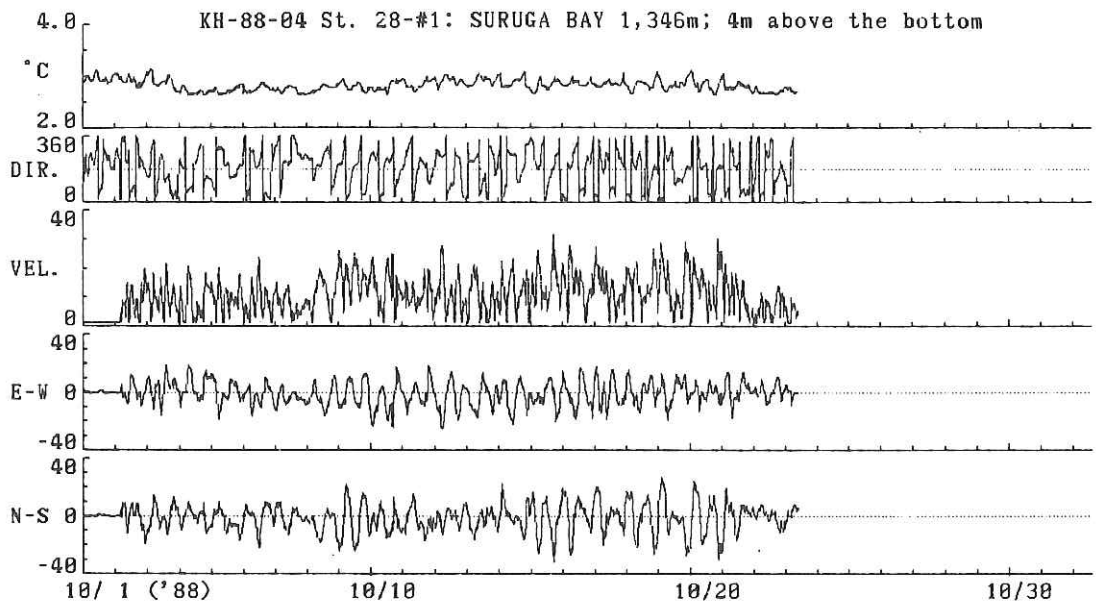


Fig. 4. Part of the time variations of temperature, current direction, and velocity (raw, E-W and N-S components) 4m above the bottom (St. 28: 1,346m - west off Osezaki, Suruga Bay).

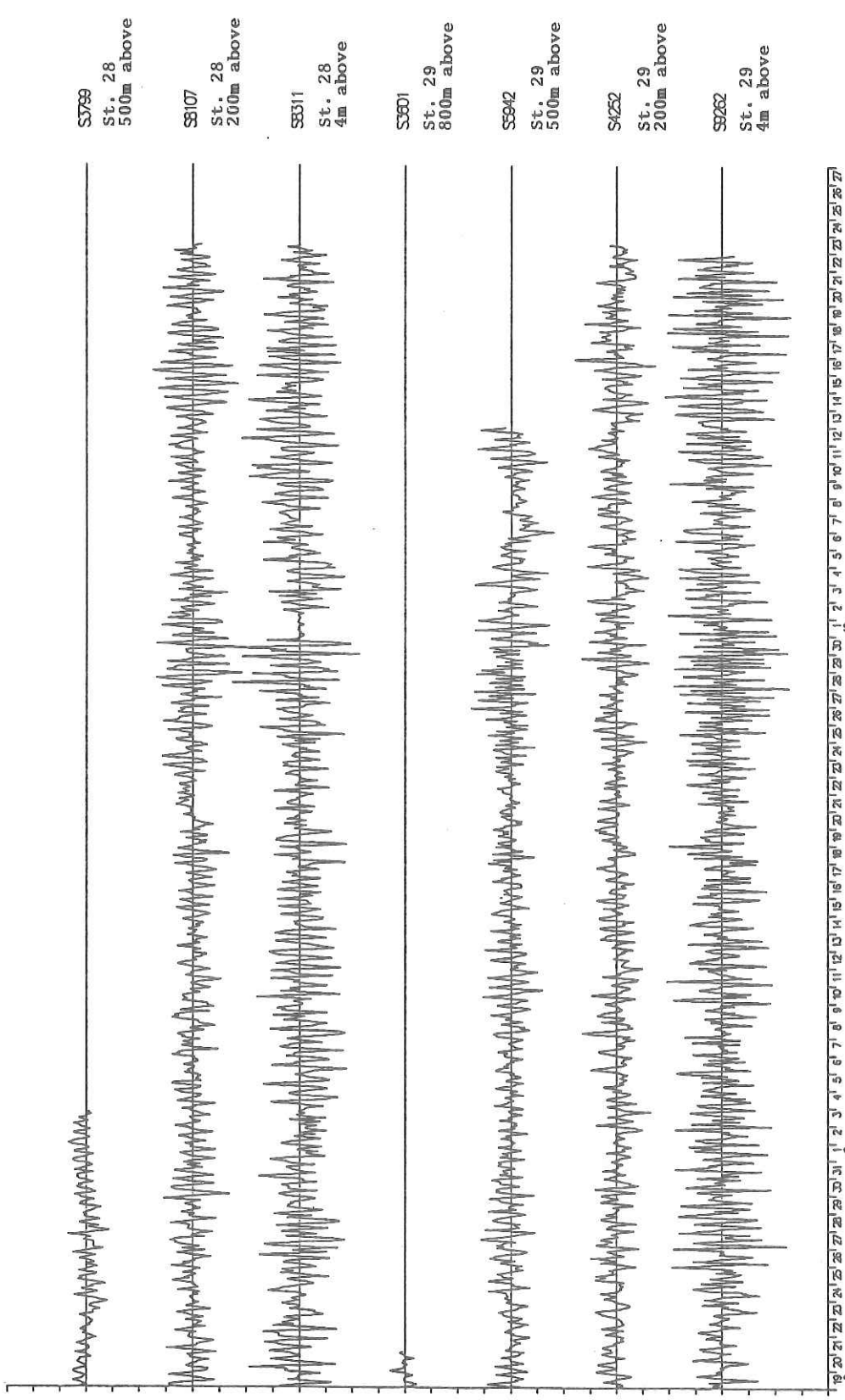


Fig. 5. Parallel presentation of all the N-S velocity components recorded at St. 28 (upper three) and St. 29 (lower four) within the Suruga Trough. [1 graticule represents 10cm/sec]

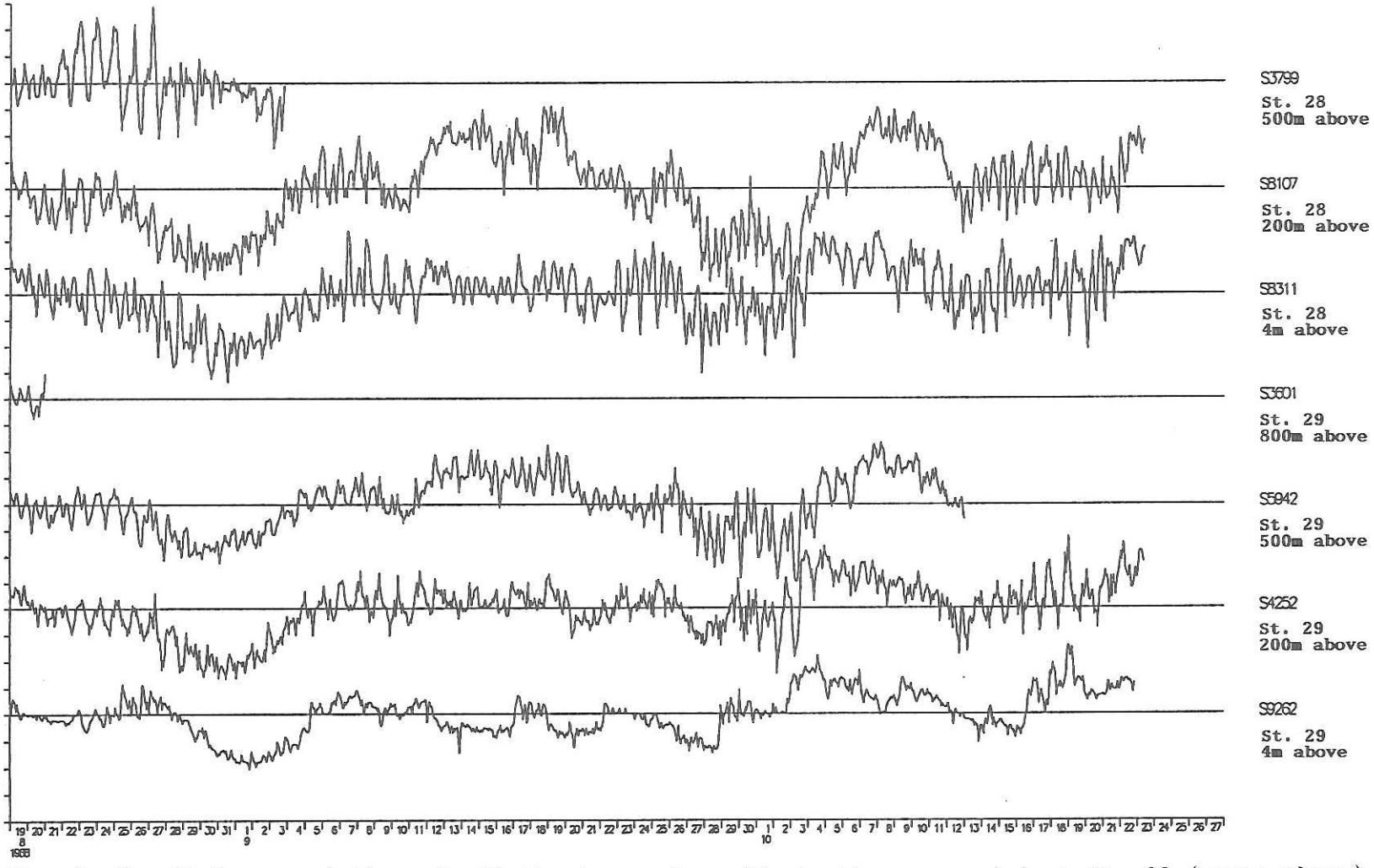
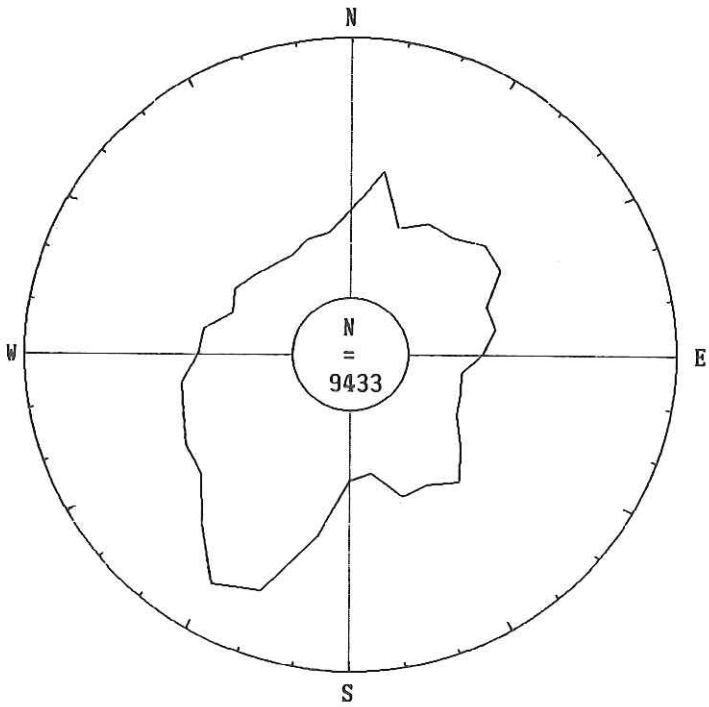


Fig. 6. Parallel presentation of all the temperature fluctuations recorded at St. 28 (upper three) and at St. 29 (lower four) within the Suruga Trough. [1 graticule represents 0.1°C]



Stn: KH-88-4, St.28-#1

off Osezaki,Suruga Bay
35°00.53'N;138°38.68'E
1346m; 4.0m off bottom
1988.08.18/13:00:00 -
1988.10.23/01:10:00
AANDERAA RCM4, No.8311
#1: '88.08.18/13:10:00
#2: '88.10.23/01:10:00

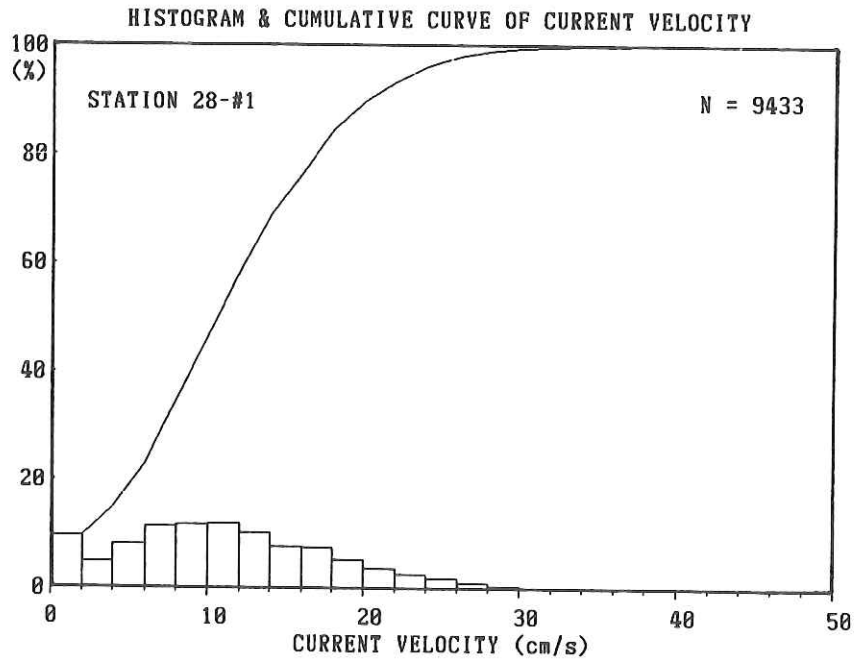
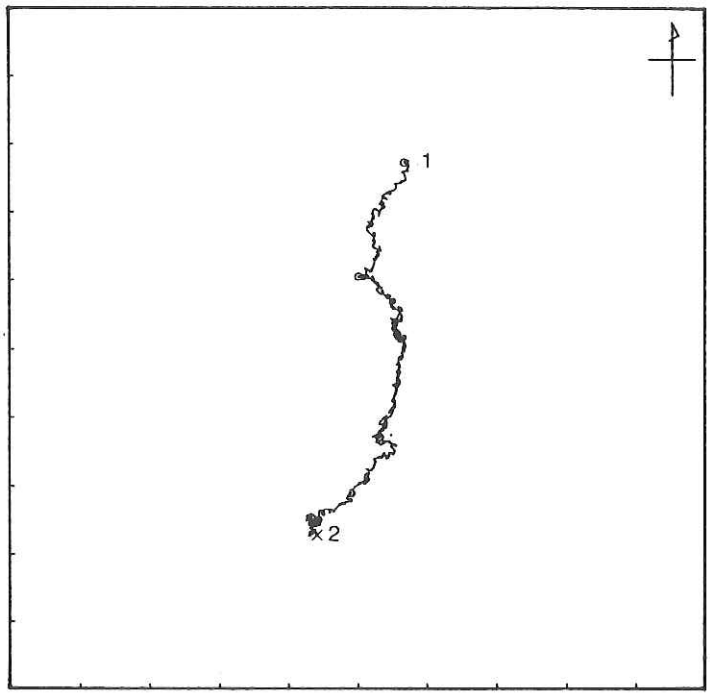


Fig. 7. Histogram of current direction (above) and the histogram and cumulative curve of the current velocity (below) 4m above the see floor at St. 28 (1,346m, west off Osezaki, Suruga Bay).

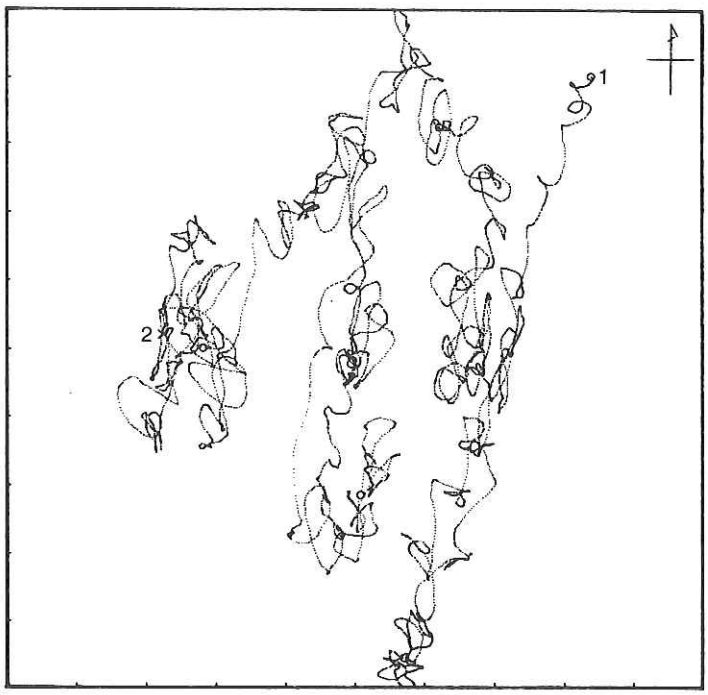


[PROGRESSIVE VECTOR]

Stn: KH-88-4, St.28-#1

off Osezaki,Suruga Bay
35°00.53'N;138°38.68'E
1346m; 4.0m off bottom
1988.08.18/13:00:00 -
1988.10.23/01:10:00
AANDERAA RCM4, No.8311
#1: '88.08.18/13:10:00
#2: '88.10.23/01:10:00

[One stick = 25000m]



[PROGRESSIVE VECTOR]

Stn: KH-88-4, St.29-#2

W. off Toi, Suruga Bay
34°54.41'N;138°38.21'E
1571m; 200m off bottom
1988.08.18/16:10:00 -
1988.10.26/16:00:00
AANDERAA RCM4, No.4252
#1: '88.08.18/16:10:00
#2: '88.10.26/16:00:00

[One stick = 2500m]

Fig. 8. Progressive vector plots 4m above the sea floor at St. 28 (above), and 200m above the sea floor at St. 29 (1,571m) over the hole recording period.

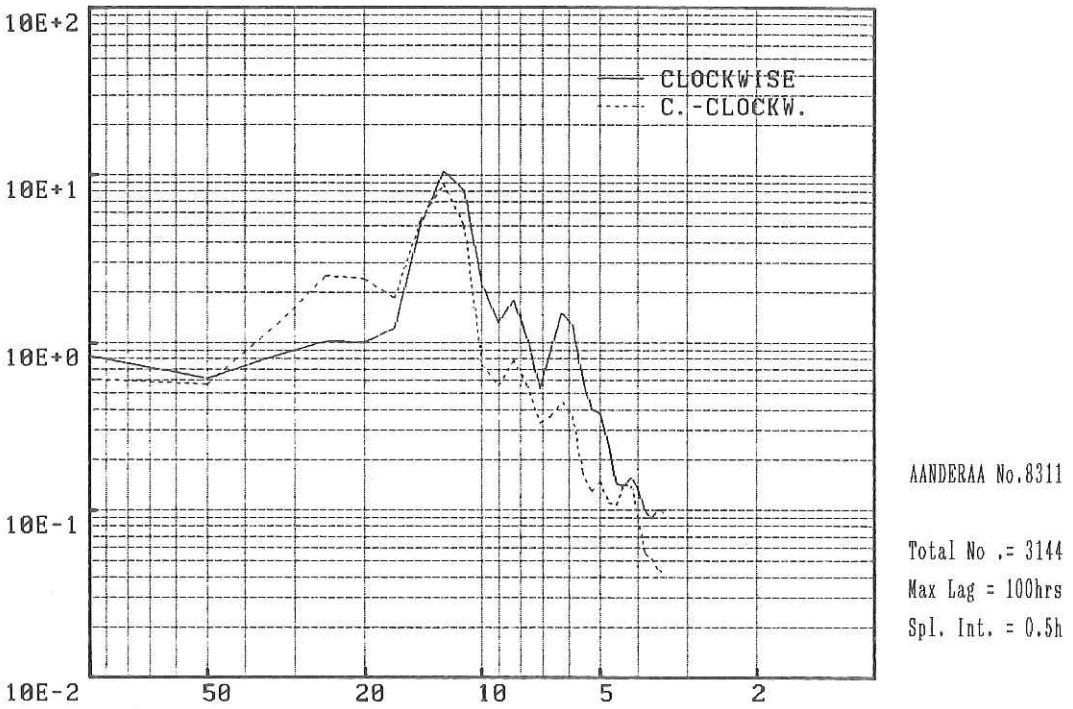


Fig. 9. Rotary power spectrum analysis of the data 4m above the sea floor at the St. 28 (1,346m, west off Osezaki, Suruga Bay).

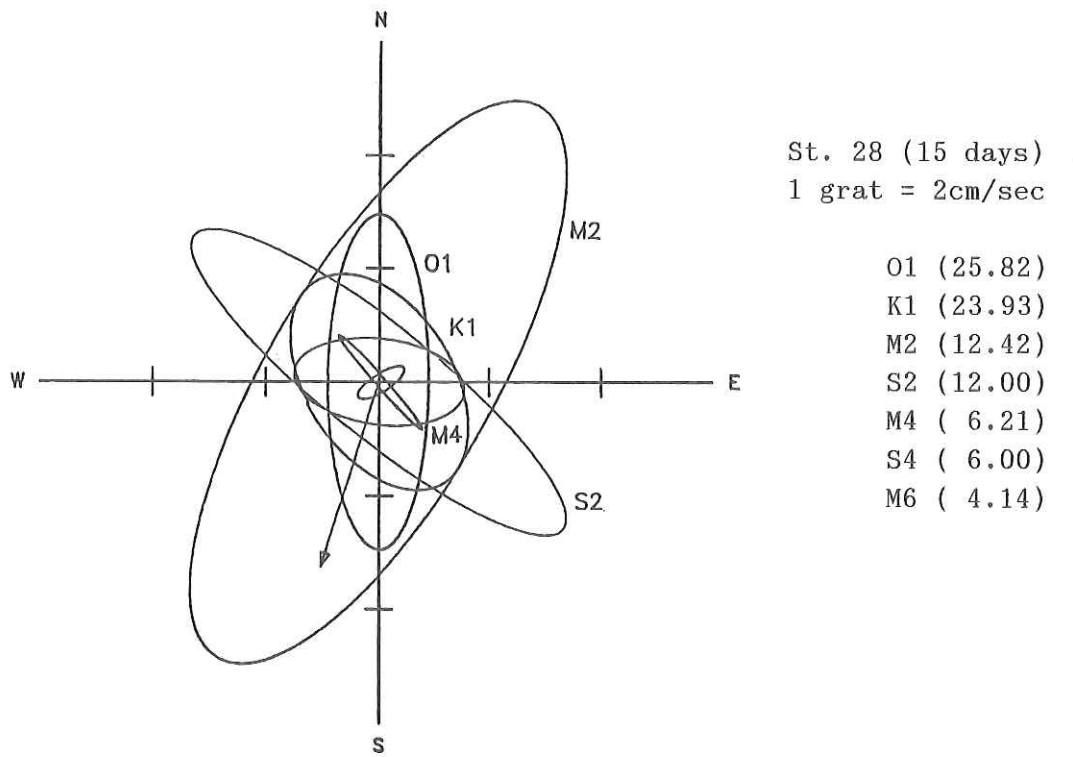


Fig. 10. Harmonic analysis of the data over 15 days, 4m above the sea floor at St. 28 (1,346m, west off Osezaki, Suruga Bay).

5-2. Sampling of Bottom Sediments by Spade Corers and a Grab

Bottom sediments were collected either by a large or small type USNEL box corer (sampling area: 0.25m^2 or 0.1m^2, respectively) for the following nine study items.

A: Ecological study of macrobenthos (Kojima, S. and S. Ohta)
B: Analysis of sediment characteristics (Kojima, S. and S. Ohta)
C: Ecological and taxonomical studies of small-size polychaetous annelids (Ohwada, T.)
D: Early diagenetic processes of organic nitrogen compounds and phytopigments in marine sediments (Montani, S.)
E: Ecological and physiological studies of microorganisms in the deep-sea bottom sediments (Ohwada, K.)
F: Vertical distribution of macrobenthos in sediments (Hayashi, I. and N. Maekawa)
G: Chemical analysis of pore water in sediments (Harada, K. *et al.*)
H: Ecological study of meiobenthos (Shirayama, Y.)
I: Ecological study of *Limopsis* (Nakaoka, M.)

Sampling stations and sample size for each study are summarized in Table 2.

The purpose(s) and the methods of representative study items are briefly described as follows.

5-2-1. Ecological study of macrobenthos and analysis of sediment characteristics

Shigeaki KOJIMA and Suguru OHTA (ORI, Univ. Tokyo)

Purpose: 1). Description of the trends of composition of macrobenthos communities and bottom environments along the depth gradient in the bathyal and abyssal zone off Sanriku (Sts. SR64-75).

2). Analysis of seasonal changes of macrobenthos communities (Sts. SR64 and 65).

3). Analysis of horizontal distribution of macrobenthos (St. SR65).

Methods: All the samples for studies of macrobenthos communities were sieved on a mesh of 0.5mm openings and fixed and preserved in 10% neutralized seawater formalin on the vessel. Macrobenthic organisms in these samples are to be sorted, counted and weighted.

At Station SR65, a single core sample were divided into thirty-four 5 x 5cm subcores and four 10 x 10cm subcores. Each subcore sample was treated as the whole sediment samples.

One or two subcores were taken from undisturbed portion of the sediment from all core samples. These subcore samples were sliced horizontally at 1cm intervals from the sediment surface and kept in a freezer. They are to be used for the analyses of granulometry, organic contents of the bottom sediments, stable carbon isotope ratios and so on.

5-2-2. Ecological and taxonomical studies of small-size polychaetous annelids

Takashi OHWADA (ORI, Univ. Tokyo)

Purpose: Gathering of the primary data for the zoogeographic studies of the small size polychaetous annelids in the deep sea, and collection of the specimens for the taxonomic studies on the rarely known small size polychaetous annelids in the deep sea.

Methods: For the quantitative sampling of the small size polychaetous annelids, four subcore sediment samples (sample size of each subcore: 50cm^2 x 12cm deep) sediment samples were obtained from one of the box corer samples at each station except at St. SR75, where three subcore samples were available. Additional surface sediment was also collected, when available, for the taxonomic purposes. These sediment samples were fixed with sea water with 10% buffered formalin for the later biological studies.

Back in the laboratory, the sediment samples will be washed through the stacked mesh screens of several grades, and the specimens of polychaetous annelids will be sorted from the remnant on each mesh screen and preserved in 70% ethanol for the ecological and taxonomical studies.

5-2-3. Early diagenetic processes of organic nitrogen compounds and phytopigments in marine sediments

Shigeru MONTANI (Kagawa Univ.)

1. Core samples were immediately sectioned upon sampling in every 1-2cm and frozen for preservation. After the cruise, these samples will be freeze-dried and powdered to provide the materials for chemical analyses.

2. Following analyses will be conducted on these materials.

(1) Amino acids: Qualitative and quantitative analyses will be carried out on the amino acids in the following three treatments.

i) Extracts from the materials in hot water
ii) Products of the hydrolysis of the extracts
iii) Products of the hydrolysis of the residue (sediment particles left after the extraction in hot water)

(2) Phytopigments: Extracts from the materials in the solvent such as acetone will be quantitatively analyzed on the degradation products such as chlorophylls and carotenoids by HPLC.

(3) Organic carbons and metals: Quantitative analyses will be conducted simultaneously by the CHN analyzer on the materials after the second freeze-drying treatment following the removal of carbonates in HCl.

3. Early diagenetic processes of organic nitrogen compounds (especially amino acids) and phytopigments will be discussed on the basis of the results of the above mentioned analyses and also the data on the water content and porosity.

5-2-4. Vertical distribution of macrobenthic organisms in the sediment

Isao HAYASHI and Nobuyuki MAEKAWA (Kyoto Univ.)

Purpose: Clarification of the vertical distribution of macrobenthic organisms in sediments, especially of polychaetous annelids, and search for the relationships between the vertical profiles of macrobenthic organisms and the physico-chemical conditions of the near-bottom water and/or the sediment.

Methods: A single subcore sample (sample size: 15 x 15cm) was obtained from one of core samples at each station except for the two stations (Sts. SR67 and SR73), where no subcore sample was available. Each subcore sample was sliced horizontally with a metal plate into several vertical sections at the fixed depths of sediment, those are, 2cm, 5cm, 10cm, and 15cm from the sediment surface. The number of the vertical sections and the thickness of the deepest section differed from sample to sample due to the variation of the total thickness of each subcore sample. Each vertical section was washed through the stacked mesh screens (mesh size: 1.0mm and 0.5mm), and those retained on the screens were then preserved separately in the sea water with about 10% formalin. Macrobenthic organisms will be sorted, counted and weighed later. Polychaetous annelids will be identified down to species as precisely as possible.

5-2-5. Ecological studies of *Limopsis tajimae*, with special reference to seasonal periodicity in the deep-sea benthos

Masahiro NAKAOKA (Ocean Research Institute, Univ. Tokyo)

In order to investigate whether seasonal periodicity could exist among the deep-sea benthos which live in stable environment, a time-series sampling program was planned and is now in progress at the bathyal zone of Suruga Bay. In this cruise, the box corings at St. 30 in the bay head of Suruga Bay were done as a part of this program.

Six sediment samples were taken with a $1/10m^2$ USNEL spade corer. Two small subcores were sampled from each core in order to analyze grain size and organic materials in the sediment. The rest of the top 15cm sediment was then sieved on a mesh of 0.5mm openings and preserved in 10% neutralized seawater formalin for the estimation of macrobenthos biomass. Among the organisms sieved, *Limopsis tajimae* (Bivalvia), the most dominant megabenthos at this site were sorted out and a half of the specimen were frozen at -20° C and another half were preserved in 10% seawater formalin for later analysis of physiological and reproductive seasonality.

For the purpose of analyzing the seasonality in physical environments, a memory thermometer and a small water sampler were attached to the spade corer, and temperature, DO and POC of bottom water were measured.

5-3. Ecological and Physiological Studies of Microorganisms in the Deep-sea Area

Kouichi OHWADA and Suwan OH
(Ocean Research Institute, Univ. Tokyo)

A unique parameter of the deep-sea is hydrostatic pressure, which increases about one atmospheric pressure (1 kg per square cm) for every ten meters in depth. It has been an interesting subject for marine microbiologists as to whether population of deep-sea bacteria exist which are well adapted, not only to cold temperature, but also to the hydrostatic pressure of the deep-sea. Recently several strains of barophilic bacteria have been isolated from samples of seawater and guts of some invertebrates. There still remains question whether degradation of organic matter in the deep-sea area has been conducted mainly by barophilic population, or bacterial activities would be restricted by high hydrostatic pressure.

To obtain basic information of bacterial population in the deep-sea area, following works have been carried out in this cruise.

(1) Effect of different hydrostatic pressure levels for the growth of bacterial population

Suspensions of seawater, sediments and guts of some invertebrates were incubated with liquid medium of ZoBell 2216E in glass tubes at different pressure levels at 5°C. Bacterial growth rate in each sample will be examined later. Isolation of barotolerant and/or barophilic bacteria in the samples was also conducted using pressurized cultures in solidified medium. Sediment samples from Sts. SR71, SR72, SR73, SR74-2, 20 and 21, seawater samples from Sts. SR71, SR72, 9, 20B and 21, and invertebrate samples from Sts. SR71, SR72 and SR75 were used for this study.

(2) Operations of Pressure Retaining Sampler for microbiological study

For retrieval, subsequent subsampling and culture of deep-sea microorganisms without decompression, operations of Pressure Retaining Sampler, which has been under construction, were carried out. This sampler is equipped with timer operated trigger and stopper for *in situ* water pump, Millipore filtration system to concentrate microorganisms in seawater and closing valves for

holding *in situ* pressure. Test operation at St. SR66 and two operations at Sts. SR71 and 20B were done. Sampling at St. 71 was successful from both holding pressure and volume of water filtered. However, subsampling into a transfer system without decompression was unsuccessful due to a leak of pressure at the transfer system. Holding pressure of the sampler at St. 20B was incomplete due to a leak from a valve at the water intake part.

(3) Distribution and isolation of heterotrophic and spore-forming thermophilic bacteria

Suspensions of suitably diluted or concentrated samples were incubated at 20° C for heterotrophic bacteria and at 65° C for thermophilic bacteria using ZoBell 2216E medium. Sediment samples from Sts. SR64, SR65, SR66, SR67, SR68, SR71, SR72, SR73, SR74-2, 18, 20C, 21 and 22, seawater samples from Sts. SR71, SR72, 9, 20B and 21, and invertebrate samples from Sts. SR71, SR72 and SR75 were used for this study. About 100 strains of thermophilic bacteria were isolated during this cruise.

5-4. Studies of Plankton and Micronekton

5-4-1. Ecological and taxonomical studies of off-shore cephalopods

Tsunemi KUBODERA (National Science Museum, Tokyo)

For the purpose of studying meso-bathypelagic and bathy-benthic cephalopod fauna in the adjacent seas of Japan, squids and octopods were sorted out from the samples collected by the 10-foot IKMT (Isaacs-Kidd Midwater Trawl), 10-foot IKPT (Isaacs-Kidd Plankton Trawl), ORI-69 plankton net and 2, 3 and 4m beam trawls during the research cruise of Hakuho Maru KH-88-4 in the western North Pacific from September 23 to October 31, 1988.

The 10-foot IKMT and IKPT were towed obliquely from surface to the attaining depths of 3,000m wire paid out, about 1,000-1,500m depth, with an hour or half an hour horizontal tow at the deepest. The ORI-69 was towed obliquely from surface to the attaining depths of 1,500-2,500m wire paid out. The ORI-69 was also towed at the surface about 10 minutes with 2-3 knot velocity at as many stations as possible. See Tables 6-7 for detailed position, date and time. Beam trawls were towed at the bottom of various depths from 138m to 7,570m. See Table 1 for detailed position, date and time.

The 10-foot IKMT and IKPT provided 61 individuals of epipelagic and mesopelagic cephalopods. Eighteen species belonging to 8 families were identified (Table 13). Cranchidae was the dominant group comprising 6 species. Next was Enoploteuthidae comprising 4 species and two unidentified larvae. Gonatidae included two species among which specimens collected at St. SR75 which were tentatively identified into *Gonatopsis borealis* seem to be new species or subspecies in the genus. Mastigoteuthidae, Onychoteuthidae, Ommastrephidae, Histioteuthidae and Vampyroteuthidae contained one species each. The ORI-69 tows captured 90 individuals of small larval cephalopods. Most of them were too small to be identified into species. Enoploteuthid larvae were the dominant comprising 2/3 of the catch (Table 14). Rhynchoteuthion stage larvae of *Symplectoteuthis oualaniensis* and *Todarodes pacificus* were caught at stations in the southern Japan Sea and East China Sea. Larvae of epipelagic octopus, *Argonauta argo* and *Ocythoe tuberculata*, were collected at St. SR71 and St. 22, respectively. The beam trawls did not contribute much for the cephalopod collection, but seven specimens of benthic octopus were

collected from the bottom of 200-3,000m depth (Table 15). Among them, *Octopus* sp. collected at St. SR62 seems to be new species. Three species of epipelagic squids were obtained by hand jigging at St. SR72 and off Shimonoseki (Table 16).

Taxonomical studies on unidentified specimens and the species which seem to be new to science is now in progress.

Table 13. Cephalopods collected by 10-foot IKPT & IKMT during KH-88-4 cruise.

St.	Date	Position	Species	N	ML(mm)
1-1 IKMT	Sep. 23 1988 (Night)	35-20.6 N 141-09.8 E	*Watasenia scintillans* (Berry, 1912)	1	5.0
2 IKMT	Sep. 23 1988 (Mon.)	35-35.0 N 142-03.6 E	*Enoploteuthis chunii* Ishikawa, 1914	1	8.2
			Abralia andamanica Goodrich, 1900	1	12.0
			Liocranchia reinhardti (Steenstrup, 1856)	3	20-25
			Sandalops melancholicus Chun, 1906	2	68-70
			Vampyroteuthis infernalis Chun, 1903	1	BM.
4 IKMT	Sep. 24 1988 (Mon.)	38-00.8 N 142-33.0 E	Enoploteuthid fragment (head)	1	
			Gonatus onyx Young, 1972	1	20
			Mastigoteuthid fragment (arms)	1	
			Galiteuthis armata Joubin, 1829	2	55-105
SR71 IKMT	Sep. 29 1988 (Night)	38-36.6 N 144-02.6 E	*Watasenia scintillans* (Berry, 1912)	2	14-25
			Enoploteuthis sp.	1	12.4
			Liocranchia reinhardti (Steenstrup, 1856)	2	20-21
			Taonius pavo Lesueur, 1821	1	27
SR72 IKMT	Sep. 30 1988 (Night)	39-14.1 N 147-09.9 E	*Enoploteuthis chunii* Ishikawa, 1914	2	28-45
			Liocranchia reinhardti (Steenstrup, 1856)	1	14.5
SR75 IKMT	Oct. 4 1988 (Night)	40-45.6 N 144-02.8 E	*Gonatopsis* cf. *borealis* (new sp.?)	2	150-160
			Mastigoteuthis cf. *glaukopis* Chun, 1908	1	60
			Grimalditeuthis bomplandi (Verany, 1837)	1	60
23 IKPT	Oct. 21 1988 (Night)	20-59.5 N 129-52.7 E	*Abralia* sp. larva	1	3.5
			Enoploteuthis sp. larva	2	1.5-2.0
			Octopoteuthis sp.? larva	1	2.5
			Onychoteuthis borealijaponica Okada, 1927	1	3.5
			Symplectoteuthis oualaniensis (Sasaki, 1929)	8	2.0-3.5
			Cranchiid larva cf. *Leachia*	3	3.0-3.0
			Unid. larva (never described)	1	3.0
			Broken unid. larva	1	
25 IKMT+ EMPS	Oct. 28 1988 (Day)	31-03.0 N 133-07.5 E	No. 1 (0-744 m layer)		
			Liocranchia reinhardti (Steenstrup, 1856)	1	11.0
			Vampyroteuthis infernalis (Chun, 1903)	1	60>
			No. 2 (744-862 m layer)		
			Mastigoteuthis n. sp. (slender type)	1	135
			Vampyroteuthis infernalis (Chun, 1903)		
			No. 3 (862-750 m layer)		
			Vampyroteuthis infernalis (Chun, 1903)	1	40
			No. 4 (750-422 m layer)		
			Enoploteuthis sp.	1	
			Sandalops melancholicus Chun, 1906	1	35
26 IKMT+ EMPS	Oct. 28 1988 (Night)	32-20.7 N 135-09.5 E	No. 2 (840-871 m layer)		
			Cranchia scabra Leach, 1817	1	7
			No. 5 (317-0 m layer)		
			Abraliopsis sp.	1	12
			Pterygioteuthis giardi Fisher, 1896	2	8-15
			Histioteuthis meleagroteuthis (Chun, 1910)	1	18
			Liocranchia reinhardti (Steenstrup, 1856)	1	15
			Cranchiid larva cf. *Leachia*	1	
			Vampyroteuthis imfernalis (Chun, 1903)	1	11
27 IKMT	Oct. 29 1988 (Day)	33-34.6 N 137-10.2 E	*Mastigoteuthis* cf. *glaukopis* Chun, 1908	1	91
			Vampyroteuthis infernalis Chun, 1903	1	60*

Table 14. Cephalopods collected by ORI-69 during KH-88-4 cruise.

St.	Date	Position	Species	No	ML(mm)
1-1	Sep. 23	35-20.8 N 141-09.9 E	*Watasenia scintillans* ? larvae	1	4
4	Sep. 24	37-58.7 N 143-31.9 E	Enoploteuthid larvae *Symplectoteuthis oualaniensis* (Lesson, 1803)	20 1	2-4 4
SR71	Sep. 29	38-35.8 N 144-04.0 E	*Watasenia scintillans* ? larvae *Liocranchia reinhardti* (Steenstrup, 1856) *Argonauta argo* Linnaeus, 1758	1 1 2	2.5 13 7
SR72	Oct. 1	39-14.0 N 147-10.5 E	*Watasenia scintillans* ? larvae *Liocranchia reinhardti* (Steenstrup, 1856)	1	19
SR75	Oct. 4	40-45.3 N 144-02.6 E	*Liocranchia reinhardti* (Steenstrup, 1856) too small to be identified	1 2	10.5 1-2
13	Oct. 9 Obl.	35-42.2 N 132-02.1 E	Enoploteuthid larvae *Symplectoteuthis oualaniensis* (Lesson, 1808) *Todarodes pacificus* Steenstrup, 1880	1 1 2	3.2 4.5 5.2-6.5
14	Oct. 17	33.00.2 N 127-59.9 E	*Todarodes pacificus* Steenstrup, 1880	1	3-4
15	Oct. 17	29-59.8 N 127-30.1 E	Enoploteuthid larvae	7	2-3
16	Oct. 18	28-00.2 N 127-00.3 E	Enoploteuthid larvae *Symplectoteuthis oualaniensis* (Lesson, 1808)	10 2	2-3 2-3
17	Oct. 18	25-11.9 N 125-34.6 E	Enoploteuthid larvae *Symplectoteuthis oualaniensis* (Lesson, 1808)	18 3	1.5-2.5 2-3.5
19	Oct. 19	24-34.8 N 126-44.1 E	*Symplectoteuthis oualaniensis* (Lesson, 1808)	2	3-4
21	Oct. 26	25-01.1 N 129-44.4 E	*Liocranchia reinhardti* (Steenstrup, 1856) Cranchiid larvae cf. *Leachia* *Symplectoteuthis oualaniensis* (Lesson, 1808)	1 1 1	3.5 3.0 3
22	Oct. 26	25-33.6 N 130-43.2 E	*Ocythoe tuberculata* Rafinesque, 1814	1	3
26	Oct. 28	32-21.0 N 135-09.6 E	*Onykia* sp. cf. *carribaea* Lesueur, 1821 *Cranchia scabra* Leach, 1817 *Leachia pacifica* (Issel, 1908) *Liocranchia reinhardti* (Steenstrup, 1856) *Octopus* sp. larvae	1 1 2 2 1	2.0 8.0 8-9 3-4 2.5
27	Oct. 29	33-39.9 N 137-10.0 E	Enoploteuthid larvae *Onykia* sp. cf. *carribaea* Lesueur, 1821	1 1	2 3.0

Table 15. Cephalopods collected by beam trawls during KH-88-4 cruise.

St.	Date	Position	Gear Depth(m)	Species	No.	ML	TL(mm)
SR62	Sep. 24	39-16.7 N 142-11.0 E	2m-BT 353-355	*Octopus* sp. (new sp.?)	3	70 56 45	300 220 170
SR65	Sep. 25	39-08.2 N 142-24.0 E	3m-BT 1000-1005	*Benthoctopus fuscus* Taki, 1964	2	82 60	510 340
SR68	Sep. 27	38-28.8 N 143-32.0 E	4m-BT 2840-3020	*Benthoctopus violescens* Taki, 1964 *Benthoctopus* sp.	1 1	70 24	360 88
7	Oct. 4-5	40-49.4 N 141-52.4 E	2m-BT 225-227	*Octopus* sp. (adolescent)	1	9	

Table 16. Cephalopods collected by hand jigging during KH-88-4 cruise

St.	Date	Position	Species	No.	ML(mm)
SR72	Sep. 30	39-13.2 N 147-08.7 E	*Eucleoteuthis luminosa* (Sasaki, 1915) *Onychoteuthis banksii* (Leach, 1817)	10 1	140-160 80
	Oct. 9	off Shimonoseki	*Loligo edulis budo* Wakiya & Ishikawa, 1921	1	220

5-4-2. Pelagic ichthyofauna in the Western North Pacific

Youichi TSUKAMOTO (Ocean Research Institute, Univ. Tokyo)

In order to investigate the species composition and distribution patterns of fishes in the Western North Pacific off Tohoku Region, Japan Sea, Philippine Sea and the Kuroshio Current, sampling was conducted using 10-foot IKMT, 10-foot IKPT and ORI-69 nets during the research cruise (see Tables 6 and 7).

Midwater components of the bottom trawl sample were also put to use. Stations 1-1 and 1-2 established off Chosi were intended in vain to collect the leptocephalus larvae of *Pterothrissus gissu*, and the St. 13 established off Hinomisaki was to collect the eggs of *Maurolicus muelleri*.

All the fish were sorted out from the samples taken, resulting in a collection of total 5,073 specimens. The fish families collected are shown in Tables 17 and 18.

Table 17. List of fish families collected by IKMT during KH-88-4.

Stations :	1-1	1-2	2	4	SR71	SR72	SR75	19	23	22A	25-1	25-2	25-3	25-4	25-5	26-1	26-2	26-3	26-4	26-5	27
Nets :	IM	IM	IM	IM	IM	IM	IM	IP	IP	IM	IE					IE					IM
Engraulidae	1																				
Anguillidae									1												
Nemichthyidae				2			2			2		1									5
Synaphobranchidae								1					1								1
Muraenidae	1					1												1		2	1
Congridae	1		1			2		1	16						1					1	
Ophichthidae	1		1						7												
Bathylagidae		10		5	7	5				1											1
Alepocephalidae																	1			2	
Gonostomatidae	122	132	483	225	258	110	369	58	473	100	65	40	50	43	14	46	92	26	115	307	198
Sternoptychidae	7		38	2	4	1	3	5	7	15			1	2	1			5	2	4	15
Chauliodontidae	5	2			3				2	7			1		5				3	3	2
Stomiidae			3					1	1												1
Astronesthidae	2																				1
Melanostomiidae	2	1						1	11	2					2	2					
Idiacanthidae									7												1
Scopelarchidae									1												3
Notosudidae								2													
Myctophidae	24	97	8	26	36	23	9	26	117	15	1		1	4	5	19	7			5	159
Paralepididae					2			1	7		1	1								1	6
Alepisauridae																					1
Bregmacerotidae		1	18																	1	1
Macrouridae		1																			
Carapodidae									3	1											
Antennariidae									4												
Himantolophidae								1							1					1	
Linophrynidae								1													
Melamphaidae	2		9		10	3	8	1	4		2	3	2	1				2	1		10
Cetomimidae			1																		
Trachipteridae									1												
Bramidae									1												
Labridae									1												
Chiasmodontidae																					1
Scombridae									32												
Gempylidae								1	10												
Acanthuridae								2													
Gobiidae									7												
Scorpaenidae	1																				
Callionymidae									4												
Bothidae						2			42	1											
Balistidae									1												
Unidentified									8												
Total	169	244	562	260	320	147	391	102	769	144	69	45	56	50	29	67	100	34	121	327	407

IM: Isaacs-Kidd Midwater Trawl; IP: Isaacs-Kidd Plankton Trawl; IE: Electrical Multilayer Plankton Sampler attached to IKMT

Table 18. List of fish families collected by ORI-69 net during KH-88-4.

Stations:	1-1	1-2	4	SR71	SR72	14	15	16	17	18	19	20B-1	20B-2	21	22	25	26-1	27
Engraulidae	70	4						2	6					1				
Muraenidae		2		1	2													
Congridae		1			1	1								1			1	
Ophichthidae				1	5										1		1	
Gonostomatidae								1					1		1			
Melanostomiidae								1										
Gonorynchidae	1						1	1			1	1				2	1	
Synodontidae	2					2			2			3	3	2	4		5	1
Chlorophthalmidae									1									
Myctophidae		10	3	9	22	10	1	5	14	1	4	2	2	7	1	2	20	
Paralepididae								1	13									
Alepisauridae										1								
Scomberesocidae				1	2													
Exocoetidae				1						1	1							
Bregmacerotidae		1				1			2									
Carapodidae						1												
Ophidiidae						1												
Melamphaeidae									5									
Holocentridae		2	1															
Mugilidae																		189
Percichthyidae						9			11									
Serranidae						2		1										
Apogonidae									1									
Labracoglossidae		1																27
Carangidae				3				1	4		1							
Coryphaenidae				1					3									
Leiognathidae																		
Bramidae														1				
Mullidae	1	3		1						1								
Girellidae	1																	
Lutjanidae								1	3									
Pomacanthidae									1									
Pomacentridae								1										5
Cheilodactylidae																		1
Labridae			1					2										8
Champsodontidae						5												
Chiasmodontidae									3									
Scombridae									12	1								
Gempylidae									1									
Acanthuridae									17									
Gobiidae						3			3									
Mugiloididae								1	11									
Uranoscopidae						1			2									
Blenniidae																		3
Scorpaenidae		1	1	1			4											
Callionymidae									1									
Bothidae	1					1	2		3									
Balistidae									1							1		
Monacanthidae									1									
Tetraodontidae									1									
Unidentified						1			5							1		
Total	76	25	6	19	32	38	8	18	127	5	7	6	6	12	7	6	28	234

5-4-3. Study of epi- and mesopelagic shrimps

Tomohiko KIKUCHI (ORI, Univ. Tokyo)

Aims

1) To characterize the general geographical distribution patterns of epi- and mesopelagic shrimps

2) To investigate the role of epipelagic shrimps of the genus *Lucifer* in relation to the epipelagic food chain

Methods

Epipelagic shrimp samples were obtained by surface horizontal hauls of the ORI-69 net.

Mesopelagic shrimp samples were obtained by oblique hauls of 10-foot IKMT, IKPT and 10-foot IKMT-EMPS (Isaacs-Kidd Midwater Trawl with Electric Multi-layer Plankton Sampler) samplers.

Results

Epipelagic species : Among seven recognized species belonging to the genus *Lucifer*, five species, i.e., *Lucifer chacei*, *L. hanseni*, *L. intermedius*, *L. penicillifer*, and *L. typus* were found in the survey areas.

Mesopelagic species : Sergestid and oplophorid shrimps were the main components of the mesopelagic shrimp communities. Sergestids, *Sergia japonica* and *S. prehensilis* and oplophorids, *Acanthephyra quadrispinosa* and *Oplophorus spinosus* were dominant at stations off Sanriku area. Besides these species, a penaeid *Bentheogennema borealis* occurred abundantly at stations where the midwater samplers reached below 1,000m.

Species composition, geographical distribution of the both epi- and mesopelagic shrimps and the ecological roles of the epipelagic shrimps of the genus *Lucifer* are now being analyzed.

5-4-4. Zooplankton community in the Kuroshio region

Tatsuki TODA and Bong-Cheol OH
(Ocean Research Institute, Univ. Tokyo)

Plankton samplings were performed at the stations on the transect across the Kuroshio to investigate surface zooplankton communities. Samples were collected by 0-150m vertical hauls of a twin NORPAC net (Table 4).

Although the samples are now being analyzed, preliminary observations revealed that the following species to be dominant of the copepods in this area: *Mesocalanus tenuicornis*, *Cosmocalanus darwini*, *Pontellopsis regalis* and *Corycaeus* spp.

Several copepods were fixed in 4% glutaraldehyde in order to observe their gut contents and gut structures with scanning electron microscope.

5-4-5. Distribution of *Sapphirina* (Copepoda; Poecilostomatoida)

Tatsuki TODA (Ocean Research Institute, Univ. Tokyo)

Sapphirina species were sorted out from the zooplankton samples collected with ORI-69 net and NORPAC net for the purpose of studying species composition and distribution in the Kuroshio region (Tables 4 and 6).

At present, the following 9 species of *Sapphirina* were identified: *Sapphirina angusta*, *S. darwini*, *S. metallina*, *S. gamma*, *S. opalina*, *S. stellata*, *S. intestinata*, *S. scarlata* and *S. nigromaculata*.

Further analysis will be continued at out institute.

5-4-6. The vertical distributions of zooplankton and the food webs in the Oyashio Current area and the Sea of Japan

Hiroya SUGISAKI (Ocean Research Institute, Univ. Tokyo)

Both in the Oyashio Current area and in the Sea of Japan, many zooplankton species perform diurnal vertical migrations. Some species of them usually occurring only in the Oyashio Current area at depths shallower than 200-500m are found in the Sea of Japan at depths deeper than 1,000m (Vinogradov, 1968). But the reason of this fact, and the detailed movement of the diurnal migrations of these species have not been clarified yet.

In order to construct the frameworks of the food web and to clarify the vertical migrations and distributions of zooplankton in the Oyashio Current area and the Sea of Japan, the following samplings were carried out through 12 hours at St. 6 (in the Oyashio Current area) and through 24 hours at St. 9 (in the Sea of Japan). Both series included MTD net towings (4 times, 10-13 layers: see Table 5), ORI net towings (2 times, 1,500m wire out at St. 6, and 3,000m wire out at St. 9: see Table 6), and water samplings with van Dorn water samplers (5 layers). The sampling layers were between 0 and 750m at St. 6, and 0 to 1,500m at St. 9.

The zooplankton caught with MTD nets were preserved in 5% buffered formalin sea water immediately after collection. The detailed vertical distributions and diurnal migrations of the zooplankton are now being analyzed.

The water samples were filtered through silica fiber filters (Advantec Toyo QR80) and rinsed with 0.1N HCl to remove carbonate and salts. They and the zooplankton caught with the ORI net are ready to measure the natural stable carbon and nitrogen isotope ratios. Because it has been established that these ratios of an animal reflect those of its diet (De Niro and Epstein, 1978 and 1981), these samples are to be used for analysis of the food webs.

References

De Niro, M. J. and S. Epstein, 1978: Influence of diet on the distribution of carbon isotopes in animals. Geochim. Cosmochim. Acta, **42**: 495-506.

De Niro, M. J. and S. Epstein, 1981: Influence of diet on the distribution of nitrogen isotopes in animal. Geochim. Cosmochim. Acta, **45**: 341-351.

Vinogradov, M. E., 1968: Vertical distribution of oceanic zooplankton. Nauka, Moscow, 320pp.

5-5. Chemical and Radiochemical Studies of the Western North Pacific, the Sea of Japan and the East China Sea

Koh HARADA, Seiya NAGAO, Yutaka WATANABE, Shimei SAITO and Masayuki MINAKAWA (Hokkaido University)

1. Manganese and aluminum in sea water

Sea water samples were taken at stations along two lines, one located off Sanriku in the western North Pacific and the other located in East China Sea (see the track chart [Fig. 1] and Table 9), to clarify variations in the vertical distributions of Mn and Al from coastal ocean to open ocean. The sampling was carried out at Sts. SR64, 5, SR68, SR71 and SR72 off Sanriku, and Sts. 14, 15, 16, 19 and 20B in the East China Sea by using 5-liter Niskin bottles attached to a CTD system or 23-liter Niskin bottles. The sample water were collected sub-samples from the Niskin bottles into acid-washed plastic bottles and acidified with hydrochloric acid. The samples will be transported to Hokkaido University in Hakodate and analyzed for Mn and Al with an atomic absorption spectrometer after pre-treatment in a clean room.

2. Tritium in sea water

Tritium is one of the most useful tracers for mixing processes between surface water and underlying water. In this cruise, we made our efforts to clarify the existence of the Oyashio Under Current and vertical mixing processes in the Sea of Japan. Water samples for tritium were collected at Sts. 3, 4, 5, 6, SR68, 9 and 13 by using a CTD-RMS system (Table 9). Tritium in the samples will be concentrated by electrolysis and counted with a liquid scintillation counter after sample transportation to our laboratory in Hakodate.

3. Chlorofluoromethane in maritime air and sea water

Chlorofluoromethane (CFM) is one of the anthropogenic chemical compounds which have been released to natural environment by industrial activity from 1950's. Two kinds of CFM, F-11 and F-12, in maritime air were determined to assess their most recent concentration in air. The compounds are quite stable and they have a possibility to be useful tracers for natural phenomena which operate in sea water. To clarify vertical distributions of the CFMs in water columns, water samples were taken at Sts. 6, 9, 11', 12', 13, 14, 15 and 16 by using a CTD-

RMS system. Immediately after collection, CFMs in the samples were determined with a gas chromatography coupled with a electron capture detector on board of the ship.

4. Metals and radioactive isotopes in sediment

Subcore samples from the sediment collected with a box corer were taken at Sts. SR67, SR68, SR72, SR73 and SR75-2 (Table 2). The core samples were cut into segments of 2-4cm thickness. The sectioned samples were subject to pore water extraction with a mechanical pressure squeezer made of stainless steel. Nitrate, nitrite, ammonium and phosphate in the pore waters were determined. The remaining pore waters, solid fractions and untreated sediment samples will be transported to our laboratory at Hakodate and analyzed for major components, some metals such as Mn, Fe, Ni and Co and uranium and thorium series radioisotopes. The data can be used to elucidate the behaviors of chemical materials during early diagenesis of hemipelagic and pelagic sediments.

5. Carbon-14 in sea water

Two hundred liter of water samples were taken from various depths at St. 23 (Table 11). Carbon dioxide in the samples was extracted and collected into sodium hydroxide solution immediately after sampling. Carbon-14 in the solution will be counted with a liquid scintillation counter. The data will be used for a discussion of deep sea water formation process in the Philippine Sea.

5-6. Vertical Distribution of Organic Compounds and Pigments, and their Roles in Marine Ecosystem

Shigeru MONTANI*, Yasufumi MISHIMA** and Mitsuyoshi YOSHIDA*
(* Kagawa University; ** Ehime University)

It is well known that organic nitrogen compounds play important roles in marine ecosystem. Organic nitrogen compounds and pigments are also produced by photosynthesis of phytoplankton in the euphotic zone. Especially amino acids which are the building blocks of protein molecules, form the largest reservoir of organic nitrogen in marine organisms. The composition of amino acids in the organisms change during the transformation processes through the marine food web.

The distribution and the changing processes of the essential amino acids play important roles in mesopelagic and bathypelagic ecosystem, and the secondary production in these layers will depend on the vertical transport of the essential amino acids.

However, the information on this problem is still limited. It is also important to know the distribution of pigments and nucleic acid bases, which will serve to make clear the secondary production and biochemical processes of suspended particles.

In this study, zooplankton, pelagic fish and benthos samples were collected by MTD, IKPT and ORI nets and beam trawls and then analyzed for organic nitrogen compounds (amino acids and nucleic acid bases etc.) and pigments. Water samples were collected from various depths (0, 25, 50, 75, 125, 200, 400, 600, 800, 1000, 2000, . . . , 7000m) by Niskin bottles (see Table 10), and suspended particles were obtained by filtration through a nuclepore filter and pre-combusted GF/C filter.

Amino acids, nucleic acid bases and pigments are analyzed by appropriate HPLC system, respectively, after hydrolysis and extraction procedure. In addition the organisms living in mesopelagic, bathypelagic and benthic layers are also analyzed by the same method of suspended particles for amino acids, nucleic acid bases and pigments.

5-7. Impressions and suggestion of the KH-88-4 Cruise by a WESTPAC scientist

Zheng ZHOU (State Oceanic Administration, P.R.C.)

Following the "Letter of Agreement" of UNESCO, I have participated in the cruise KH-88-4, and during this cruise I could have several invaluable experiences and exchange of ideas with Japanese marine scientists. It was very fortunate that I could work with Japanese scientists in the KH-88-4 cruise. I could see advanced marine technology of Japan with my own eyes, and also I could learn some new knowledge on the effective management of the research cruise. I am sure that these experiences are very important for my present work in China.

In KH-88-4 cruise, I have participated in the most of operations for the collection of the chemical and biological data. A CTD profiler system with 24-bottle rosette sampler and several water sampling bottles were utilized to describe the characteristics of the sea water for the collection of the environmental data. The water samples were analyzed on board for their chemical compositions or processed for the future studies back in the institutions. MTD net, ORI-69 net, and 10-foot IKMT were used for the collection of plankton. Each of these sampling apparatuses was applied for specific purpose. EMPS was attached to IKMT, and this was interesting to me. For the collection of benthic organisms, trawls and box corers were used. This was the first time for me to operate the box corers, and their very good sampling efficiency made me feel that these sampler would be very important for my present work in China such as environmental monitoring for the detection of marine pollution. While I experienced the operations of several sampling devices which were new to me, I also made discussions with Japanese scientists and provided some suggestions to them from my own experiences and knowledges in China. I am sure that my participation in the cruise was beneficial for both sides and will contribute to the mutual understanding between the marine scientists in two countries.

There is one thing which I regret. I think I can provide some suggestion for the improvement of the "Resolution 10.2(d)(i)" of UNESCO in this point. The information of my participation in the cruise did not arrive in due time. If I had been informed sufficiently before my departure to Japan, I could have had enough time to prepare scrupulouly for my participa-

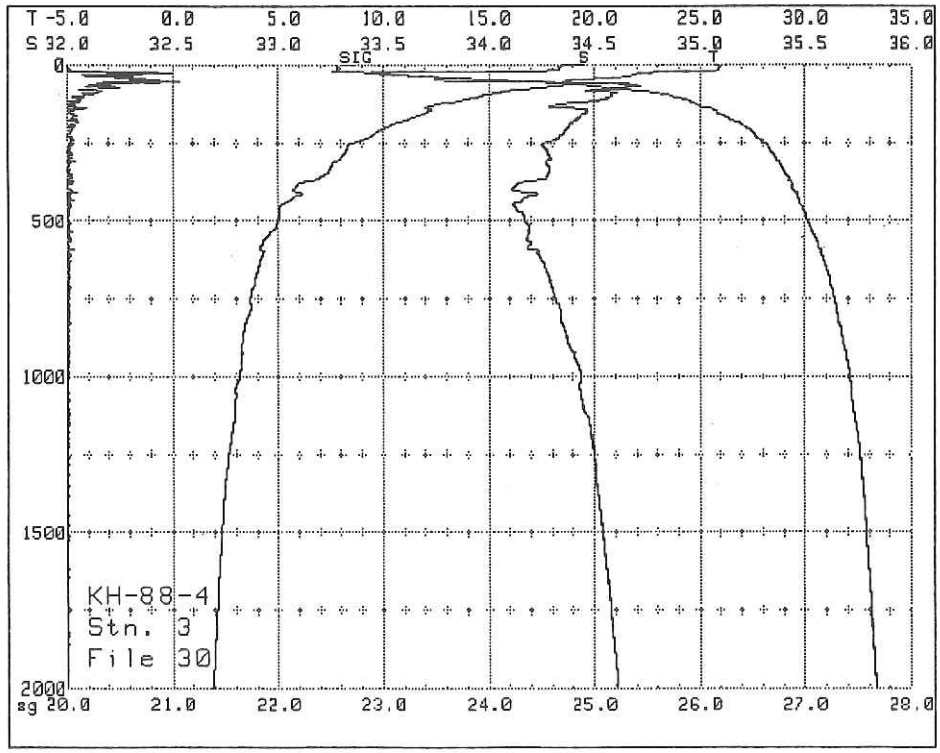
tion in the cruise. It would be better for UNESCO to provide a sufficient period of preparation to the participants of the IOC international cruise.

Finally, if some foreign scientists can visit my country with the assistance of UNESCO to participate in the investigations in China, it will benefit both countries.

I am grateful to the Director of the Ocean Research Institute, University of Tokyo, Prof. Takahisa Nemoto and Dr. Mario Ruivo of the secretary general of IOC for affording me to participate in the cruise. My special thanks are extended to Dr. Suguru Ohta (ORI, University of Tokyo: chief scientist of the cruise) and Kouichi Ohwada (ORI, UT: vice-chief of the cruise) for making my participation a fruitful, pleasant and enjoyable one. All participants of the cruise and the crew of the R.V. Hakuho Maru provided me many advises and discussions, and I wish to express my sincere thanks to them.

VI. APPENDICES (routine data)

A



B

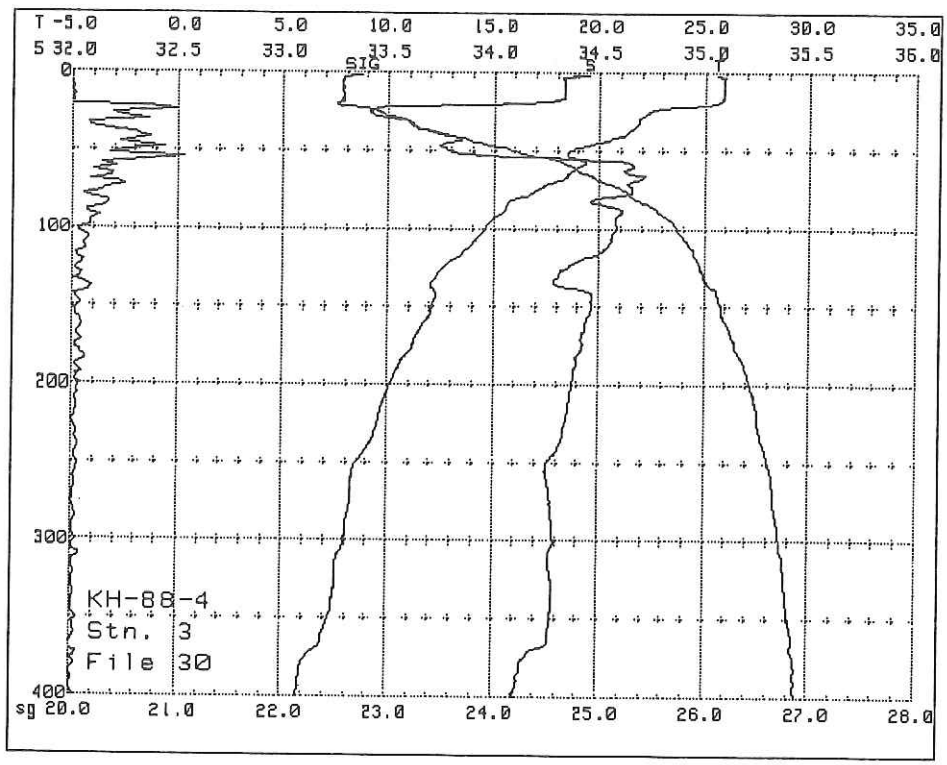


Fig. 11. Vertical profiles of temperature, salinity and σ_t at Station 3 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 19. List of CTD vertical profile data obtained through downward operation at Station 3

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 3 Cruise name KH-88-4
File name 30
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	25.849	25.848	34.341	22.585	22.585	525.2	0.0000	1.0226	1536.1	1536.1
10	25.894	25.892	34.335	22.566	22.567	527.0	0.0526	1.0226	1536.3	1536.2
20	25.068	25.064	33.946	22.526	22.527	530.8	0.1056	1.0226	1534.1	1535.7
30	21.892	21.886	33.567	23.160	23.162	470.2	0.1557	1.0227	1526.0	1533.8
40	21.082	21.074	33.792	23.554	23.556	432.6	0.2010	1.0229	1524.3	1531.7
50	18.613	18.604	33.797	24.200	24.202	371.0	0.2413	1.0232	1517.6	1529.5
60	19.042	19.031	34.658	24.750	24.753	318.5	0.2760	1.0234	1520.1	1527.8
70	17.864	17.852	34.655	25.042	25.045	290.8	0.3066	1.0237	1516.8	1526.4
75	17.030	17.017	34.658	25.245	25.248	271.4	0.3208	1.0238	1514.5	1525.7
80	16.129	16.116	34.503	25.337	25.340	262.7	0.3343	1.0239	1511.6	1524.9
90	15.398	15.384	34.601	25.577	25.581	239.8	0.3597	1.0241	1509.6	1523.3
100	14.577	14.562	34.578	25.739	25.743	224.5	0.3831	1.0243	1507.2	1521.8
125	12.607	12.590	34.341	25.960	25.964	203.5	0.4374	1.0247	1500.8	1518.3
150	12.088	12.068	34.466	26.158	26.162	184.7	0.4867	1.0250	1499.5	1515.2
175	11.203	11.181	34.423	26.290	26.294	172.1	0.5323	1.0253	1496.8	1512.8
200	10.140	10.116	34.373	26.439	26.443	158.0	0.5746	1.0256	1493.4	1510.6
250	8.507	8.480	34.257	26.614	26.618	141.4	0.6516	1.0260	1488.0	1506.6
300	7.960	7.929	34.292	26.724	26.729	130.9	0.7220	1.0263	1486.7	1503.4
350	7.226	7.192	34.278	26.819	26.824	121.9	0.7879	1.0266	1484.7	1500.9
400	5.726	5.691	34.111	26.884	26.889	115.7	0.8499	1.0268	1479.3	1498.5
450	5.118	5.082	34.117	26.962	26.966	108.4	0.9084	1.0270	1477.7	1496.3
500	4.996	4.955	34.171	27.019	27.023	103.0	0.9638	1.0273	1478.1	1494.4
550	4.467	4.424	34.185	27.088	27.093	96.4	1.0163	1.0275	1476.7	1492.9
600	4.281	4.235	34.230	27.144	27.149	91.1	1.0659	1.0277	1476.8	1491.6
650	4.053	4.005	34.265	27.196	27.201	86.2	1.1131	1.0278	1476.7	1490.4
700	3.865	3.813	34.291	27.236	27.242	82.4	1.1581	1.0280	1476.8	1489.4
750	3.678	3.624	34.316	27.275	27.280	78.7	1.2013	1.0282	1476.9	1488.6
800	3.614	3.556	34.345	27.304	27.310	75.9	1.2431	1.0284	1477.5	1487.9
850	3.382	3.321	34.360	27.338	27.344	72.7	1.2834	1.0285	1477.3	1487.3
900	3.263	3.199	34.381	27.367	27.373	70.0	1.3222	1.0287	1477.7	1486.7
950	3.227	3.159	34.416	27.398	27.404	67.1	1.3598	1.0288	1478.4	1486.3
1000	3.157	3.086	34.437	27.422	27.428	64.8	1.3962	1.0290	1478.9	1485.9
1100	2.938	2.862	34.448	27.450	27.457	62.1	1.4666	1.0293	1479.7	1485.3
1200	2.775	2.693	34.489	27.497	27.505	57.6	1.5337	1.0296	1480.7	1484.9
1250	2.659	2.573	34.498	27.515	27.523	56.0	1.5657	1.0297	1481.0	1484.7
1300	2.557	2.469	34.505	27.529	27.536	54.7	1.5970	1.0299	1481.4	1484.6
1400	2.414	2.319	34.522	27.555	27.563	52.2	1.6577	1.0302	1482.5	1484.4
1500	2.328	2.226	34.538	27.575	27.583	50.3	1.7164	1.0304	1483.8	1484.3
1750	2.110	1.991	34.578	27.625	27.634	45.6	1.8558	1.0311	1487.1	1484.5
2000	1.911	1.774	34.612	27.668	27.679	41.5	1.9849	1.0317	1490.4	1485.0

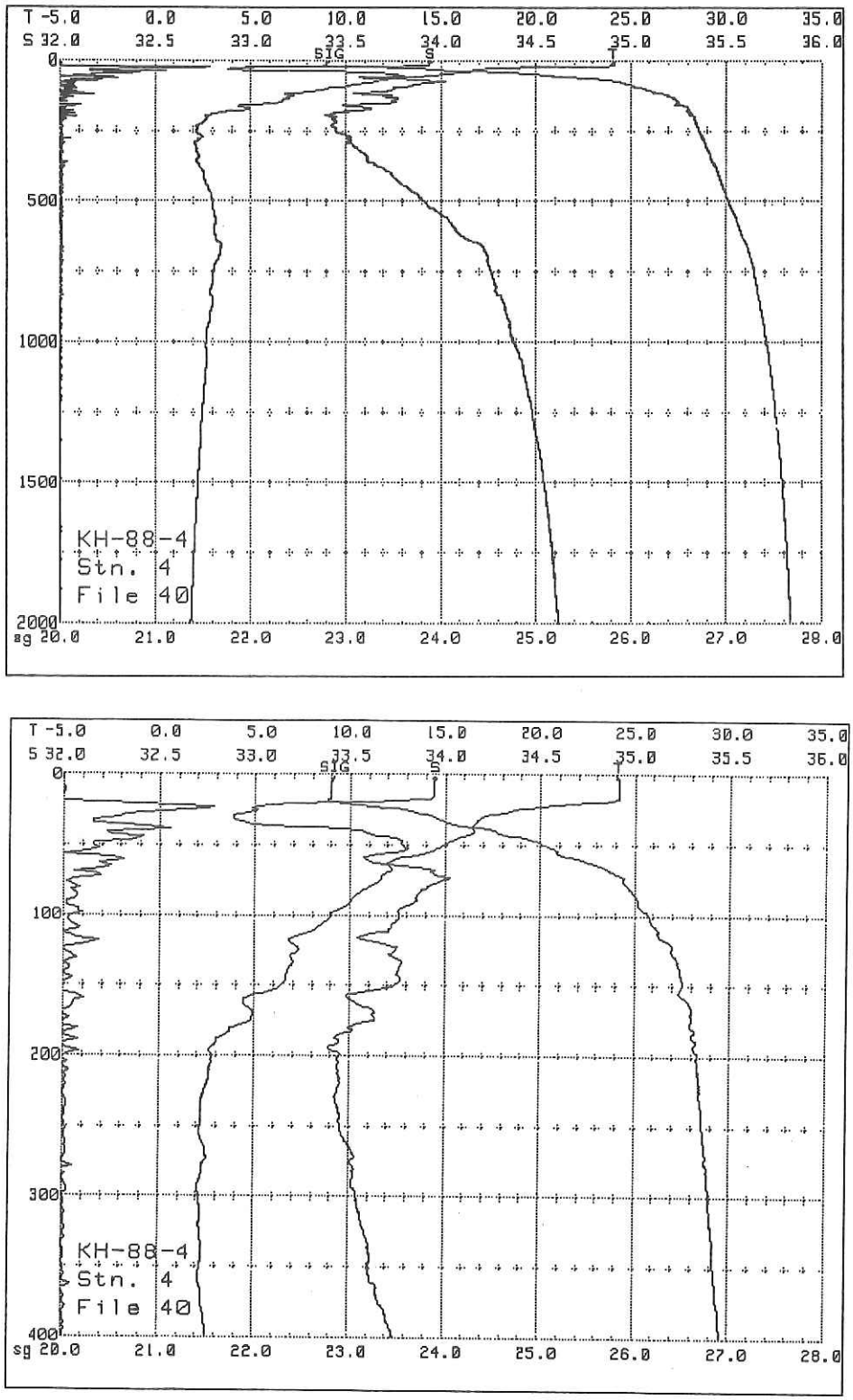


Fig. 12. Vertical profiles of temperature, salinity and σ_t at Station 4 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 20. List of CTD vertical profile data obtained through downward operation at Station 4.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 4 Cruise name KH-88-4
File name 40
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	24.125	24.124	33.943	22.806	22.807	504.0	0.0000	1.0228	1531.6	1531.6
10	24.161	24.159	33.942	22.795	22.796	505.1	0.0505	1.0228	1531.8	1531.7
20	22.449	22.445	33.422	22.895	22.897	495.5	0.1006	1.0229	1527.1	1530.6
30	17.022	17.017	32.891	23.892	23.893	400.4	0.1454	1.0231	1511.6	1526.8
40	16.434	16.428	33.560	24.542	24.544	338.4	0.1825	1.0234	1510.8	1522.9
50	14.785	14.778	33.787	25.084	25.086	286.8	0.2139	1.0237	1506.0	1520.0
60	12.345	12.337	33.595	25.433	25.435	253.6	0.2410	1.0240	1497.9	1517.0
70	11.879	11.870	33.944	25.792	25.794	219.4	0.2648	1.0243	1496.9	1514.2
75	11.537	11.528	33.983	25.887	25.888	210.5	0.2757	1.0244	1495.8	1513.0
80	10.941	10.931	33.905	25.934	25.935	206.0	0.2862	1.0245	1493.7	1511.9
90	10.045	10.035	33.841	26.040	26.041	195.9	0.3064	1.0247	1490.5	1509.7
100	8.975	8.964	33.758	26.150	26.152	185.4	0.3257	1.0249	1486.6	1507.6
125	7.196	7.184	33.731	26.393	26.394	162.4	0.3696	1.0253	1480.2	1502.7
150	6.269	6.255	33.707	26.497	26.499	152.5	0.4094	1.0256	1476.9	1498.7
175	4.723	4.710	33.604	26.600	26.601	142.8	0.4468	1.0258	1470.9	1495.2
200	2.757	2.745	33.442	26.663	26.664	136.8	0.4821	1.0260	1462.7	1491.6
250	2.161	2.148	33.452	26.719	26.720	131.4	0.5496	1.0264	1460.9	1485.7
300	2.126	2.109	33.540	26.793	26.794	124.4	0.6140	1.0267	1461.7	1481.6
350	2.200	2.180	33.612	26.845	26.846	119.5	0.6755	1.0269	1463.0	1478.9
400	2.565	2.542	33.741	26.918	26.920	112.6	0.7343	1.0271	1465.6	1477.0
450	2.773	2.745	33.827	26.969	26.971	107.7	0.7905	1.0273	1467.4	1475.9
500	2.985	2.953	33.917	27.022	27.025	102.7	0.8444	1.0275	1469.3	1475.1
550	3.110	3.074	34.012	27.087	27.090	96.6	0.8958	1.0277	1470.7	1474.6
600	3.107	3.068	34.079	27.140	27.144	91.5	0.9447	1.0279	1471.6	1474.4
650	3.460	3.415	34.202	27.205	27.210	85.3	0.9910	1.0280	1474.1	1474.2
700	3.319	3.271	34.247	27.255	27.259	80.6	1.0349	1.0282	1474.4	1474.2
750	3.052	3.002	34.265	27.294	27.298	77.0	1.0768	1.0284	1474.1	1474.2
800	2.968	2.914	34.291	27.322	27.327	74.3	1.1171	1.0285	1474.6	1474.3
850	3.008	2.951	34.327	27.347	27.352	71.9	1.1563	1.0287	1475.7	1474.3
900	2.877	2.816	34.345	27.373	27.379	69.4	1.1943	1.0288	1475.9	1474.4
950	2.727	2.663	34.362	27.400	27.406	66.9	1.2312	1.0290	1476.2	1474.5
1000	2.687	2.621	34.385	27.422	27.428	64.7	1.2669	1.0291	1476.8	1474.6
1100	2.629	2.556	34.434	27.466	27.473	60.6	1.3356	1.0294	1478.3	1474.9
1200	2.531	2.451	34.468	27.502	27.509	57.2	1.4009	1.0297	1479.6	1475.2
1250	2.472	2.388	34.482	27.518	27.525	55.7	1.4324	1.0298	1480.2	1475.4
1300	2.404	2.318	34.494	27.534	27.541	54.2	1.4633	1.0300	1480.7	1475.6
1400	2.320	2.226	34.524	27.564	27.572	51.3	1.5229	1.0303	1482.1	1476.0
1500	2.239	2.139	34.543	27.587	27.595	49.2	1.5804	1.0305	1483.4	1476.4
1750	2.032	1.914	34.588	27.639	27.648	44.2	1.7159	1.0312	1486.7	1477.7
2000	1.871	1.735	34.617	27.675	27.685	40.8	1.8419	1.0318	1490.3	1479.0

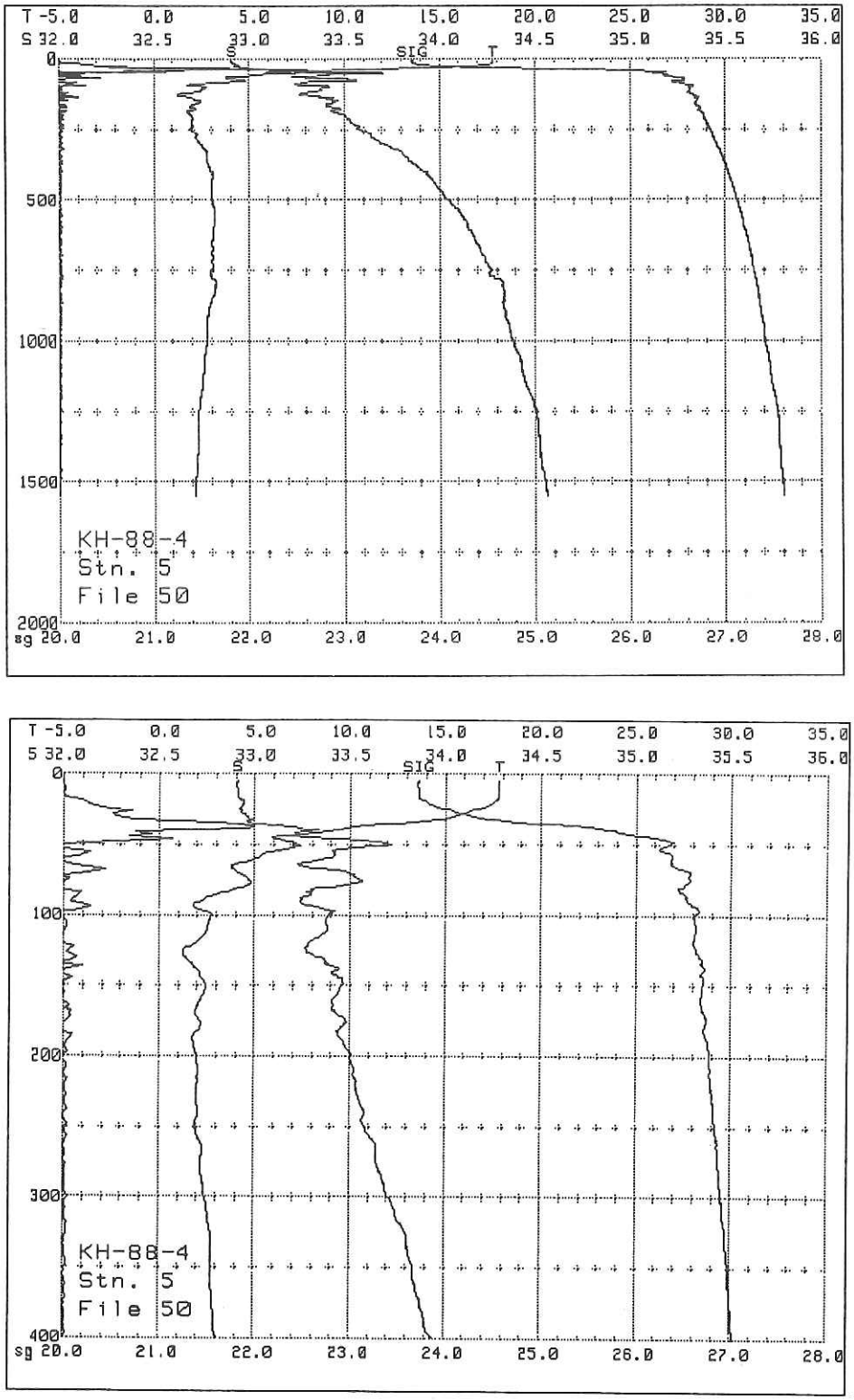


Fig. 13. Vertical profiles of temperature, salinity and σ_t at Station 5 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 21. List of CTD vertical profile data obtained through downward operation at Station 5.

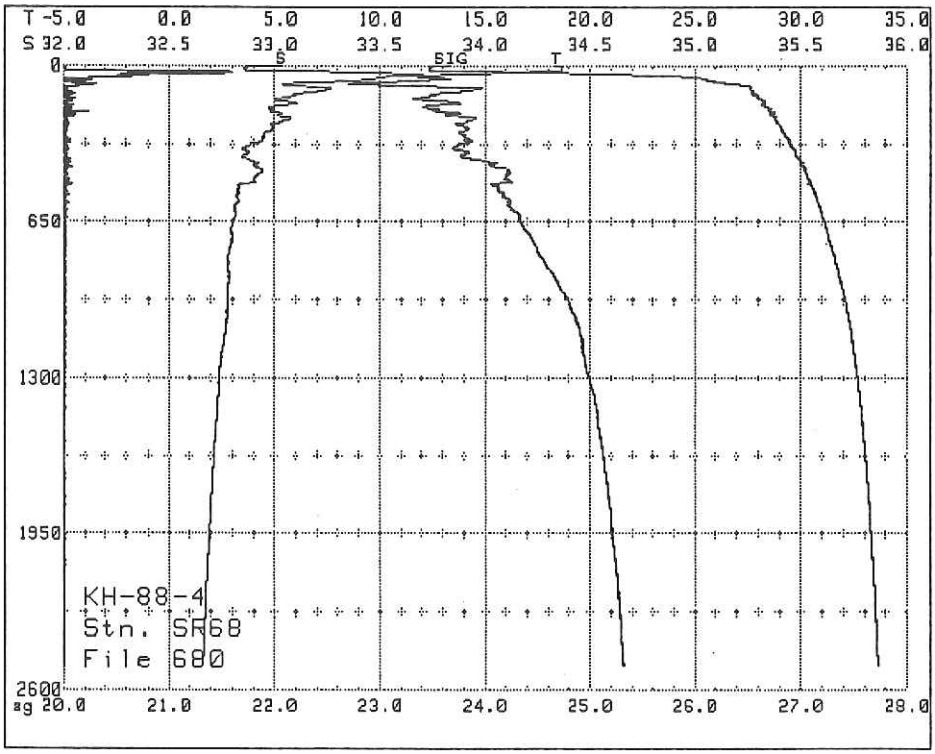
[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 5 Cruise name KH-88-4
File name 50
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	17.809	17.808	32.907	23.717	23.717	417.0	0.0000	1.0237	1513.5	1513.5
10	17.810	17.808	32.908	23.717	23.718	417.0	0.0417	1.0238	1513.6	1513.6
20	17.481	17.478	32.938	23.819	23.820	407.3	0.0830	1.0238	1512.8	1513.4
30	15.408	15.403	32.962	24.313	24.314	360.2	0.1214	1.0239	1506.7	1512.2
40	8.639	8.634	33.262	25.813	25.814	217.4	0.1504	1.0242	1483.8	1507.9
50	7.238	7.233	33.642	26.317	26.318	169.6	0.1698	1.0247	1479.0	1502.6
60	4.873	4.868	33.343	26.376	26.376	164.0	0.1865	1.0250	1469.3	1497.9
70	4.252	4.247	33.503	26.570	26.570	145.6	0.2021	1.0252	1467.1	1493.6
75	4.721	4.715	33.553	26.559	26.560	146.6	0.2094	1.0253	1469.2	1491.9
80	4.129	4.123	33.355	26.464	26.465	155.6	0.2170	1.0254	1466.5	1490.4
90	2.073	2.069	33.247	26.562	26.562	146.4	0.2322	1.0256	1457.7	1487.3
100	2.733	2.727	33.388	26.622	26.622	140.7	0.2465	1.0257	1460.9	1484.5
125	1.293	1.288	33.275	26.640	26.640	139.0	0.2816	1.0260	1454.8	1479.2
150	2.463	2.454	33.454	26.697	26.698	133.5	0.3157	1.0262	1460.6	1475.6
175	2.160	2.151	33.477	26.739	26.740	129.5	0.3487	1.0264	1459.8	1473.4
200	1.982	1.971	33.504	26.775	26.775	126.2	0.3809	1.0266	1459.4	1471.7
250	1.916	1.903	33.580	26.840	26.841	119.9	0.4427	1.0268	1460.0	1469.3
300	2.413	2.396	33.711	26.906	26.908	113.7	0.5016	1.0271	1463.2	1468.0
350	2.777	2.755	33.839	26.978	26.980	106.9	0.5575	1.0273	1465.8	1467.5
400	3.067	3.042	33.936	27.029	27.032	102.0	0.6108	1.0274	1468.0	1467.4
450	3.036	3.007	33.988	27.074	27.076	97.8	0.6621	1.0276	1468.8	1467.5
500	3.064	3.031	34.053	27.123	27.126	93.1	0.7113	1.0278	1469.8	1467.7
550	3.204	3.167	34.117	27.161	27.165	89.5	0.7586	1.0280	1471.3	1468.0
600	3.113	3.073	34.153	27.199	27.202	85.9	0.8044	1.0281	1471.8	1468.3
650	3.046	3.003	34.193	27.237	27.241	82.3	0.8485	1.0283	1472.4	1468.5
700	3.074	3.027	34.237	27.269	27.273	79.3	0.8910	1.0284	1473.4	1468.9
750	3.076	3.025	34.271	27.296	27.301	76.7	0.9324	1.0286	1474.2	1469.2
800	3.249	3.193	34.334	27.330	27.335	73.5	0.9726	1.0287	1475.9	1469.6
850	3.021	2.964	34.338	27.355	27.360	71.1	1.0115	1.0289	1475.7	1469.9
900	2.876	2.815	34.347	27.375	27.380	69.2	1.0494	1.0290	1475.9	1470.2
950	2.776	2.713	34.364	27.397	27.403	67.1	1.0863	1.0291	1476.4	1470.6
1000	2.751	2.684	34.385	27.417	27.422	65.3	1.1223	1.0293	1477.1	1470.9
1100	2.604	2.530	34.431	27.466	27.472	60.6	1.1913	1.0296	1478.2	1471.5
1200	2.428	2.348	34.482	27.522	27.529	55.3	1.2555	1.0298	1479.2	1472.1
1250	2.341	2.259	34.506	27.548	27.555	52.8	1.2857	1.0300	1479.6	1472.4
1300	2.309	2.224	34.515	27.558	27.565	51.9	1.3151	1.0301	1480.4	1472.7
1400	2.270	2.177	34.526	27.570	27.578	50.8	1.3731	1.0304	1481.9	1473.3
1500	2.178	2.078	34.552	27.598	27.606	48.1	1.4295	1.0306	1483.1	1473.9

A



B

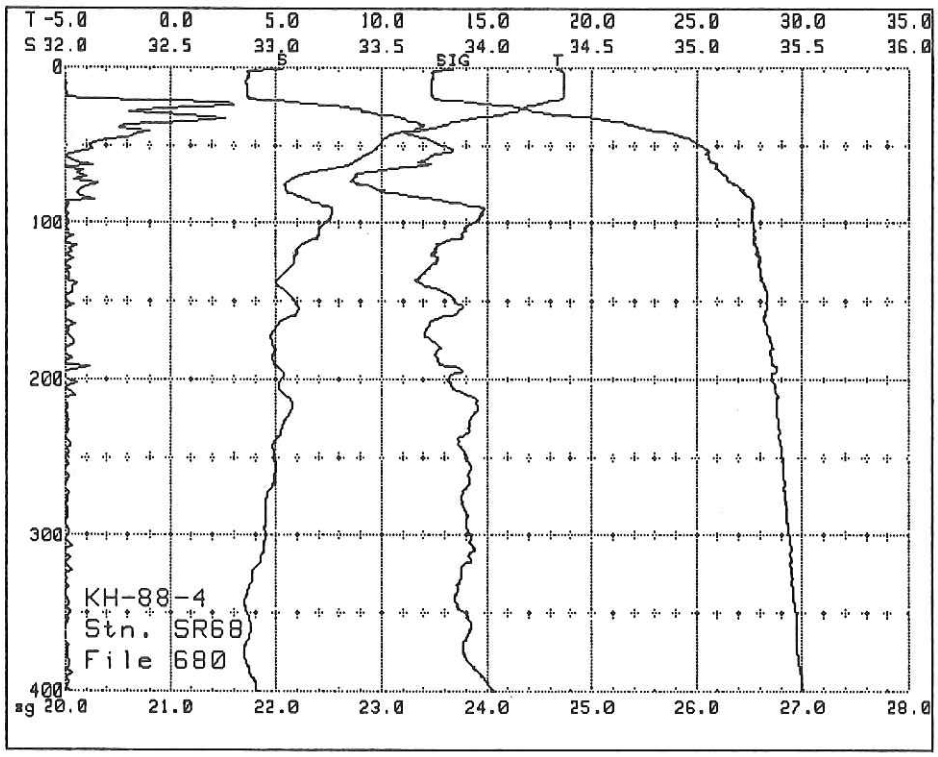


Fig. 14. Vertical profiles of temperature, salinity and σ_t at Station SR68 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 22. List of CTD vertical profile data obtained through downward operation at Station SR68.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name SR68 Cruise name KH-88-4
File name 680
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	18.624	18.623	32.871	23.490	23.490	438.7	0.0000	1.0235	1515.8	1515.8
10	18.644	18.643	32.861	23.477	23.477	439.9	0.0440	1.0235	1516.0	1515.9
20	18.450	18.447	32.916	23.567	23.568	431.3	0.0876	1.0236	1515.6	1515.9
30	15.392	15.387	33.530	24.754	24.755	318.2	0.1251	1.0238	1507.3	1514.4
40	11.618	11.613	33.644	25.607	25.608	237.0	0.1530	1.0242	1495.1	1511.1
50	9.848	9.842	33.793	26.036	26.037	196.3	0.1747	1.0245	1489.1	1507.3
60	8.719	8.713	33.713	26.154	26.155	185.0	0.1939	1.0248	1485.0	1503.9
70	6.006	6.000	33.378	26.270	26.271	174.0	0.2119	1.0251	1474.1	1500.4
75	5.466	5.460	33.401	26.354	26.355	166.1	0.2205	1.0252	1472.0	1498.6
80	5.612	5.606	33.538	26.445	26.446	157.4	0.2286	1.0253	1472.9	1497.0
90	7.586	7.578	33.979	26.532	26.533	149.2	0.2441	1.0255	1481.5	1494.8
100	7.259	7.250	33.923	26.535	26.536	148.9	0.2591	1.0256	1480.3	1493.4
125	5.827	5.816	33.753	26.589	26.591	143.7	0.2961	1.0259	1474.8	1490.2
150	5.909	5.896	33.858	26.661	26.663	136.9	0.3316	1.0261	1475.7	1487.7
175	4.812	4.799	33.747	26.703	26.705	132.9	0.3657	1.0263	1471.4	1485.7
200	5.190	5.174	33.821	26.719	26.721	131.5	0.3993	1.0265	1473.5	1484.0
250	4.922	4.903	33.902	26.814	26.816	122.4	0.4639	1.0267	1473.3	1481.9
300	4.507	4.484	33.925	26.878	26.881	116.3	0.5250	1.0270	1472.4	1480.4
350	3.624	3.600	33.892	26.942	26.945	110.2	0.5830	1.0272	1469.5	1479.1
400	4.098	4.069	34.035	27.009	27.012	104.0	0.6380	1.0274	1472.5	1478.1
450	4.254	4.220	34.108	27.050	27.054	100.0	0.6909	1.0276	1474.1	1477.5
500	3.317	3.284	34.061	27.106	27.109	94.7	0.7415	1.0277	1470.9	1477.0
550	3.239	3.202	34.103	27.147	27.151	90.8	0.7896	1.0279	1471.4	1476.5
600	3.099	3.059	34.136	27.186	27.190	87.1	0.8360	1.0281	1471.7	1476.1
650	3.024	2.981	34.172	27.222	27.226	83.7	0.8807	1.0282	1472.2	1475.8
700	2.982	2.936	34.211	27.257	27.261	80.4	0.9239	1.0284	1472.9	1475.5
750	2.931	2.881	34.243	27.287	27.292	77.6	0.9656	1.0285	1473.6	1475.4
800	2.801	2.748	34.272	27.322	27.327	74.3	1.0059	1.0287	1473.9	1475.3
850	2.806	2.749	34.311	27.352	27.357	71.4	1.0448	1.0288	1474.8	1475.2
900	2.828	2.768	34.347	27.379	27.384	68.9	1.0825	1.0290	1475.8	1475.2
950	2.788	2.725	34.379	27.408	27.414	66.1	1.1190	1.0291	1476.4	1475.3
1000	2.769	2.702	34.405	27.431	27.437	63.9	1.1544	1.0293	1477.2	1475.3
1100	2.694	2.620	34.452	27.475	27.481	59.8	1.2225	1.0295	1478.6	1475.6
1200	2.480	2.400	34.469	27.507	27.514	56.7	1.2872	1.0298	1479.4	1475.9
1250	2.424	2.341	34.481	27.521	27.528	55.4	1.3185	1.0299	1480.0	1476.0
1300	2.371	2.284	34.495	27.537	27.544	53.9	1.3491	1.0301	1480.6	1476.2
1400	2.331	2.237	34.525	27.564	27.572	51.3	1.4086	1.0303	1482.1	1476.6
1500	2.249	2.149	34.541	27.584	27.592	49.5	1.4662	1.0306	1483.4	1477.0
1750	2.053	1.935	34.583	27.633	27.643	44.8	1.6028	1.0313	1486.8	1478.1
2000	1.903	1.767	34.612	27.669	27.679	41.4	1.7305	1.0319	1490.4	1479.4
2250	1.743	1.587	34.641	27.704	27.715	38.1	1.8507	1.0325	1493.9	1480.9
2500	1.619	1.444	34.661	27.729	27.742	35.7	1.9642	1.0331	1497.6	1482.3

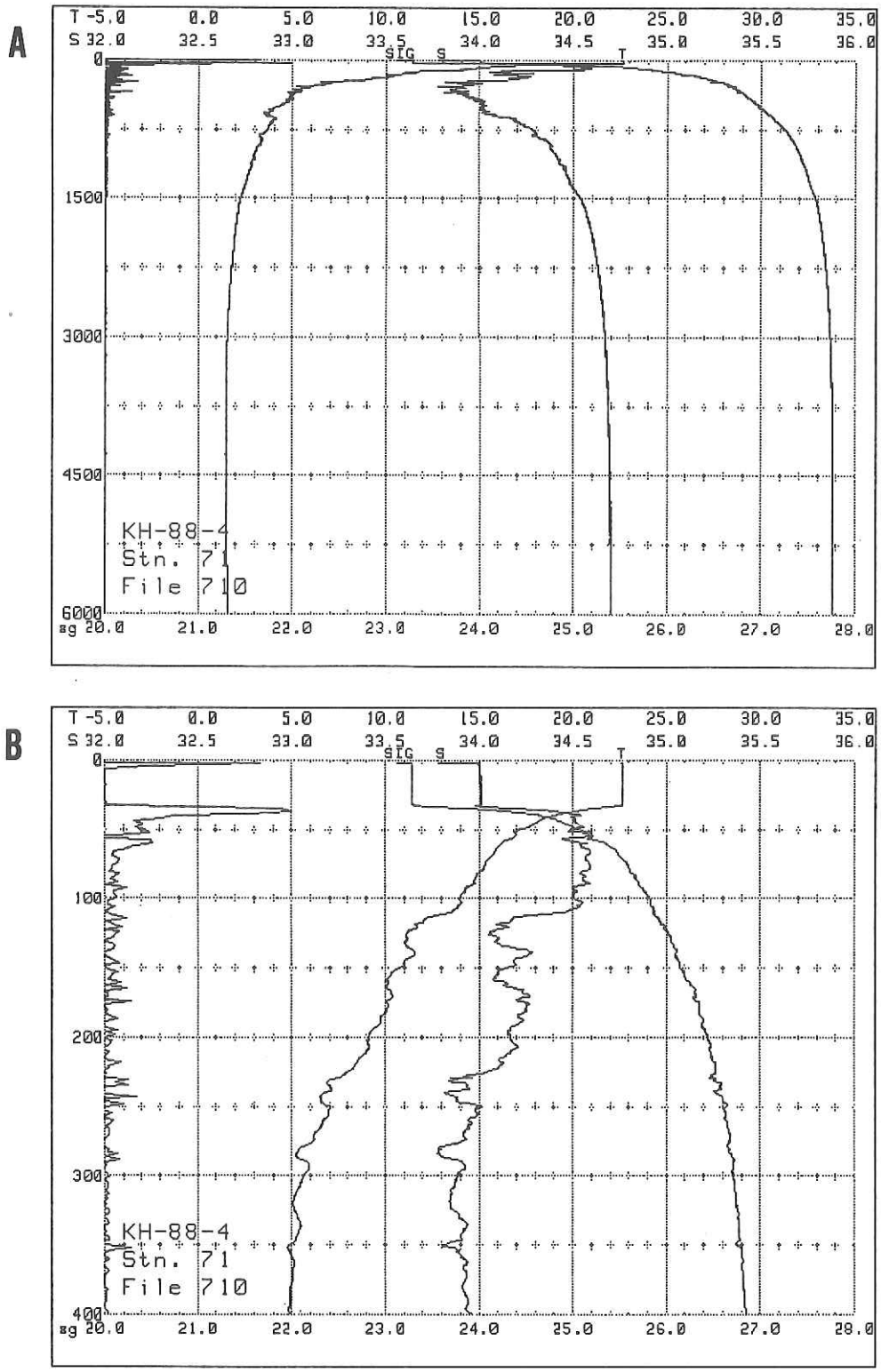


Fig. 15. Vertical profiles of temperature, salinity and σ_t at Station SR71 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 23. List of CTD vertical profile data obtained through downward operation at Station SR71.

[see Table 9 for the detailed station data]

Station name 71 Cruise name KH-88-4
File name 710
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	22.631	22.631	33.987	23.272	23.273	459.5	0.0000	1.0233	1527.9	1527.9
10	22.642	22.640	34.007	23.285	23.285	458.3	0.0459	1.0233	1528.1	1528.0
20	22.634	22.630	34.009	23.288	23.289	458.0	0.0918	1.0233	1528.2	1528.1
30	22.631	22.625	34.011	23.290	23.292	457.8	0.1377	1.0234	1528.4	1528.2
40	18.905	18.898	34.513	24.674	24.676	325.8	0.1770	1.0235	1519.2	1527.1
50	17.121	17.113	34.487	25.093	25.095	285.9	0.2077	1.0239	1514.1	1525.0
60	16.201	16.191	34.555	25.360	25.362	260.5	0.2352	1.0241	1511.6	1523.0
70	15.520	15.509	34.570	25.526	25.529	244.7	0.2606	1.0244	1509.7	1521.2
75	15.338	15.327	34.592	25.583	25.586	239.3	0.2728	1.0245	1509.2	1520.4
80	15.033	15.021	34.552	25.620	25.623	235.8	0.2848	1.0245	1508.3	1519.7
90	14.562	14.549	34.537	25.711	25.714	227.2	0.3082	1.0247	1506.9	1518.3
100	13.966	13.951	34.519	25.823	25.826	216.5	0.3307	1.0249	1505.1	1517.1
125	11.129	11.113	34.063	26.023	26.026	197.5	0.3831	1.0252	1495.3	1513.7
150	10.644	10.626	34.127	26.159	26.163	184.5	0.4316	1.0254	1494.0	1510.5
175	10.115	10.094	34.255	26.351	26.354	166.4	0.4763	1.0257	1492.7	1508.1
200	9.155	9.133	34.169	26.443	26.447	157.6	0.5177	1.0259	1489.5	1506.0
250	6.960	6.936	33.999	26.636	26.639	139.3	0.5938	1.0262	1481.7	1501.9
300	5.620	5.594	33.888	26.721	26.724	131.2	0.6633	1.0265	1477.0	1498.1
350	4.895	4.868	33.825	26.756	26.759	128.0	0.7298	1.0267	1474.7	1494.9
400	4.939	4.908	33.961	26.859	26.862	118.2	0.7933	1.0270	1475.9	1492.5
450	4.750	4.715	34.011	26.919	26.923	112.4	0.8531	1.0272	1476.0	1490.7
500	4.223	4.186	34.015	26.979	26.983	106.7	0.9101	1.0274	1474.7	1489.1
550	3.946	3.905	34.049	27.035	27.039	101.5	0.9644	1.0276	1474.4	1487.8
600	3.620	3.577	34.069	27.084	27.088	96.8	1.0163	1.0277	1473.8	1486.6
650	3.976	3.928	34.186	27.141	27.146	91.4	1.0658	1.0279	1476.3	1485.8
700	3.820	3.769	34.237	27.197	27.203	86.1	1.1130	1.0281	1476.5	1485.1
750	3.680	3.626	34.285	27.250	27.256	81.1	1.1578	1.0283	1476.8	1484.5
800	3.378	3.321	34.291	27.284	27.289	77.9	1.2004	1.0284	1476.4	1484.0
850	3.359	3.299	34.338	27.323	27.329	74.2	1.2414	1.0286	1477.2	1483.6
900	3.321	3.257	34.371	27.354	27.360	71.3	1.2810	1.0287	1477.9	1483.3
950	3.096	3.030	34.376	27.378	27.384	68.9	1.3193	1.0289	1477.8	1483.0
1000	3.028	2.959	34.396	27.401	27.407	66.8	1.3564	1.0290	1478.3	1482.7
1100	2.862	2.787	34.422	27.436	27.443	63.4	1.4283	1.0293	1479.3	1482.4
1200	2.701	2.619	34.453	27.475	27.482	59.7	1.4968	1.0296	1480.3	1482.2
1250	2.637	2.552	34.465	27.491	27.498	58.3	1.5298	1.0298	1480.9	1482.1
1300	2.596	2.507	34.480	27.506	27.513	56.8	1.5622	1.0299	1481.5	1482.1
1400	2.416	2.321	34.506	27.542	27.550	53.4	1.6247	1.0302	1482.5	1482.1
1500	2.260	2.160	34.538	27.580	27.589	49.8	1.6836	1.0305	1483.5	1482.1
1750	2.048	1.930	34.581	27.632	27.642	44.9	1.8208	1.0311	1486.8	1482.6
2000	1.908	1.771	34.610	27.666	27.677	41.6	1.9489	1.0318	1490.4	1483.3
2250	1.790	1.634	34.631	27.692	27.704	39.2	2.0709	1.0324	1494.1	1484.3
2500	1.701	1.524	34.647	27.712	27.725	37.3	2.1886	1.0330	1498.0	1485.5
2750	1.626	1.427	34.660	27.728	27.743	35.8	2.3030	1.0336	1501.9	1486.8
3000	1.569	1.348	34.671	27.741	27.757	34.6	2.4150	1.0342	1505.9	1488.2
3250	1.531	1.286	34.678	27.750	27.767	33.8	2.5256	1.0348	1510.0	1489.7
3500	1.503	1.233	34.684	27.757	27.776	33.1	2.6356	1.0354	1514.2	1491.3
3750	1.496	1.200	34.688	27.760	27.781	32.8	2.7458	1.0360	1518.4	1493.0
4000	1.486	1.163	34.691	27.763	27.786	32.5	2.8568	1.0366	1522.7	1494.7
4250	1.484	1.133	34.694	27.766	27.791	32.2	2.9685	1.0372	1527.0	1496.5
4500	1.489	1.109	34.697	27.768	27.794	32.1	3.0814	1.0378	1531.3	1498.3
4750	1.503	1.093	34.698	27.768	27.797	32.0	3.1960	1.0383	1535.7	1500.2
5000	1.520	1.079	34.700	27.768	27.799	32.0	3.3126	1.0389	1540.2	1502.0
5250	1.540	1.066	34.700	27.767	27.800	32.1	3.4313	1.0394	1544.6	1504.0
5500	1.565	1.058	34.701	27.765	27.801	32.3	3.5525	1.0400	1549.1	1505.9
5750	1.590	1.049	34.701	27.764	27.802	32.4	3.6764	1.0406	1553.6	1507.9

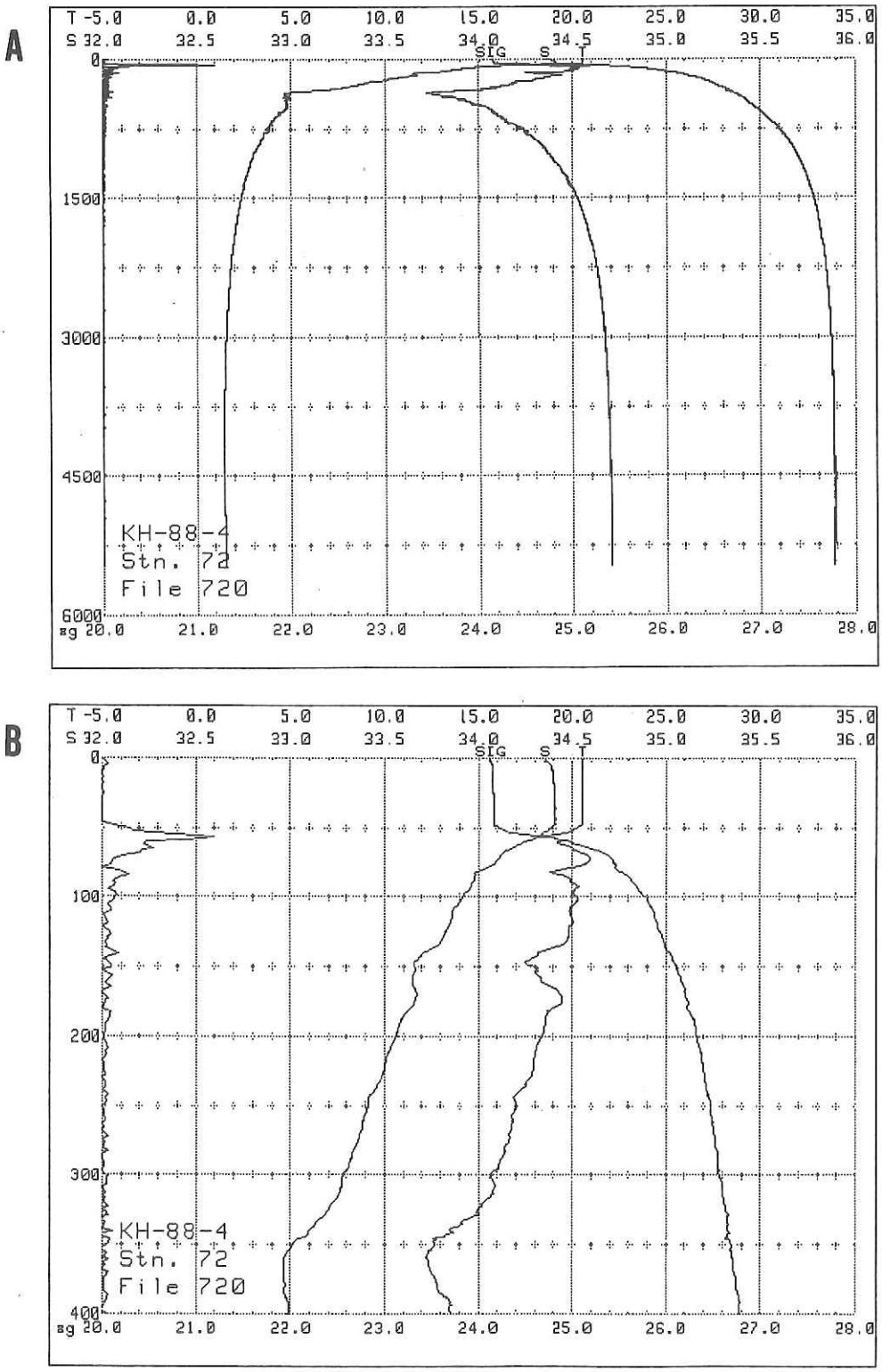


Fig. 16. Vertical profiles of temperature, salinity and σ_t at Station SR72 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 24. List of CTD vertical profile data obtained through downward operation at Station SR72.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 72 Cruise name KH-88-4
File name 720
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	20.558	20.557	34.375	24.138	24.138	376.9	0.0000	1.0242	1523.0	1523.0
10	20.573	20.571	34.394	24.149	24.150	375.8	0.0377	1.0242	1523.1	1523.1
20	20.571	20.568	34.402	24.156	24.157	375.2	0.0753	1.0242	1523.3	1523.1
30	20.571	20.565	34.406	24.159	24.161	374.9	0.1129	1.0242	1523.5	1523.2
40	20.577	20.569	34.407	24.158	24.160	375.0	0.1505	1.0242	1523.7	1523.3
50	20.161	20.151	34.379	24.247	24.250	366.5	0.1877	1.0243	1522.7	1523.3
60	17.428	17.418	34.431	24.976	24.979	297.0	0.2210	1.0244	1515.1	1522.5
70	16.168	16.157	34.585	25.391	25.394	257.6	0.2490	1.0245	1511.7	1521.2
75	15.863	15.850	34.573	25.451	25.454	251.9	0.2618	1.0246	1510.8	1520.6
80	15.198	15.186	34.432	25.491	25.494	248.0	0.2744	1.0247	1508.6	1519.9
90	14.689	14.675	34.510	25.662	25.665	231.8	0.2987	1.0248	1507.3	1518.6
100	14.152	14.137	34.526	25.790	25.793	219.7	0.3215	1.0250	1505.7	1517.4
125	13.257	13.239	34.484	25.942	25.946	205.2	0.3754	1.0252	1503.1	1514.8
150	11.637	11.618	34.306	26.119	26.122	188.4	0.4254	1.0255	1497.8	1512.4
175	11.613	11.590	34.444	26.231	26.235	177.8	0.4721	1.0257	1498.3	1510.3
200	10.585	10.560	34.332	26.330	26.334	168.3	0.5164	1.0259	1494.9	1508.6
250	9.104	9.076	34.201	26.476	26.480	154.5	0.5994	1.0262	1490.1	1505.4
300	7.760	7.729	34.065	26.575	26.580	145.1	0.6767	1.0264	1485.7	1502.5
350	5.048	5.020	33.764	26.690	26.693	134.2	0.7487	1.0267	1475.3	1499.3
400	4.897	4.866	33.857	26.781	26.784	125.6	0.8155	1.0269	1475.6	1496.4
450	4.738	4.703	33.934	26.860	26.864	118.1	0.8786	1.0271	1475.9	1494.1
500	4.815	4.775	34.029	26.926	26.931	111.8	0.9384	1.0273	1477.1	1492.3
550	4.612	4.569	34.070	26.981	26.986	106.5	0.9956	1.0275	1477.2	1490.9
600	4.358	4.312	34.101	27.033	27.038	101.6	1.0504	1.0277	1477.0	1489.8
650	4.127	4.078	34.146	27.094	27.099	95.9	1.1026	1.0279	1476.9	1488.8
700	3.939	3.887	34.193	27.150	27.156	90.5	1.1521	1.0280	1477.0	1487.9
750	3.693	3.638	34.213	27.192	27.197	86.6	1.1993	1.0282	1476.8	1487.2
800	3.559	3.501	34.249	27.233	27.239	82.7	1.2446	1.0284	1477.1	1486.6
850	3.527	3.465	34.295	27.273	27.279	78.9	1.2882	1.0285	1477.8	1486.0
900	3.381	3.317	34.325	27.311	27.317	75.3	1.3300	1.0287	1478.1	1485.6
950	3.212	3.145	34.344	27.342	27.348	72.3	1.3702	1.0288	1478.2	1485.2
1000	3.073	3.003	34.364	27.371	27.377	69.7	1.4090	1.0290	1478.5	1484.8
1100	2.866	2.790	34.401	27.419	27.426	65.1	1.4830	1.0293	1479.3	1484.3
1200	2.766	2.684	34.443	27.461	27.469	61.1	1.5531	1.0296	1480.6	1483.9
1250	2.673	2.588	34.459	27.482	27.490	59.1	1.5868	1.0297	1481.0	1483.8
1300	2.593	2.504	34.474	27.501	27.509	57.3	1.6195	1.0299	1481.5	1483.7
1400	2.511	2.416	34.502	27.531	27.539	54.5	1.6829	1.0301	1482.9	1483.6
1500	2.367	2.264	34.526	27.563	27.571	51.5	1.7435	1.0304	1483.9	1483.6
1750	2.141	2.021	34.570	27.616	27.625	46.4	1.8856	1.0311	1487.2	1483.9
2000	1.945	1.807	34.605	27.659	27.670	42.3	2.0171	1.0317	1490.6	1484.5
2250	1.808	1.652	34.629	27.690	27.701	39.4	2.1406	1.0324	1494.2	1485.4
2500	1.707	1.530	34.647	27.712	27.725	37.4	2.2588	1.0330	1498.0	1486.4
2750	1.630	1.432	34.660	27.728	27.743	35.8	2.3734	1.0336	1501.9	1487.7
3000	1.568	1.347	34.671	27.741	27.757	34.6	2.4855	1.0342	1505.9	1489.0
3250	1.523	1.278	34.679	27.751	27.769	33.6	2.5958	1.0348	1510.0	1490.5
3500	1.489	1.220	34.686	27.759	27.778	32.9	2.7052	1.0354	1514.1	1492.0
3750	1.469	1.174	34.691	27.764	27.785	32.4	2.8142	1.0360	1518.3	1493.6
4000	1.455	1.134	34.695	27.768	27.791	32.0	2.9235	1.0366	1522.5	1495.3
4250	1.456	1.106	34.697	27.770	27.795	31.8	3.0335	1.0372	1526.9	1497.0
4500	1.456	1.077	34.700	27.773	27.799	31.6	3.1446	1.0377	1531.2	1498.8
4750	1.469	1.060	34.702	27.773	27.802	31.5	3.2572	1.0383	1535.6	1500.6
5000	1.490	1.050	34.703	27.773	27.803	31.6	3.3717	1.0389	1540.0	1502.5
5250	1.513	1.040	34.704	27.771	27.805	31.7	3.4886	1.0394	1544.5	1504.4

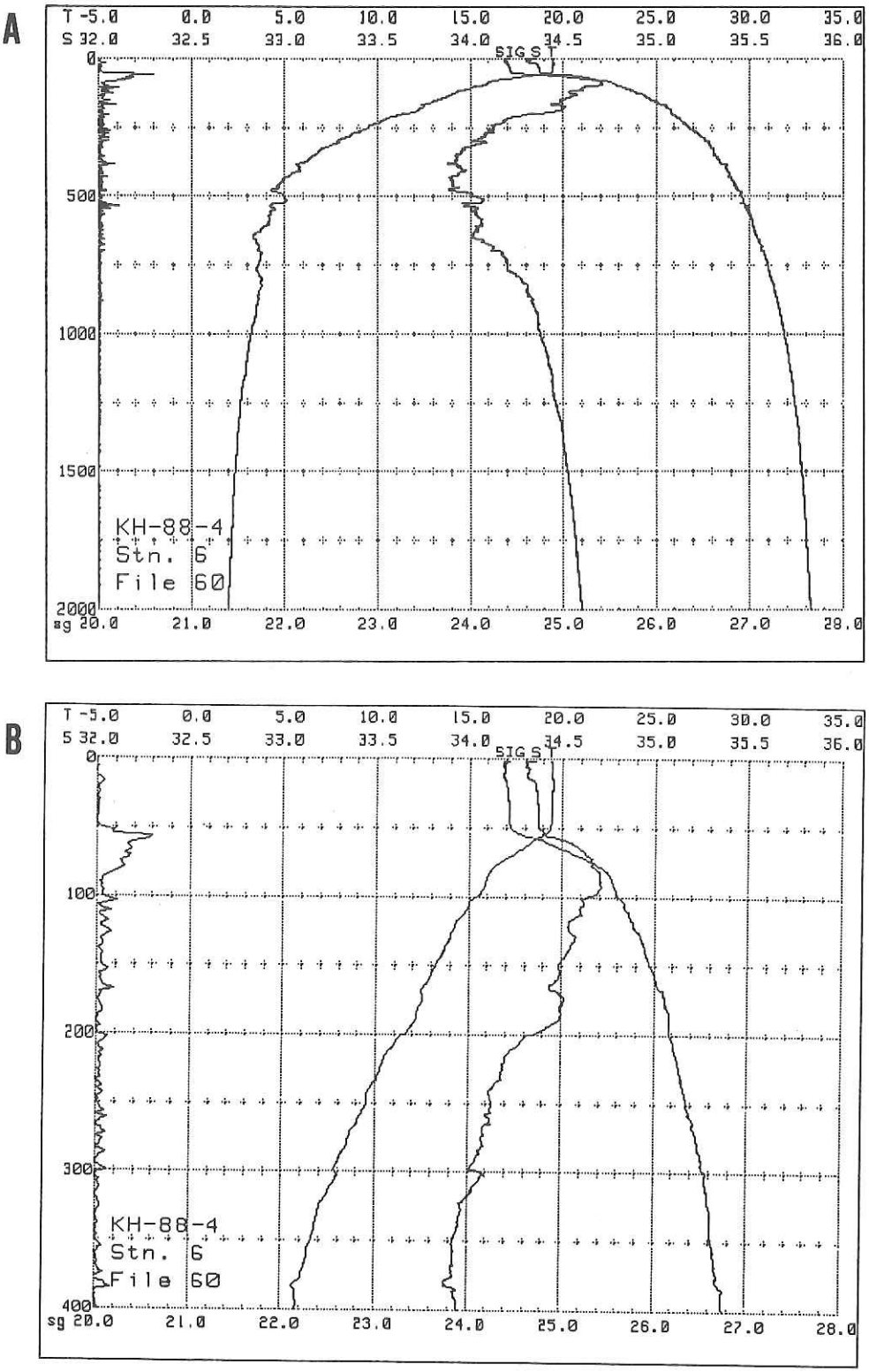


Fig. 17. Vertical profiles of temperature, salinity and σ_t at Station 6 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 25. List of CTD vertical profile data obtained through downward operation at Station 6.

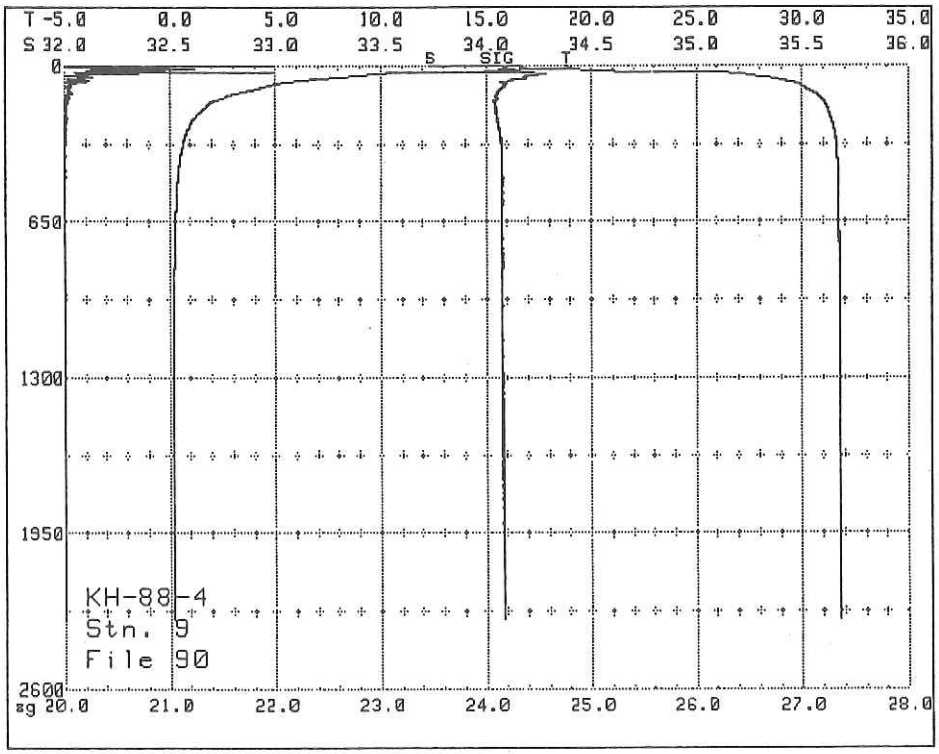
[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 6 Cruise name KH-88-4
File name 60
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	19.463	19.462	34.310	24.377	24.377	354.1	0.0000	1.0244	1519.9	1519.9
10	19.474	19.472	34.314	24.377	24.377	354.1	0.0354	1.0244	1520.0	1520.0
20	19.487	19.483	34.359	24.408	24.409	351.2	0.0708	1.0244	1520.3	1520.1
30	19.444	19.438	34.368	24.425	24.427	349.5	0.1059	1.0245	1520.3	1520.1
40	19.412	19.404	34.373	24.438	24.440	348.3	0.1409	1.0245	1520.4	1520.2
50	19.372	19.362	34.379	24.453	24.455	346.9	0.1758	1.0245	1520.5	1520.3
60	18.381	18.370	34.541	24.827	24.830	311.2	0.2089	1.0246	1518.0	1520.1
70	17.289	17.277	34.641	25.171	25.173	278.5	0.2386	1.0247	1515.1	1519.6
75	16.677	16.664	34.659	25.329	25.332	263.4	0.2522	1.0247	1513.4	1519.2
80	16.242	16.229	34.688	25.453	25.456	251.7	0.2652	1.0248	1512.2	1518.8
90	15.904	15.889	34.706	25.544	25.548	243.0	0.2902	1.0249	1511.3	1518.0
100	15.372	15.356	34.632	25.607	25.611	237.0	0.3145	1.0250	1509.8	1517.3
125	14.111	14.092	34.546	25.814	25.818	217.4	0.3721	1.0253	1506.0	1515.4
150	13.196	13.175	34.485	25.955	25.959	204.0	0.4257	1.0255	1503.3	1513.6
175	12.494	12.470	34.512	26.115	26.120	188.7	0.4758	1.0257	1501.4	1512.0
200	11.456	11.430	34.327	26.169	26.174	183.7	0.5235	1.0258	1498.0	1510.5
250	9.520	9.491	34.129	26.352	26.357	166.2	0.6133	1.0261	1491.6	1507.3
300	7.888	7.857	34.074	26.564	26.568	146.2	0.6938	1.0264	1486.2	1504.3
350	6.594	6.562	33.923	26.626	26.630	140.3	0.7679	1.0266	1481.7	1501.4
400	5.776	5.741	33.956	26.756	26.760	127.9	0.8374	1.0268	1479.3	1498.8
450	4.801	4.766	33.907	26.831	26.835	120.8	0.9019	1.0271	1476.1	1496.4
500	4.978	4.938	34.036	26.914	26.918	113.0	0.9628	1.0273	1477.8	1494.5
550	4.336	4.295	34.012	26.966	26.970	108.0	1.0206	1.0275	1475.9	1492.9
600	4.139	4.094	34.063	27.026	27.031	102.3	1.0757	1.0276	1476.0	1491.5
650	3.316	3.271	34.022	27.075	27.079	97.7	1.1281	1.0278	1473.3	1490.2
700	3.736	3.685	34.170	27.153	27.158	90.3	1.1776	1.0280	1476.1	1489.1
750	3.577	3.523	34.199	27.192	27.197	86.6	1.2246	1.0282	1476.3	1488.2
800	3.794	3.735	34.277	27.232	27.238	82.8	1.2701	1.0283	1478.1	1487.5
850	3.609	3.547	34.309	27.276	27.282	78.6	1.3137	1.0285	1478.2	1487.0
900	3.517	3.452	34.342	27.311	27.318	75.3	1.3556	1.0286	1478.7	1486.5
950	3.415	3.347	34.368	27.342	27.349	72.4	1.3959	1.0288	1479.1	1486.1
1000	3.205	3.134	34.380	27.371	27.378	69.6	1.4349	1.0290	1479.1	1485.7
1100	2.978	2.901	34.421	27.425	27.432	64.5	1.5090	1.0293	1479.8	1485.2
1200	2.728	2.645	34.445	27.467	27.474	60.5	1.5786	1.0295	1480.4	1484.7
1250	2.645	2.559	34.461	27.487	27.494	58.6	1.6120	1.0297	1480.9	1484.6
1300	2.589	2.500	34.479	27.506	27.513	56.8	1.6445	1.0298	1481.5	1484.5
1400	2.461	2.366	34.504	27.537	27.545	53.9	1.7073	1.0301	1482.6	1484.3
1500	2.365	2.263	34.528	27.564	27.572	51.3	1.7675	1.0304	1483.9	1484.2
1750	2.163	2.043	34.568	27.612	27.622	46.8	1.9099	1.0311	1487.3	1484.4
2000	1.971	1.833	34.602	27.655	27.666	42.7	2.0426	1.0317	1490.7	1485.0

A



B

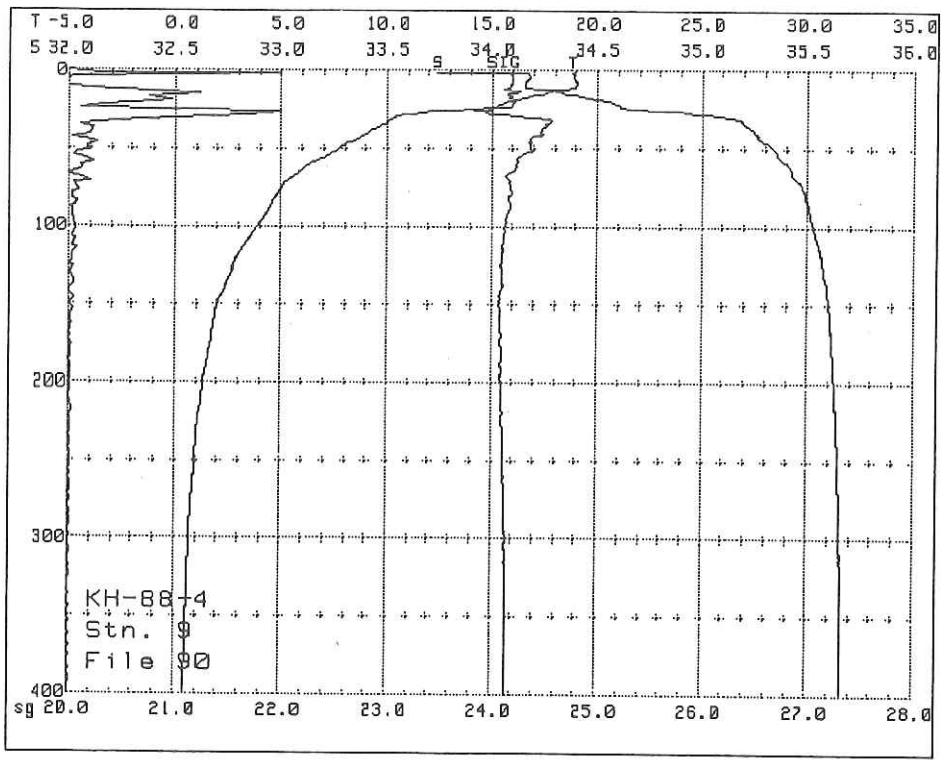


Fig. 18. Vertical profiles of temperature, salinity and σ_t at Station 9 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 26. List of CTD vertical profile data obtained through downward operation at Station 9.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 9 Cruise name KH-88-4
File name 90
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	18.867	18.866	34.091	24.362	24.362	355.6	0.0000	1.0244	1518.0	1518.0
10	18.969	18.968	34.086	24.332	24.332	358.4	0.0357	1.0244	1518.4	1518.2
20	15.611	15.608	34.101	25.145	25.145	281.0	0.0677	1.0246	1508.5	1515.8
30	10.290	10.286	34.210	26.286	26.286	172.6	0.0905	1.0250	1490.9	1510.4
40	9.013	9.009	34.232	26.515	26.516	150.8	0.1067	1.0254	1486.4	1505.0
50	7.610	7.605	34.186	26.692	26.693	134.0	0.1210	1.0257	1481.2	1500.8
60	6.255	6.250	34.121	26.825	26.826	121.3	0.1339	1.0259	1475.9	1497.1
70	5.285	5.279	34.086	26.917	26.918	112.6	0.1457	1.0261	1472.1	1493.8
75	4.971	4.965	34.093	26.960	26.961	108.6	0.1512	1.0262	1470.9	1492.3
80	4.783	4.777	34.090	26.978	26.979	106.9	0.1567	1.0262	1470.2	1490.9
90	4.342	4.336	34.081	27.020	27.020	102.9	0.1672	1.0264	1468.5	1488.5
100	3.860	3.853	34.064	27.056	27.056	99.5	0.1774	1.0265	1466.6	1486.4
125	2.743	2.736	34.048	27.148	27.149	90.7	0.2014	1.0267	1462.3	1482.0
150	1.997	1.989	34.037	27.200	27.201	85.8	0.2236	1.0269	1459.4	1478.5
175	1.671	1.662	34.046	27.232	27.233	82.8	0.2448	1.0270	1458.4	1475.7
200	1.331	1.321	34.049	27.259	27.260	80.2	0.2653	1.0272	1457.3	1473.5
250	0.963	0.952	34.061	27.293	27.294	77.0	0.3048	1.0274	1456.5	1470.1
300	0.710	0.697	34.070	27.316	27.317	74.8	0.3429	1.0276	1456.2	1467.8
350	0.588	0.573	34.074	27.326	27.327	73.9	0.3801	1.0278	1456.4	1466.2
400	0.485	0.469	34.076	27.334	27.335	73.1	0.4168	1.0280	1456.8	1465.0
450	0.408	0.389	34.077	27.339	27.340	72.6	0.4532	1.0281	1457.3	1464.1
500	0.366	0.346	34.078	27.342	27.343	72.4	0.4894	1.0283	1457.9	1463.5
550	0.335	0.312	34.078	27.344	27.345	72.2	0.5254	1.0284	1458.6	1463.0
600	0.307	0.281	34.078	27.345	27.347	72.1	0.5613	1.0285	1459.3	1462.6
650	0.278	0.251	34.077	27.346	27.348	71.9	0.5971	1.0287	1460.0	1462.4
700	0.256	0.226	34.077	27.348	27.349	71.8	0.6328	1.0288	1460.7	1462.3
750	0.242	0.210	34.077	27.348	27.350	71.8	0.6685	1.0289	1461.4	1462.2
800	0.233	0.199	34.078	27.349	27.351	71.7	0.7041	1.0291	1462.2	1462.2
850	0.222	0.185	34.078	27.350	27.352	71.6	0.7395	1.0292	1463.0	1462.2
900	0.206	0.167	34.077	27.350	27.352	71.6	0.7750	1.0293	1463.8	1462.3
950	0.196	0.154	34.077	27.351	27.353	71.5	0.8104	1.0295	1464.6	1462.4
1000	0.190	0.145	34.078	27.352	27.354	71.4	0.8457	1.0296	1465.4	1462.5
1100	0.175	0.125	34.078	27.352	27.355	71.4	0.9162	1.0298	1466.9	1462.8
1200	0.167	0.112	34.077	27.352	27.355	71.4	0.9865	1.0301	1468.6	1463.2
1250	0.162	0.104	34.078	27.353	27.356	71.3	1.0216	1.0302	1469.4	1463.5
1300	0.160	0.099	34.078	27.354	27.357	71.2	1.0566	1.0303	1470.2	1463.7
1400	0.155	0.088	34.078	27.354	27.357	71.2	1.1266	1.0306	1471.8	1464.2
1500	0.154	0.081	34.078	27.354	27.357	71.3	1.1965	1.0308	1473.5	1464.8
1750	0.155	0.067	34.079	27.355	27.359	71.1	1.3707	1.0314	1477.7	1466.3
2000	0.164	0.058	34.079	27.354	27.360	71.2	1.5442	1.0320	1481.9	1468.0
2250	0.176	0.052	34.080	27.355	27.361	71.2	1.7174	1.0326	1486.2	1469.8

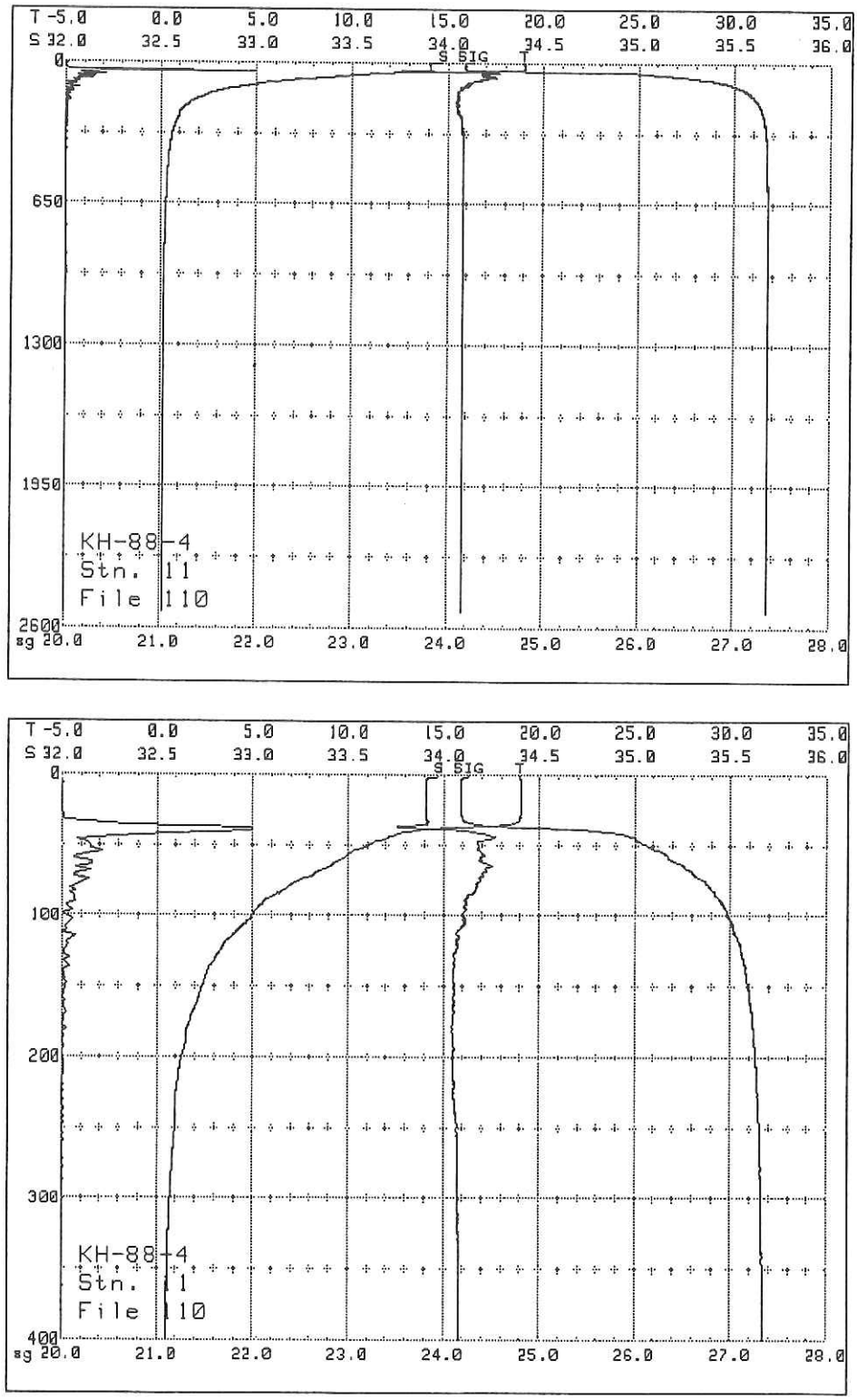


Fig. 19. Vertical profiles of temperature, salinity and σ_t at Station 11 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 27. List of CTD vertical profile data obtained through downward operation at Station 11.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 11 Cruise name KH-88-4
File name 110
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp.	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	19.008	19.007	33.912	24.189	24.189	372.0	0.0000	1.0242	1518.1	1518.1
10	19.013	19.011	33.909	24.186	24.186	372.3	0.0372	1.0242	1518.3	1518.2
20	19.019	19.015	33.910	24.184	24.185	372.5	0.0745	1.0242	1518.4	1518.3
30	19.010	19.004	33.912	24.189	24.190	372.1	0.1118	1.0243	1518.6	1518.4
40	13.483	13.477	34.134	25.625	25.626	235.3	0.1423	1.0245	1502.1	1516.3
50	11.108	11.102	34.186	26.122	26.123	188.1	0.1636	1.0248	1494.1	1512.7
60	9.703	9.696	34.201	26.379	26.380	163.7	0.1813	1.0251	1489.3	1509.2
70	8.228	8.221	34.207	26.617	26.619	141.1	0.1967	1.0253	1483.9	1506.0
75	7.426	7.419	34.193	26.723	26.725	131.0	0.2035	1.0254	1480.9	1504.4
80	6.866	6.859	34.177	26.789	26.790	124.8	0.2100	1.0255	1478.7	1502.9
90	5.577	5.570	34.122	26.911	26.912	113.2	0.2220	1.0257	1473.7	1499.9
100	4.942	4.934	34.102	26.970	26.971	107.6	0.2331	1.0259	1471.2	1497.2
125	3.301	3.293	34.065	27.111	27.111	94.3	0.2586	1.0262	1464.7	1491.3
150	2.363	2.354	34.056	27.187	27.187	87.1	0.2815	1.0265	1461.0	1486.6
175	1.724	1.715	34.052	27.233	27.233	82.7	0.3029	1.0267	1458.6	1482.7
200	1.298	1.288	34.047	27.259	27.260	80.2	0.3233	1.0269	1457.1	1479.6
250	0.950	0.939	34.070	27.301	27.302	76.2	0.3626	1.0272	1456.4	1475.1
300	0.697	0.685	34.079	27.324	27.325	74.1	0.4003	1.0274	1456.1	1471.9
350	0.555	0.540	34.080	27.333	27.334	73.2	0.4372	1.0276	1456.3	1469.7
400	0.473	0.456	34.081	27.339	27.340	72.7	0.4736	1.0278	1456.7	1468.0
450	0.413	0.394	34.082	27.343	27.344	72.3	0.5098	1.0280	1457.3	1466.8
500	0.366	0.345	34.083	27.346	27.347	72.0	0.5458	1.0281	1457.9	1465.9
550	0.341	0.318	34.082	27.347	27.348	71.9	0.5816	1.0283	1458.6	1465.2
600	0.318	0.293	34.083	27.349	27.350	71.7	0.6174	1.0284	1459.3	1464.7
650	0.290	0.263	34.082	27.350	27.351	71.6	0.6531	1.0286	1460.0	1464.3
700	0.269	0.239	34.083	27.351	27.353	71.5	0.6886	1.0287	1460.8	1464.0
750	0.251	0.219	34.081	27.351	27.353	71.5	0.7241	1.0289	1461.5	1463.8
800	0.235	0.201	34.081	27.352	27.354	71.4	0.7596	1.0290	1462.2	1463.7
850	0.223	0.186	34.081	27.353	27.355	71.4	0.7949	1.0291	1463.0	1463.6
900	0.210	0.171	34.081	27.353	27.355	71.3	0.8303	1.0293	1463.8	1463.6
950	0.198	0.156	34.081	27.354	27.356	71.2	0.8655	1.0294	1464.6	1463.7
1000	0.186	0.142	34.081	27.354	27.357	71.2	0.9007	1.0295	1465.3	1463.7
1100	0.173	0.123	34.080	27.355	27.357	71.2	0.9710	1.0298	1466.9	1463.9
1200	0.164	0.109	34.080	27.355	27.358	71.1	1.0410	1.0300	1468.6	1464.3
1250	0.160	0.102	34.081	27.356	27.359	71.1	1.0760	1.0301	1469.4	1464.4
1300	0.157	0.096	34.080	27.355	27.359	71.1	1.1109	1.0303	1470.2	1464.6
1400	0.153	0.086	34.081	27.356	27.360	71.0	1.1807	1.0305	1471.8	1465.1
1500	0.152	0.079	34.081	27.356	27.360	71.0	1.2503	1.0308	1473.5	1465.6
1750	0.156	0.067	34.082	27.357	27.362	70.9	1.4240	1.0314	1477.7	1467.0
2000	0.166	0.060	34.083	27.357	27.363	70.9	1.5970	1.0320	1481.9	1468.6
2250	0.182	0.058	34.083	27.356	27.363	71.0	1.7698	1.0325	1486.2	1470.3
2500	0.200	0.056	34.084	27.356	27.364	71.0	1.9424	1.0331	1490.5	1472.2

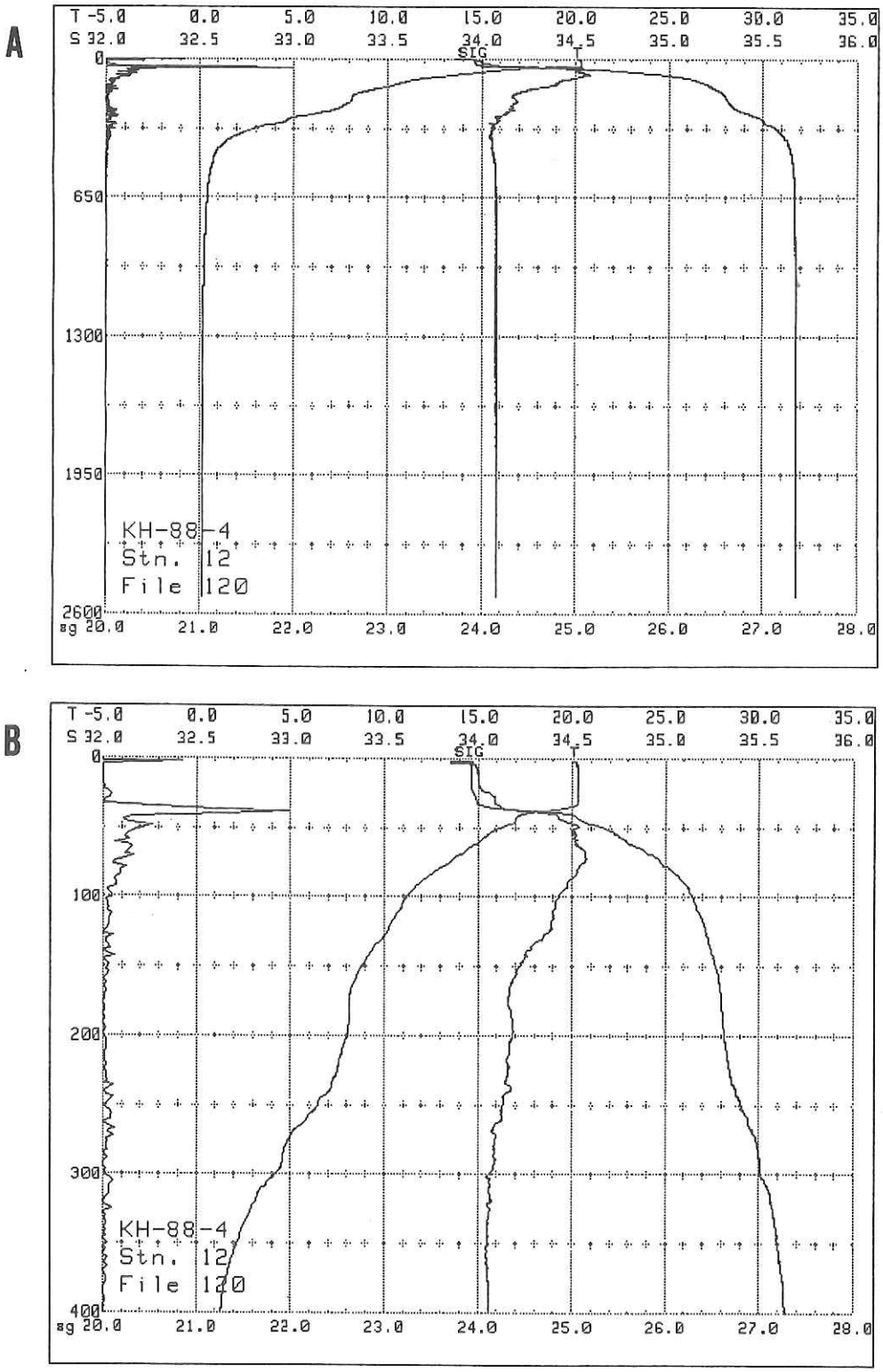


Fig. 20. Vertical profiles of temperature, salinity and σ_t at Station 12 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 28. List of CTD vertical profile data obtained through downward operation at Station 12.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 12 Cruise name KH-88-4
File name 120
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	20.245	20.244	33.942	23.892	23.892	400.3	0.0000	1.0239	1521.6	1521.6
10	20.278	20.276	34.000	23.927	23.928	397.0	0.0399	1.0239	1521.9	1521.7
20	20.287	20.283	34.010	23.932	23.933	396.5	0.0796	1.0240	1522.1	1521.9
30	20.316	20.311	34.092	23.987	23.989	391.3	0.1191	1.0240	1522.4	1522.0
40	17.377	17.370	34.398	24.964	24.965	298.2	0.1537	1.0242	1514.6	1521.1
50	16.159	16.151	34.522	25.344	25.346	262.0	0.1818	1.0244	1511.2	1519.5
60	15.022	15.012	34.523	25.600	25.603	237.6	0.2070	1.0246	1507.9	1517.8
70	13.919	13.909	34.572	25.874	25.876	211.7	0.2296	1.0248	1504.5	1516.2
75	13.459	13.448	34.557	25.958	25.960	203.7	0.2401	1.0249	1503.1	1515.3
80	12.817	12.806	34.530	26.065	26.068	193.5	0.2501	1.0250	1501.0	1514.5
90	11.812	11.800	34.474	26.217	26.219	179.1	0.2690	1.0252	1497.6	1512.8
100	11.181	11.168	34.424	26.295	26.297	171.7	0.2867	1.0253	1495.5	1511.2
125	10.119	10.104	34.366	26.437	26.440	158.2	0.3286	1.0256	1492.1	1507.7
150	8.774	8.758	34.220	26.543	26.546	148.1	0.3675	1.0259	1487.3	1504.7
175	8.106	8.087	34.164	26.602	26.605	142.5	0.4046	1.0261	1485.1	1502.1
200	8.012	7.991	34.184	26.631	26.634	139.8	0.4407	1.0263	1485.2	1499.9
250	6.424	6.401	34.133	26.813	26.816	122.5	0.5079	1.0266	1479.7	1496.4
300	4.153	4.131	34.056	27.020	27.022	102.9	0.5658	1.0268	1471.1	1492.9
350	2.165	2.145	34.053	27.200	27.202	85.8	0.6140	1.0271	1463.4	1489.3
400	1.291	1.271	34.060	27.270	27.272	79.1	0.6558	1.0273	1460.4	1485.9
450	0.815	0.795	34.063	27.303	27.305	76.0	0.6949	1.0275	1459.1	1483.0
500	0.659	0.637	34.073	27.321	27.322	74.4	0.7326	1.0277	1459.2	1480.6
550	0.522	0.498	34.075	27.331	27.332	73.4	0.7696	1.0279	1459.4	1478.6
600	0.445	0.419	34.077	27.337	27.339	72.8	0.8061	1.0281	1459.9	1477.1
650	0.402	0.374	34.079	27.341	27.343	72.4	0.8424	1.0283	1460.5	1475.8
700	0.364	0.334	34.079	27.343	27.345	72.2	0.8784	1.0284	1461.2	1474.7
750	0.335	0.302	34.080	27.345	27.347	72.0	0.9143	1.0286	1461.9	1473.8
800	0.317	0.281	34.079	27.346	27.348	72.0	0.9501	1.0287	1462.6	1473.1
850	0.290	0.252	34.079	27.347	27.349	71.9	0.9858	1.0289	1463.3	1472.5
900	0.276	0.236	34.079	27.348	27.351	71.8	1.0215	1.0290	1464.1	1472.0
950	0.258	0.216	34.079	27.349	27.352	71.7	1.0570	1.0292	1464.8	1471.6
1000	0.241	0.196	34.079	27.350	27.352	71.6	1.0925	1.0293	1465.6	1471.3
1100	0.213	0.163	34.079	27.351	27.354	71.5	1.1632	1.0296	1467.1	1470.8
1200	0.198	0.142	34.079	27.352	27.355	71.4	1.2337	1.0299	1468.7	1470.6
1250	0.192	0.134	34.079	27.352	27.356	71.4	1.2689	1.0300	1469.5	1470.5
1300	0.190	0.129	34.079	27.352	27.356	71.4	1.3040	1.0301	1470.3	1470.5
1400	0.181	0.114	34.079	27.353	27.357	71.3	1.3742	1.0304	1472.0	1470.6
1500	0.173	0.100	34.080	27.354	27.358	71.2	1.4442	1.0306	1473.6	1470.7
1750	0.175	0.086	34.080	27.354	27.359	71.2	1.6186	1.0312	1477.8	1471.4
2000	0.178	0.072	34.080	27.355	27.360	71.2	1.7924	1.0319	1482.0	1472.5
2250	0.189	0.065	34.081	27.355	27.361	71.2	1.9657	1.0325	1486.3	1473.8
2500	0.204	0.060	34.082	27.354	27.362	71.2	2.1388	1.0330	1490.5	1475.2

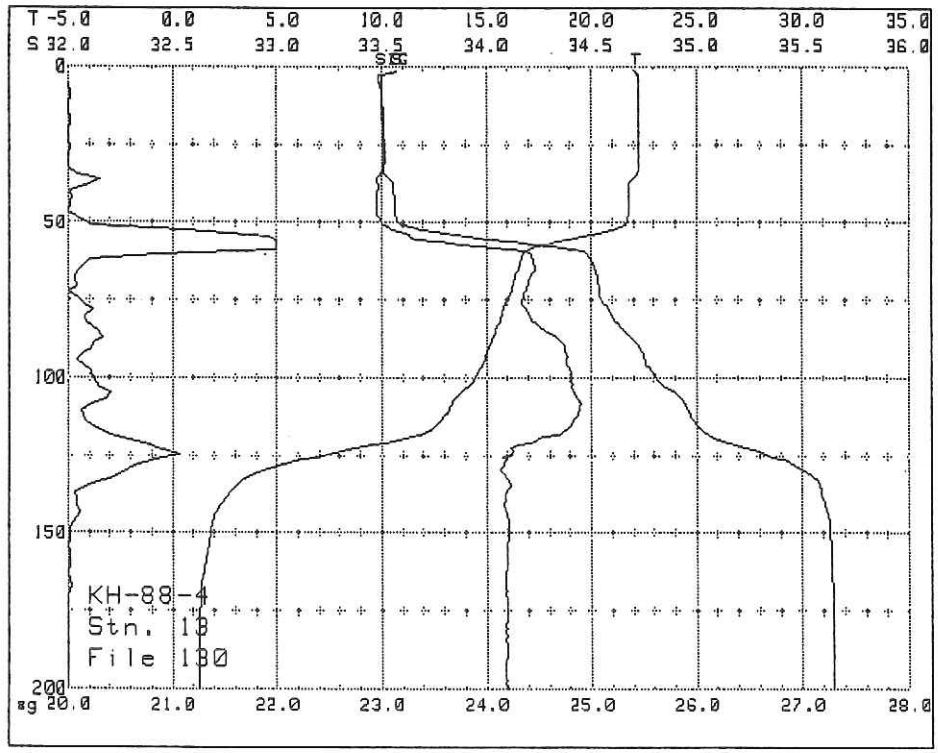


Fig. 21. Vertical profiles of temperature, salinity and σ_t at Station 13 obtained through downward CTD observation.

Table 29. List of CTD vertical profile data obtained through downward operation at Station 13.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 13 Cruise name KH-88-4
File name 130
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	22.242	22.242	33.496	23.009	23.010	484.6	0.0000	1.0230	1526.4	1526.4
10	22.273	22.271	33.502	23.005	23.006	485.0	0.0485	1.0230	1526.6	1526.5
20	22.276	22.272	33.511	23.011	23.013	484.4	0.0970	1.0231	1526.8	1526.6
30	22.281	22.275	33.514	23.012	23.014	484.4	0.1456	1.0231	1527.0	1526.7
40	21.804	21.796	33.481	23.120	23.122	474.1	0.1936	1.0231	1525.8	1526.6
50	21.498	21.487	33.516	23.230	23.233	463.5	0.2406	1.0232	1525.2	1526.4
60	16.817	16.807	34.192	24.938	24.940	300.7	0.2790	1.0234	1513.0	1525.2
70	16.243	16.232	34.195	25.074	25.076	287.8	0.3086	1.0236	1511.4	1523.3
80	15.727	15.714	34.207	25.200	25.203	275.7	0.3370	1.0239	1510.0	1521.8
90	15.115	15.101	34.373	25.464	25.467	250.6	0.3636	1.0241	1508.5	1520.4
100	14.478	14.463	34.408	25.629	25.632	234.9	0.3881	1.0243	1506.6	1519.1
110	13.196	13.180	34.442	25.922	25.925	207.1	0.4105	1.0244	1502.6	1517.8
120	10.162	10.148	34.203	26.302	26.305	171.0	0.4297	1.0246	1491.9	1516.1
130	4.213	4.204	34.083	27.035	27.036	101.5	0.4435	1.0248	1468.6	1513.3
140	2.337	2.330	34.090	27.215	27.216	84.4	0.4529	1.0250	1460.8	1509.8
150	1.821	1.813	34.104	27.268	27.268	79.4	0.4611	1.0252	1458.7	1506.5
160	1.551	1.543	34.096	27.281	27.281	78.2	0.4691	1.0254	1457.7	1503.5
170	1.341	1.333	34.095	27.295	27.295	76.8	0.4769	1.0256	1456.9	1500.8
180	1.308	1.300	34.095	27.297	27.298	76.6	0.4846	1.0257	1456.9	1498.3
190	1.297	1.288	34.094	27.298	27.298	76.6	0.4923	1.0258	1457.0	1496.1
200	1.290	1.280	34.094	27.297	27.298	76.6	0.5000	1.0260	1457.2	1494.2
220	1.280	1.269	34.093	27.297	27.298	76.6	0.5154	1.0262	1457.4	1490.8

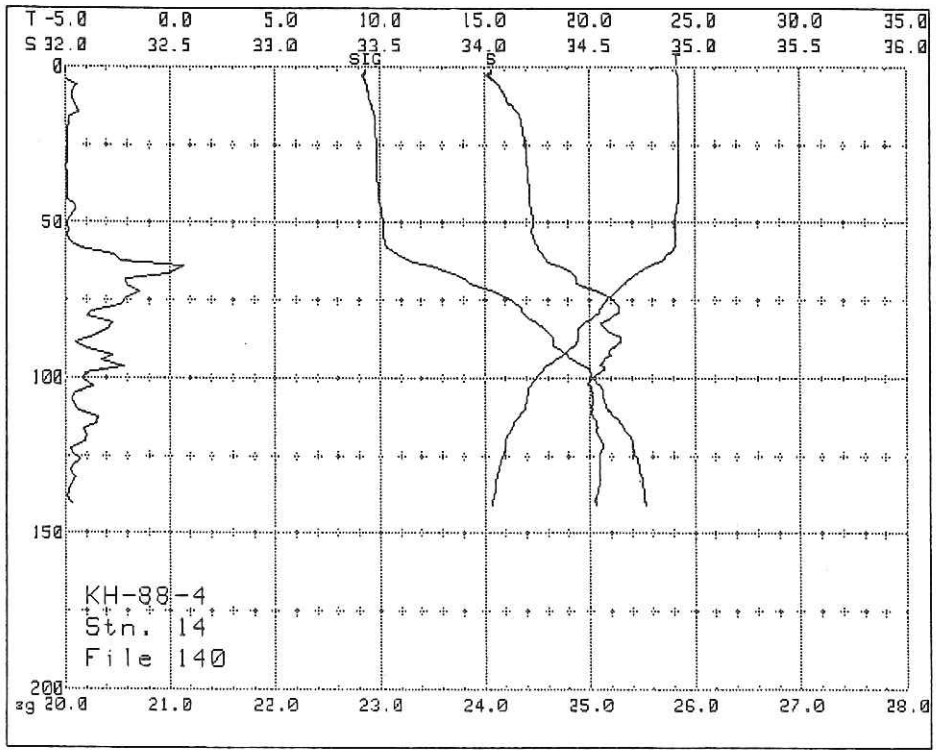


Fig. 22. Vertical profiles of temperature, salinity and σ_t at Station 14 obtained through downward CTD observation.

Table 30. List of CTD vertical profile data obtained through downward operation at Station 14.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 14 Cruise name KH-88-4
File name 140
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	24.211	24.210	34.029	22.845	22.846	500.3	0.0000	1.0229	1531.9	1531.9
10	24.227	24.224	34.106	22.899	22.900	495.1	0.0498	1.0229	1532.1	1532.0
20	24.227	24.223	34.185	22.959	22.960	489.4	0.0991	1.0229	1532.4	1532.2
30	24.228	24.221	34.203	22.972	22.974	488.2	0.1481	1.0230	1532.6	1532.3
40	24.226	24.217	34.215	22.982	22.985	487.2	0.1970	1.0230	1532.8	1532.4
50	24.104	24.093	34.229	23.029	23.032	482.8	0.2456	1.0231	1532.6	1532.4
60	23.709	23.695	34.281	23.184	23.188	467.9	0.2934	1.0231	1531.9	1532.4
70	21.493	21.479	34.476	23.962	23.966	393.7	0.3367	1.0232	1526.7	1532.0
80	20.204	20.189	34.608	24.410	24.414	350.9	0.3742	1.0234	1523.5	1531.1
90	19.081	19.064	34.607	24.702	24.706	323.2	0.4082	1.0236	1520.6	1530.1
100	17.386	17.369	34.509	25.046	25.051	290.4	0.4392	1.0237	1515.7	1528.9
110	16.823	16.804	34.511	25.182	25.186	277.5	0.4679	1.0239	1514.2	1527.6
120	16.008	15.988	34.554	25.403	25.408	256.4	0.4949	1.0241	1512.0	1526.4
130	15.650	15.630	34.546	25.478	25.483	249.3	0.5206	1.0242	1511.0	1525.3

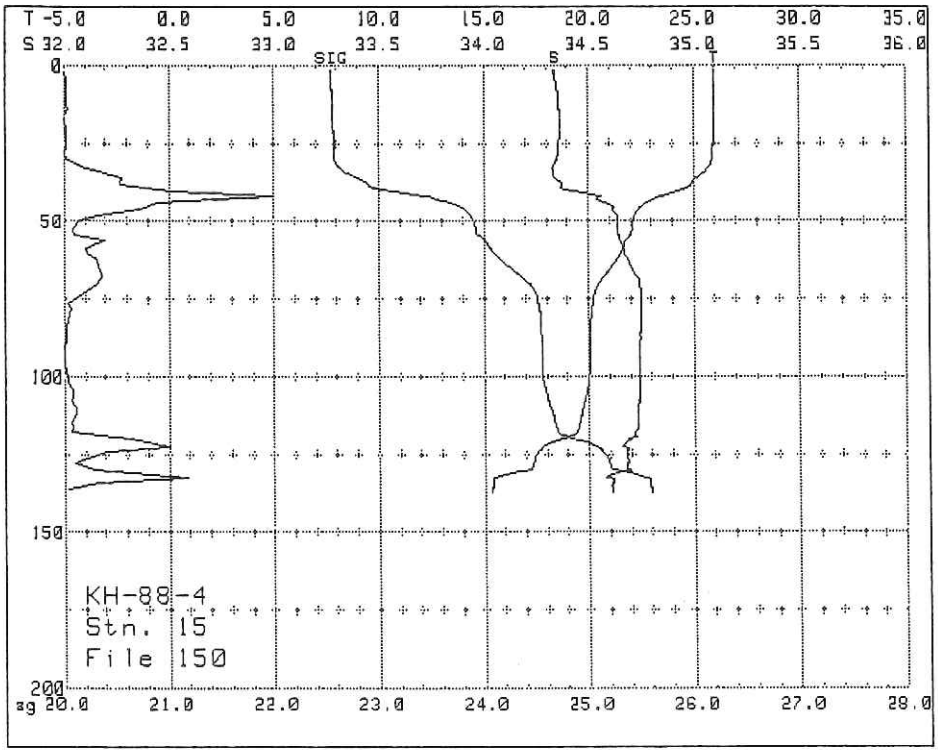


Fig. 23. Vertical profiles of temperature, salinity and σ_t at Station 15 obtained through downward CTD observation.

Table 31. List of CTD vertical profile data obtained through downward operation at Station 15.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 15 Cruise name KH-88-4
File name 150
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	25.971	25.970	34.340	22.547	22.547	528.8	0.0000	1.0226	1536.4	1536.4
10	25.979	25.976	34.358	22.558	22.558	527.8	0.0529	1.0226	1536.6	1536.5
20	25.968	25.963	34.367	22.568	22.569	526.8	0.1056	1.0226	1536.7	1536.6
30	25.855	25.848	34.346	22.587	22.589	525.0	0.1583	1.0226	1536.6	1536.6
40	24.253	24.244	34.435	23.141	23.143	472.1	0.2083	1.0227	1533.1	1536.1
50	22.153	22.143	34.642	23.904	23.907	399.2	0.2521	1.0229	1528.2	1535.0
60	21.536	21.523	34.673	24.100	24.103	380.5	0.2912	1.0231	1526.8	1533.8
70	20.467	20.453	34.745	24.445	24.448	347.7	0.3279	1.0233	1524.2	1532.6
80	20.123	20.107	34.748	24.539	24.543	338.7	0.3625	1.0235	1523.5	1531.5
90	20.067	20.050	34.745	24.551	24.555	337.6	0.3966	1.0237	1523.5	1530.6
100	20.020	20.001	34.743	24.562	24.567	336.5	0.4306	1.0238	1523.5	1529.9
110	19.719	19.698	34.735	24.635	24.640	329.5	0.4643	1.0239	1522.8	1529.3
120	18.778	18.756	34.702	24.851	24.857	308.9	0.4966	1.0240	1520.3	1528.7
130	16.890	16.868	34.676	25.292	25.297	267.0	0.5258	1.0242	1514.9	1527.8

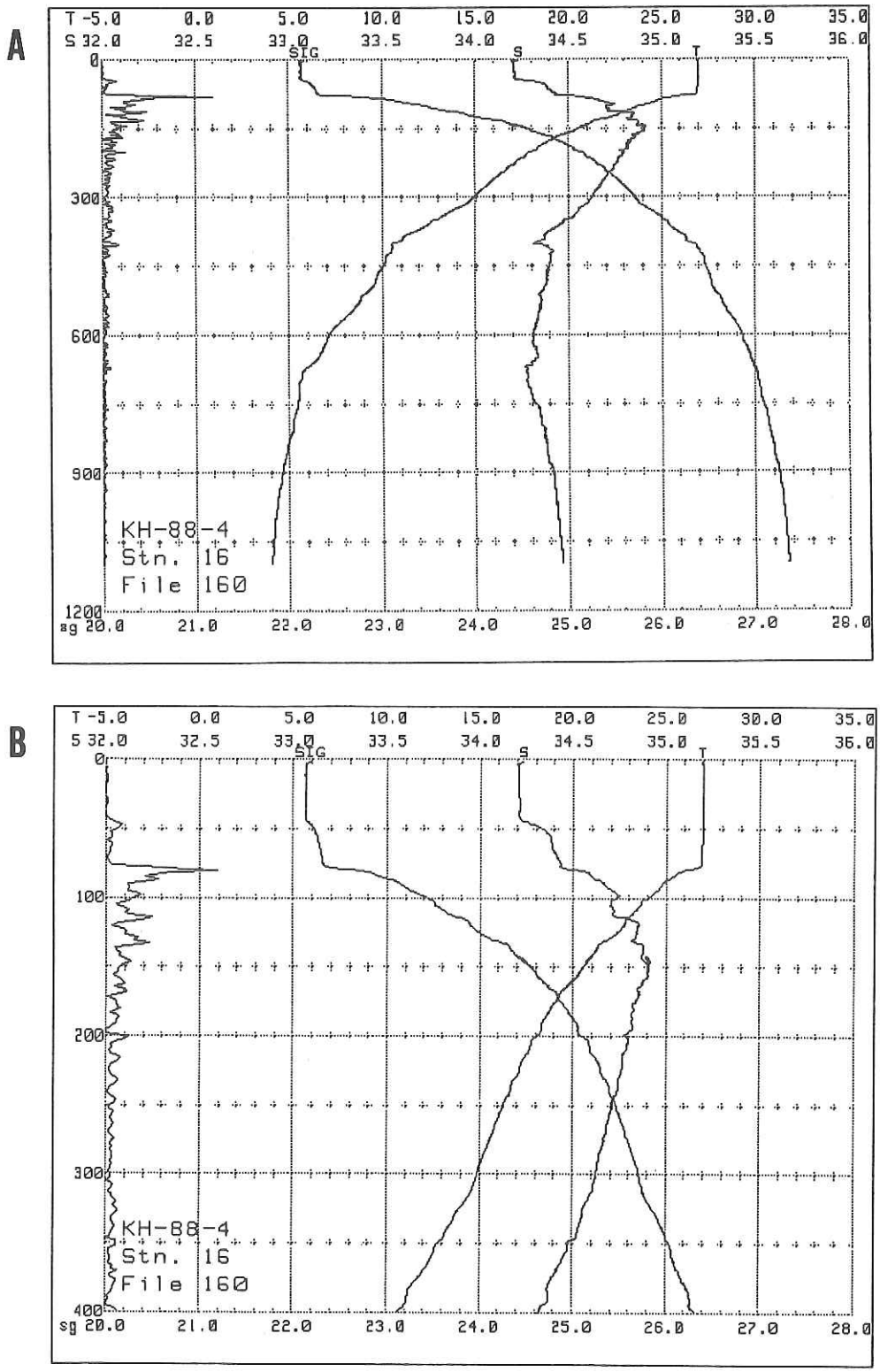


Fig. 24. Vertical profiles of temperature, salinity and σ_t at Station 16 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 32. List of CTD vertical profile data obtained through downward operation at Station 16.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 16 Cruise name KH-88-4
File name 160
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	26.959	26.958	34.207	22.136	22.136	568.1	0.0000	1.0222	1538.5	1538.5
10	26.976	26.974	34.206	22.129	22.130	568.8	0.0569	1.0222	1538.7	1538.6
20	26.965	26.960	34.206	22.133	22.134	568.4	0.1138	1.0222	1538.8	1538.7
30	26.993	26.985	34.217	22.133	22.135	568.5	0.1707	1.0222	1539.0	1538.7
40	26.985	26.975	34.210	22.130	22.133	568.7	0.2277	1.0222	1539.2	1538.8
50	26.999	26.987	34.340	22.223	22.227	559.8	0.2843	1.0223	1539.5	1538.9
60	26.964	26.949	34.385	22.268	22.273	555.5	0.3403	1.0223	1539.6	1539.0
70	26.936	26.919	34.416	22.301	22.306	552.4	0.3960	1.0223	1539.8	1539.1
75	26.906	26.888	34.433	22.323	22.329	550.2	0.4237	1.0223	1539.8	1539.2
80	25.972	25.953	34.544	22.700	22.706	514.1	0.4504	1.0224	1537.9	1539.2
90	24.815	24.795	34.669	23.149	23.155	471.3	0.5000	1.0225	1535.5	1538.9
100	23.981	23.959	34.726	23.441	23.447	443.4	0.5461	1.0226	1533.7	1538.5
125	22.325	22.299	34.841	24.007	24.014	389.4	0.6513	1.0229	1530.1	1537.2
150	20.525	20.496	34.908	24.553	24.561	337.3	0.7434	1.0233	1525.9	1535.6
175	19.046	19.014	34.831	24.881	24.890	306.1	0.8252	1.0236	1522.1	1534.0
200	18.000	17.965	34.786	25.109	25.118	284.4	0.9005	1.0238	1519.5	1532.3
250	16.281	16.240	34.713	25.463	25.472	250.7	1.0378	1.0243	1515.1	1529.3
300	14.867	14.821	34.625	25.713	25.723	227.0	1.1612	1.0247	1511.4	1526.6
350	12.741	12.692	34.477	26.040	26.049	195.9	1.2712	1.0251	1505.0	1524.0
400	10.582	10.532	34.318	26.320	26.328	169.3	1.3669	1.0255	1498.1	1521.2
450	10.016	9.962	34.394	26.477	26.486	154.4	1.4523	1.0258	1497.0	1518.6
500	9.340	9.282	34.364	26.566	26.575	146.0	1.5321	1.0261	1495.3	1516.3
550	8.328	8.269	34.339	26.705	26.714	132.7	1.6066	1.0263	1492.3	1514.3
600	7.091	7.032	34.310	26.863	26.871	117.8	1.6739	1.0266	1488.3	1512.3
650	6.523	6.462	34.324	26.951	26.959	109.4	1.7353	1.0268	1486.9	1510.4
700	5.565	5.504	34.276	27.034	27.042	101.5	1.7924	1.0271	1483.8	1508.6
750	5.451	5.386	34.323	27.086	27.093	96.7	1.8463	1.0273	1484.2	1507.0
800	5.233	5.164	34.365	27.145	27.153	91.1	1.8977	1.0275	1484.2	1505.5
850	4.907	4.836	34.382	27.196	27.204	86.2	1.9466	1.0277	1483.7	1504.3
900	4.632	4.558	34.413	27.252	27.260	80.9	1.9930	1.0279	1483.5	1503.1
950	4.396	4.320	34.431	27.291	27.300	77.2	2.0371	1.0281	1483.3	1502.1
1000	4.221	4.142	34.438	27.316	27.325	74.8	2.0797	1.0283	1483.4	1501.2

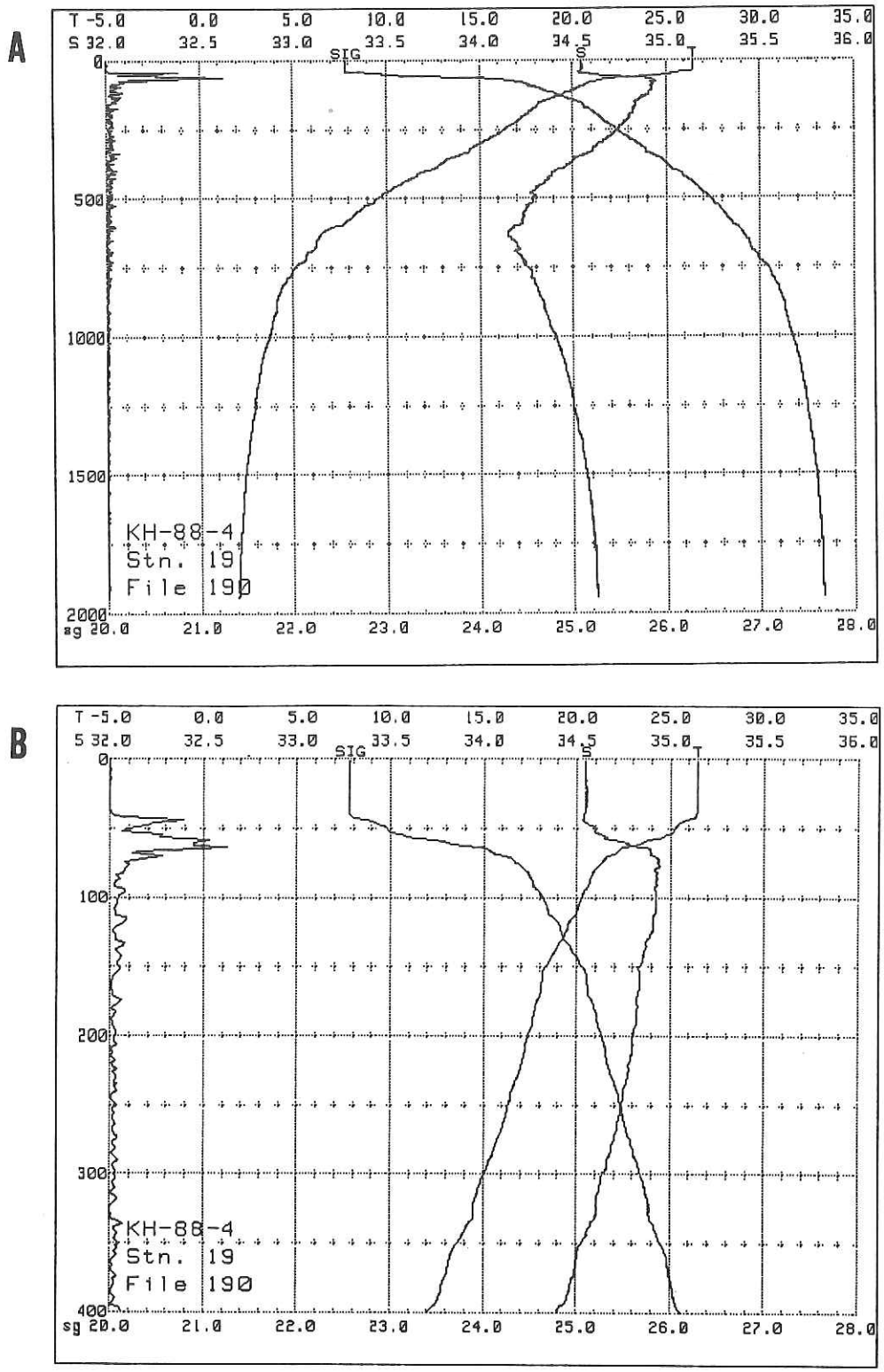


Fig. 25. Vertical profiles of temperature, salinity and σ_t at Station 19 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 33. List of CTD vertical profile data obtained through downward operation at Station 19.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 19 Cruise name KH-88-4
File name 190
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	26.413	26.412	34.546	22.564	22.564	527.2	0.0000	1.0226	1537.6	1537.6
10	26.419	26.417	34.548	22.563	22.564	527.3	0.0527	1.0226	1537.8	1537.7
20	26.425	26.420	34.550	22.563	22.565	527.3	0.1055	1.0226	1538.0	1537.8
30	26.426	26.419	34.550	22.563	22.565	527.3	0.1584	1.0226	1538.1	1537.9
40	26.357	26.348	34.540	22.577	22.580	525.9	0.2112	1.0227	1538.1	1537.9
50	25.241	25.230	34.594	22.963	22.967	489.0	0.2621	1.0227	1535.8	1537.7
60	23.519	23.506	34.759	23.602	23.606	428.0	0.3081	1.0229	1532.0	1537.1
70	21.699	21.684	34.917	24.240	24.244	367.2	0.3481	1.0230	1527.7	1536.1
75	21.326	21.311	34.935	24.357	24.361	356.0	0.3664	1.0231	1526.8	1535.5
80	20.951	20.935	34.921	24.449	24.453	347.3	0.3841	1.0232	1525.9	1534.9
90	20.656	20.638	34.926	24.532	24.537	339.3	0.4187	1.0234	1525.3	1533.9
100	20.252	20.233	34.924	24.638	24.643	329.2	0.4525	1.0236	1524.4	1533.0
125	19.424	19.401	34.901	24.838	24.844	310.2	0.5334	1.0239	1522.5	1531.1
150	18.304	18.277	34.832	25.069	25.076	288.2	0.6093	1.0242	1519.6	1529.4
175	17.836	17.805	34.824	25.178	25.186	277.8	0.6814	1.0244	1518.7	1527.9
200	17.378	17.343	34.803	25.274	25.282	268.7	0.7512	1.0246	1517.7	1526.7
250	16.331	16.290	34.739	25.472	25.481	249.9	0.8843	1.0250	1515.3	1524.7
300	15.012	14.966	34.639	25.692	25.702	229.0	1.0081	1.0253	1511.9	1522.8
350	13.601	13.550	34.528	25.906	25.917	208.6	1.1219	1.0256	1508.0	1521.0
400	12.050	11.996	34.405	26.118	26.128	188.5	1.2259	1.0258	1503.4	1519.1
450	10.685	10.629	34.326	26.307	26.317	170.5	1.3204	1.0261	1499.3	1517.1
500	9.486	9.428	34.283	26.478	26.488	154.3	1.4065	1.0263	1495.7	1515.1
550	8.397	8.337	34.237	26.615	26.624	141.3	1.4852	1.0266	1492.4	1513.2
600	7.202	7.142	34.183	26.748	26.756	128.7	1.5574	1.0268	1488.6	1511.3
650	6.247	6.187	34.179	26.872	26.880	116.9	1.6232	1.0270	1485.6	1509.5
700	5.738	5.676	34.209	26.960	26.968	108.5	1.6839	1.0272	1484.4	1507.7
750	5.085	5.022	34.266	27.083	27.091	96.9	1.7395	1.0274	1482.7	1506.1
800	4.639	4.575	34.295	27.157	27.164	89.9	1.7902	1.0276	1481.7	1504.6
850	4.223	4.156	34.322	27.223	27.230	83.6	1.8376	1.0278	1480.8	1503.2
900	4.091	4.021	34.346	27.257	27.264	80.4	1.8825	1.0280	1481.1	1502.0
950	3.891	3.819	34.375	27.300	27.307	76.3	1.9258	1.0282	1481.1	1500.9
1000	3.709	3.634	34.404	27.342	27.349	72.4	1.9670	1.0284	1481.2	1499.9
1100	3.285	3.206	34.457	27.425	27.433	64.5	2.0435	1.0287	1481.2	1498.2
1200	3.030	2.945	34.490	27.475	27.483	59.8	2.1136	1.0291	1481.8	1496.8
1250	2.951	2.862	34.501	27.491	27.499	58.2	2.1471	1.0292	1482.3	1496.2
1300	2.808	2.717	34.518	27.518	27.526	55.7	2.1796	1.0294	1482.5	1495.7
1400	2.621	2.523	34.547	27.558	27.566	51.9	2.2415	1.0297	1483.4	1494.8
1500	2.423	2.320	34.570	27.592	27.601	48.7	2.2998	1.0300	1484.2	1494.1
1750	2.125	2.006	34.612	27.651	27.660	43.1	2.4347	1.0307	1487.2	1492.9

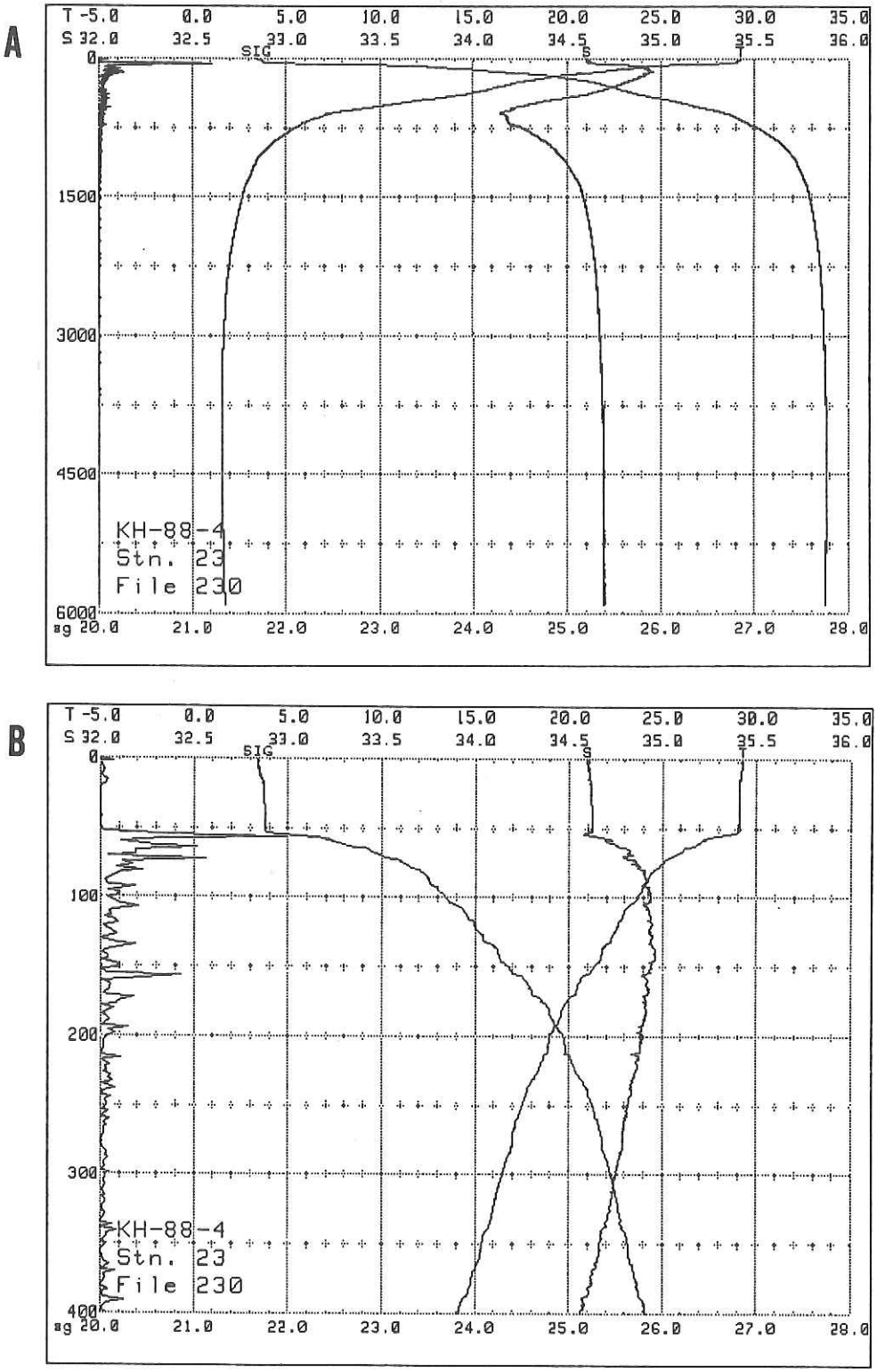


Fig. 26. Vertical profiles of temperature, salinity and σ_t at Station 23 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 34. List of CTD vertical profile data obtained through downward operation at Station 23.

[see Table 9 for the detailed station data]

Station name 23 Cruise name KH-88-4
File name 230
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	29.250	29.249	34.598	21.681	21.681	611.7	0.0000	1.0217	1543.9	1543.9
10	29.206	29.204	34.608	21.703	21.704	609.6	0.0611	1.0217	1543.9	1543.9
20	29.097	29.092	34.616	21.746	21.748	605.5	0.1219	1.0218	1543.9	1543.9
30	29.089	29.081	34.619	21.751	21.754	605.0	0.1825	1.0218	1544.0	1543.9
40	29.083	29.073	34.623	21.755	21.759	604.6	0.2432	1.0218	1544.2	1544.0
50	29.080	29.067	34.625	21.758	21.762	604.3	0.3038	1.0218	1544.3	1544.0
60	26.961	26.946	34.736	22.534	22.538	530.1	0.3607	1.0219	1540.0	1543.7
70	25.571	25.555	34.823	23.034	23.039	482.2	0.4116	1.0221	1537.1	1543.0
75	24.988	24.971	34.858	23.240	23.245	462.6	0.4354	1.0222	1535.9	1542.6
80	24.561	24.543	34.901	23.401	23.406	447.2	0.4583	1.0223	1535.0	1542.1
90	24.095	24.075	34.915	23.550	23.556	432.9	0.5026	1.0225	1534.1	1541.3
100	23.646	23.624	34.931	23.695	23.701	419.1	0.5456	1.0226	1533.1	1540.5
125	22.444	22.417	34.936	24.046	24.053	385.7	0.6472	1.0230	1530.5	1538.8
150	21.284	21.254	34.937	24.370	24.378	354.8	0.7410	1.0233	1528.0	1537.2
175	19.894	19.861	34.909	24.722	24.731	321.3	0.8269	1.0236	1524.6	1535.6
200	18.977	18.940	34.888	24.942	24.952	300.3	0.9062	1.0238	1522.4	1534.1
250	17.497	17.454	34.817	25.256	25.266	270.4	1.0526	1.0243	1518.9	1531.4
300	16.451	16.401	34.752	25.454	25.465	251.6	1.1873	1.0247	1516.5	1529.1
350	15.351	15.296	34.668	25.640	25.652	233.9	1.3135	1.0250	1513.8	1527.1
400	14.032	13.972	34.559	25.840	25.853	214.8	1.4309	1.0253	1510.3	1525.2
450	12.094	12.033	34.406	26.110	26.122	189.2	1.5373	1.0256	1504.4	1523.3
500	10.479	10.418	34.288	26.314	26.325	169.8	1.6324	1.0259	1499.4	1521.1
550	8.797	8.736	34.213	26.534	26.544	149.0	1.7173	1.0261	1493.9	1518.9
600	7.167	7.108	34.148	26.725	26.733	130.9	1.7920	1.0264	1488.4	1516.6
650	6.499	6.438	34.178	26.839	26.847	120.1	1.8592	1.0266	1486.6	1514.3
700	5.853	5.790	34.190	26.932	26.939	111.3	1.9215	1.0269	1484.9	1512.3
750	5.472	5.407	34.267	27.039	27.047	101.1	1.9790	1.0271	1484.2	1510.4
800	5.080	5.013	34.305	27.115	27.123	93.8	2.0321	1.0273	1483.5	1508.8
850	4.730	4.660	34.344	27.186	27.194	87.1	2.0818	1.0275	1482.9	1507.3
900	4.341	4.270	34.384	27.261	27.268	80.1	2.1279	1.0277	1482.2	1505.9
950	4.118	4.044	34.416	27.310	27.317	75.4	2.1711	1.0279	1482.1	1504.7
1000	3.850	3.774	34.440	27.356	27.364	71.1	2.2120	1.0281	1481.9	1503.5
1100	3.444	3.363	34.488	27.435	27.443	63.6	2.2877	1.0285	1481.9	1501.6
1200	3.219	3.132	34.518	27.480	27.488	59.3	2.3576	1.0289	1482.6	1499.9
1250	3.143	3.053	34.531	27.498	27.506	57.6	2.3912	1.0290	1483.1	1499.3
1300	3.022	2.928	34.547	27.522	27.530	55.3	2.4238	1.0292	1483.5	1498.7
1400	2.815	2.715	34.571	27.559	27.568	51.8	2.4861	1.0295	1484.3	1497.6
1500	2.687	2.580	34.584	27.581	27.590	49.7	2.5457	1.0298	1485.4	1496.7
1750	2.378	2.255	34.614	27.632	27.642	44.9	2.6866	1.0306	1488.3	1495.3
2000	2.128	1.988	34.635	27.669	27.680	41.4	2.8176	1.0313	1491.4	1494.6
2250	1.938	1.779	34.650	27.696	27.708	38.8	2.9413	1.0320	1494.8	1494.5
2500	1.818	1.639	34.660	27.714	27.727	37.1	3.0603	1.0327	1498.5	1494.7
2750	1.739	1.538	34.669	27.726	27.741	36.0	3.1765	1.0333	1502.4	1495.2
3000	1.679	1.455	34.676	27.737	27.753	35.0	3.2912	1.0339	1506.4	1496.0
3250	1.613	1.366	34.681	27.746	27.764	34.1	3.4044	1.0346	1510.4	1496.9
3500	1.583	1.311	34.687	27.753	27.773	33.4	3.5169	1.0352	1514.5	1498.0
3750	1.566	1.268	34.691	27.757	27.779	33.0	3.6294	1.0358	1518.7	1499.3
4000	1.566	1.241	34.693	27.759	27.783	32.8	3.7428	1.0364	1523.0	1500.6
4250	1.574	1.220	34.695	27.760	27.785	32.8	3.8578	1.0370	1527.4	1502.1
4500	1.588	1.205	34.697	27.760	27.788	32.8	3.9746	1.0375	1531.8	1503.6
4750	1.608	1.194	34.697	27.759	27.789	32.9	4.0937	1.0381	1536.2	1505.2
5000	1.631	1.185	34.698	27.758	27.790	33.0	4.2152	1.0387	1540.6	1506.9
5250	1.656	1.178	34.698	27.756	27.791	33.1	4.3394	1.0393	1545.1	1508.6
5500	1.685	1.173	34.698	27.754	27.791	33.3	4.4665	1.0398	1549.6	1510.3
5750	1.716	1.170	34.698	27.752	27.791	33.5	4.5967	1.0404	1554.1	1512.1

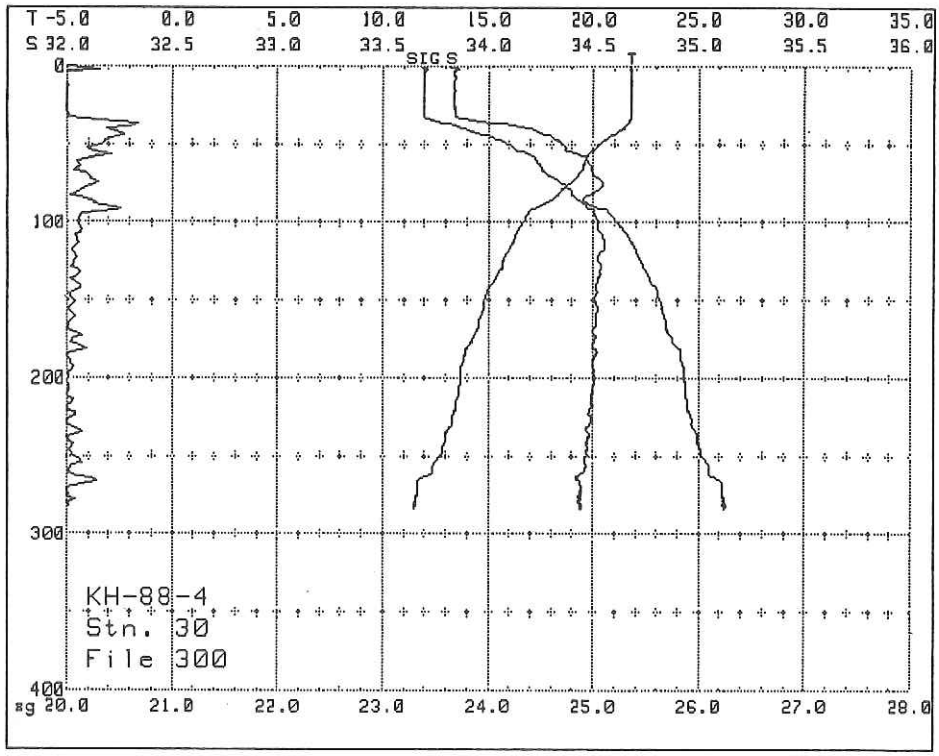


Fig. 27. Vertical profiles of temperature, salinity and σ_t at Station 30 obtained through downward CTD observation.

Table 35. List of CTD vertical profile data obtained through downward operation at Station 30.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 30 Cruise name KH-88-4
File name 300
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	21.777	21.776	33.844	23.403	23.403	447.0	0.0000	1.0234	1525.6	1525.6
10	21.819	21.817	33.842	23.390	23.391	448.2	0.0448	1.0234	1525.8	1525.7
20	21.814	21.810	33.840	23.390	23.391	448.3	0.0897	1.0234	1526.0	1525.8
30	21.815	21.809	33.846	23.394	23.396	447.8	0.1346	1.0235	1526.1	1525.9
40	21.377	21.369	34.197	23.782	23.784	410.9	0.1776	1.0235	1525.5	1525.9
50	20.254	20.244	34.359	24.208	24.210	370.3	0.2168	1.0237	1522.9	1525.5
60	19.627	19.616	34.473	24.458	24.461	346.4	0.2529	1.0238	1521.5	1525.0
70	19.212	19.199	34.515	24.597	24.601	333.1	0.2870	1.0240	1520.5	1524.4
75	18.814	18.800	34.545	24.722	24.725	321.2	0.3035	1.0240	1519.5	1524.1
80	18.426	18.412	34.508	24.791	24.795	314.7	0.3196	1.0241	1518.5	1523.8
90	17.256	17.240	34.483	25.057	25.061	289.3	0.3500	1.0242	1515.2	1523.0
100	16.636	16.620	34.523	25.235	25.239	272.4	0.3784	1.0244	1513.5	1522.2
125	15.695	15.675	34.532	25.457	25.462	251.3	0.4447	1.0247	1511.0	1520.2
150	14.811	14.788	34.509	25.635	25.640	234.3	0.5064	1.0249	1508.6	1518.5
175	14.258	14.231	34.506	25.752	25.758	223.2	0.5647	1.0251	1507.3	1517.0
200	13.696	13.667	34.505	25.868	25.874	212.2	0.6204	1.0253	1505.8	1515.7
250	12.680	12.646	34.464	26.041	26.048	195.8	0.7253	1.0256	1503.2	1513.4

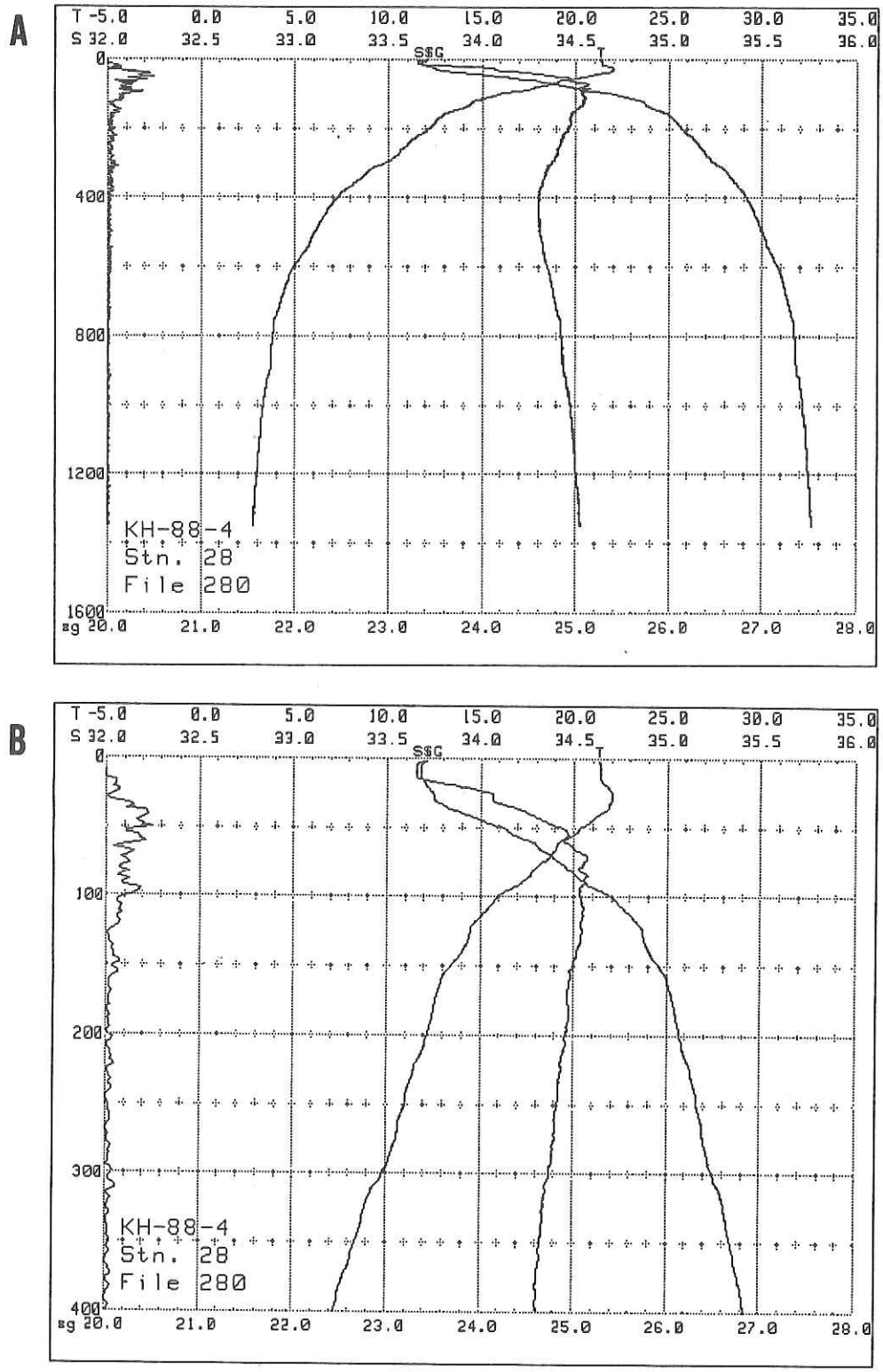


Fig. 28. Vertical profiles of temperature, salinity and σ_t at Station 28 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 36. List of CTD vertical profile data obtained through downward operation at Station 28.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 28 Cruise name KH-88-4
File name 280
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	21.363	21.362	33.672	23.386	23.387	448.6	0.0000	1.0234	1524.3	1524.3
10	21.390	21.387	33.658	23.368	23.369	450.3	0.0450	1.0234	1524.5	1524.4
20	21.824	21.819	33.899	23.432	23.433	444.3	0.0898	1.0234	1526.0	1524.8
30	21.986	21.980	34.075	23.520	23.522	435.8	0.1338	1.0235	1526.8	1525.4
40	21.364	21.356	34.271	23.841	23.843	405.2	0.1760	1.0236	1525.6	1525.6
50	20.358	20.349	34.433	24.235	24.238	367.6	0.2148	1.0237	1523.3	1525.3
60	19.227	19.216	34.459	24.551	24.553	337.6	0.2503	1.0239	1520.3	1524.8
70	18.725	18.712	34.563	24.758	24.761	317.8	0.2832	1.0240	1519.2	1524.0
75	18.303	18.289	34.555	24.858	24.861	308.3	0.2990	1.0241	1518.1	1523.7
80	17.882	17.868	34.532	24.943	24.947	300.2	0.3144	1.0242	1516.9	1523.3
90	17.155	17.140	34.556	25.138	25.141	281.7	0.3437	1.0243	1514.9	1522.5
100	15.881	15.865	34.536	25.419	25.422	254.9	0.3708	1.0244	1511.2	1521.5
125	14.452	14.433	34.542	25.739	25.743	224.5	0.4316	1.0248	1507.1	1519.1
150	13.414	13.393	34.498	25.921	25.925	207.2	0.4865	1.0250	1504.1	1516.8
175	12.603	12.579	34.470	26.062	26.066	193.8	0.5376	1.0253	1501.7	1514.8
200	12.171	12.144	34.456	26.134	26.140	186.9	0.5864	1.0255	1500.6	1513.1
250	10.993	10.961	34.414	26.321	26.327	169.2	0.6780	1.0258	1497.3	1510.3
300	9.795	9.760	34.373	26.497	26.503	152.5	0.7614	1.0261	1493.7	1507.8
350	8.341	8.303	34.326	26.694	26.699	133.8	0.8360	1.0264	1489.1	1505.5
400	7.256	7.216	34.307	26.838	26.843	120.2	0.9026	1.0267	1485.7	1503.2
450	6.582	6.540	34.301	26.925	26.930	111.9	0.9638	1.0269	1483.8	1501.2
500	6.010	5.965	34.312	27.008	27.013	104.1	1.0210	1.0271	1482.4	1499.4
550	5.594	5.547	34.329	27.073	27.079	97.9	1.0748	1.0273	1481.5	1497.8
600	4.948	4.899	34.352	27.167	27.173	88.9	1.1248	1.0276	1479.8	1496.3
650	4.540	4.488	34.374	27.230	27.236	82.9	1.1710	1.0277	1478.9	1495.0
700	4.243	4.189	34.393	27.278	27.283	78.5	1.2146	1.0279	1478.5	1493.9
750	3.925	3.869	34.416	27.329	27.335	73.6	1.2559	1.0281	1478.0	1492.8
800	3.834	3.774	34.424	27.345	27.351	72.1	1.2957	1.0283	1478.5	1491.9
850	3.747	3.684	34.431	27.360	27.366	70.7	1.3348	1.0285	1479.0	1491.1
900	3.676	3.610	34.438	27.372	27.378	69.5	1.3735	1.0286	1479.5	1490.5
950	3.443	3.374	34.457	27.410	27.416	65.9	1.4110	1.0288	1479.3	1489.9
1000	3.293	3.221	34.474	27.438	27.444	63.3	1.4469	1.0289	1479.6	1489.4
1100	3.120	3.042	34.490	27.467	27.474	60.5	1.5163	1.0292	1480.5	1488.5
1200	2.967	2.882	34.506	27.494	27.501	58.0	1.5832	1.0295	1481.5	1487.9
1250	2.863	2.775	34.515	27.511	27.519	56.4	1.6158	1.0297	1481.9	1487.7
1300	2.818	2.726	34.520	27.519	27.527	55.6	1.6478	1.0298	1482.6	1487.4

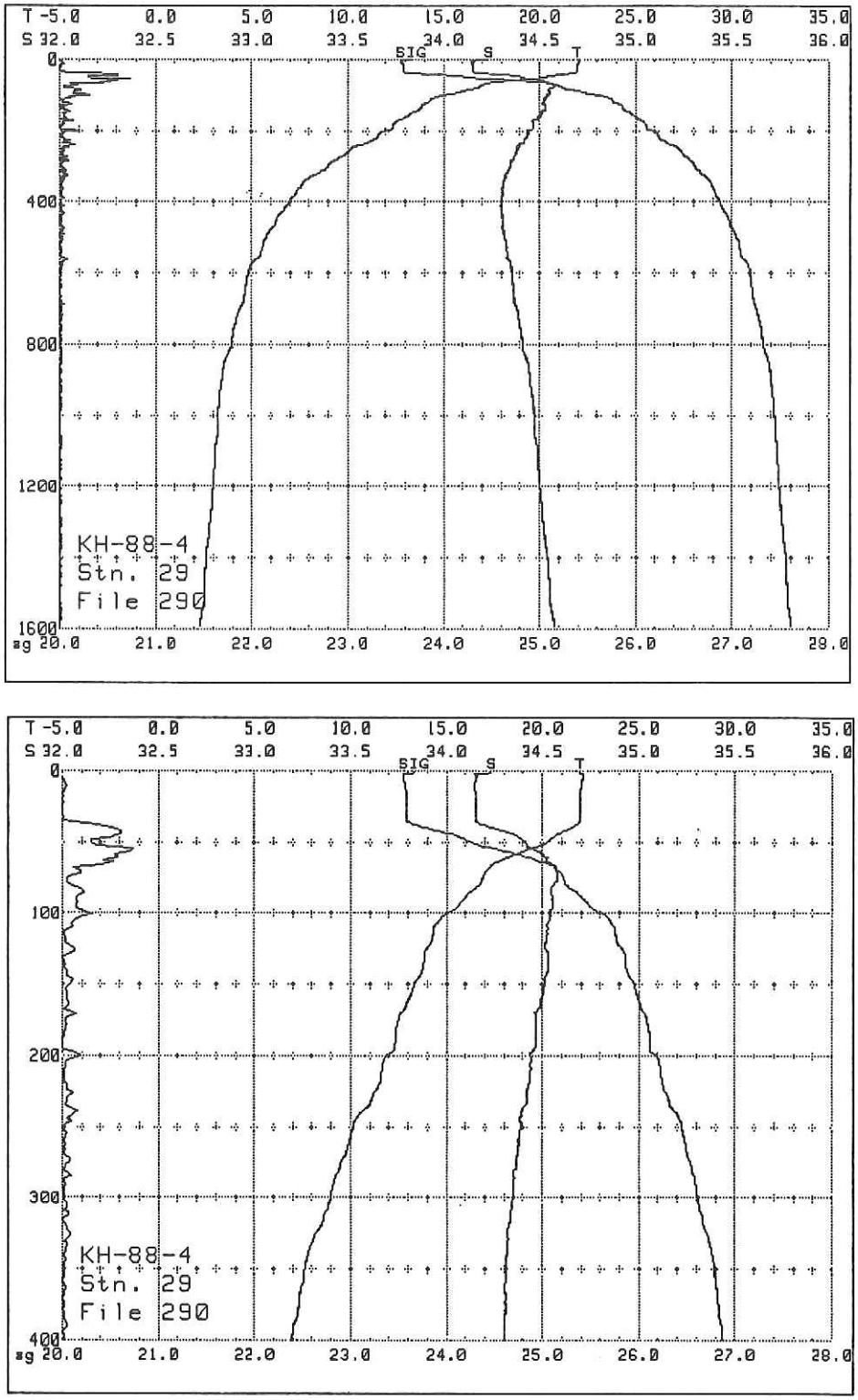


Fig. 29. Vertical profiles of temperature, salinity and σ_t at Station 29 obtained through downward CTD observation. A: full scale, B: expanded between the surface and 400m.

Table 37. List of CTD vertical profile data obtained through downward operation at Station 29.

[see Table 9 for the detailed station data]

LIST OF CTD DATA

Station name 29 Cruise name KH-88-4
File name 290
Correction value (P,T,C) 0 , 0 , 0
S.cal.coef. C-std= 42.909 C-fact.= 1.00009

Press	Temp	P-temp	Sal	Sig-t	Sig-pt	D-st	D-dyn	Rhobar	S.V.	MeanSV
0	22.089	22.088	34.155	23.553	23.553	432.7	0.0000	1.0236	1526.7	1526.7
10	22.013	22.011	34.148	23.568	23.569	431.2	0.0432	1.0236	1526.7	1526.7
20	21.971	21.967	34.150	23.582	23.583	429.9	0.0863	1.0236	1526.7	1526.7
30	21.964	21.958	34.153	23.586	23.588	429.6	0.1294	1.0236	1526.9	1526.7
40	21.477	21.469	34.244	23.789	23.792	410.1	0.1715	1.0237	1525.9	1526.6
50	20.207	20.198	34.415	24.262	24.264	365.1	0.2104	1.0238	1522.8	1526.2
60	18.270	18.259	34.518	24.837	24.840	310.3	0.2444	1.0240	1517.7	1525.2
70	17.066	17.054	34.571	25.170	25.173	278.6	0.2740	1.0242	1514.4	1523.9
75	16.892	16.879	34.579	25.217	25.220	274.1	0.2880	1.0242	1513.9	1523.2
80	16.681	16.668	34.557	25.250	25.254	270.9	0.3017	1.0243	1513.4	1522.6
90	15.876	15.861	34.550	25.431	25.434	253.8	0.3282	1.0245	1511.1	1521.5
100	14.949	14.934	34.539	25.629	25.632	235.0	0.3529	1.0246	1508.3	1520.3
125	13.919	13.900	34.522	25.836	25.839	215.3	0.4100	1.0250	1505.4	1517.6
150	13.306	13.285	34.511	25.953	25.957	204.2	0.4633	1.0252	1503.7	1515.4
175	12.494	12.470	34.468	26.081	26.086	192.0	0.5139	1.0254	1501.3	1513.6
200	11.825	11.799	34.439	26.187	26.192	181.9	0.5618	1.0256	1499.4	1511.9
250	10.150	10.121	34.388	26.449	26.454	157.1	0.6490	1.0260	1494.2	1508.9
300	8.961	8.928	34.346	26.612	26.618	141.6	0.7264	1.0263	1490.6	1506.2
350	7.607	7.572	34.312	26.791	26.796	124.6	0.7958	1.0265	1486.2	1503.6
400	6.954	6.915	34.305	26.878	26.883	116.3	0.8589	1.0268	1484.5	1501.3
450	6.290	6.249	34.308	26.969	26.975	107.7	0.9179	1.0270	1482.7	1499.4
500	5.735	5.691	34.320	27.048	27.054	100.2	0.9730	1.0272	1481.3	1497.6
550	5.442	5.395	34.332	27.094	27.100	95.9	1.0252	1.0274	1480.9	1496.1
600	4.807	4.758	34.357	27.188	27.193	87.0	1.0742	1.0276	1479.2	1494.8
650	4.651	4.599	34.366	27.212	27.218	84.7	1.1203	1.0278	1479.4	1493.6
700	4.380	4.325	34.380	27.253	27.259	80.8	1.1651	1.0280	1479.1	1492.6
750	4.090	4.032	34.400	27.300	27.306	76.3	1.2077	1.0282	1478.7	1491.7
800	3.947	3.887	34.411	27.323	27.330	74.1	1.2488	1.0284	1479.0	1490.9
850	3.580	3.518	34.440	27.383	27.389	68.5	1.2879	1.0285	1478.3	1490.1
900	3.446	3.381	34.451	27.405	27.411	66.4	1.3250	1.0287	1478.5	1489.5
950	3.327	3.259	34.467	27.429	27.435	64.1	1.3611	1.0288	1478.9	1488.9
1000	3.258	3.186	34.474	27.441	27.448	62.9	1.3964	1.0290	1479.4	1488.4
1100	3.104	3.026	34.490	27.469	27.476	60.4	1.4654	1.0293	1480.4	1487.7
1200	2.986	2.901	34.502	27.489	27.497	58.4	1.5326	1.0296	1481.6	1487.1
1250	2.902	2.814	34.512	27.504	27.512	57.0	1.5654	1.0297	1482.1	1486.9
1300	2.821	2.730	34.519	27.517	27.525	55.8	1.5976	1.0299	1482.6	1486.7
1400	2.611	2.514	34.542	27.554	27.563	52.3	1.6597	1.0302	1483.4	1486.4
1500	2.514	2.410	34.554	27.572	27.581	50.5	1.7192	1.0304	1484.6	1486.3

Table 38. CTD-RMS routine data [1/5].

St.No.	Date Time	Location	Depth at St.	Depth db	Sal.	D.O. ml/l	%D.O. %	SiO2 µM	PO4 µM	NO3 µM	NO2 µM	NH4 µM	Temp. °C	Sal.
3	Sept. 23 20:53 - 22:30	36-55.9'N 143-26.2'E	7,360	surface	34.325	4.86	104	1.3	0.00	0.0	0.0	0.0	25.9	--
				50.0	33.846	4.34	82.9	6.1	0.13	1.6	0.5	0.0	19.514	33.759
				99.6	34.588	3.56	62.0	18.1	0.54	11.7	0.0	0.0	14.480	34.573
				200.1	34.364	3.20	50.8	44.3	1.13	21.1	0.0	0.0	10.103	34.384
				300.3	34.281	2.53	38.2	64.0	1.52	26.3	0.0	0.0	7.882	34.296
				399.9	34.130	2.38	34.0	78.7	1.83	30.0	0.0	0.0	5.741	34.129
				500.1	34.169	1.94	27.3	96.0	2.09	33.2	0.0	0.0	4.948	34.170
				600.0	34.208	1.44	19.9	111	2.29	35.5	0.0	0.0	4.290	34.228
				750.0	34.299	1.12	15.4	124	2.46	37.2	0.0	0.0	3.744	34.318
				998.9	34.424	1.35	18.2	140	2.46	37.4	0.0	0.0	3.164	34.437
				1249.9	34.477	1.33	17.7	152	2.46	37.8	0.0	0.0	2.645	34.496
				1500.1	34.524	1.25	16.5	162	2.46	38.2	0.0	0.0	2.328	34.534
				2001.8	34.585	1.71	22.3	167	2.27	36.7	0.0	0.0	1.906	34.613
4	Sept. 24 04:19 - 05:00	37-59.1'N 143-30.7'E	4,370	surface	33.972	4.39	91.2	1.0	0.00	0.0	0.0	0.0	24.1	--
				50	33.704	4.76	83.3	5.9	0.14	3.5	0.1	0.0	15.298	33.722
				99	--	5.15	81.7	13.1	0.37	7.6	0.1	0.0	10.298	33.912
				199	33.553	5.37	72.1	41.1	1.07	0.6	0.0	0.0	3.259	33.556
				300	33.536	4.34	57.1	68.2	1.60	29.3	0.0	0.0	2.453	33.562
				399	33.686	2.73	36.0	95.6	2.01	36.4	0.0	0.0	2.442	33.710
				501	33.878	1.93	25.7	108	2.15	38.4	0.0	0.0	2.942	33.903
				600	34.055	1.16	15.6	125	2.29	40.4	0.0	0.0	3.122	34.079
				700	34.204	1.02	13.8	135	2.25	40.2	0.0	0.0	3.370	34.231
				800	34.256	0.88	11.8	144	2.33	41.0	0.0	0.0	3.004	34.277
				895	34.317	0.86	11.5	146	2.27	40.8	0.0	0.0	2.996	34.332
				1298	34.467	1.04	13.8	164	2.27	40.8	0.0	0.0	2.414	34.490
				2003	34.597	1.91	24.4	169	2.05	39.0	0.0	0.0	1.870	34.617
5	Sept. 25 22:45 - Sept. 26 00:04	38-59.0'N 143-00.6'E	1,614	surface	32.854	5.13	94.5	3.4	0.00	0.0	0.0	0.0	17.9	--
				50	33.653	5.35	79.8	22.9	0.59	13.0	0.2	0.0	7.556	33.661
				99	33.572	5.66	75.5	46.7	1.19	25.3	0.0	0.0	2.998	33.404
				250	33.574	3.58	46.6	86.8	2.20	43.5	0.0	0.0	2.006	33.598
				498	34.036	1.20	16.1	123	2.19	43.7	0.0	0.0	3.065	33.056
				600	34.142	1.04	14.0	133	2.20	43.9	0.0	0.0	3.118	33.164
				700	34.223	0.96	12.8	140	2.22	43.9	0.0	0.0	3.039	34.237
				799	34.307	1.03	13.9	141	2.19	43.9	0.0	0.0	3.148	34.328
				1001	34.361	0.92	12.4	154	2.20	44.1	0.0	0.0	2.753	34.379
				1250	34.488	1.21	15.9	167	2.19	43.9	0.0	0.0	2.335	34.509
				1400	34.507	1.21	16.0	168	2.17	42.9	0.0	0.0	2.266	34.528
				1499	34.532	1.34	17.6	166	2.13	42.9	0.0	0.0	2.176	34.559
				1548	34.540	1.34	17.6	167	2.09	42.9	0.0	0.0	2.134	34.561

(to be continued)

Table 38. CTD-RMS routine data (continued [2/5]).

St.No.	Date Time	Location	Depth at St.	Depth db	Sal.	D.O. ml/l	%D.O. %	SiO2 µM	PO4 µM	NO3 µM	NO2 µM	NH4 µM	Temp. °C	Sal.
SR68	Sept. 26	38-32.0'N	2,598	surface	32.827	5.03	97.5	1.8	0.00	0.0	0.0	0.0	20.6	--
	22:04 -	143-27.7'E		100	33.687	4.89	71.4	33.6	1.16	15.3	0.0	0.0	6.697	33.886
	22:58			250	33.873	3.58	50.2	63.8	1.82	24.5	0.0	0.0	4.886	33.901
				501	34.034	1.42	19.2	117	2.64	35.7	0.0	0.0	3.316	34.057
				751	34.221	0.92	12.4	143	2.82	37.7	0.0	0.0	2.893	34.244
				1000	34.398	0.91	12.2	151	2.80	37.3	0.0	0.0	2.832	34.418
				1250	34.458	0.99	13.1	162	2.82	37.8	0.0	0.0	2.436	34.479
				1500	34.516	1.26	16.6	165	2.77	37.7	0.0	0.0	2.255	34.540
				2000	34.588	1.72	22.4	167	2.64	36.0	0.0	0.0	1.910	34.612
				2101	34.631	1.98	25.7	167	2.61	35.9	0.0	0.0	1.822	34.626
				2300	34.620	2.16	28.1	166	2.53	34.8	0.0	0.0	1.717	34.648
				2399	34.629	2.31	30.0	165	2.50	34.6	0.0	0.0	1.669	34.653
				2495	34.638	2.44	31.6	163	2.48	34.6	0.0	0.0	1.622	34.660
SR71	Sept. 28	38-40.2'N	7,529	surface	33.935	4.43	89.4	0.1	0.11	0.0	0.0	0.0	22.5	--
	20:35 -	144-06.0'E		249	34.034	3.70	54.7	47.9	1.59	20.9	0.0	0.0	7.083	33.070
	Sept. 29			498	34.093	2.11	49.5	89.8	2.35	30.5	0.0	0.0	4.832	33.110
	00:48			750	34.266	1.12	15.2	126	2.78	35.9	0.0	0.0	3.589	34.280
				1000	34.390	1.04	14.0	144	2.86	37.1	0.0	0.0	2.995	34.400
				1500	34.525	1.24	16.4	162	2.86	37.7	0.0	0.0	2.265	34.538
				2000	34.593	1.79	23.4	164	2.69	34.1	0.0	0.0	1.899	34.612
				3000	34.654	2.71	35.1	160	2.47	33.2	0.0	0.0	1.562	34.673
				4000	34.672	3.15	40.7	154	2.35	31.7	0.0	0.0	1.481	34.694
				4499	34.675	3.22	41.7	152	2.34	31.5	0.0	0.0	1.489	34.698
				5000	34.676	3.36	43.5	150	2.27	31.5	0.0	0.0	1.518	34.701
				5498	34.673	3.31	42.9	150	2.22	30.8	0.0	0.0	1.563	34.704
				6004	34.675	3.38	43.8	148	2.16	30.6	0.0	0.0	1.619	34.703
SR72	Sept. 29	39-00.8'N	5,390	surface	34.383	4.76	89.3	0.2	0.06	0.0	0.0	0.0	20.6	--
	22:42 -	147-00.2'E		500	33.986	2.66	37.3	78.3	2.03	30.0	0.0	0.0	4.861	34.004
	Sept. 30			750	34.215	1.09	14.8	120	2.53	41.2	0.0	0.0	3.670	34.229
	02:41			1000	34.354	0.96	12.9	--	2.60	41.9	0.0	0.0	3.109	34.372
				1500	34.512	1.21	16.0	160	2.59	42.7	0.0	0.0	2.377	34.526
				2001	34.596	1.70	22.2	163	2.48	41.4	0.0	0.0	1.959	34.605
				3000	34.662	2.58	33.4	156	2.25	38.6	0.0	0.0	1.566	34.670
				4004	34.688	3.13	40.4	155	2.21	37.1	0.0	0.0	1.459	34.698
				4499	34.696	3.30	42.6	156	2.05	36.1	0.0	0.0	1.459	34.700
				4997	34.716	3.32	43.0	151	2.07	36.3	0.0	0.0	1.489	34.705
				5369	34.698	3.41	44.1	144	2.02	36.1	0.0	0.0	1.524	34.703
				5424	34.698	3.39	43.9	139	2.02	35.9	0.0	0.0	1.529	34.704
				5471	34.703	3.40	44.1	136	2.10	36.1	0.0	0.9	1.533	34.703

(to be continued)

Table 38. CTD-RMS routine data (continued [3/5]).

St.No.	Date Time	Location	Depth at St.	Depth db	Sal.	D.O. ml/l	%D.O. %	SiO2 µM	PO4 µM	NO3 µM	NO2 µM	NH4 µM	Temp. °C	Sal.
6	Oct. 02	40-40.4'N	4,360	surface	34.110	4.72	90.2	0.0	0.00	0.0	0.0	0.0	19.4	--
	22:57 -	144-59.3'E		100	34.577	4.00	70.2	8.7	0.51	7.7	0.0	0.0	14.922	34.628
	Oct. 03			198	34.316	3.94	63.7	17.8	0.78	12.4	0.0	0.0	11.029	34.297
	00:28			300	34.061	4.25	63.8	33.2	1.24	17.6	0.0	0.0	7.796	34.066
				400	34.949	3.57	51.0	58.2	1.87	25.0	0.0	0.0	5.684	33.952
				501	34.004	2.62	36.9	76.2	2.30	30.4	0.0	0.0	4.910	34.032
				601	34.055	1.94	36.7	96.0	2.64	34.7	0.0	0.0	4.128	34.062
				702	--	1.31	17.9	113	2.86	36.2	0.0	0.0	3.727	34.181
				801	--	1.22	16.6	121	2.88	36.0	0.0	0.0	3.749	34.277
				901	34.349	1.13	15.4	128	2.92	36.4	0.0	0.0	3.545	34.342
				1001	34.389	1.03	13.9	136	2.97	37.2	0.0	0.0	3.195	34.380
				1500	34.559	1.18	15.7	155	3.01	38.2	0.0	0.0	2.365	34.525
				2010	34.610	1.62	21.2	157	2.83	36.8	0.0	0.0	1.962	34.604
9	Oct. 06	39-59.2'N	2,504	surface	34.093	4.73	89.3	1.7	0.00	0.0	0.0	0.0	18.8	--
	18:30 -	138-29.8'E		50	34.185	5.40	79.8	9.0	0.51	7.7	0.0	0.0	7.075	34.186
	20:34			99	34.069	5.42	73.8	18.1	0.91	12.1	0.0	0.0	3.642	34.076
				200	34.051	5.31	68.1	30.5	1.26	16.9	0.0	0.0	1.287	34.061
				300	34.078	4.90	61.9	41.4	1.72	19.8	0.0	0.0	0.682	34.075
				401	34.068	4.64	58.2	49.5	1.67	21.0	0.0	0.0	0.476	34.078
				499	34.071	4.71	58.9	51.4	1.65	21.0	0.0	0.0	0.372	34.078
				600	34.069	4.64	58.0	54.9	1.65	21.0	0.0	0.0	0.305	34.079
				799	34.098	4.50	56.1	63.3	1.70	21.9	0.0	0.0	0.232	34.079
				1000	34.075	4.33	53.9	71.8	1.77	22.5	0.0	0.0	0.183	34.076
				1249	34.098	4.25	52.9	77.2	1.77	22.8	0.0	0.0	0.159	34.080
				1500	34.072	4.24	52.7	80.8	1.77	22.8	0.0	0.0	0.152	34.079
				2306	34.082	4.34	54.0	85.0	1.74	22.8	0.0	0.0	0.179	34.081
11	Oct. 07	39-29.6'N	2,632	surface	33.926	5.25	99.2	1.2	0.00	0.0	0.0	0.0	18.9	--
	20:38 -	136-30.7'E		51	34.084	6.50	96.2	13.3	0.81	11.0	0.0	0.0	10.287	34.167
	22:48			100	34.044	5.86	81.7	28.7	1.26	16.8	0.0	0.0	4.601	34.098
				202	34.063	5.50	70.6	41.4	1.54	20.2	0.0	0.0	1.333	34.059
				300	34.068	5.35	67.6	48.3	1.64	21.3	0.0	0.0	0.711	34.075
				400	34.071	5.37	67.4	50.0	1.63	21.1	0.0	0.0	0.467	34.079
				502	34.069	5.32	66.5	53.8	1.64	21.3	0.0	0.0	0.366	34.082
				601	34.069	5.31	66.4	59.2	1.73	21.9	0.0	0.0	0.308	34.081
				800	34.069	5.07	63.2	68.1	1.73	22.6	0.0	0.0	0.246	34.077
				999	34.075	4.89	60.9	--	1.75	23.0	0.0	0.0	0.188	34.079
				1248	34.070	4.90	61.0	79.0	1.77	23.1	0.0	0.0	0.160	34.079
				1501	34.084	4.95	61.6	84.8	1.77	23.3	0.0	0.0	0.151	34.079
				2524	34.071	4.89	61.3	84.6	1.73	23.1	0.0	0.0	0.202	34.083

(to be continued)

Table 38. CTD-RMS routine data (continued [4/5]).

St.No.	Date Time	Location	Depth at St.	Depth db	Sal.	D.O. ml/l	%D.O. %	SiO2 µM	PO4 µM	NO3 µM	NO2 µM	NH4 µM	Temp. °C	Sal.
12	Oct. 08 06:19 - 08:08	38-59.6'N 135-00.3'E	2,936	surface	34.041	5.14	99.3	2.2	0.00	0.0	0.0	0.0	20.1	--
				51	34.560	5.61	70.2	3.6	0.05	0.9	0.0	0.0	15.590	34.518
				99	34.451	5.76	102	3.9	0.23	4.5	0.0	0.0	11.083	34.437
				200	34.202	6.27	101	2.6	0.28	5.2	0.0	0.0	7.868	34.176
				300	34.098	5.99	90.2	18.4	0.92	12.5	0.0	0.0	3.683	34.079
				401	34.087	5.70	77.7	32.0	1.40	17.8	0.0	0.0	1.247	34.052
				500	34.083	5.38	68.9	41.1	1.55	20.0	0.0	0.0	0.680	34.075
				601	34.111	5.33	67.2	46.7	1.61	20.9	0.0	0.0	0.448	34.079
				800	34.088	5.10	64.0	57.5	1.70	21.8	0.0	0.0	0.307	34.080
				999	34.085	5.05	63.2	63.4	1.71	21.8	0.0	0.0	0.240	34.078
				1250	34.089	4.98	62.1	70.0	1.80	22.5	0.0	0.0	0.190	34.075
				1499	34.077	4.84	60.3	75.9	1.78	22.8	0.0	0.0	0.174	34.078
				2518	34.077	4.87	60.7	84.2	1.73	23.0	0.0	0.0	0.206	34.081
13	Oct. 09 07:01 - 07:25	35-41.9'N 132-01.3'E	232	surface	33.518	4.99	100	1.8	0.17	0.0	0.0	0.0	22.4	--
				24	33.504	5.24	67.2	1.7	0.09	0.0	0.0	0.0	22.106	33.478
				48	33.860	5.27	67.5	4.1	0.09	0.7	0.0	0.0	20.404	33.705
				99	34.380	5.26	68.2	18.4	0.70	10.5	0.0	0.0	14.930	34.390
				150	34.098	3.83	67.2	44.9	1.64	19.3	0.0	0.0	1.761	34.097
				199	34.085	4.95	96.3	47.6	1.67	20.0	0.0	0.0	1.286	34.094
				223	34.084	5.01	100	47.6	1.48	20.0	0.0	0.0	1.279	34.093
14	Oct. 17 00:18 - 00:42	32-59.9'N 128-00.2'E	153	surface	34.254	4.66	97.2	2.8	0.05	0.4	0.0	0.0	24.2	--
				10.1	34.212	4.67	97.3	2.7	0.00	0.0	0.0	0.0	24.226	34.223
				25	34.214	4.69	97.7	2.6	0.00	0.0	0.0	0.0	24.227	34.222
				50	34.228	4.67	97.1	2.4	0.00	0.0	0.0	0.0	24.099	34.234
				75	34.562	3.70	73.3	9.1	0.39	5.9	0.0	0.0	21.203	34.553
				100	34.593	3.67	67.8	14.3	0.60	8.9	0.0	0.0	17.483	34.562
				138	34.521	3.62	64.1	18.5	0.74	11.3	0.0	0.0	15.321	34.523
				144	34.516	3.60	63.6	18.6	0.69	11.1	0.0	0.0	15.295	34.524
15	Oct. 17 15:57 - 16:03	30-00.0'N 127-30.0'E	138	surface	34.389	4.72	102	2.1	0.00	0.0	0.0	0.0	26.0	--
				10.5	34.367	4.64	98.8	1.8	0.00	0.0	0.0	0.0	25.964	34.368
				25	34.368	4.65	99.9	1.8	0.00	0.5	0.0	0.0	25.936	34.368
				51	34.371	4.32	91.0	4.0	0.13	2.0	0.1	0.0	24.791	34.371
				75	34.733	4.06	79.3	7.9	0.33	5.5	0.0	0.0	21.373	34.726
				100	34.721	3.94	75.0	10.4	0.44	7.0	0.0	0.0	19.000	34.695
				132	34.608	3.74	66.2	18.7	0.74	11.2	0.0	0.0	15.370	34.611
				138	34.607	3.71	65.7	18.6	0.71	11.0	0.0	0.0	15.361	34.610

(to be continued)

Table 38. CTD-RMS routine data (continued [5/5]).

St.No.	Date Time	Location	Depth at St.	Depth db	Sal.	D.O. ml/l	%D.O. %	SiO2 µM	PO4 µM	NO3 µM	NO2 µM	NH4 µM	Temp. °C	Sal.
16	Oct. 18 03:43 - 04:46	28-00.0'N 127-00.4'E	1,095	surface	34.691	4.50	98.2	1.1	0.00	0.5	0.0	0.0	26.9	--
				50.2	34.286	4.52	98.9	0.5	0.00	0.0	0.0	0.0	26.993	34.279
				101	34.691	4.19	97.7	3.1	0.18	2.6	0.0	0.0	24.265	34.673
				200	34.807	4.16	77.0	5.7	0.38	5.9	0.0	0.0	17.893	34.809
				298	34.630	3.96	69.4	14.7	0.74	10.7	0.0	0.0	14.780	34.628
				400	34.354	3.54	56.7	32.7	1.33	18.2	0.0	0.0	10.551	34.344
				500	34.368	2.91	45.3	49.4	1.69	22.5	0.0	0.0	9.311	34.379
				599	34.319	2.38	35.2	70.4	2.14	27.9	0.0	0.0	7.033	34.310
				700	34.152	2.01	28.6	86.6	2.43	31.3	0.0	0.0	5.575	34.279
				800	34.244	1.87	26.5	98.8	2.45	31.9	0.0	0.0	5.216	34.371
				899	34.288	1.89	26.4	109	2.50	32.9	0.0	0.0	4.615	34.420
				999	34.429	1.85	25.6	115	2.57	33.4	0.0	0.0	4.211	34.444
				1096	34.449	1.87	25.8	118	2.45	32.9	0.0	0.0	4.074	34.460
19	Oct. 19 18:49 - 19:34	24-35.8'N 126-43.3'E	1,937	surface	34.450	4.72	102	0.6	0.00	0.0	0.0	0.0	26.4	--
				50.1	34.949	4.11	82.2	1.4	0.15	2.7	0.0	0.0	21.599	34.945
				100	34.930	4.12	79.4	2.1	0.25	3.9	0.0	0.0	19.595	34.922
				201	34.671	4.33	79.2	5.1	0.37	5.9	0.0	0.0	16.975	34.787
				401	34.461	4.01	67.1	17.8	0.97	13.6	0.0	0.0	12.588	34.453
				599	34.192	2.65	39.2	61.7	2.16	27.8	0.0	0.0	7.093	34.198
				800	34.287	1.61	22.4	103	2.75	34.8	0.0	0.0	4.662	34.291
				1000	34.404	1.44	19.6	124	2.90	36.2	0.0	0.0	3.712	34.404
				1200	34.476	1.58	21.2	136	2.89	36.4	0.0	0.0	3.115	34.480
				1398	34.542	2.01	26.8	144	2.80	35.9	0.0	0.0	2.621	34.547
				1600	34.584	2.27	30.0	146	2.72	35.2	0.0	0.0	3.310	34.589
				1797	34.610	2.56	33.6	148	2.69	34.6	0.0	0.0	3.102	34.616
				1945	34.617	2.62	34.3	147	2.61	34.5	0.0	0.0	2.033	34.624

Table 39. Niskin-23 hydrographic and routine data [1/4].

St.No.	Date Time	Location	Depth at St.	Depth m	Temp. °C	Sal.	D.O. ml/l	%D.O. %	SiO2 µM	PO4 µM	NO3 µM	NO2 µM	NH4 µM
SR64	Sept. 25	39-12.7'N	495	0	18.7	33.355	4.89	91.8	2.6	0.00	0.0	0.0	0.0
	00:48-	142-13.2'E		25	18.45	33.578	4.82	90.2	3.0	0.00	0.0	0.0	0.0
	02:20			50	16.37	34.082	4.88	88.2	4.4	0.04	1.6	0.5	0.0
				75	13.27	34.276	5.14	87.2	5.6	0.10	3.7	0.0	0.0
				100	12.07	34.226	5.30	87.6	6.8	0.14	4.7	0.0	0.0
				125	10.48	34.140	5.20	82.9	9.9	0.19	6.6	0.0	0.0
				139	9.86	34.152	5.21	82.1	10.1	0.21	7.0	0.0	0.0
				187	--	33.731	5.41	--	28.3	0.62	15.7	0.0	0.0
				376	2.41	33.643	3.58	47.1	83.8	1.67	33.8	0.0	0.0
5	Sept. 26	38-58.6'N	1,640	0	18.85	32.854	4.94	99.0	2.9	0.00	0.0	0.0	0.0
	00:06-	143-00.9'E		25	13.07	33.068	5.62	94.1	8.7	0.20	4.8	0.1	1.5
	01:29			50	7.79	33.740	5.27	79.0	21.3	0.46	13.2	0.1	0.0
				75	4.81	33.499	5.44	75.9	36.3	0.79	21.3	0.0	0.0
				100	2.54	33.351	5.72	75.4	48.0	1.05	26.8	0.0	0.0
				125	2.29	33.383	5.58	73.1	53.4	1.12	27.9	0.0	0.0
				148	2.17	33.413	5.26	68.7	57.0	1.20	29.4	0.0	0.0
				200	--	33.452	4.08	53.0	74.9	1.46	28.8	0.0	0.0
				400	--	33.884	1.86	24.9	109	1.88	44.0	0.0	0.0
				572	3.11	34.141	1.16	15.6	129	1.97	45.9	0.0	0.0
				760	3.22	34.296	1.14	15.4	136	1.90	45.5	0.0	0.0
				950	2.80	34.351	1.10	14.7	149	1.93	46.4	0.0	0.0
				1429	2.23	34.527	1.34	17.6	165	1.88	45.7	0.0	0.0
SR68	Sept. 27	38-32.2'N	2,540	0	18.6	32.946	5.03	94.0	2.0	0.00	0.0	0.0	0.2
	00:09-	143-26.5'E		25	16.51	33.366	5.28	94.9	3.2	0.03	0.2	0.0	0.4
	01:45			50	8.78	33.763	5.14	78.9	16.5	0.80	9.3	0.1	0.0
				75	--	33.366	5.79	72.0	27.8	1.35	14.8	0.1	0.0
				100	6.67	33.852	4.72	69.0	34.2	1.30	15.4	0.0	0.0
				125	5.09	33.678	5.03	70.7	39.1	1.45	17.4	0.0	0.0
				142	4.97	33.738	4.82	67.7	45.3	1.60	19.4	0.0	0.1
				190	4.57	33.734	1.97	31.5	51.1	1.74	21.2	0.0	0.0
				380	--	33.974	2.29	31.5	94.2	2.52	31.8	0.0	0.0
				570	3.08	34.081	1.20	16.1	128	2.97	36.7	0.0	0.0
				760	--	34.252	0.90	12.0	141	3.02	37.6	0.0	0.0
				960	2.85	34.390	0.95	12.7	152	3.00	37.4	0.0	0.0
				1902	1.98	34.586	1.63	21.3	169	2.83	36.1	0.0	0.0
SR71	Sept. 27	38-31.9'N	7,450	0	23.0	33.935	4.47	91.2	0.6	0.00	0.0	0.0	0.0
	17:28-	144-04.2'E		25	--	--	--	--	--	--	--	--	--
	Sept. 28			50	17.43	34.535	3.79	69.9	10.2	0.39	5.1	0.2	0.0
	02:44			75	15.67	34.558	3.86	68.7	11.5	0.50	6.7	0.0	0.0

(to be continued)

Table 39. Niskin-23 hydrographic and routine data (continued [2/4]).

St.No.	Date Time	Location	Depth at St.	Depth m	Temp. °C	Sal.	D.O. ml/l	%D.O. %	SiO2 µM	PO4 µM	NO3 µM	NO2 µM	NH4 µM
SR71	Sept. 27	38-31.9'N	7,450	100	14.14	34.533	3.42	59.2	20.8	0.78	10.8	0.0	0.0
	17:28-	144-04.2'E		125	12.62	34.461	3.25	54.7	28.0	0.99	13.6	0.0	0.0
	Sept. 28			137	11.55	34.430	3.16	51.7	35.9	1.17	16.0	0.0	0.0
	02:44			180	9.39	33.201	3.60	56.0	35.1	1.25	16.6	0.0	0.0
				370	4.81	34.932	3.02	42.0	73.2	2.11	27.3	0.0	0.0
				550	3.08	34.138	1.46	19.9	107	2.61	34.4	0.0	0.0
				730	--	34.257	0.99	13.4	130	2.81	36.0	0.0	0.0
				890	3.31	34.268	0.98	13.2	134	2.82	36.3	0.0	0.0
				1749	2.10	34.565	1.40	18.3	164	2.74	35.3	0.0	0.0
				2689	1.59	34.643	2.42	31.6	162	2.48	33.0	0.0	0.0
				3500	1.52	34.669	2.92	37.8	157	2.34	31.7	0.0	0.0
				4400	1.53	34.682	3.28	42.3	153	2.26	31.0	0.0	0.0
				5700	1.58	34.705	3.31	43.0	153	2.24	30.3	0.0	0.0
				7060	1.68	34.690	3.51	45.6	148	2.22	30.2	0.0	0.0
SR72	Sept. 30	39-03.5'N	5,320	0	20.6	34.392	4.60	89.9	0.0	0.03	0.0	0.0	0.0
	00:46-	147-00.5'E		25	--	34.379	4.61	90.2	0.1	0.05	0.0	0.0	0.1
	07:22			50	--	34.397	4.59	89.1	3.2	0.14	1.1	0.2	0.0
				75	--	34.474	4.10	73.3	8.8	0.38	6.4	0.1	0.0
				100	--	34.379	4.10	70.7	11.0	0.53	9.0	0.0	0.0
				150	--	34.402	3.72	61.0	20.6	0.83	13.8	0.0	0.0
				319	4.82	33.951	3.97	55.6	44.9	1.45	22.6	0.0	0.0
				502	4.80	33.993	2.45	34.3	84.8	2.15	33.1	0.0	0.0
				680	3.86	34.126	1.30	17.0	116	2.55	38.9	0.0	0.0
				870	3.36	34.282	1.00	13.5	133	2.64	40.8	0.0	0.0
				1781	2.12	34.550	1.36	17.8	164	2.58	40.8	0.0	0.0
				2687	1.58	34.624	2.42	31.4	158	2.21	37.5	0.0	0.0
SR72'	Oct. 1	39-12.6'N	5,325	4178	1.49	34.660	3.35	43.4	148	2.39	32.5	0.0	0.0
	14:03-	147-06.9'E		5095	1.51	34.670	3.17	41.1	149	2.32	31.6	0.0	0.0
	18:08			5313	1.56	34.674	3.35	43.3	146	2.23	31.0	0.0	0.0
9	Oct. 6	39-59.3'N	2,530	0	18.8	34.093	4.73	89.3	1.7	0.00	0.0	0.0	0.0
	20:38-	138-30.4'E		25	6.84	34.179	5.22	76.8	8.8	0.54	8.2	0.0	0.0
	21:02			75	--	34.088	5.33	75.0	14.3	0.75	10.7	0.0	0.0
				125	4.52	34.049	5.37	74.6	22.0	1.04	13.9	0.0	0.0
				150	--	34.052	5.20	67.9	24.9	1.11	15.0	0.0	0.0
11	Oct. 7	39-29.6'N	2,680	0	18.9	33.926	5.25	99.2	--				
	22:50-	136-31.9'E		25	12.34	34.209	6.98	116	6.7	0.14	0.9	0.0	0.0
	23:15			75	11.44	34.169	6.89	98.4	--	0.36	3.8	0.0	0.0
				125	12.38	34.061	5.89	97.8	18.2	0.92	13.0	0.0	0.0
				150	--	34.050	5.98	113	21.4	1.04	14.3	0.0	0.0

(to be continued)

Table 39. Niskin-23 hydrographic and routine data (continued [3/4].)

St.No.	Date Time	Location	Depth at St.	Depth m	Temp. °C	Sal.	D.O. ml/l	%D.O. %	SiO2 µM	PO4 µM	NO3 µM	NO2 µM	NH4 µM
12	Oct. 8	38-59.4'N	3,000	0	20.1	34.041	5.14	99.3	--	0.0	0.0	0.0	0.0
	08:10-	135-00.5'E		23	16.16	34.562	5.51	99.2	3.6	0.12	0.5	0.6	0.0
	08:31			73	12.95	34.574	5.45	92.0	3.7	0.23	3.0	0.0	0.0
				123	10.04	34.343	5.93	93.8	4.2	0.30	4.6	0.0	0.0
				148	8.74	--	6.23	95.7	1.8	0.28	4.5	0.0	0.0
19	Oct. 19	24-34.8'N	2,000	0	--	34.553	4.66	101	1.0	0.00	0.2	0.0	0.0
	23:56-	126-42.9'E		25	25.77	34.542	4.62	99.0	1.7	0.00	0.0	0.0	0.0
	Oct. 20			50	23.76	34.776	4.37	90.6	3.5	0.02	0.8	0.1	0.0
	01:23			75	21.80	34.937	4.08	81.8	4.1	0.07	2.1	0.0	0.0
				100	20.73	34.928	4.07	80.0	3.2	0.09	3.2	0.0	0.0
				119	20.07	34.921	3.99	77.5	4.6	0.10	3.4	0.0	0.0
				153	19.40	34.908	4.10	78.7	4.6	0.17	4.3	0.0	0.0
				208	18.69	34.812	4.26	80.5	5.0	0.14	5.5	0.0	0.0
				398	12.62	34.452	3.99	66.8	20.1	0.88	13.2	0.0	0.0
				590	6.55	34.164	2.44	35.6	70.1	2.11	29.2	0.0	0.0
				797	4.66	34.280	1.56	21.8	109	2.54	33.9	0.1	0.0
				1000	3.55	34.403	1.40	19.1	126	5.58	36.3	0.0	0.0
				1670	2.16	34.589	2.37	31.2	150	2.46	33.8	0.0	0.0
20B-1	Oct. 24	25-01.3'N	6,940	0	27.6	34.516	4.51	99.7	0.5	1.03	0.2	0.0	0.0
	17:30-	128-09.3'E		25	27.58	34.496	4.43	87.6	0.3	0.00	0.0	0.0	0.0
	18:45			50	27.51	34.484	4.51	94.1	0.3	0.00	0.4	0.0	0.0
				75	25.59	34.716	4.51	99.8	0.7	0.02	0.4	0.0	0.0
				100	24.16	34.690	4.68	103	0.7	0.03	0.0	0.0	0.0
				120	23.67	34.750	4.72	97.8	1.0	0.05	0.4	0.0	0.0
				151	21.11	34.902	4.14	88.6	2.6	0.24	2.7	0.0	0.0
				201	19.10	34.843	4.08	77.9	3.5	0.34	5.0	0.0	0.0
				385	13.46	34.528	4.05	69.1	16.4	0.84	12.2	0.0	0.0
				575	8.87	34.123	3.22	49.6	45.1	1.70	22.6	0.0	0.0
				760	5.67	34.096	2.01	28.7	87.2	2.50	31.8	0.0	0.0
				977	4.23	34.255	1.38	19.1	118	2.82	35.9	0.0	0.0
20B-2	Oct. 24	25-02.8'N	7,000	1988	2.02	34.543	2.61	34.2	150	2.63	34.6	0.0	0.0
	18:47-	128-08.3'E		2986	1.66	34.601	3.16	41.0	151	2.50	33.6	0.0	0.0
	23:38			3919	1.60	34.647	3.32	43.1	151	2.43	32.7	0.0	0.0
				4937	1.69	34.644	3.52	45.8	151	2.40	32.7	0.0	0.0
				5904	1.79	34.654	3.56	46.4	147	2.35	32.3	0.0	0.0
21	Oct. 25	25-00.0'N	4,460	0	25.7	34.724	4.85	104	0.0	0.00	0.0	0.0	0.0
	21:40-	129-44.5'E		25	25.85	34.684	4.82	104	0.0	0.00	0.0	0.0	0.0
	Oct. 26			50	25.86	34.692	4.70	101	0.0	0.00	0.0	0.0	0.0
	01:23			75	25.48	34.730	4.70	100	0.0	0.00	0.0	0.0	0.0

(to be continued)

Table 39. Niskin-23 hydrographic and routine data (continued [4/4]).

St.No.	Date Time	Location	Depth at St.	Depth m	Temp. °C	Sal.	D.O. ml/l	%D.O. %	SiO2 µM	PO4 µM	NO3 µM	NO2 µM	NH4 µM
21	Oct. 25 21:40- Oct. 26 01:23	25-00.0'N 129-44.5'E	4,460	100	23.63	34.844	4.78	99.0	0.0	0.02	0.0	0.0	0.0
				126	22.19	34.783	4.51	90.9	0.0	0.07	1.1	0.0	0.0
				150	21.59	34.786	4.42	88.3	0.0	0.10	1.5	0.0	0.0
				204	20.46	34.802	4.46	87.2	0.6	0.16	1.9	0.0	0.0
				400	15.74	34.626	4.33	77.3	7.8	0.52	7.5	0.0	0.0
				598	9.93	34.201	3.68	58.0	35.3	1.47	18.4	0.0	0.0
				800	6.04	34.119	2.26	32.5	84.0	2.44	30.1	0.0	0.0
				1007	4.37	34.266	1.47	20.5	124	2.86	34.9	0.0	0.0
				1999	2.00	34.574	2.52	33.1	159	2.71	34.2	0.0	0.0
				2997	1.63	34.639	3.21	41.7	167	2,51	32.7	0.0	0.0
				3929	1.59	34.660	3.45	44.7	163	2.39	32.3	0.0	0.0
22	Oct. 26 17:51- 20:31	25-34.0'N 130-44.1'E	4,260	0	26.1	34.554	4.64	100	0.0	0.00	0.0	0.0	0.0
				25	26.12	34.536	4.63	99.9	0.2	0.00	0.0	0.0	0.0
				50	26.15	34.554	4.70	101	0.1	0.00	0.0	0.0	0.0
				75	25.74	34.594	4.56	97.7	0.0	0.00	0.0	0.0	0.0
				100	23.18	34.869	4.83	99.1	0.0	0.02	0.1	0.1	0.0
				121	21.70	34.878	4.63	92.6	0.1	0.05	0.5	0.1	0.0
				147	21.27	34.888	4.50	89.4	0.4	0.10	1.3	0.0	0.0
				201	19.74	34.875	4.58	88.4	1.6	0.15	1.9	0.0	0.0
				391	16.16	34.723	4.35	78.4	5.7	0.46	6.5	0.0	0.0
				583	11.18	34.352	3.87	62.8	25.9	1.23	15.9	0.0	0.0
				780	7.15	34.248	2.49	36.9	65.4	2.17	26.9	0.0	0.0
				985	4.33	34.362	1.66	23.1	111	2.77	33.8	0.0	0.0
				1949	2.00	34.611	2.58	33.8	146	2.67	33.4	0.0	0.0
				2911	1.61	34.662	3.20	41.6	145	2.50	31.9	0.0	0.0
				3755	1.56	34.678	3.48	45.1	145	2.40	40.5	0.0	0.0