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## **Biological Data Report for the Saroma-ko Site of the SARES (Saroma-Resolute Studies) Project, February-March, 1992<sup>\*,\*\*</sup>**

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## CONTENTS

ABSTRACT .....	69
INTRODUCTION .....	69
MATERIALS AND METHODS .....	70
SAMPLING PROTOCOL .....	70
ANALYTICAL PROCEDURES .....	71
RESULTS .....	75
REFERENCES .....	96
APPENDICES .....	97
A. PHYSICAL DATA FROM ROBINEAU .....	97
B. OPTICAL DATA FROM KUDOH & KISHINO .....	100
C. PIGMENT SIZE FRACTIONATION DATA FROM ROBINEAU .....	113
D. PIGMENT STANDING STOCK DATA FROM KUDOH .....	114
E. SPECIES COMPOSITION DATA FROM KUDOH .....	115
F. PHOTOSYNTHESIS DATA FROM SUZUKI .....	116
G. NUTRIENT DATA FROM KASAI & TAGUCHI .....	117
H. PIGMENT, POC AND PON DATA FROM MICHEL .....	121
I. FLUORESCENCE DATA FROM THERRIault .....	126

J. ZOOPLANKTON ABUNDANCE DATA FROM HATTORI .....	133
K. ZOOPLANKTON BIOMASS DATA FROM SAITO .....	155
L. ZOOPLANKTON INGESTION DATA FROM SAITO .....	157
M. ZOOPLANKTON ABUNDANCE DATA FROM FORTIER .....	160
N. LARVAL FISH DATA FROM FORTIER .....	161

**ABSTRACT :** The Saroma-Resolute Studies (SARES) were conducted to characterize biological processes at Saroma-ko lagoon, Hokkaido, Japan in February and March 1992. Biological data and associated data are summarized in this study. A core biomass program was established to monitor seasonal changes of biological processes. Based on the core biomass program the following specific studies were conducted. Optical data were obtained to determine the effect of light on the growth of ice algae in relation to snow coverage. Heterogeneity in the distribution of ice algal chlorophyll a was examined. Nutrient bioassay experiments were conducted to determine the effect of nutrients on the ice algal growth. Survival of ice algae in low salinity condition was examined to study a physiological response to a low saline environment underneath of sea ice. Photosynthetic activity was determined to characterize primary production at freezing temperature. Feeding activity of zooplankton was studied to estimate the consumption of ice algae by zooplankton. Zooplankton abundance was determined with three different mesh sizes of net. Sediment traps were deployed to estimate the vertical flux of ice algae. The exchange of fish larvae between the lagoon and the sea was studied at the second channel.

**要旨 :** 日本とカナダとの共同研究である「SARES (Saroma-Resolute Studies) Project」の一端として、1992年2月-3月に、冬季サロマ湖における生物過程の季節変動の特徴を調べるための観測を行った。本研究では、このサロマ湖の観測において得られた生物学的資料及びそれに関連する資料を提供する。主なものは、積雪に関連したアイスアルジーと光との関係、アイスアルジーの空間分布、アイスアルジーの成長と栄養塩との関係、低塩分環境下におけるアイスアルジーの生存性、結氷温度下における一次生産性と光合成との関係、動物プランクトンによるアイスアルジーの摂餌、沈降物質フラックス等である。

**Key words :** Ice algae, Nutrient, Photosynthetic activity, Sea ice, Zooplankton

キーワード：アイスアルジー，栄養塩，光合成，海水，動物プランクトン

## I. INTRODUCTION

The Saroma Resolute Studies (SARES) was established based on the Canada-Japan Agreement on Cooperation in Science and Technology, signed in Tokyo on May 7, 1986. A group of Canadian scientists proposed "The biological CO<sub>2</sub> pump under the first-year ice of the

Arctic Ocean”, while a group of Japanese scientists proposed “The biological processes in the Arctic polynya areas”. As a part of joint field works of the SARES program, biological studies were conducted at Saroma-ko lagoon in February and March 1992, and at Resolute from April to June 1992. This report summarizes the biological studies conducted at Saroma-ko lagoon. The atmospheric and oceanographic data should be consulted with the Physics Data Report (Shirasawa *et al.*, 1993).

## II. MATERIALS AND METHODS

### 1. Sampling Protocol

The ice camp was located approximately 2 km offshore in the eastern basin of Saroma-ko lagoon ( $44^{\circ}06'52''\text{N}$ ,  $143^{\circ}56'59''\text{E}$ , Fig. 1). Water depth was about 9.5 m. All the sampling reported

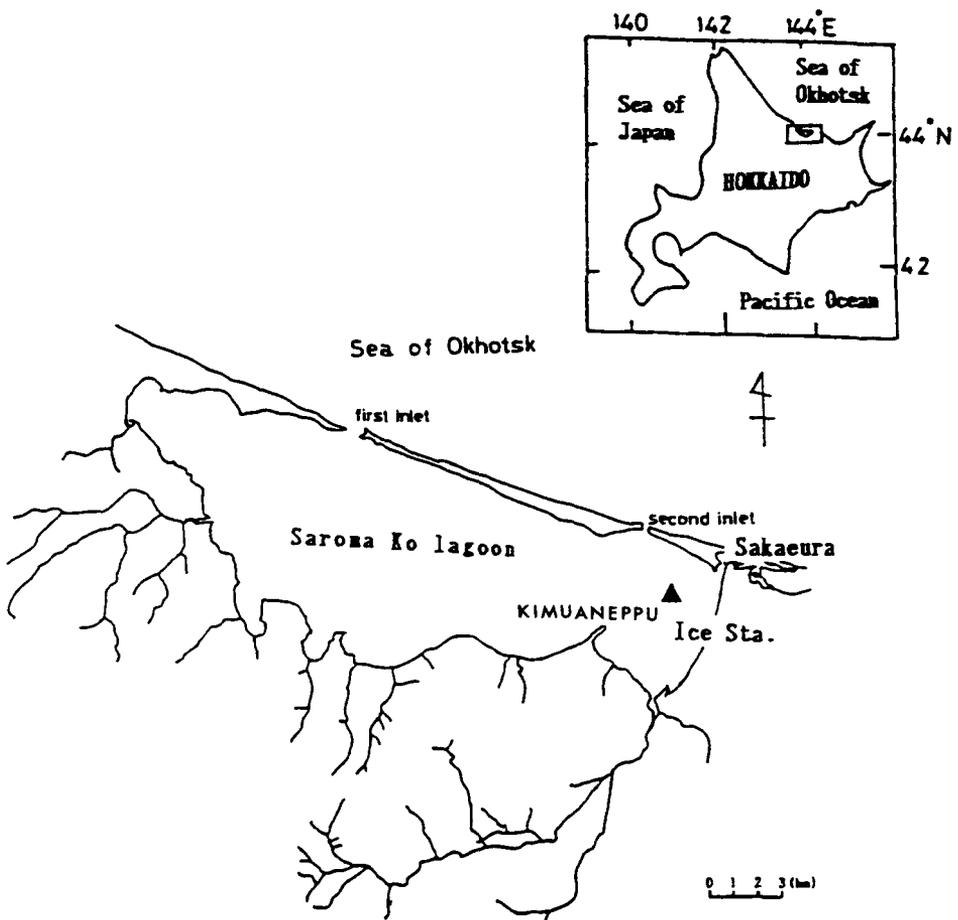


Fig. 1. Location of the experimental station in the eastern basin of Saroma-Ko lagoon, Hokkaido, Japan

here was done within several hundred meters of the ice camp. The area was covered with first-year ice.

The core biomass program used CRREL corers to obtain samples of ice from at intervals of 4 days. The bottom 3 cm of cores were scraped gently and placed with a known volume of the filtered sea water. Subsamples were taken for replicate determinations of chlorophyll pigments, particulate organic carbon (POC), particulate organic nitrogen (PON), species identification and cell counts, microheterotrophs, dissolved organic carbon (DOC), and dissolved inorganic nutrients.

Two sites were sampled from February 24 to March 16, 1992. At the open site, the ice was cleared of snow at the beginning of the sampling period. At the natural site, snow depth was left untouched. Open and natural sites were sampled every third or fourth day. Snow depth was recorded at the natural site, and ice thickness at the both sites. Salinity was measured with a Solomat instrument for samples from the natural site. At the open site, each sample consisted of seven to twelve ice cores and, at the natural site, of twelve to fifteen cores. Each core measured 3 cm long by 7.2 cm diameter. Each sample was melted at room temperature in the dark.

For the fluorometric determination of size fractionized chlorophyll a, subsamples (10 to 100 ml) were filtered in parallel of Porestics polycarbonate filters with a respective porosity of 5  $\mu\text{m}$  and 0.4  $\mu\text{m}$  subtracting 5  $\mu\text{m}$  values (large cells) from 0.4  $\mu\text{m}$  ones (total cells) gave the contribution of small cells (0.4 - 5  $\mu\text{m}$ ) to the total biomass. Additional filtrations (10 to 100 ml) were conducted on GF/F filters (0.7  $\mu\text{m}$  porosity). Chlorophyll a was extracted during 24 h with DMF (n, n-Dimethylformamide, Suzuki and Ishimaru, 1990), at 4 °C in darkness. Fluorescence of the samples was read on a Turner Designs fluorometer model 10.

## 2. Analytical Procedures

Complete details should be available from the investigators responsible for the data. Only a brief account is given here.

Physical and optical data: Snow depth was measured in cm. Ice thickness was determined in meters.

Photosynthetically Active Radiation (PAR) was measured using a LICOR cosine collector at the indicated times.  $E_d$  denotes downwelling PAR above the snow surface.  $E_u$  denotes upwelling PAR and  $E_o$  denotes PAR determined just below the ice by deploying the sensor on an arm with ice-covered hole. All measurements are in  $\mu\text{W m}^{-2} \text{s}^{-1}$ .

Downward spectral irradiance in and under sea ice was measured by MER-1000 multichannel underwater irradiance meter designed by Kishino et al. (1984) with some modification. The

photodetectors are 16 separate silicon diodes and each of the diodes was covered with an interference filter having a wavelength of maximum transmittance at 402.4, 418.8, 438.8, 455.9, 473.3, 496.6, 516.2, 535.1, 554.8, 587.9, 595.3, 614.7, 633.8, 650.6, 677.7 and 694.5 nm with typical band width of 10 nm. The meter was rapidly scanned (about 10 ms to scan entire spectrum), and several measurements were averaged at each depth. The instrument was calibrated with a 1,000 W quartz-halogen irradiance standard lamp supplied by the National Bureau of Standard, USA. The measurements were carried with special attention avoiding possible disturbance of light environment by ice hole.

Chemical data for ice: Inorganic nutrients were analyzed on a Bran & Lubbe analyzer at Hokkaido National Fisheries Research Institute (HNFRI) after filtration through a membrane filter (type Milex-HV). The results are averages of duplicate determinations. Units are micro-mol l<sup>-1</sup>. Hiromi Kasai (HNFRI ; Tel. : 0154-91-9136) can provide further details if needed.

DOC (mean of triplicate determinations) was analyzed on a Dohrman wet combustion (persulfate) system at University of Waterloo after filtration through pre-combusted GF/F filters. Units are mgC l<sup>-1</sup>. Ralph Smith (University of Waterloo ; Tel. : 519-885-1211) can provide further details if needed.

Pigment samples for the core program were collected either direct filtration on GF/F filters, or by size fraction (filtration on 10  $\mu$ m, 2  $\mu$ m, and 0.2  $\mu$ m polycarbonate filters). In either case, the pigments were then extracted with either 90% acetone or N, N-Dimethylformamide (DMF) solution (Suzuki and Ishimaru, 1990) and analyzed on Turner Design fluorometer by the method of Holm-Hansen et al. (1965).

POC and PON (mg m<sup>-3</sup>) samples were filtered on a precombusted glass fiber filter (type GF/F) and determined on YANACO CHN corder model MT-5 at the Hokkaido National Fisheries Research Institute. Satoru Taguchi (HNFRI ; Tel. : 0154-91-9136) can provide further details if needed.

Biological data for ice : Net photosynthetic rates of ice algae collected from the natural and open site were measured using oxygen electrode (Rank & Brothers, Clark-type Pt-Ag electrode) at 0 °C at five light intensities ; 0, 2.0, 3.0, 4.5, 10, and 25  $\mu$  E m<sup>-2</sup> s<sup>-1</sup> for 10 min incubation in the laboratory. At first, dark respiration rate of ice algae was determined after algal cells were centrifuged. Then the algal cells were exposed to various light levels provided by an incandescent lamp (Nikon). Light intensities exposed to the samples were measured by means of quantum meter (Biospherical, QSL-100). Yoshihiro Suzuki and Sakae Kudoh (University of Tokyo ; Tel. : 03-3812-2111, ext.4474) can provide further details if needed.

Enrichment experiments to assess limiting factors for ice algal growth were conducted with natural community cultures in the laboratory. Nitrogen (either ammonium or nitrate),

phosphorus and silicon were added alone and in combination to determine effects on algal growth and assimilation of carbon and nitrogen. Samples for chlorophyll a (by fluorometry of acetone extracts) and dissolved inorganic nutrients (by autoanalyzer) were taken at 4 day intervals, while samples for POC and PON (by automated elemental analyzer) were taken at the beginning and end of the 20-day experiment. Ralph Smith (University of Waterloo ; Tel. : 519-885-1211) can provide details.

Silicon enrichment experiments were conducted with ice algae in synthetic sea water with 22 ppt of salinity to determine effects on algal growth and photosynthesis. Samples for chlorophyll a and dissolved inorganic nutrients were analyzed as mentioned above. Samples for  $^{13}\text{C}$  were taken at 6, 12, and 16 th day of the incubation experiment and analyzed on JASCO Model EX 130  $^{13}\text{C}$  analyzer at the National Institute of Polar Research. Satoru Taguchi (HNFRI ; Tel. : 0154-91-9136) can provide details.

Dissolved organic carbon in seawater and melted ice samples was determined using a Dorham wet combustion system, following filtration through pre-combusted GF/F filters (Ralph Smith for details).

Incubation experiments with low salinity were conducted with three levels of silicate enrichment. Satoru Taguchi (HNFRI ; Tel. : 0154-91-9136) can provide further details if needed.

Sediment traps, which were PVC cylinders 40 cm high and 10 cm in diameter, were attached to the ice at depths of 0.5, 2.5, and 7.5 m from the ice cover. Prior to deployment, the traps were filled with filtered seawater (GF/F filters) to which salt was added in order to obtain a saline solution of about 60 ppt. During the sampling period, which extended from the third or fourth day, triplicate subsamples were taken except on one occasion. After recovery, the total volume of the trap was brought back to the shore laboratory where it was prefiltered through a 330  $\mu\text{m}$  mesh and splitted into subsamples. Duplicate subsamples were filtered on Whatman GF/F filters for the determination of chlorophyll and pheopigments (extraction in DMF and fluorometric determination on a Turner Design Fluorometer). Other subsamples in duplicate were filtered on pre-combusted GF/F filters, and kept frozen for later determination of POC and PON. A subsample was taken for enumeration of fecal pellets which were filtered on GF/F filters. A subsample was also kept in acidic Lugol solution for cell enumeration under the inverted microscope. C. Michel (University of Laval ; Tel. : 418-656-5917) can provide further details if needed. POC and PON were analyzed on YANACO CHN corder model MT-5 at HNFRI. Satoru Taguchi can provide further details if needed.

Chemical and biological data for water column : Every three or four days, water column samples were taken using 4-l Niskin bottles at 1, 2.5, and 7.5 m from the ice cover. Duplicate

subsamples were used for chlorophyll and pheopigment determination, as well as POC and PON analyses. Nutrient analyses were performed on frozen filtrates after filtration with disposable syringe filter unit on acetate filter 0.45  $\mu\text{m}$ . Cell enumeration and identification were also performed under the inverted microscope on samples preserved with acidic Lugol solution. C. Michel can provide further details if needed.

Toward the end of the sampling period in the Saroma-Ko lagoon, vertical profiles of temperature, salinity, sigma-t, transmissivity and fluorescence were collected under the ice during day and night time using a specially designed instrument. For further details contact Jean-Claude Therriault (Maurice Lamontagne Institute ; Tel. : 418-775-0500).

Diel vertical distribution and feeding rate for copepods were investigated during February 25 to 26, and March 23 to 24, 1992. Copepods were collected seven times a day by the NIPR-net (Fukuchi et al., 1979) fitted with 333  $\mu\text{m}$  mesh at 0, 1, 3, 6, and 9 m layers from the under surface of the sea ice. Sampling was carried out twice in each layer for the analysis of gut pigment contents and for the determination of biomass. Copepods for the gut pigment analysis were sorted and placed into 6 ml of 90% acetone for chlorophyll a and pheopigment analysis (Holme-Hansen et al., 1965). The second sample was divided by folsom splitter, and supplied for enumeration and for the analysis of dry weight, carbon, and nitrogen, respectively. Chlorophyll ingestion rate of individual copepod was calculated according to the method of Saito et al. (1991). Hiroshi Hattori (Hokkaido Tokai University ; Tel. : 011-571-5111) and Hiroaki Saito (HNFRI ; Tel. : 0154-91-9136) can provide further details if needed.

Zooplankton was sampled under the ice of the lagoon using a 45-cm Bongo sampler equipped with two plankton nets (100- $\mu\text{m}$  and 330- $\mu\text{m}$  mesh) and Tsurumi Seiki Co.'s flowmeters during the period from February 23 to March 24, 1992. The sampler was tied to a cable forming a loop between holes 150 m apart in the ice. A heavy-duty snowmobile was used to tow the sampler. Circular buoys mounted on the frame allowed to sample the 0.5 to 1 m layer directly under the ice. Sampling was carried out twice daily, once during the day and once at night. Microzooplankton (including copepod nauplii) were sampled with a vertical haul from bottom to surface, using a 35- $\mu\text{m}$  mesh net mounted on a 30 cm diameter ring. Zooplankton in the 100- $\mu\text{m}$  mesh net were identified and counted under the dissecting microscope and the copepodite development stages of the dominant copepod species were noted. Density of copepod nauplii in the water column was estimated from the 35- $\mu\text{m}$  mesh net. Martin Fortier (University of Laval ; Tel. : 418-656-5917) can provide further details if needed.

To study the exchange of fish larvae between the lagoon and the sea, a 500- $\mu\text{m}$  mesh net mounted on a 45 cm diameter ring equipped with internal and external flowmeters (Tsurumi Seiki Co.) was deployed from a bridge crossing the second channel linking the lagoon to the Sea

of Okhotsk. This man-made channel is 50 m wide, 320 m long and 5.2 m deep. Tidal transport of fish larvae through the channel was studied by conducting two 24-h sampling periods from 5 to 6 March 1992 (Period 1) and from 16 to 17 March 1992 (Period 2), respectively. During these periods, the net was deployed from the bridge for 20-min every half hour. Temperature and salinity profiles (Sea-Bird Model SBE-19) were recorded on the ebb and flood during Period 2. The 48 samples collected on each period enabled us to detail the exchange of fish larvae over two complete semidiurnal tidal cycles. Recruitment of fish larvae to the lagoon was monitored from 28 February to 19 March by deploying the same sampler twice daily, at the end of flood and ebb tides. All fish larvae captured at the inlet were sorted and measured to the nearest 0.1 mm using an eyepiece micrometer mounted on a dissecting microscope. Identification was based on descriptions by Okiyama (1988). Martin Fortier (University of Laval ; Tel. : 418-656-5917) can provide further details if needed.

### III. RESULTS

#### PAR in Air, Snow, Ice, and Water Column

Temporal variation of PAR indicates a gradual increase with season (Fig. 2). Spectral irradiance in a water column was measured under natural sea ice covered with snow (A) and under sea ice after removal of snow (B) on February 22, 1992 (Fig. 3). Although a large difference of PAR was observed between treatments, the spectral irradiance showed almost identical pattern between the treatments. Wavelength of maximum transmittance occurred between 580 and 600 nm. The attenuation coefficient of seawater in the water column was  $0.3 - 0.32 \text{ m}^{-1}$ , which indicated one order decrease of PAR with a depth of 8 m. Relative PAR

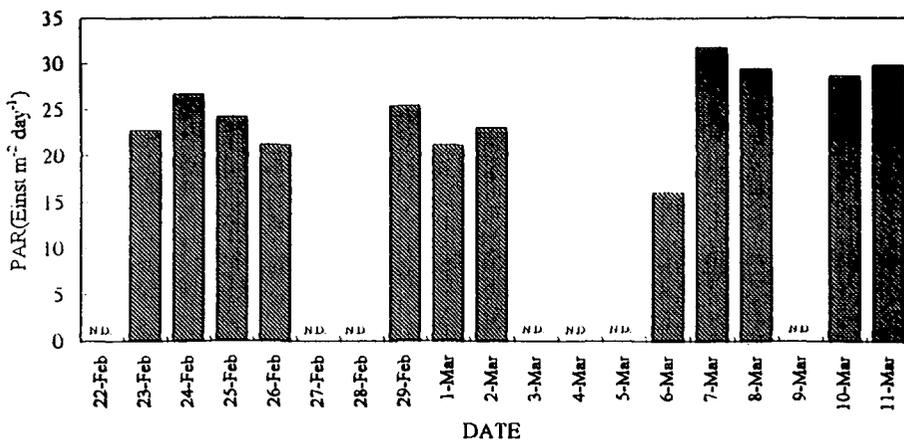


Fig. 2. Seasonal change of PAR ( $\text{E m}^{-2} \text{ d}^{-1}$ ) in air measured at the experimental station

reaching below sea ice was about 0.7 % under natural condition and about 4 % after removal of surface snow coverage (Fig. 4). Snow thickness during the observations was about 10 cm, upper sea ice was 25 cm in thickness and bottom sea ice including ice algae was about 8 cm in thickness.

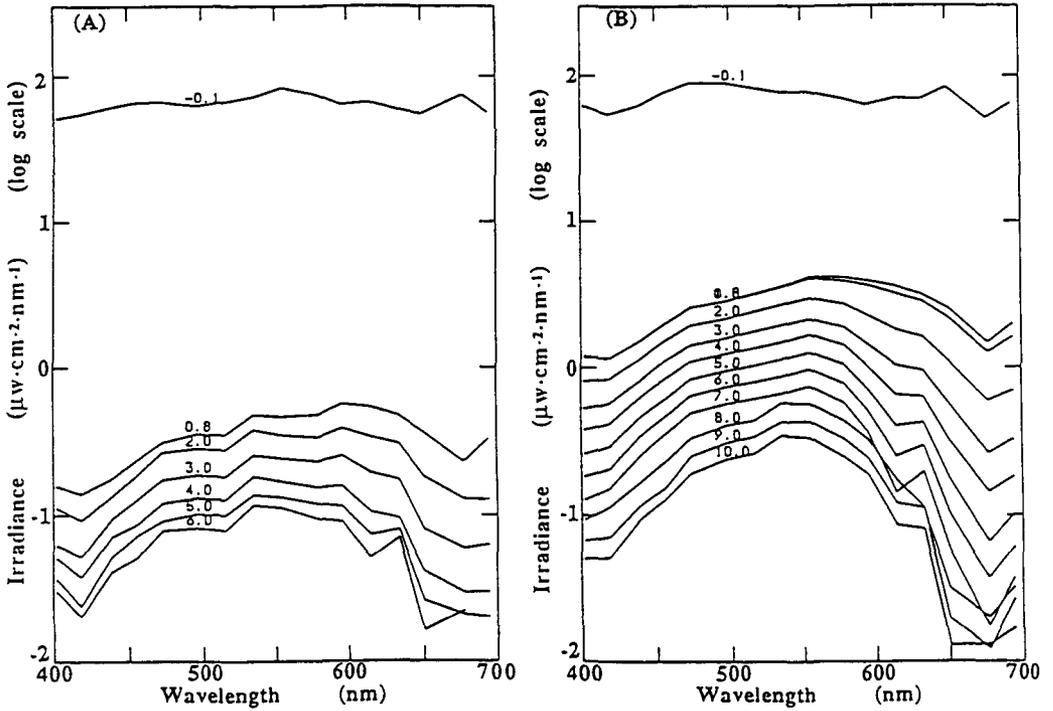


Fig. 3. Downward spectral irradiance measured under sea ice on February 22, 1992. (A) : Natural condition, (B) : After removal of snow

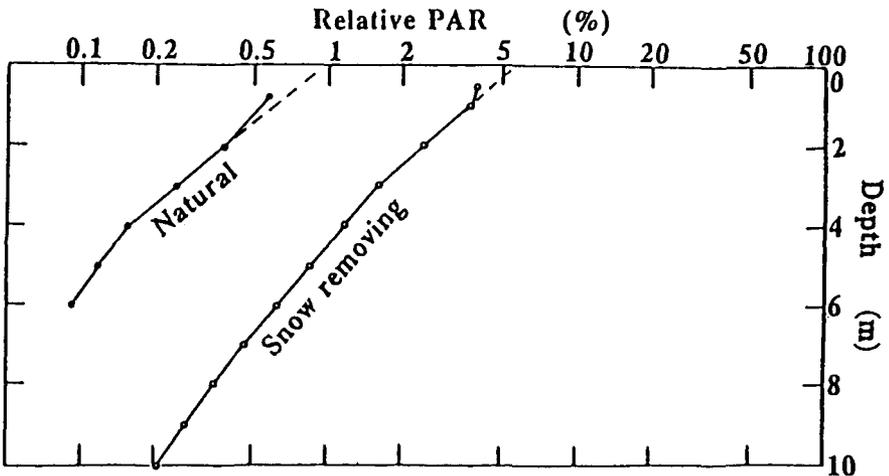


Fig. 4. Relative light intensity of PAR in the water column estimated from downward spectral irradiance shown in Figure 3

Spectral irradiance in the sea ice was determined on March 13, 1992 (Fig. 5). Snow thickness was about 9 cm, and upper and bottom sea ice was 31 cm and 13 cm, respectively. Relative PAR was 11.5 % under the surface snow coverage, 2.81 % below the upper sea ice and 0.716 % below the bottom sea ice. All the spectral patterns were nearly the same as shown in Figure 3.

The transmittance was determined for each layer (Fig. 6). The layer of snow included the reflectance of snow surface, which was estimated as more than 50 % although it changed with the surface condition of snow. The spectral transmittance of surface snow was independent of wavelength and estimated as about 10 %. The light environment of bottom sea ice was considered to be strongly determined by the light absorption of ice algae as studied in the Antarctica by SooHoo et al. (1987).

### Snow and Ice Thickness

At the natural site, snow depth ranged from 0 cm to 10 cm, with a decreasing seasonal trend

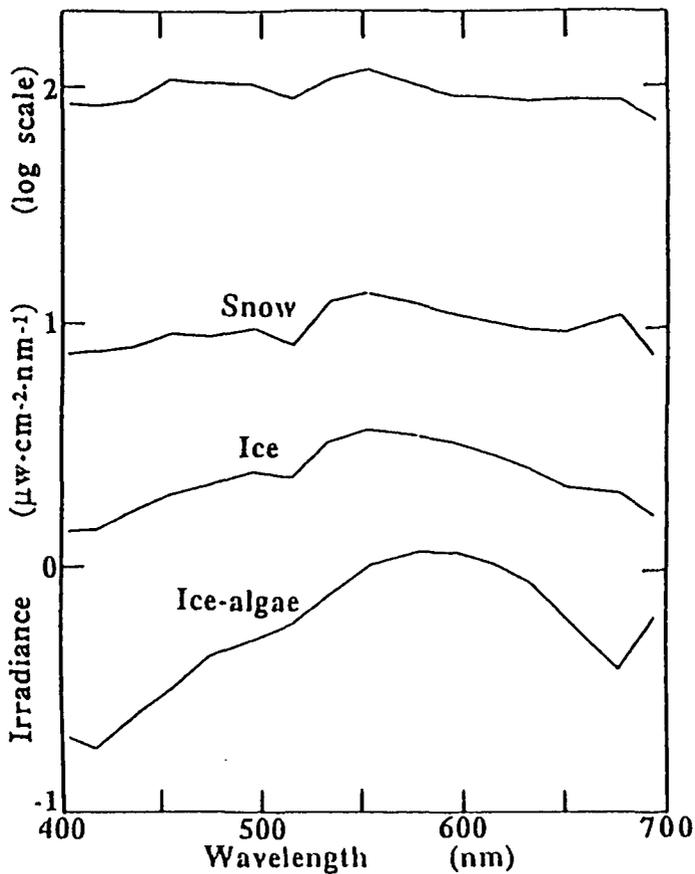


Fig. 5. Downward spectral irradiance measured in sea ice on March 13, 1992

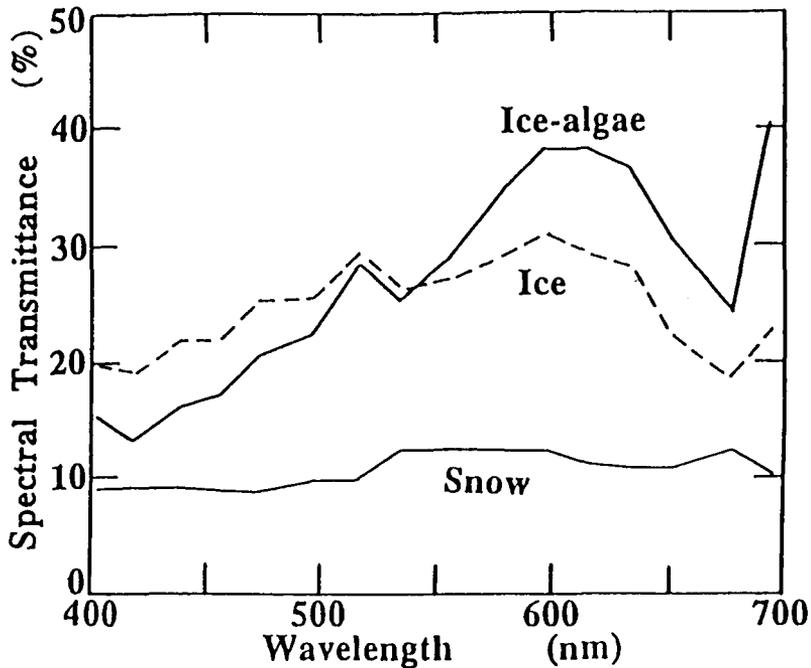


Fig. 6. The transmittance of the layers of surface snow, upper sea ice (Ice), and bottom sea ice (Ice-algae) including ice algae

(Fig. 7 A). Ice thickness slightly increased during the study period at the open site (from 35 to 42 cm) as well at the natural site (from 36 to 44 cm) (Fig. 7 B). The salinity of the bottom ice at the natural site followed a decreasing trend, with abrupt fluctuations between 6 and 10. Ice thickness and salinity at the natural site suggested the beginning of the melting process (Fig. 7 C).

### Chlorophyll a Contents of Ice

Chlorophyll a filtered on GF/F filters were higher at the natural site (heavy snow) than at the open site (thin snow) (Fig. 8). Maximum values of biomass for total and large cells filtered on porosity filters were also largely reduced at the open site compared to the natural site ( $20 \text{ mg m}^{-2}$  versus  $42 \text{ mg m}^{-2}$ , Fig. 9 A). Total and large cell biomass tended to decrease after February 27 (Julian day 58) at both sites.

At the open site (Fig. 9 B), similar amounts of chlorophyll a were found on the  $0.4 \mu\text{m}$  (total cells) and  $5 \mu\text{m}$  (large cells) filters, from  $0.7$  to  $20 \text{ mg m}^{-2}$ . Chlorophyll a in the small cell fraction ranged from  $1$  to  $11 \text{ mg m}^{-2}$ . The contribution of small cells to total biomass was generally low ( $<26\%$ ), except in late February (Julian day 55) and on March 5 (Julian day 65) coincided with the further reduction of biomass to near-zero values at the open site. Growth resumed after the storm.

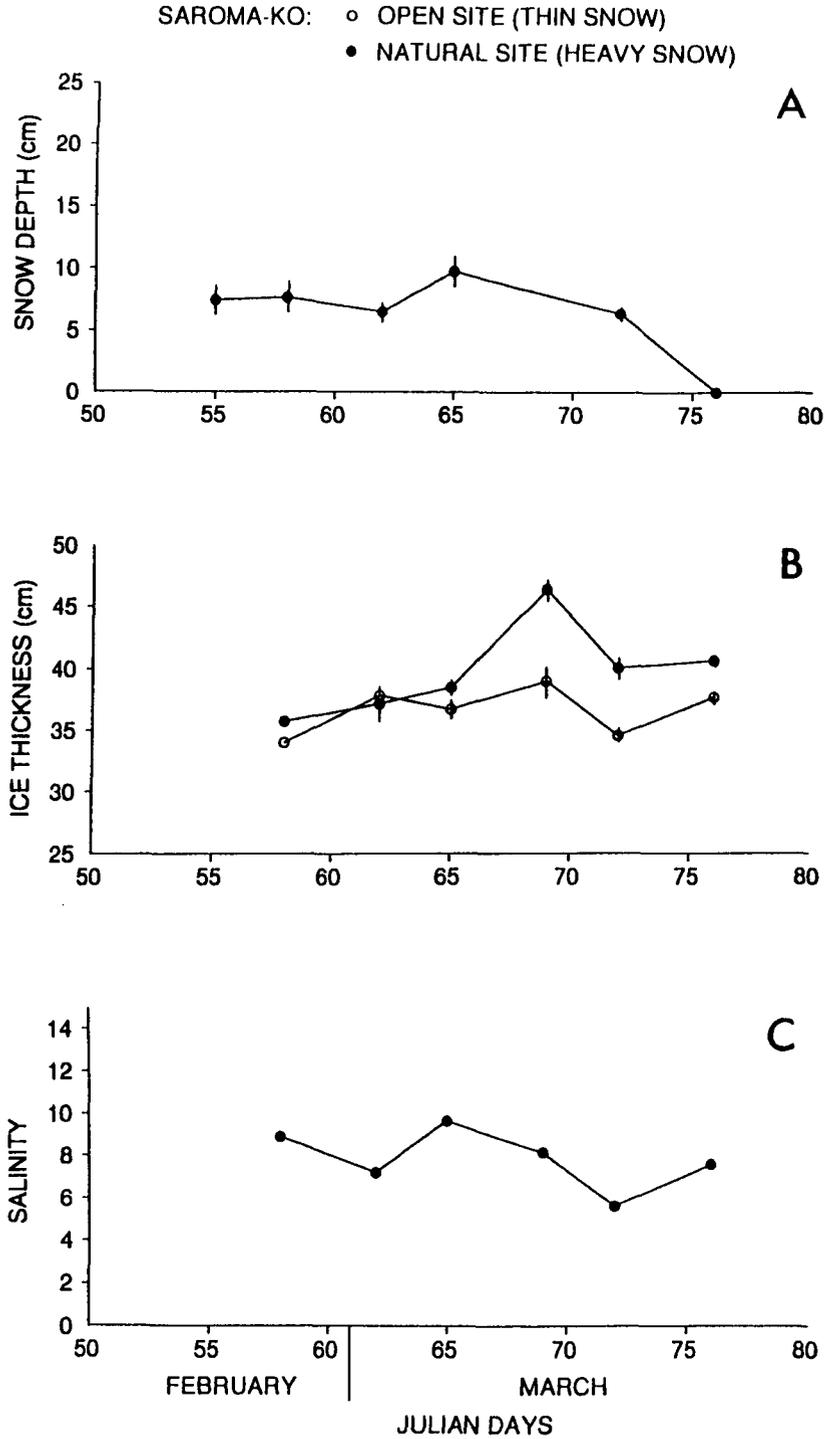


Fig. 7. Seasonal changes of thickness of snow (A) and sea ice (B), and salinity (C, psu) of ice at the natural (closed circles) and open site (open circles) during the period from February 22 to March 20, 1992. Vertical bars indicate the standard error.

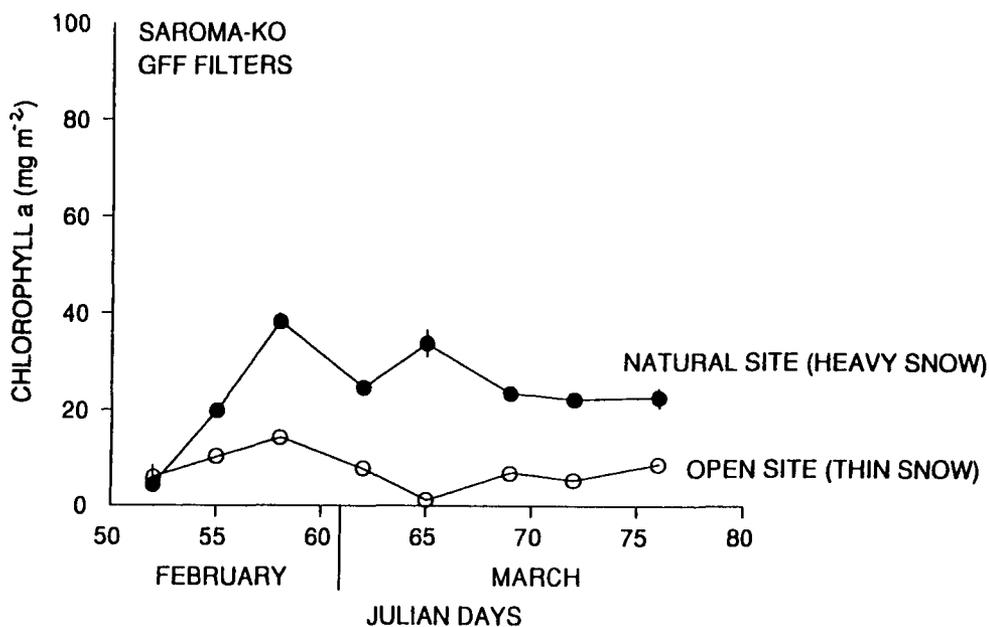


Fig. 8. Seasonal change of ice algal chlorophyll a concentrations at the natural (closed circles) and open (open circles) site during the period from February 22 to March 20, 1992

At the natural site (Fig. 9 B), chlorophyll a in the total cell and large cell fractions followed similar seasonal trends, from 6 to 42 mg m<sup>-2</sup>. Small cells ranged from 0.4 to 8 mg m<sup>-2</sup> and thus generally contributed a larger fraction of total biomass (3–65%) than at the open site. At the natural site, the biomass of the total, large cells and small cells was little affected by the snow storm and actually increased immediately after the storm to decrease later again. Since the biomass of the ice algae was higher at the natural site than at the open site, it may be concluded that the high light transmitted through the thin ice and snow cover probably inhibited the growth of the cells at the open site. The snow storm greatly influenced the biomass.

### DOC in Ice

DOC measurements commenced at or shortly before the observed maximum concentration of chlorophyll a in the ice. DOC concentrations were generally higher in ice than in the underlying seawater (Fig. 10), and were in fact remarkably high compared to the known range for unpolluted seawater. The concentrations in seawater were comparable to the higher values previously reported for coastal seawaters.

### Ice Algal Photosynthesis

Photosynthetic rate of ice algae collected at the natural site was higher at low light and

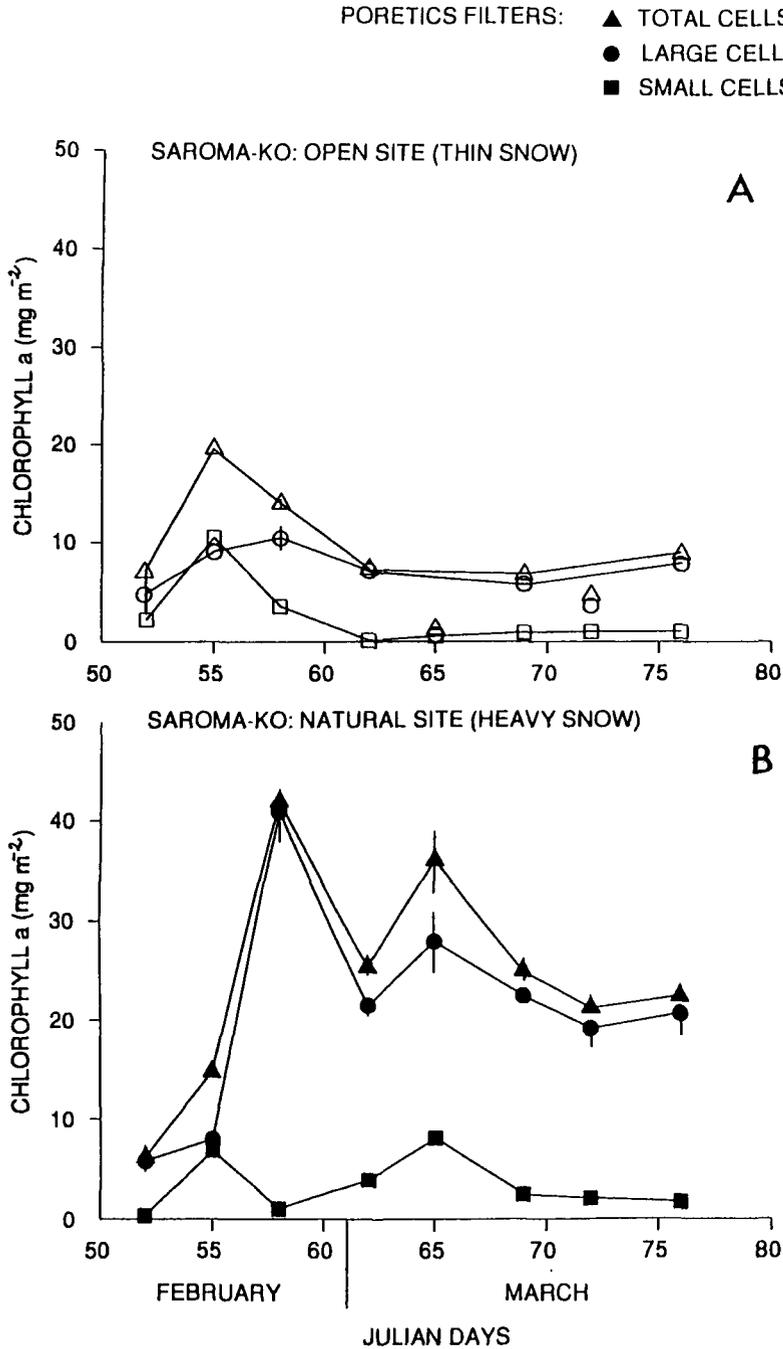
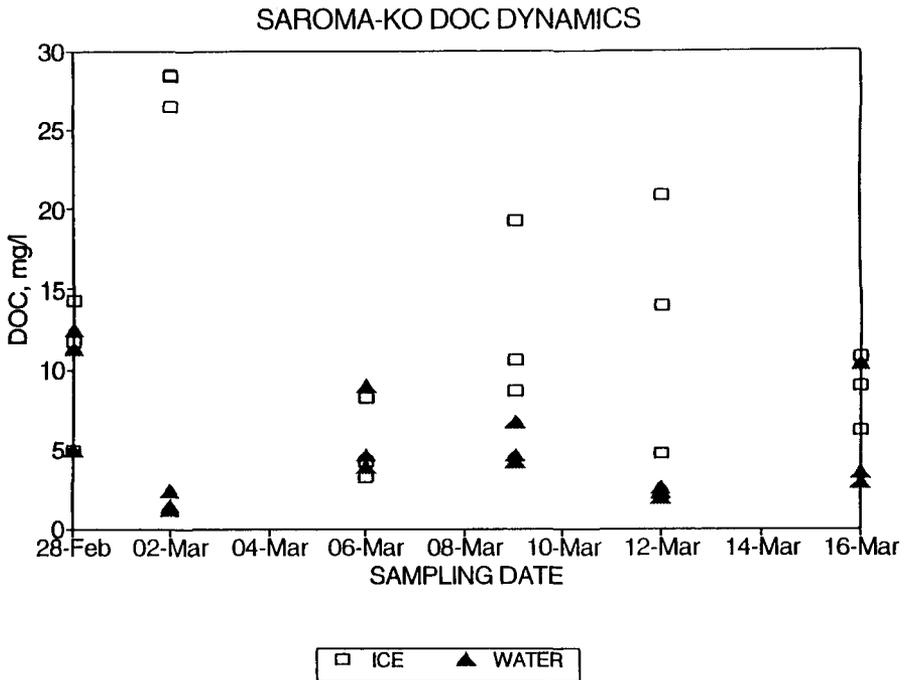


Fig. 9. Seasonal change of size-fractionated chlorophyll a standing crop of ice algae at the open site (A) and the natural site (B). Triangle indicates total cell larger than 0.4  $\mu\text{m}$ , circle indicates larger cells than 5  $\mu\text{m}$ , and square indicates small cells in the size range between 0.4 and 5  $\mu\text{m}$

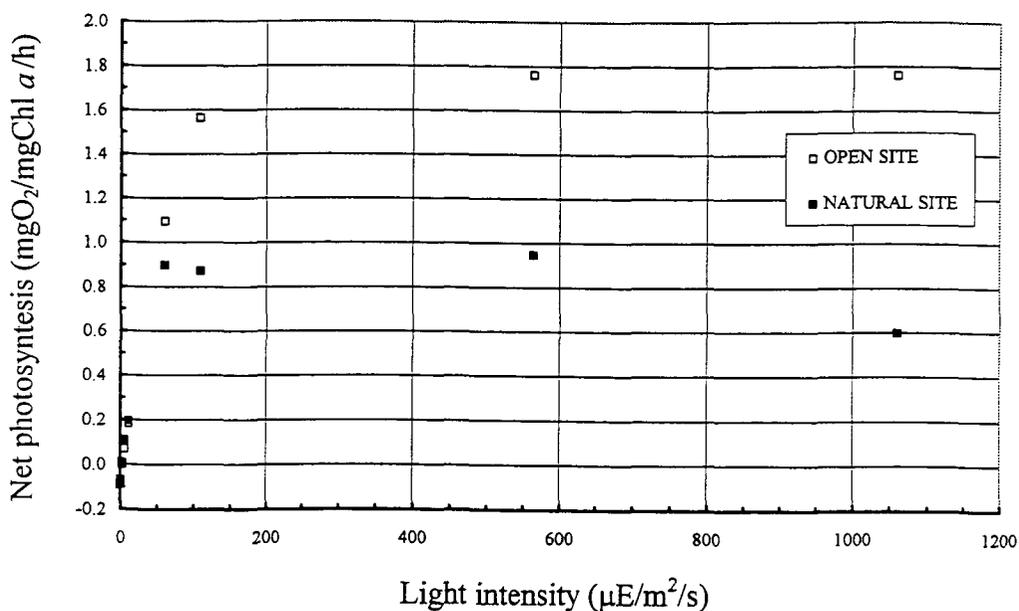
lower at a saturated light level than one at the open site (Fig. 11). The saturated photosynthetic rate for the natural site was lower than one for the open site. Photosynthetic parameters estimated by fitting data from the ice algae experiment shown in Figure 11 to the equation by Platt *et al.* (1980) are summarized in Table 1. The initial slope was not different between the treatments but the saturated photosynthetic rate at the open site was almost double of one at the natural site. However, the inhibitory index for the natural site was significantly higher than one for the open site.



**Fig. 10.** Seasonal change of dissolved organic carbon (DOC,  $\text{mgC l}^{-1}$ ) in the sea ice (square) and the water column (triangle)

**Table 1.** Photosynthesis parameters of ice algae collected at the natural and open site in the eastern basin of Saroma-Ko lagoon on February 24, 1992.

	$P^B$ ( $\text{mgO}_2/\text{mgCHLa}/\text{h}$ )	$P^B$ ( $\text{mgO}_2/\text{mgCHLa}/\text{h}$ )	$I_B$ ( $\mu\text{E}/\text{m}^2/\text{s}$ )	alpha ( $\text{mgO}_2/\text{mgCHLa}/\text{h}$ )	beta ( $\mu\text{E}/\text{m}^2/\text{s}$ )
Natural	1.17	1.08	153	0.032	0.00049
Open	1.97	1.92	360	0.031	0.00012



**Fig. 11.** Net photosynthesis vs irradiance relationship collected on February 24, 1992. Open and closed squares indicate the open and natural site, respectively

### Nutrient Bioassay

A nutrient bioassay experiment indicated that phosphorus was the most immediately stimulating nutrient for growth of ice algae at Saroma-Ko lagoon, as judged by chlorophyll a concentrations (Fig. 12) and particulate organic carbon (POC). Silicon also stimulated chlorophyll and POC development, but nitrate and ammonium had little effect.

Silicon enrichment experiments with low salinity (22 ppt) indicated that ice algae might not survive in the low salinity lens immediately below the ice (Fig. 13). However, ice algal cells were shown to recover from the damage when they sunk to the silicate rich underlying water in Saroma-Ko lagoon.

### Vertical Flux

Vertical distribution of particulate matters including chlorophyll pigments showed a strong stratification on February 19 and March 6, 1992 (Fig. 14). A sudden increase of the particulate matters was observed in a whole water column on March 20, 1992. Vertical flux of chlorophyll a and POC did not change during the period from February 25 to March 16, 1992 (Fig. 15). However, the vertical flux increased to maximum of 5 mgCHL a m<sup>-2</sup> d<sup>-1</sup> and 120 mgC m<sup>-2</sup> d<sup>-1</sup>, respectively on March 23, 1992. Percent chlorophyll a of total pigments did not change during the period from February 25 to March 16, 1992, but gradually increased to higher than 80% on March 23, 1992.

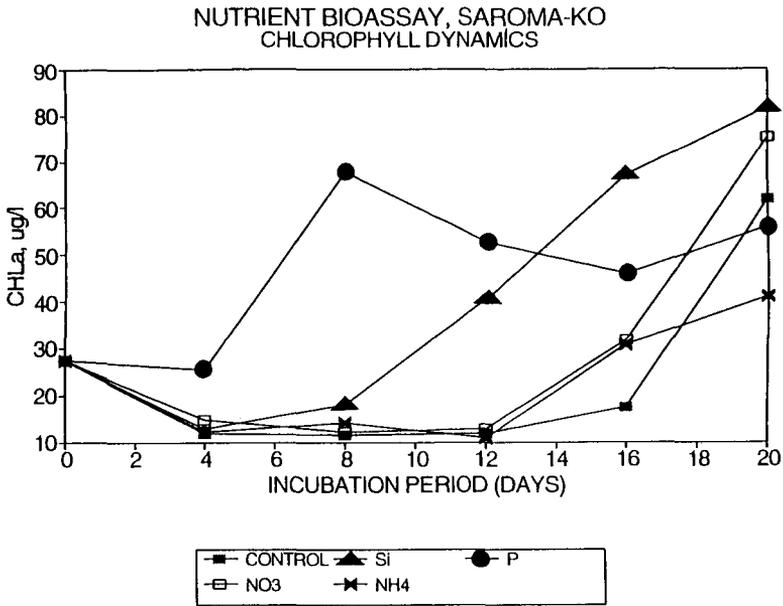


Fig. 12. Chlorophyll a concentrations of ice algae enriched with different nutrients. Closed and open squares indicates the experimental control and nitrate enrichment, respectively. Triangle, circle, and cross indicate silicate, phosphorus, and ammonium enrichment, respectively

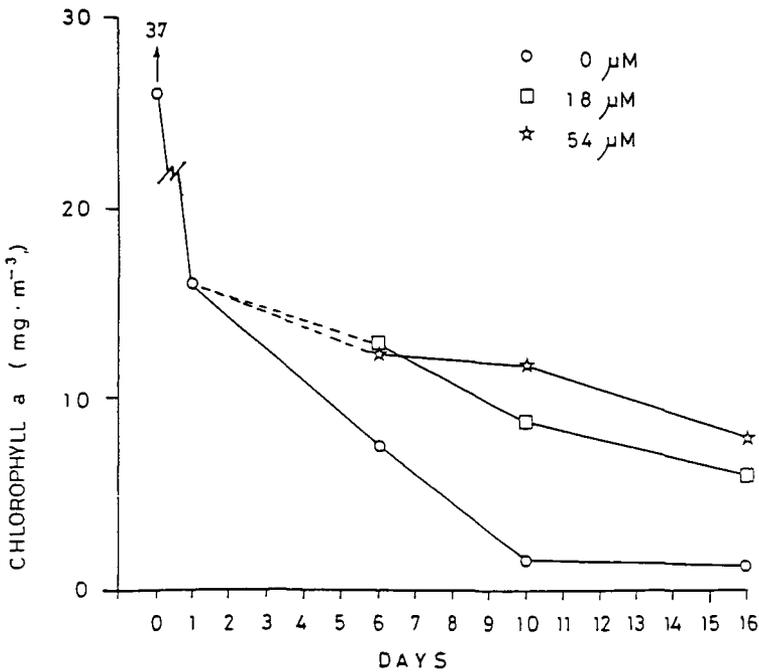


Fig. 13. Temporal variations of chlorophyll a concentration in the experimental bottles with enrichment of zero (circle), 18 µM (square), and 54 µM (star) silicate

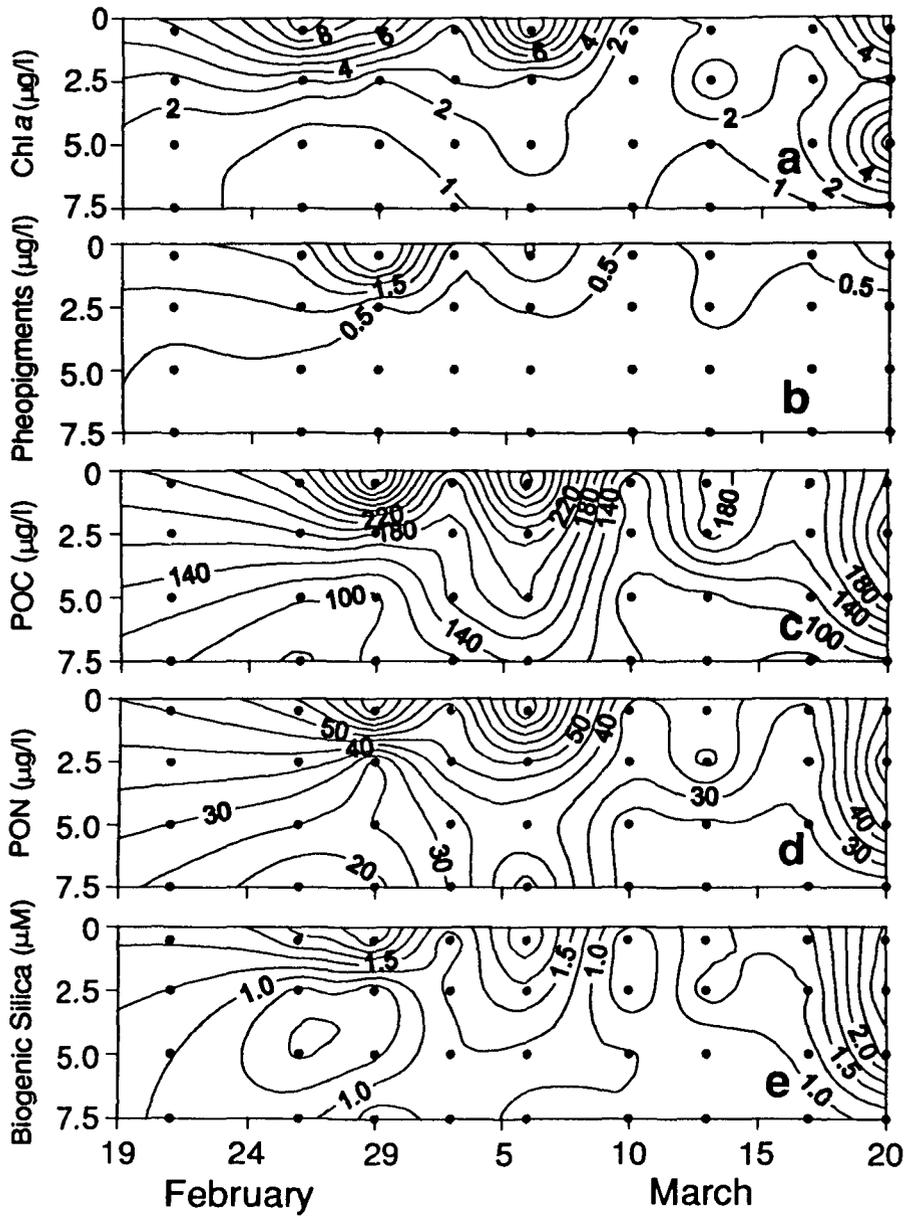


Fig. 14. Seasonal change of chlorophyll a (a), pheopigments (b), POC (c), PON (d), and biogenic silica (e) in a water column during the period from February 19 to March 20, 1992

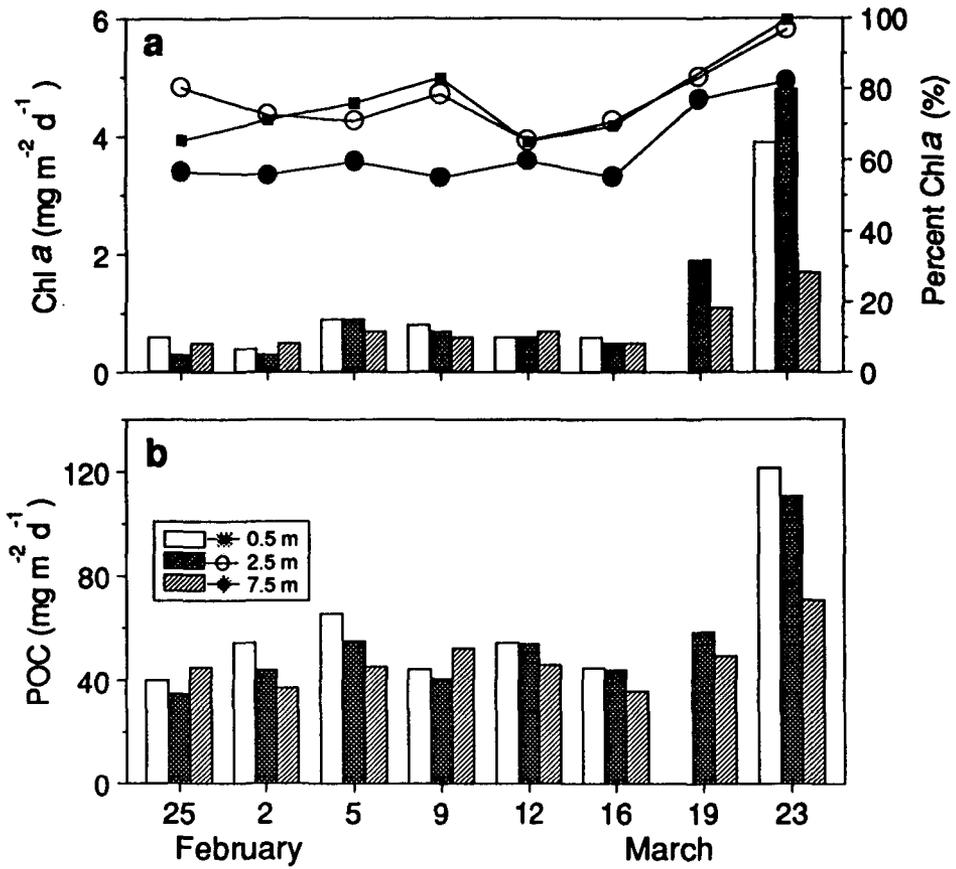


Fig. 15. Seasonal change of vertical flux of chlorophyll a (a) and POC (b) at 0.5, 2.5, and 7.5 m during the period from February 19 to March 20, 1992. Percent chlorophyll a of total pigments at 0.5 (dark square), 2.5 (open circle), and 7.5 m (dark circle) are also shown in the upper panel (a)

### Fluorescence Profile

Figure 16 shows the typical profiles of temperature, salinity, sigma-t, transmissivity and fluorescence collected under the ice at the end of the sampling period. The strong vertical gradients in fluorescence, which did not necessarily reflect the vertical distribution of the physical variables, were observed.

### Vertical Distribution of Copepods

During the investigation, 90% of zooplankton in number was occupied by copepods. Among copepods, *Pseudocalanus* spp. and *Acartia* spp. were dominated. *Pseudocalanus* spp. was distinguished by promsome length to small and large form. During the day time, *Pseudocalanus* spp. were densest at near bottom layer (9 m) and scarce in shallower layer than 3 m (Fig. 17). After the sunset, most of them started upward migration and distributed densest at sub-ice layer (0-1

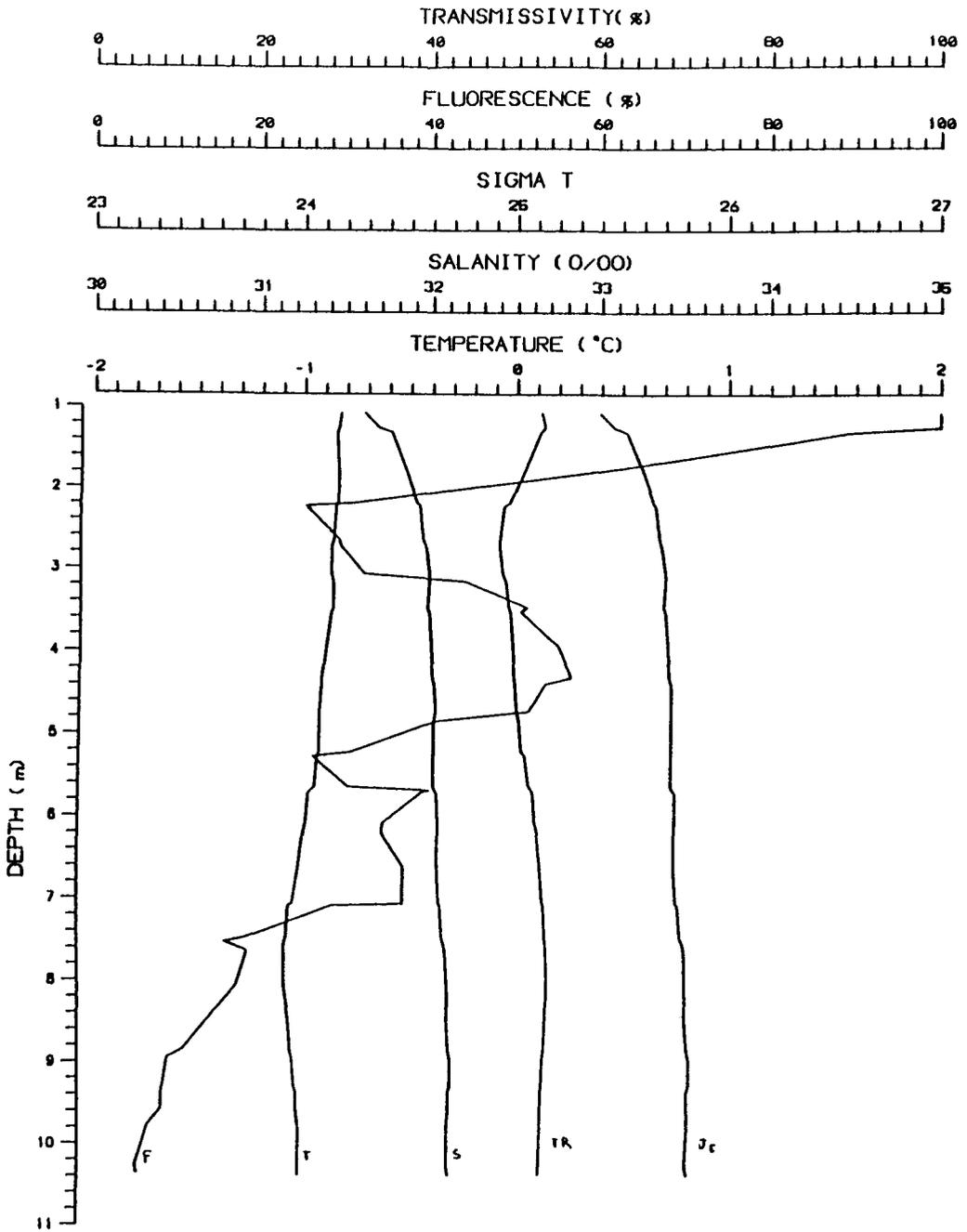


Fig. 16. Vertical profiles of temperature (T), salinity (S), sigma-t ( $\sigma_t$ ), transmissivity (TR), and fluorescence (F) at 1606 hr on March 21, 1992

m). Most of them left the sub-ice layer by midnight and then they reached near bottom layer again more than 2 hour before the sun rise.

*Acartia* spp. distributed mainly at near bottom layer during day time and in sub-ice layer after sunset as shown in *Pseudocalanus* spp. At midnight, however, they did not descend to the near bottom as shown in *Pseudocalanus* spp., they stayed intermediate layer (3-6 m) until sunrise.

### Ingestion Rate of Copepods

Figure 18 shows diel and vertical change in ingestion rate of adult females of *Pseudocalanus* spp. small form. Patterns of diel and vertical change in ingestion rate were quite resemble between examined species or sexes. The ingestion rate was always higher in the night time than in the day time in each depth. During night time, ingestion rate at sub-ice layer was higher than deeper layer. However, vertical difference in ingestion rate was small during day time.

### Zooplankton Abundance

*Pseudocalanus* spp. and *Oithona* spp. were abundant on February 29 and on March 18, 1992, respectively (Fig. 19). No apparent seasonal change was observed for *Acartia* spp. *Pseudocalanus* spp. were dominated during night regardless developmental stages (Fig. 20).

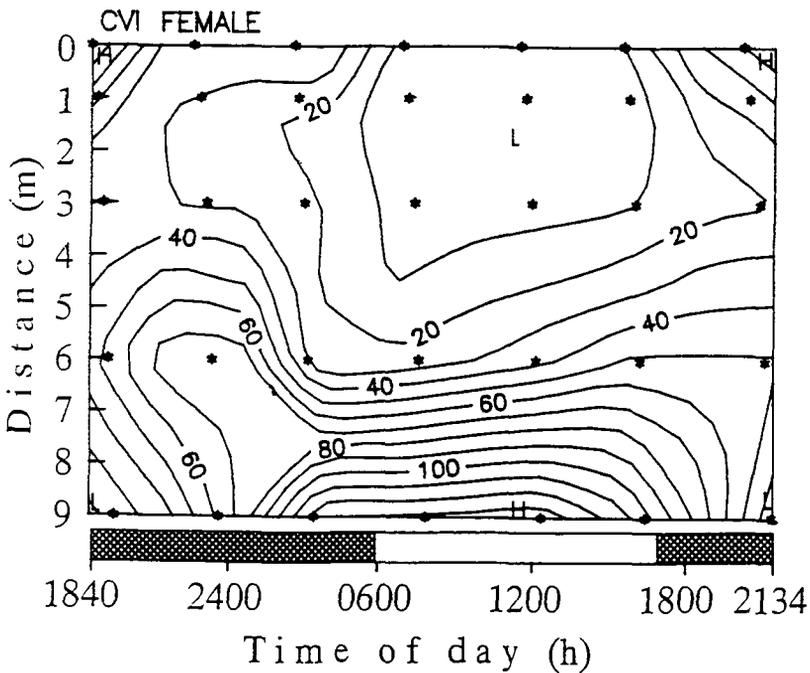


Fig. 17. Diel and vertical distribution of adult females of *Pseudocalanus* spp. small form (ind. m<sup>-3</sup>) on February 25-26, 1992

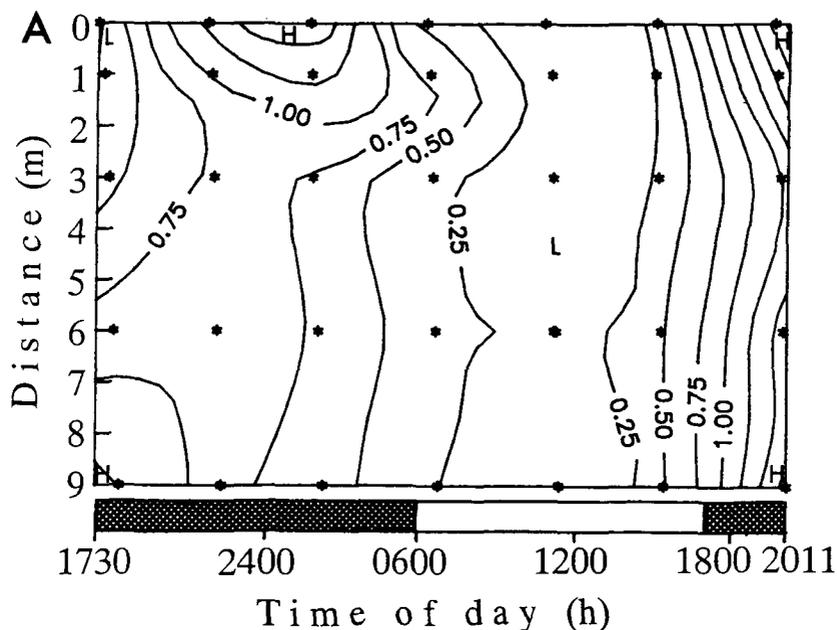


Fig. 18. Diel and vertical change in ingestion rate of adult females of *Pseudocalanus* spp. small form (ngPIG ind<sup>-1</sup> h<sup>-1</sup>) on February 25-26, 1992

Older stages than CV of *Acartia* spp. were abundant during night while older stages than CIII of *Oithona* spp. were abundant during night. Analysis of stage composition indicated that the uniform growth was observed for *Pseudocalanus* spp. and *Oithona* spp. (Fig. 21). *Acartia* spp. showed a general increase of young stages with time. However, a density of copepod nauplii decreased with time.

### Fish Larvae Recruitment

Analysis of the exchange of fish larvae between the lagoon and the sea indicated, species specific recruitment among the four species (Fig. 22). Saroma-Ko lagoon might play a role of nursery area for Snake prickleback on March 16-17, 1992, although little change was observed on March 5-6, 1992. Other four species seemed to be recruited from the Sea of Okhotsk. Size frequency distribution of Sand lance and Snake lance was similar between flood and ebb tides (Fig. 23). A large size of Sculpin was recruited from the Sea of Okhotsk, while a small size of Sculpin was lost. Walleye pollock showed a reverse pattern compared to Sculpin. Seasonal study of the exchange of fish larvae between the lagoon and the sea indicated the recruitment of Sand lance, Sculpin, and Walleye pollock (Fig. 24).

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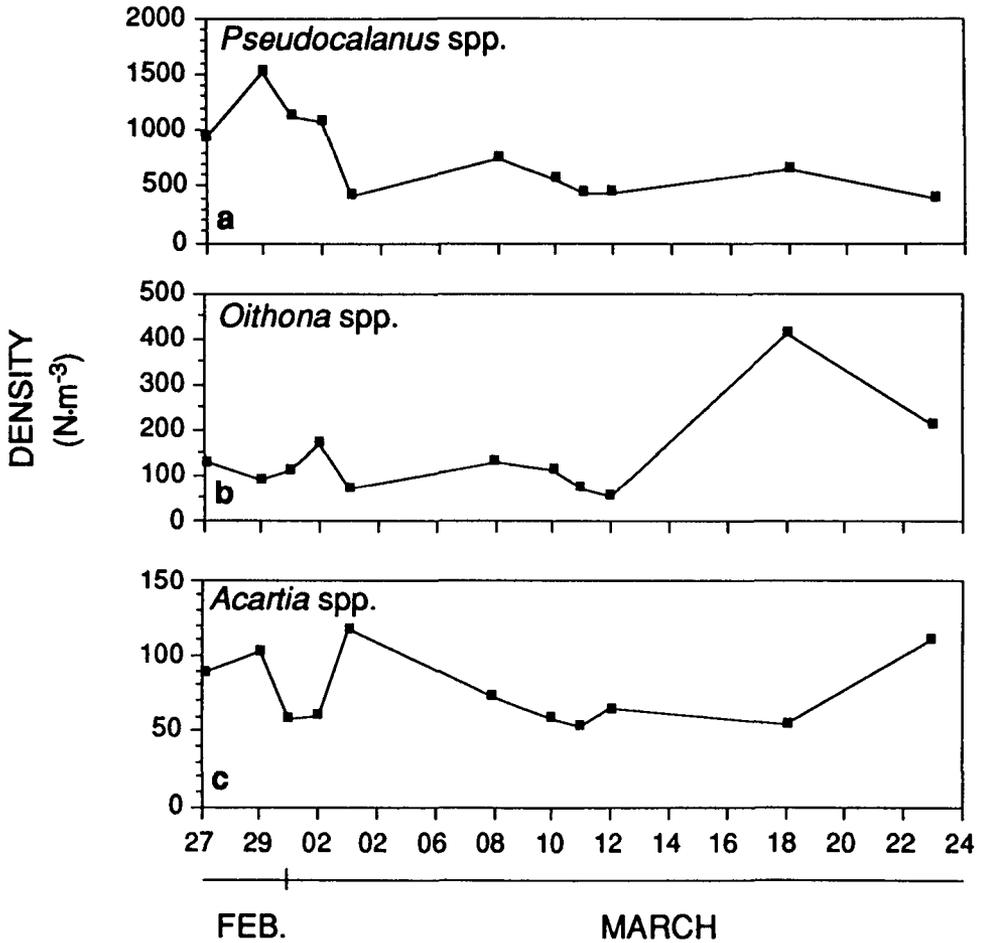


Fig. 19. Densities of the principal copepod species sampled at night under the ice-cover of Saroma-ko Lagoon from February 27 to March 24, 1992

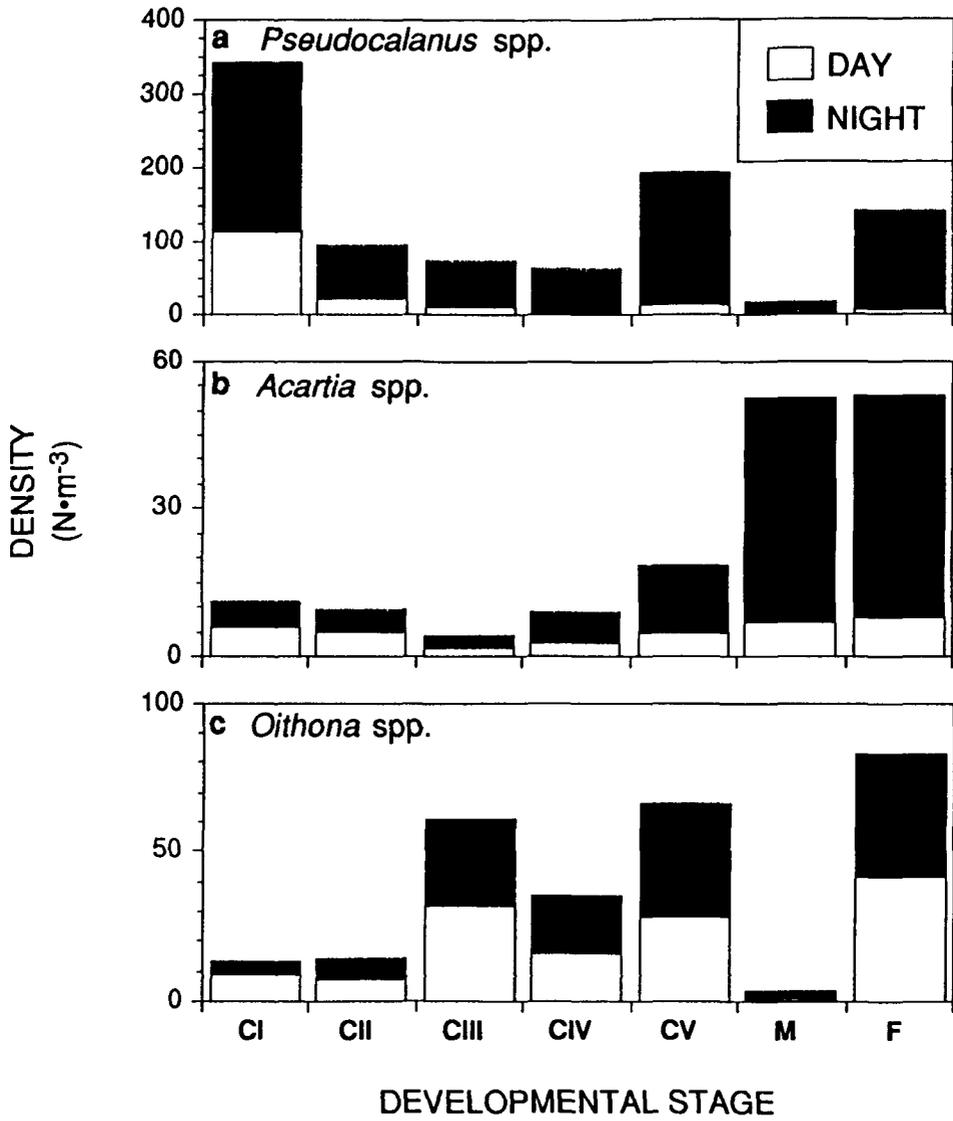
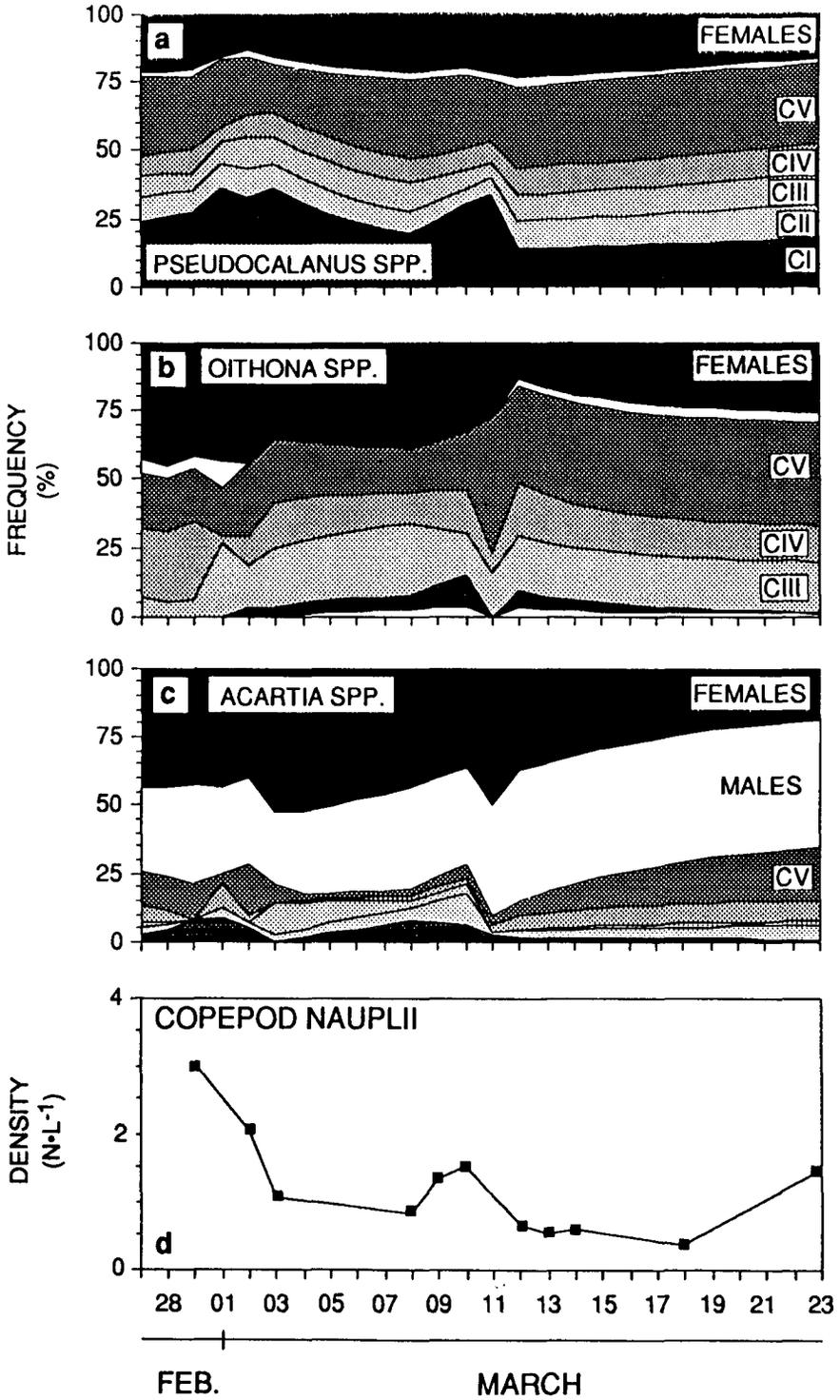


Fig. 20. Day-time and night-time average densities of the copepodite and adult developmental stages of the principal zooplankton species sampled in the 0.5 and 1 m layer under the ice of Saroma-ko Lagoon



**Fig. 21.** Stage composition of the dominant zooplankton species and density of copepod nauplii sampled under the ice of the Saroma-ko Lagoon from February 27 to March 23, 1992

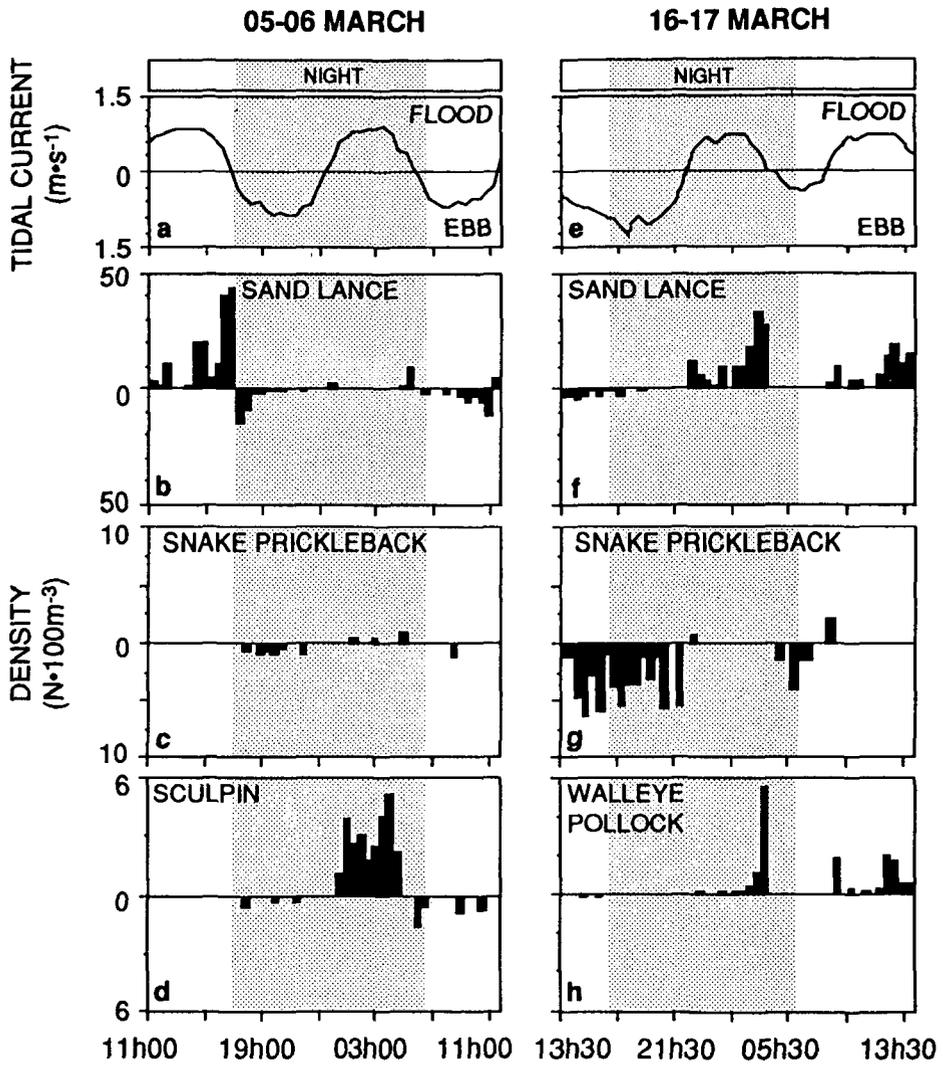


Fig. 22. Time series of larval fish abundance over 24 hours at the second channel of Saroma-ko Lagoon from 5-6 March and 16-17 March 1992. Histograms for the abundance of larvae during ebb are plotted below the origin for contrast

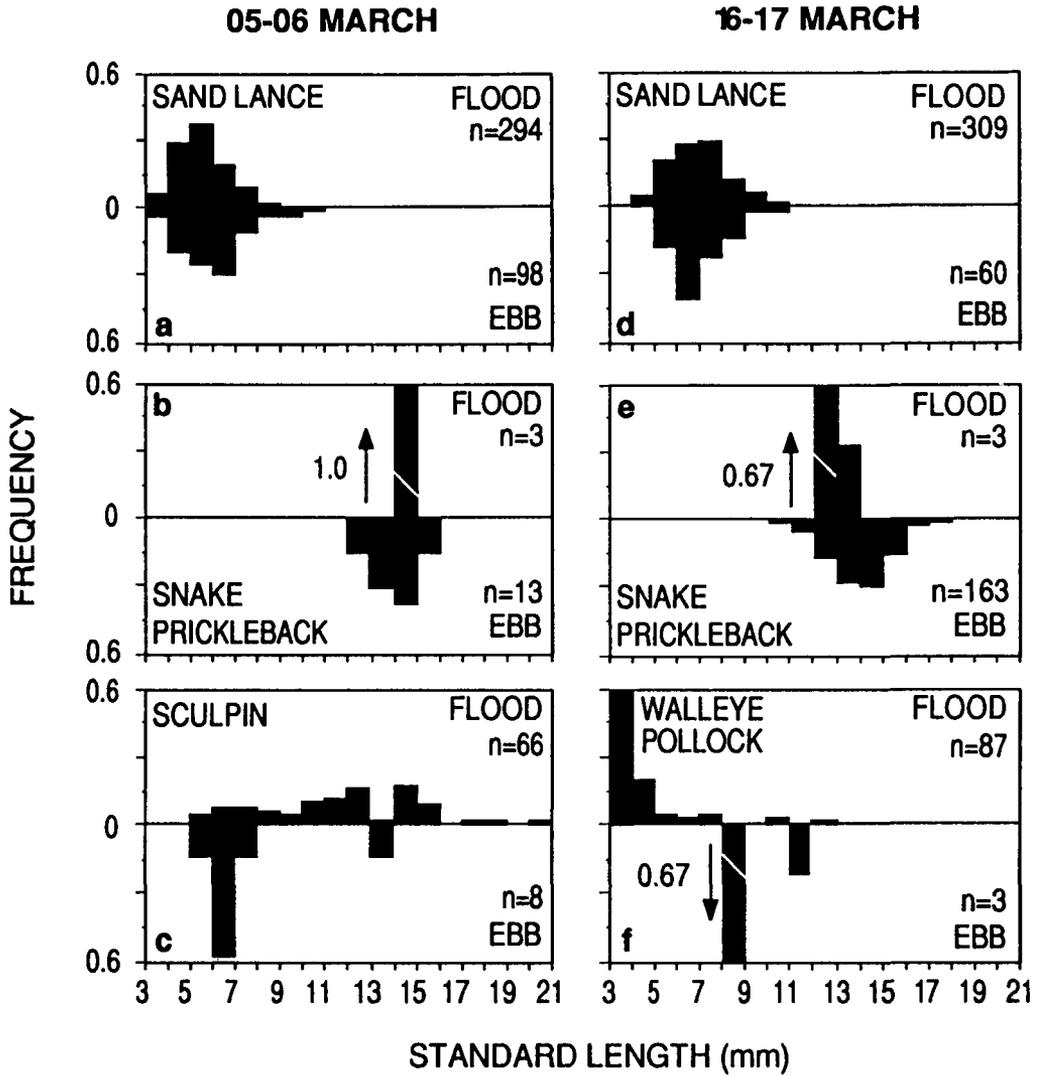


Fig. 23. Length-frequency distribution of larvae of the dominant fish species captured during the period from 5 to 6 March and from 16 to 17 March. Histograms for the frequency of larvae during ebb are plotted below the origin for contrast

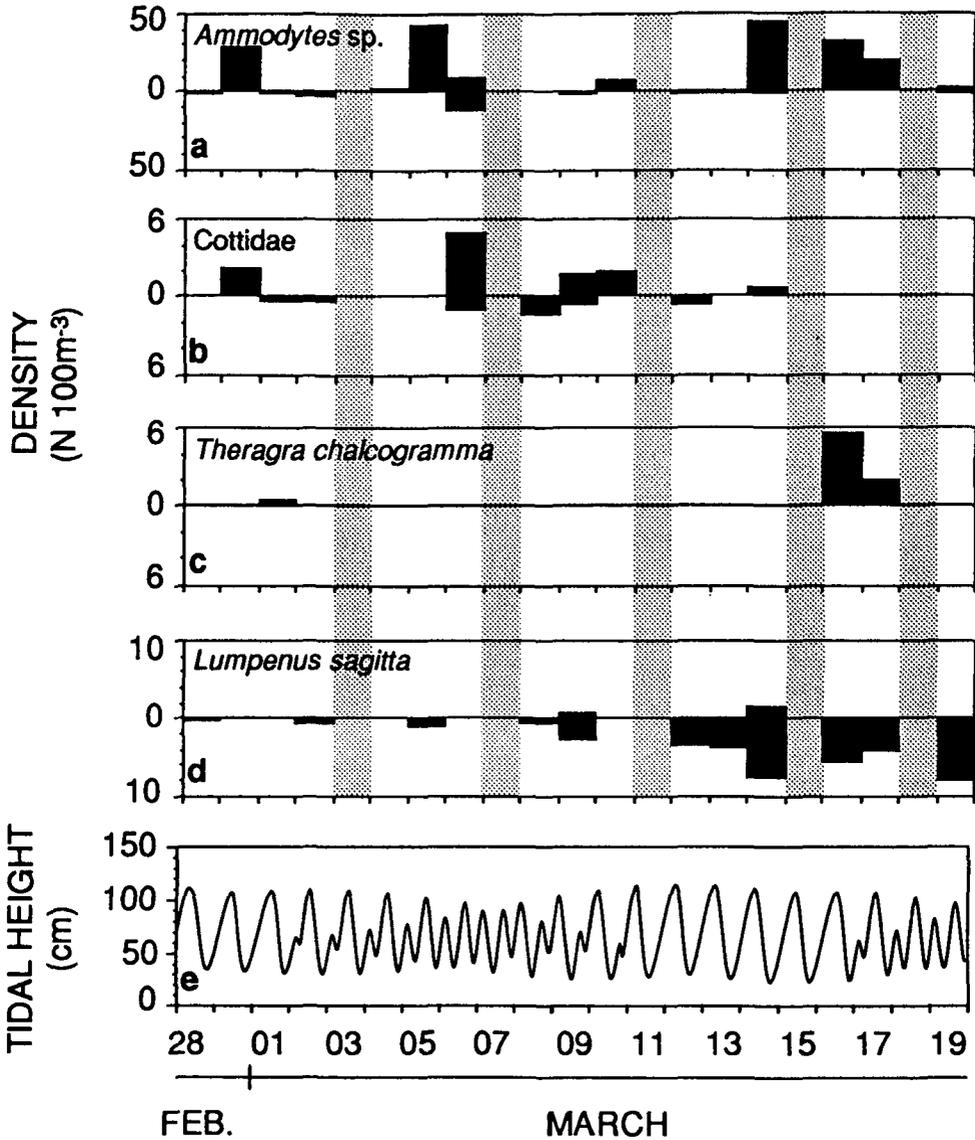


Fig. 24. Daily variations in the density of larvae of the dominant fish species captured at the second channel linking Saroma-Ko Lagoon to the Sea of Okhotsk from February 27 to March 19, 1992. Histograms for the abundance of larvae during ebb are plotted below the origin for contrast. Shaded areas indicate days with no data

## REFERENCES

- Fukuchi, M., A. Tanimura, and T. Hoshiai (1979) "NIPR-I", a new plankton sampler under sea ice. *Bull. Plankton Soc. Japan* **26**, 104-109.
- Holm-Hansen, O., C. J. Lorenzen, R. W. Holmes and J. D. H. Strickland (1965) Fluorometric determination of chlorophyll. *J. Cons. Cons. int. Explor. Mer* **30**, 3-15.
- Kishino, M., C. R. Booth, and N. Okami (1984) Underwater radiant energy absorbed by phytoplankton, detritus, dissolved organic matter, and pure water. *Limnol. Oceanogr.* **29**, 340-349.
- Okiyama, M. (editor) (1988) An atlas of the early stage fishes in Japan. 1154 p. Tokai University Press. Tokyo.
- Platt, T. C. L. Gallegos and W. G. Harrison (1980) Photoinhibition of photosynthesis in natural assemblages of marine phytoplankton. *J. Mar. Res.* **38**, 687-701.
- Saito, H., T. Ogishima and S. Taguchi (1991) Gut clearance rate of boreal copepods *Eurytemora herdmani* Thompson and Scott (1897) and *Pseudocalanus* spp. at different food concentration. *Bull. Plankton Soc. Japan Spec. Vol.*, 563-572.
- Shirasawa, K., M. Ikeda, T. Takatsuka, M. Ishikawa, M. Aota, G. Ingram, C. Belanger, P. Peltola, S. Takahashi, E. Hudier, Y. Fujiyoshi, Y. Kodama and N. Ishikawa (1993) Atmospheric and oceanographic data report for Saroma-ko lagoon of the SARES (Saroma-Resolute Studies) Project, 1992. *Low Temperature Science*, Ser. A, **52**, Data Report, 69-267.
- SooHoo, J. B., A. C. Palmisano, S. T. Kottmeier, M. P. Lizotte, S. L. SooHoo, and C. W. Sullivan (1987) Spectral light absorption and quantum yield of photosynthesis in sea ice microalgae and a bloom of *Phaeocystis pouchetii* from McMurdo Sound, Antarctica. *Mar. Ecol. Prog. Ser.* **39**, 175-189.
- Suzuki, R. and T. Ishimaru (1990) An improved method for the determination of phytoplankton chlorophyll using N, N-Dimethylformamide. *J. Oceanogr. Soc. Japan* **45**, 190-194.

## APPENDICES

A. Biological data: Basic physical data on snow depth and ice thickness in cm. SD indicates a standard deviation. n.a. indicates not available. (Robineau)

Date	Julian day	Site	Sample	Thickness	Number of samples	Mean	SD
Feb 24	55	natural	snow	5.0			
Feb 24	55	natural	snow	6.0			
Feb 24	55	natural	snow	9.0			
Feb 24	55	natural	snow	10.0	4	7.5	2.06
Feb 24	55	open	ice	n.a.			
Feb 24	55	natural	ice	n.a.			
Feb 27	58	natural	snow	6.5			
Feb 27	58	natural	snow	9.5			
Feb 27	58	natural	snow	12.0			
Feb 27	58	natural	snow	4.0			
Feb 27	58	natural	snow	6.5	5	7.7	2.77
Feb 27	58	open	ice	34.0	1	34.0	
Feb 27	58	natural	ice	36.0			
Feb 27	58	natural	ice	35.5	2	35.75	
Mar 02	62	natural	snow	4.0			
Mar 02	62	natural	snow	7.0			
Mar 02	62	natural	snow	9.0			
Mar 02	62	natural	snow	10.0			
Mar 02	62	natural	snow	5.0			
Mar 02	62	natural	snow	6.0			
Mar 02	62	natural	snow	5.0	7	6.57	2.06
Mar 02	62	open	ice	38.0			
Mar 02	62	open	ice	41.0			
Mar 02	62	open	ice	36.0			
Mar 02	62	open	ice	37.0			
Mar 02	62	open	ice	39.0			
Mar 02	62	open	ice	36.0	6	37.83	1.77
Mar 02	62	natural	ice	42.0			
Mar 02	62	natural	ice	44.0			
Mar 02	62	natural	ice	38.0			
Mar 02	62	natural	ice	36.0			
Mar 02	62	natural	ice	41.0			
Mar 02	62	natural	ice	24.0			
Mar 02	62	natural	ice	38.0			
Mar 02	62	natural	ice	36.0			
Mar 02	62	natural	ice	38.0			
Mar 02	62	natural	ice	36.0			
Mar 02	62	natural	ice	32.0			
Mar 02	62	natural	ice	41.0	12	37.17	5.05

Mar 05	65	natural	snow	11.5			
Mar 05	65	natural	snow	5.0			
Mar 05	65	natural	snow	11.0			
Mar 05	65	natural	snow	8.5			
Mar 05	65	natural	snow	13.0	5	9.80	2.80
Mar 05	65	open	ice	35.0			
Mar 05	65	open	ice	38.0			
Mar 05	65	open	ice	38.0			
Mar 05	65	open	ice	39.0			
Mar 05	65	open	ice	37.0			
Mar 05	65	open	ice	33.0			
Mar 05	65	open	ice	37.0	7	36.71	1.91
Mar 05	65	natural	ice	42.0			
Mar 05	65	natural	ice	40.0			
Mar 05	65	natural	ice	37.0			
Mar 05	65	natural	ice	44.0			
Mar 05	65	natural	ice	40.0			
Mar 05	65	natural	ice	36.0			
Mar 05	65	natural	ice	36.0			
Mar 05	65	natural	ice	36.0			
Mar 05	65	natural	ice	38.0			
Mar 05	65	natural	ice	37.0			
Mar 05	65	natural	ice	39.0			
Mar 05	65	natural	ice	38.0			
Mar 05	65	natural	ice	37.0			
Mar 05	65	natural	ice	39.0	14	38.50	2.29
Mar 09	69	natural	snow	n. a.			
Mar 09	69	open	ice	36.0			
Mar 09	69	open	ice	46.0			
Mar 09	69	open	ice	36.0			
Mar 09	69	open	ice	41.0			
Mar 09	69	open	ice	35.0			
Mar 09	69	open	ice	41.0			
Mar 09	69	open	ice	38.0	7	39.0	3.63
Mar 09	69	natural	ice	42.0			
Mar 09	69	natural	ice	52.0			
Mar 09	69	natural	ice	50.0			
Mar 09	69	natural	ice	47.0			
Mar 09	69	natural	ice	52.0			
Mar 09	69	natural	ice	42.0			
Mar 09	69	natural	ice	46.0			
Mar 09	69	natural	ice	42.0			
Mar 09	69	natural	ice	46.0			
Mar 09	69	natural	ice	42.0			
Mar 09	69	natural	ice	46.0			
Mar 09	69	natural	ice	46.0			
Mar 09	69	natural	ice	46.0			
Mar 09	69	natural	ice	46.0			
Mar 09	69	natural	ice	51.0			
Mar 09	69	natural	ice	45.0			
Mar 09	69	natural	ice	48.0	16	45.44	3.35

Mar 12	72	natural	snow	7.0			
Mar 12	72	natural	snow	7.0			
Mar 12	72	natural	snow	4.0			
Mar 12	72	natural	snow	8.0			
Mar 12	72	natural	snow	5.0			
Mar 12	72	natural	snow	7.0			
Mar 12	72	natural	snow	7.0	7	6.43	1.29
Mar 12	72	open	ice	34.0			
Mar 12	72	open	ice	35.0			
Mar 12	72	open	ice	32.0			
Mar 12	72	open	ice	37.0			
Mar 12	72	open	ice	36.0			
Mar 12	72	open	ice	34.0			
Mar 12	72	open	ice	34.0	7	34.57	1.50
Mar 12	72	natural	ice	36.0			
Mar 12	72	natural	ice	38.0			
Mar 12	72	natural	ice	50.0			
Mar 12	72	natural	ice	40.0			
Mar 12	72	natural	ice	40.0			
Mar 12	72	natural	ice	40.0			
Mar 12	72	natural	ice	38.0			
Mar 12	72	natural	ice	39.0			
Mar 12	72	natural	ice	38.0			
Mar 12	72	natural	ice	38.0			
Mar 12	72	natural	ice	39.0			
Mar 12	72	natural	ice	40.0			
Mar 12	72	natural	ice	43.0			
Mar 12	72	natural	ice	42.0	14	40.07	3.24
Mar 16	76	natural	snow	0.0			
Mar 16	76	natural	snow	0.0			
Mar 16	76	natural	snow	0.0			
Mar 16	76	natural	snow	0.0			
Mar 16	76	natural	snow	0.0	5	0.0	0.0
Mar 16	76	open	ice	39.0			
Mar 16	76	open	ice	38.0			
Mar 16	76	open	ice	38.0			
Mar 16	76	open	ice	37.0			
Mar 16	76	open	ice	36.0			
Mar 16	76	open	ice	36.0			
Mar 16	76	open	ice	40.0	7	37.71	1.39
Mar 16	76	natural	ice	41.0			
Mar 16	76	natural	ice	44.0			
Mar 16	76	natural	ice	42.0			
Mar 16	76	natural	ice	42.0			
Mar 16	76	natural	ice	42.0			
Mar 16	76	natural	ice	40.0			
Mar 16	76	natural	ice	40.0			
Mar 16	76	natural	ice	41.0			
Mar 16	76	natural	ice	39.0			
Mar 16	76	natural	ice	39.0			
Mar 16	76	natural	ice	39.0			
Mar 16	76	natural	ice	39.0	12	40.67	1.55

B. Biological data: Photosynthetic Active Radiation (PAR;  $\mu E m^{-2} s^{-1}$ ) at the surface of Saroma ko lagoon in 1992. (Kudoh)

Local Time	February						
	22	23	24	25	26	27	28
0- 5	nd	0	0	0	0	0	nd
5- 6	nd	0.025	0.026	0.038	0.082	0.11	nd
6- 7	nd	50.2	33.1	35.7	50.9	65.0	nd
7- 8	nd	324	246	213	203	347	nd
8- 9	nd	695	511	445	347	632	nd
9-10	nd	920	910	459	612	959	nd
10-11	nd	973	958	1,200	695	942	nd
11-12	nd	1,069	1,173	913	856	1,456	1,317
12-13	653	1,048	1,318	1,192	1,010	1,327	1,188
13-14	578	862	1,053	1,093	727	1,109	997
14-15	585	462	725	635	817	nm	709
15-16	294	294	386	424	438	nm	392
16-17	55.3	83.6	101	111	116	nm	123
17-18	0.49	1.24	1.65	2.38	2.77	nm	3.35
18-23	0	0	0	0	0	nm	0
Total ( $E m^{-2} d^{-1}$ )		22.7	26.7	24.2	21.2		
Local Time	February		March				
	29	1	2	3	4	5	6
0- 5	0	0	0	0	nm	nm	0
5- 6	0.14	0.20	0.22	0.36	nm	nm	0.67
6- 7	43.6	62.9	35.4	59.7	nm	nm	59.5
7- 8	239	278	152	244	nm	nm	168
8- 9	522	622	309	530	nm	nm	243
9-10	808	510	501	841	nm	nm	450
10-11	1,009	763	762	1,103	nm	nm	637
11-12	1,196	1,063	1,250	947	nm	nm	650
12-13	1,114	823	1,285	1,186	nm	936	649
13-14	925	579	939	1,104	nm	926	626
14-15	669	642	640	649	nm	725	514
15-16	390	413	386	nm	nm	416	315
16-17	123	99.4	127	nm	nm	147	121
17-18	3.35	4.0	6.25	nm	nm	8.3	6.58
18-23	0	0	0	0	nm	0	0
Total ( $E m^{-2} d^{-1}$ )	25.4	21.1	23.0				16.1

Local Time	March				
	7	8	9	10	11
0- 5	0	0	0	0	0
5- 6	0.99	1.07	nm	3.55	3.34
6- 7	100	86.4	nm	120	94
7- 8	398	308	nm	399	281
8- 9	813	732	nm	717	586
9-10	1,135	1,065	nm	1,004	848
10-11	1,228	1,247	1,327	1,181	1,219
11-12	1,360	1,127	1,322	1,265	1,422
12-13	1,289	1,192	1,153	1,154	1,303
13-14	1,081	1,024	1,011	994	1,080
14-15	791	800	760	729	790
15-16	460	406	372	290	464
16-17	164	173	147	78.2	181
17-18	11.3	nm	11.8	10.8	15.6
18-23	0	nm	0	0	0
Total	31.8	29.4		28.6	29.8
(E m <sup>-2</sup> d <sup>-1</sup> )					

nd: not determined

nm: not measured

B. Biological data: Downward spectral irradiance ( $\mu\text{W cm}^{-2} \text{nm}^{-1}$ ) measured under natural sea ice covered with snow on February 22, 1992. -1.0 indicates the spectral irradiance just above the ice. (Kishino)

Wave Length (nm)	Depth (m)				
	-0.1	0.8	2.0	3.0	4.0
	( $\mu\text{W cm}^{-2} \text{nm}^{-1}$ )				
402.4	5.08E+01	1.58E-01	1.12E-01	6.29E-02	5.16E-02
418.8	5.43E+01	1.39E-01	9.27E-02	5.24E-02	3.77E-02
438.8	6.07E+01	1.78E-01	1.35E-01	9.52E-02	7.22E-02
455.9	6.54E+01	2.36E-01	1.87E-01	1.28E-01	8.71E-02
473.3	6.60E+01	3.11E-01	2.67E-01	1.74E-01	1.21E-01
496.6	6.21E+01	3.55E-01	2.84E-01	1.88E-01	1.32E-01
516.2	6.61E+01	3.51E-01	2.77E-01	1.83E-01	1.28E-01
535.1	7.14E+01	4.80E-01	3.18E-01	2.56E-01	1.84E-01
554.8	8.29E+01	4.67E-01	3.50E-01	2.45E-01	1.70E-01
578.9	7.42E+01	4.80E-01	3.36E-01	2.33E-01	1.56E-01
595.3	6.37E+01	5.70E-01	3.90E-01	2.54E-01	1.59E-01
614.7	6.57E+01	5.41E-01	3.39E-01	1.95E-01	1.06E-01
633.8	5.85E+01	4.75E-01	3.05E-01	1.75E-01	9.60E-02
650.6	5.47E+01	3.64E-01	1.85E-01	8.09E-02	4.18E-02
677.7	7.40E+01	2.30E-01	1.28E-01	5.93E-02	2.94E-02
694.5	5.60E+01	3.26E-01	1.28E-01	6.31E-02	2.99E-02
T-E	1.94E+04	1.08E+02	7.47E+01	4.69E+01	3.07E+01
%	1.00E+02	5.55E-01	3.84E-1	2.41E-01	1.58E-01
Wave Length (nm)	Depth (m)				
	5.0	6.0			
402.4	3.67E-02	3.03E-02			
418.8	2.39E-02	2.02E-02			
438.8	5.23E-02	4.13E-02			
455.9	7.36E-02	5.15E-02			
473.3	9.20E-02	7.96E-02			
496.6	1.03E-01	8.27E-02			
516.2	1.01E-01	7.96E-02			
535.1	1.39E-01	1.18E-01			
554.8	1.34E-01	1.13E-01			
578.9	1.20E-01	9.55E-02			
595.3	1.16E-01	9.17E-02			
614.7	7.39E-02	5.13E-02			
633.8	8.04E-02	7.11E-02			
650.6	2.62E-02	1.63E-02			
677.7	2.08E-02	2.22E-02			
694.5	2.01E-02	3.15E-03			
T-E	2.32E+01	1.85E+01			
%	1.19E-01	9.50E-02			

T-E: Total energy ( $\mu\text{W cm}^{-2}$ )

Wave Length (nm)	Depth (m)				
	-0.1	0.8	2.0	3.0	4.0
	(quanta $\text{cm}^{-2} \text{nm}^{-1} \text{sec}^{-1}$ )				
402.4	1.02E+14	3.17E+11	2.25E+11	1.27E+11	1.04E+11
418.8	1.11E+14	2.83E+11	1.89E+11	1.07E+11	7.70E+10
438.8	1.25E+14	3.67E+11	2.79E+11	1.97E+11	1.49E+11
455.9	1.37E+14	4.94E+11	3.90E+11	2.67E+11	1.82E+11
473.3	1.40E+14	6.75E+11	5.64E+11	3.69E+11	2.55E+11
496.6	1.33E+14	7.60E+11	6.07E+11	4.02E+11	2.83E+11
516.2	1.43E+14	7.60E+11	6.00E+11	3.97E+11	2.77E+11
535.1	1.56E+14	1.05E+12	8.34E+11	5.61E+11	4.04E+11
554.8	1.84E+14	1.04E+12	7.75E+11	5.42E+11	3.76E+11
578.9	1.66E+14	1.08E+12	7.53E+11	5.21E+11	3.49E+11
595.3	1.44E+14	1.29E+12	8.84E+11	5.76E+11	3.60E+11
614.7	1.51E+14	1.24E+12	7.76E+11	4.47E+11	2.43E+11
633.8	1.36E+14	1.10E+12	7.06E+11	4.05E+11	2.22E+11
650.6	1.28E+14	8.52E+11	4.33E+11	1.89E+11	9.79E+10
677.7	1.75E+14	5.44E+11	3.04E+11	1.40E+11	6.96E+10
694.5	1.34E+14	7.81E+11	3.05E+11	1.51E+11	7.15E+10
T-Q	5.40E+16	3.08E+14	2.09E+14	1.30E+14	8.40E+13
%	1.00E+02	5.70E-01	3.87E-01	2.41E-01	1.56E-01

Wave Length (nm)	Depth (m)	
	5.0	6.0
	(quanta $\text{cm}^{-2} \text{nm}^{-1} \text{sec}^{-1}$ )	
402.4	7.38E+10	6.09E+10
418.8	4.88E+10	4.13E+10
438.8	1.08E+11	8.53E+10
455.9	1.54E+11	1.08E+11
473.3	1.95E+11	1.68E+11
496.6	2.20E+11	1.77E+11
516.2	2.18E+11	1.72E+11
535.1	3.04E+11	2.58E+11
554.8	2.96E+11	1.50E+11
578.9	2.69E+11	2.14E+11
595.3	2.62E+11	2.08E+11
614.7	1.69E+11	1.17E+11
633.8	1.86E+11	1.65E+11
650.6	6.13E+10	3.81E+10
677.7	4.93E+10	5.26E+10
694.5	4.81E+10	7.53E+09
T-Q	6.34E+13	5.03E+13
%	1.17E-01	9.32E-02

T-Q: Total quanta ( $\text{quanta cm}^{-2} \text{sec}^{-1}$ )

B. Biological data: Downward spectral irradiance measured under sea ice after removal snow on February 22, 1992. -0.1 indicates the spectral irradiance obtained just above the ice. (Kishino)

Wave Length (nm)	Depth (m)					
	-0.1	0.5	1.0	2.0	3.0	4.0
	$(\mu\text{W cm}^{-2} \text{ nm}^{-1})$					
402.4	6.17E+01	1.20E+00	1.17E+00	8.09E-01	5.29E-01	3.81E-01
418.8	5.39E+01	1.16E+00	1.16E+00	8.42E-01	5.71E-01	4.20E-01
438.8	6.21E+01	1.51E+00	1.52E+00	1.15E+00	8.16E-01	6.29E-01
455.9	7.69E+01	1.99E+00	2.02E+00	1.55E+00	1.13E+00	8.51E-01
473.3	8.96E+01	2.57E+00	2.61E+00	1.96E+00	1.44E+00	1.12E+00
496.6	8.87E+01	2.85E+00	2.86E+00	2.16E+00	1.60E+00	1.25E+00
516.2	8.27E+01	3.18E+00	3.15E+00	2.41E+00	1.77E+00	1.36E+00
535.1	7.67E+00	3.58E+00	3.51E+00	2.69E+00	1.95E+00	1.46E+00
554.8	7.76E+01	4.20E+00	4.06E+00	3.00E+00	2.16E+00	1.69E+00
578.9	6.95E+01	4.14E+00	3.95E+00	2.74E+00	1.90E+00	1.43E+00
595.3	6.29E+01	3.93E+00	3.64E+00	2.28E+00	1.45E+00	1.02E+00
614.7	6.07E+01	3.61E+00	3.21E+00	1.82E+00	1.04E+00	6.56E-01
633.8	6.92E+01	3.14E+00	2.83E+00	1.61E+00	9.54E-01	6.34E-01
650.6	8.32E+01	2.55E+00	2.18E+00	1.10E+00	5.71E-01	3.23E-01
677.7	5.08E+01	1.47E+00	1.27E+00	5.93E-01	2.61E-01	1.44E-01
694.5	6.45E+01	1.98E+00	1.61E+00	6.97E-01	3.24E-01	1.82E-01
T-E	2.15E+04	8.26E+02	7.82E+02	5.27E+02	3.56E+02	2.62E+02
%	1.00E+02	3.84E+00	3.63E+00	2.45E+00	1.65E+00	1.22E+00

Wave Length (nm)	Depth (m)					
	5.0	6.0	7.0	8.0	9.0	10.0
	$(\mu\text{W cm}^{-2} \text{ nm}^{-1})$					
402.4	2.61E-01	1.83E-01	1.28E-01	9.39E-02	6.77E-02	5.08E-02
418.8	2.93E-01	2.07E-01	1.53E-01	1.15E-01	7.15E-02	5.16E-02
438.8	4.62E-01	3.44E-01	2.53E-01	1.67E-01	1.17E-01	9.43E-02
455.9	6.16E-01	4.70E-01	3.58E-01	2.32E-01	1.55E-01	1.30E-01
473.3	8.45E-01	6.54E-01	4.98E-01	3.35E-01	2.53E-01	1.94E-01
496.6	9.56E-01	7.43E-01	5.70E-01	4.08E-01	3.10E-01	2.40E-01
516.2	1.04E+00	8.02E-01	6.17E-01	4.39E-01	3.41E-01	2.63E-01
535.1	1.14E+00	8.74E-01	6.67E-01	5.85E-01	4.30E-01	3.46E-01
554.8	1.28E+00	8.85E-01	7.51E-01	5.71E-01	4.37E-01	3.37E-01
578.9	1.06E+00	7.87E-01	5.80E-01	4.38E-01	3.29E-01	2.48E-01
595.3	7.11E-01	5.10E-01	3.64E-01	3.25E-01	2.44E-01	1.90E-01
614.7	4.01E-01	2.50E-01	1.43E-01	1.76E-01	1.21E-01	8.67E-02
633.8	4.25E-01	2.97E-01	1.99E-01	1.13E-01	1.13E-01	9.17E-02
650.6	1.79E-01	1.04E-01	5.95E-02	3.21E-02	1.97E-02	1.29E-02
677.7	6.61E-02	3.74E-02	1.74E-02	2.01E-02	1.22E-02	1.30E-02
694.5	1.02E-01	6.10E-02	3.76E-02	3.23E-02	2.69E-02	1.69E-02
T-E	1.90E+02	1.41E+02	1.04E+02	7.89E+01	5.89E+01	4.56E+01
%	8.83E-01	6.56E-01	4.84E-01	3.67E-01	2.74E-01	2.12E-01

T-E: Total energy ( $\mu\text{W cm}^{-2}$ )

Wave Length (nm)	Depth (m)					
	-0.1	0.5	1.0	2.0	3.0	4.0
	(quanta $\text{cm}^{-2} \text{nm}^{-1} \text{sec}^{-1}$ )					
402.4	1.24E+14	2.42E+12	2.36E+12	1.63E+12	1.07E+12	7.68E+11
418.8	1.10E+14	2.37E+12	2.36E+12	1.72E+12	1.16E+12	8.56E+11
438.8	1.28E+14	3.13E+12	3.15E+12	2.37E+12	1.68E+12	1.30E+12
455.9	1.61E+14	4.16E+12	4.22E+12	3.23E+12	2.35E+12	1.78E+12
473.3	1.90E+13	5.44E+12	5.53E+12	4.12E+12	3.04E+12	2.36E+12
496.6	1.90E+14	6.09E+12	6.12E+12	4.63E+12	3.42E+12	2.68E+12
516.2	1.79E+14	6.89E+12	6.84E+12	5.22E+12	3.82E+12	2.94E+12
535.1	1.68E+14	7.84E+12	7.68E+12	5.89E+12	4.28E+12	3.27E+12
554.8	1.72E+14	9.31E+12	9.00E+12	6.65E+12	4.79E+12	3.75E+12
578.9	1.56E+14	9.28E+12	8.80E+12	6.14E+12	4.25E+12	3.21E+12
595.3	1.43E+14	8.91E+12	8.24E+12	5.16E+12	3.28E+12	2.31E+12
614.7	1.60E+14	8.26E+12	7.35E+12	4.17E+12	2.38E+12	1.50E+12
633.8	1.60E+14	7.26E+12	6.56E+12	3.73E+12	2.21E+12	1.47E+12
650.6	1.94E+14	5.96E+12	5.11E+12	2.58E+12	1.34E+12	7.56E+11
677.7	1.20E+14	3.48E+12	3.00E+12	1.40E+12	6.18E+11	3.42E+11
694.5	1.54E+14	4.74E+12	3.85E+12	1.67E+12	7.75E+11	4.36E+11
T-Q	5.93E+16	2.33E+15	2.19E+15	1.45E+15	9.67E+14	7.07E+14
%	1.00E+02	3.92E+00	3.68E+00	2.44E+00	1.63E+00	1.19E+00

Wave Length (nm)	Depth (m)					
	5.0	6.0	7.0	8.0	9.0	10.0
	(quanta $\text{cm}^{-2} \text{nm}^{-1} \text{sec}^{-1}$ )					
402.4	5.25E+11	3.69E+11	2.57E+11	1.89E+11	1.36E+11	1.02E+11
418.8	5.96E+11	4.22E+11	3.11E+11	2.34E+11	1.46E+11	1.05E+11
438.8	9.53E+11	7.10E+11	5.22E+11	3.45E+11	2.41E+11	1.95E+11
455.9	1.29E+12	9.81E+11	7.58E+11	4.85E+11	3.23E+11	2.71E+11
473.3	1.79E+12	1.38E+12	1.05E+12	7.09E+11	5.36E+11	4.10E+11
496.6	2.05E+12	1.59E+12	1.22E+12	8.74E+11	6.63E+11	5.14E+11
516.2	2.24E+12	1.74E+12	1.34E+12	9.51E+11	7.38E+11	5.69E+11
535.1	2.50E+12	1.91E+12	1.46E+12	1.26E+12	9.42E+11	7.59E+11
554.8	2.83E+12	2.18E+12	1.66E+12	1.27E+12	9.67E+11	7.67E+11
578.9	2.38E+12	1.76E+12	1.30E+12	9.81E+11	7.38E+11	5.56E+11
595.3	1.61E+12	1.16E+12	8.25E+11	7.36E+11	5.52E+11	4.31E+11
614.7	9.20E+11	5.72E+11	3.28E+11	4.03E+11	2.78E+11	1.99E+11
633.8	9.85E+11	6.89E+11	4.60E+11	2.62E+11	2.61E+11	1.89E+11
650.6	4.19E+11	2.43E+11	1.39E+11	7.51E+10	4.60E+10	3.02E+10
677.7	1.56E+11	8.86E+10	4.11E+10	4.76E+10	2.88E+10	3.08E+10
694.5	2.43E+11	1.46E+10	8.98E+10	7.72E+10	6.43E+10	4.05E+10
T-Q	5.10E+14	3.77E+14	2.77E+14	2.11E+14	1.58E+14	1.22E+14
%	8.59E-01	6.36E-01	4.67E-01	3.56E-01	2.67E-01	2.06E-01

T-Q: Total quanta ( $\text{quanta cm}^{-2} \text{sec}^{-1}$ )

B. Biological data: Downward spectral irradiance measured in sea ice on March 13, 1992. (Kishino)

Wave Length (nm)	above ice	under snow	under upper ice	under lower ice
	(μW cm <sup>-2</sup> nm <sup>-1</sup> )			
402.4	8.16E+01	7.51E+00	1.42E+00	2.10E-01
418.8	8.16E+01	7.69E+00	1.42E+00	1.86E-01
438.8	8.59E+01	8.12E+00	1.71E+00	2.57E-01
455.9	1.03E+02	9.27E+00	1.98E+00	3.18E-01
473.3	1.00E+02	8.85E+00	2.19E+00	4.43E-01
496.6	9.93E+01	9.80E+00	2.42E+00	5.19E-01
516.2	8.36E+01	8.30E+00	2.31E+00	6.11E-01
535.1	1.04E+02	1.29E+00	3.43E+00	8.41E-01
554.8	1.12E+02	1.38E+01	3.72E+00	1.03E+00
578.9	9.72E+01	1.23E+01	3.48E+00	1.18E+00
595.3	8.96E+01	1.11E+01	3.28E+00	1.17E+00
614.7	8.99E+01	1.04E+01	2.92E+00	1.05E+00
633.8	8.50E+01	9.71E+00	2.58E+00	8.86E-01
650.6	8.76E+01	9.63E+00	2.14E+00	6.37E-01
677.7	8.72E+01	1.11E+01	2.03E+00	3.92E-01
694.5	7.18E+01	7.64E+00	1.61E+00	6.19E-01
T-E	2.76E+04	3.01E+03	7.40E+02	1.98E+02
%	1.00E+02	1.09E+01	2.68E+00	7.18E-01

Wave Length (nm)	above ice	under snow	under upper ice	under lower ice
	(quanta cm <sup>-2</sup> nm <sup>-1</sup> sec <sup>-1</sup> )			
402.4	1.65E+14	1.51E+13	2.86E+12	4.25E+11
418.8	1.66E+14	1.57E+13	2.90E+12	3.80E+11
438.8	1.77E+14	1.68E+13	3.53E+12	5.31E+11
455.9	2.16E+12	1.94E+13	4.15E+12	6.65E+11
473.3	2.12E+14	1.87E+13	4.64E+12	9.36E+11
496.6	2.13E+14	2.10E+13	5.17E+12	1.11E+12
516.2	1.82E+14	1.80E+13	5.01E+12	1.32E+12
535.1	2.27E+14	2.84E+13	7.52E+12	1.84E+12
554.8	2.49E+14	3.06E+13	8.25E+12	2.29E+12
578.9	2.18E+14	2.76E+13	7.80E+12	2.63E+12
595.3	2.03E+14	2.52E+13	7.43E+12	2.65E+12
614.7	2.06E+14	2.39E+13	6.70E+12	2.41E+12
633.8	1.97E+14	2.25E+13	5.99E+12	2.05E+12
650.6	2.05E+14	2.26E+13	5.01E+12	1.49E+12
677.7	2.06E+14	2.63E+13	4.81E+12	9.28E+11
694.5	1.72E+14	1.83E+13	3.85E+12	1.48E+12
T-Q	7.61E+16	8.41E+15	2.08E+15	5.71E+14
%	1.00E+02	1.10E+01	2.73E+00	7.50E-01

T-E: Total energy (μW cm<sup>-2</sup>)

T-Q: Total quanta (quanta cm<sup>-2</sup> sec<sup>-1</sup>)

B. Biological data: Downward spectral irradiance measured above natural sea ice on March 11, 1992. \* denotes saturated value. All stations were located from Kimuaneppu to the second inlet. (Kishino)

Wave Length (nm)	Station					
	1	2	3	4	5	6
	$(\mu W cm^{-2} nm^{-1})$					
402.4	7.09E+01	8.08E+01	9.70E+01	1.07E+02	1.04E+02	7.50E+01
418.8	6.88E+01	7.98E+01	9.84E+01	1.07E+02	1.09E+02	6.80E+01
438.8	7.62E+01	8.66E+01	1.10E+02	1.20E+02	1.16E+02	7.76E+01
455.9	8.84E+01	1.00E+02	1.25E+02	1.38E+02	1.34E+02	9.62E+01
473.3	8.55E+01	9.72E+01	1.15E+02*	1.15E+02*	1.15E+02*	1.07E+02
496.6	8.09E+01	9.11E+01	1.04E+02*	1.04E+02*	1.04E+02*	1.03E+02*
516.2	8.29E+01	8.36E+01*	8.36E+01*	8.36E+01*	8.36E+01*	8.35E+01*
535.1	7.80E+01	9.33E+01	1.49E+02	1.54E+02*	1.54E+02*	8.64E+01
554.8	8.48E+01	1.01E+02	1.18E+02*	1.10E+02*	1.03E+02*	9.50E+01
578.9	7.84E+01	9.11E+01	1.14E+02	1.18E+02	1.27E+02	8.45E+01
595.3	7.21E+01	8.33E+01	1.15E+02	1.45E+02	1.48E+02	7.59E+01
614.7	8.46E+01	8.46E+01	1.19E+02	1.31E+02	1.25E+02	8.35E+01
633.8	6.89E+01	7.84E+01	1.07E+02	1.13E+02	1.10E+02	8.18E+01
650.6	6.57E+01	7.46E+01	9.96E+01	1.06E+02	1.06E+02	9.23E+01
677.7	6.23E+01	7.72E+01	1.08E+02	1.16E+02	1.31E+02	6.35E+01
694.5	5.76E+01	6.60E+01	9.97E+01	1.05E+02	1.02E+02	7.21E+01
T-E	2.25E+04	2.58E+04*	3.31E+04*	3.50E+04*	3.50E+04*	2.54E+04*

Wave Length (nm)	Station					
	7	8	9	10	11	12
	$(\mu W cm^{-2} nm^{-1})$					
402.4	6.90E+01	5.62E+01	5.26E+01	4.79E+01	4.15E+01	3.72E+01
418.8	6.40E+01	5.69E+01	5.15E+01	4.36E+01	3.78E+01	3.67E+01
438.8	7.65E+01	6.26E+01	5.58E+01	5.02E+01	4.48E+01	4.73E+01
455.9	9.40E+01	7.47E+01	6.75E+01	6.14E+01	5.50E+01	5.29E+01
473.3	1.04E+02	7.13E+01	6.83E+01	6.44E+01	6.17E+01	5.28E+01
496.6	9.21E+01	6.98E+01	6.85E+01	6.60E+01	5.83E+01	4.75E+01
516.2	8.14E+01	7.89E+01	8.05E+01	6.84E+01	5.38E+01	4.89E+01
535.1	8.64E+01	7.67E+01	6.71E+01	5.74E+01	5.09E+01	4.63E+01
554.8	8.35E+01	8.06E+01	7.35E+01	6.26E+01	5.33E+01	5.03E+01
578.9	7.51E+01	7.32E+01	6.81E+01	5.78E+01	4.78E+01	5.06E+01
595.3	8.22E+01	6.92E+01	5.95E+01	5.11E+01	4.52E+01	5.62E+01
614.7	8.85E+01	6.95E+01	6.06E+01	5.44E+01	5.10E+01	5.61E+01
633.8	8.32E+01	6.57E+01	5.97E+01	5.45E+01	5.03E+01	5.34E+01
650.6	7.54E+01	6.52E+01	6.92E+01	6.60E+01	5.32E+01	4.60E+01
677.7	6.93E+01	7.14E+01	5.88E+01	4.67E+01	4.17E+01	4.60E+01
694.5	6.56E+01	5.60E+01	5.41E+01	5.38E+01	4.61E+01	5.14E+01
T-E	2.44E+04	2.08E+04	1.92E+04	1.71E+04	1.50E+04	1.47E+04

T-E: Total energy ( $\mu W cm^{-2}$ )

Wave Length (nm)	Station					
	1	2	3 (quanta $\text{cm}^{-2} \text{nm}^{-1} \text{sec}^{-1}$ )	4	5	6
402.4	1.43E+14	1.63E+14	1.95E+14	2.15E+14	2.10E+14	1.51E+14
418.8	1.40E+14	1.63E+14	2.01E+14	2.18E+14	2.23E+14	1.39E+14
438.8	1.57E+14	1.79E+14	2.26E+14	2.48E+14	2.40E+14	1.60E+14
455.9	1.85E+14	2.10E+14	2.62E+14	2.88E+14	2.81E+14	2.01E+14
473.3	1.81E+14	2.06E+14	2.43E+14*	2.43E+14*	2.43E+14*	2.26E+14
496.6	1.73E+14	1.95E+14	2.21E+14*	2.22E+14*	2.22E+14*	2.21E+14
516.2	1.79E+14	1.81E+14*	1.81E+14*	1.81E+14*	1.81E+14*	1.81E+14*
535.1	1.71E+14	2.04E+14	3.26E+14	3.36E+14*	3.36E+14*	1.89E+14
554.8	1.88E+14	2.24E+14	2.61E+14*	2.44E+14	2.28E+14	2.10E+14
578.9	1.76E+14	2.04E+14	2.56E+14	2.64E+14	2.83E+14	1.89E+14
595.3	1.63E+14	1.89E+14	2.61E+14	3.27E+14	3.35E+14	1.71E+14
614.7	1.69E+14	1.94E+14	2.73E+14	2.99E+14	2.86E+14	1.91E+14
633.8	1.60E+14	1.82E+14	2.48E+14	2.63E+14	2.55E+14	1.89E+14
650.6	1.54E+14	1.75E+14	2.33E+14	2.48E+14	2.48E+14	2.16E+14
677.7	1.48E+14	1.83E+14	2.56E+14	2.75E+14	3.10E+14	1.50E+14
694.5	1.38E+14	1.58E+14	2.39E+14	2.50E+14	2.44E+14	1.72E+14
T-Q	6.17E+16	7.08E+16*	9.16E+16*	9.69E+16*	9.72E+16*	6.99E+16*

Wave Length (nm)	Station					
	7	8	9 (quanta $\text{cm}^{-2} \text{nm}^{-1} \text{sec}^{-1}$ )	10	12	13
402.4	1.39E+14	1.13E+14	1.06E+14	9.64E+13	8.53E+13	7.48E+13
418.8	1.31E+14	1.16E+14	1.05E+14	8.90E+13	7.71E+13	7.49E+13
438.8	1.58E+14	1.29E+14	1.15E+14	1.04E+14	9.24E+13	9.76E+13
455.9	1.96E+14	1.56E+14	1.41E+14	1.28E+14	1.15E+14	1.11E+14
473.3	2.20E+14	1.51E+14	1.44E+14	1.36E+14	1.30E+14	1.12E+14
496.6	1.97E+14	1.49E+14	1.47E+14	1.41E+14	1.25E+14	1.02E+14
516.2	1.76E+14	1.71E+14	1.74E+14	1.48E+14	1.16E+14	1.06E+14
535.1	1.89E+14	1.68E+14	1.47E+14	1.26E+14	1.12E+14	1.01E+14
554.8	1.85E+14	1.79E+14	1.63E+14	1.39E+14	1.18E+14	1.12E+14
578.9	1.68E+14	1.64E+14	1.53E+14	1.30E+14	1.07E+14	1.13E+14
595.3	1.86E+14	1.57E+14	1.35E+14	1.16E+14	1.02E+14	1.28E+14
614.7	2.03E+14	1.59E+14	1.39E+14	1.25E+14	1.17E+14	1.29E+14
633.8	1.93E+14	1.52E+14	1.38E+14	1.26E+14	1.16E+14	1.24E+14
650.6	1.76E+14	1.53E+14	1.62E+14	1.54E+14	1.25E+14	1.08E+14
677.7	1.64E+14	1.69E+14	1.39E+14	1.10E+14	9.87E+13	1.09E+14
694.5	1.57E+14	1.34E+14	1.29E+14	1.29E+14	1.10E+14	1.23E+14
T-Q	6.71E+16	5.76E+16	5.32E+16	4.74E+16	4.14E+16	4.09E+16

T-Q: Total quanta ( $\text{quanta cm}^{-2} \text{sec}^{-1}$ )

Wave Length (nm)	Station					
	13	14	15	16	17	18
	( $\mu\text{W cm}^{-2} \text{ nm}^{-1}$ )					
402.4	3.04E+01	3.10E+01	2.27E+01	2.35E+01	2.25E+01	2.10E+01
418.8	3.25E+01	3.00E+01	2.30E+01	2.41E+01	2.26E+01	2.03E+01
438.8	3.77E+01	3.12E+01	2.84E+01	2.46E+01	2.33E+01	2.21E+01
455.9	4.02E+01	3.84E+01	2.99E+01	3.06E+01	2.87E+01	2.79E+01
473.3	4.01E+01	3.89E+01	2.85E+01	2.93E+01	2.86E+01	2.88E+01
496.6	3.80E+01	4.04E+01	2.55E+01	2.85E+01	2.85E+01	3.04E+01
516.2	3.97E+01	5.08E+01	2.68E+01	3.80E+01	3.78E+01	3.71E+01
535.1	4.25E+01	3.89E+01	2.42E+01	3.30E+01	3.01E+01	2.84E+01
554.8	5.11E+01	4.39E+01	2.92E+01	3.58E+01	3.29E+01	3.12E+01
578.9	4.65E+01	3.76E+01	3.00E+01	3.06E+01	2.86E+01	2.84E+01
595.3	3.97E+01	3.27E+01	3.00E+01	2.61E+01	2.46E+01	2.44E+01
614.7	4.08E+01	3.28E+01	2.94E+01	2.67E+01	2.51E+01	2.57E+01
633.8	3.75E+01	3.24E+01	2.74E+01	2.55E+01	2.46E+01	2.65E+01
650.6	3.38E+01	4.31E+01	2.04E+01	2.92E+01	3.14E+01	3.53E+01
677.7	4.78E+01	3.80E+01	2.52E+01	3.87E+01	3.39E+01	2.91E+01
694.5	3.85E+01	2.79E+01	2.93E+01	1.91E+01	2.02E+01	2.58E+01
T-E	1.21E+04	1.12E+04	8.06E+03	8.79E+03	8.43E+03	8.40E+03

Wave Length (nm)	Station			
	19	20	21	22
	( $\mu\text{W cm}^{-2} \text{ nm}^{-1}$ )			
402.4	1.83E+01	1.23E+01	1.04E+01	6.86E+00
418.8	1.79E+01	1.25E+01	9.87E+00	6.67E+00
438.8	1.86E+01	1.33E+01	1.06E+01	7.14E+00
455.9	2.37E+01	1.65E+01	1.29E+01	8.60E+00
473.3	2.41E+01	1.61E+01	1.32E+01	8.33E+00
496.6	2.44E+01	1.57E+01	1.38E+01	8.30E+00
516.2	3.02E+01	2.00E+01	1.59E+01	9.64E+00
535.1	2.40E+01	1.69E+01	1.20E+01	7.84E+00
554.8	2.56E+01	1.82E+01	1.31E+01	8.11E+00
578.9	2.21E+01	1.55E+01	1.11E+01	6.82E+00
595.3	1.87E+01	1.37E+01	9.40E+00	6.13E+00
614.7	1.95E+01	1.41E+01	9.75E+00	6.19E+00
633.8	1.96E+01	1.38E+01	1.03E+01	6.45E+00
650.6	2.65E+01	1.66E+01	1.54E+01	8.66E+00
677.7	2.50E+01	2.13E+01	1.11E+01	8.11E+00
694.5	1.65E+01	1.13E+01	1.07E+01	6.11E+00
T-E	6.74E+03	4.70E+03	3.59E+03	2.27E+03

T-E: Total energy ( $\mu\text{W cm}^{-2}$ )

Wave Length (nm)	Station					
	13	14	15	16	17	18
	(quanta $\text{cm}^{-2} \text{nm}^{-1} \text{sec}^{-1}$ )					
402.4	6.13E+13	6.24E+13	4.57E+13	4.73E+13	4.53E+13	4.23E+13
418.8	6.62E+13	6.13E+13	4.69E+13	4.92E+13	4.62E+13	4.13E+13
438.8	7.78E+13	6.44E+13	5.86E+13	5.08E+13	4.81E+13	4.56E+13
455.9	8.40E+13	8.02E+13	6.24E+13	6.40E+13	6.00E+13	5.83E+13
473.3	8.47E+13	8.24E+13	6.03E+13	6.20E+13	6.05E+13	6.09E+13
496.6	8.13E+13	8.64E+13	5.45E+13	6.09E+13	6.11E+13	6.50E+13
516.2	8.61E+13	1.10E+14	5.81E+13	8.22E+13	8.18E+13	8.03E+13
535.1	9.32E+13	8.53E+13	5.29E+13	7.22E+13	6.59E+13	6.22E+13
554.8	1.13E+14	9.73E+13	6.48E+13	7.93E+13	7.30E+13	6.91E+13
578.9	1.04E+14	8.42E+13	6.73E+13	6.85E+13	6.40E+13	6.36E+13
595.3	9.01E+13	7.41E+13	6.79E+13	5.91E+13	5.58E+13	5.53E+13
614.7	9.36E+13	7.51E+13	6.74E+13	6.12E+13	5.75E+13	5.88E+13
633.8	8.69E+13	7.50E+13	6.34E+13	5.90E+13	5.71E+13	6.15E+13
650.6	7.92E+13	1.01E+14	4.77E+13	6.83E+13	7.35E+13	8.27E+13
677.7	1.13E+14	8.98E+13	5.97E+13	9.15E+13	8.01E+13	6.89E+13
694.5	9.20E+13	6.67E+13	7.01E+13	4.57E+13	4.83E+13	6.17E+13
T-Q	3.36E+16	2.23E+16	2.23E+16	2.44E+16	2.34E+16	2.35E+16

Wave Length (nm)	Station			
	19	20	21	22
	(quanta $\text{cm}^{-2} \text{nm}^{-1} \text{sec}^{-1}$ )			
402.4	3.68E+13	2.48E+13	2.09E+13	1.38E+13
418.8	3.65E+13	2.55E+13	2.01E+13	1.36E+13
438.8	3.83E+13	2.74E+13	2.20E+13	1.47E+13
455.9	4.95E+13	3.45E+13	2.71E+13	1.80E+13
473.3	5.10E+13	3.40E+13	2.78E+13	1.76E+13
496.6	5.21E+13	3.35E+13	2.96E+13	1.78E+13
516.2	6.54E+13	4.33E+13	3.45E+13	2.09E+13
535.1	5.26E+13	3.68E+13	2.63E+13	1.72E+13
554.8	5.67E+13	4.02E+13	2.91E+13	1.80E+13
578.9	4.94E+13	3.48E+13	2.49E+13	1.53E+13
595.3	4.25E+13	3.11E+13	2.13E+13	1.39E+13
614.7	4.46E+13	3.22E+13	2.23E+13	1.42E+13
633.8	4.54E+13	3.21E+13	2.39E+13	1.49E+13
650.6	6.21E+13	3.88E+13	3.60E+13	2.03E+13
677.7	5.92E+13	5.03E+13	2.63E+13	1.92E+13
694.5	3.95E+13	2.71E+13	2.55E+13	1.46E+13
T-Q	1.87E+16	1.31E+16	9.91E+15	6.25E+15

T-Q: Total quanta (quanta  $\text{cm}^{-2} \text{sec}^{-1}$ )

B. Biological data: Downward spectral irradiance measured under natural sea ice on March 11, 1992. All stations were located from Kimuanepu to the second inlet. (Kishino)

Wave Length (nm)	Station					
	1	2	3	4	5	6
	$(\mu\text{W cm}^{-2} \text{ nm}^{-1})$					
402.4	8.33E-01	1.50E+00	6.72E-01	5.45E-01	3.60E-01	2.98E-01
418.8	9.91E-01	1.63E+00	6.00E-01	6.11E-01	3.22E-01	3.16E-01
438.8	1.67E+00	2.92E+00	1.14E+00	9.87E-01	4.68E-01	4.94E-01
455.9	2.09E+00	3.96E+00	1.70E+00	1.17E+00	6.46E-01	6.13E-01
473.3	2.63E+00	5.29E+00	2.71E+00	1.49E+00	9.10E-01	8.15E-01
496.6	2.81E+00	5.43E+00	2.72E+00	1.65E+00	1.08E+00	9.15E-01
516.2	3.01E+00	5.18E+00	2.32E+00	1.94E+00	1.32E+00	1.05E+00
535.1	3.53E+00	6.31E+00	3.06E+00	2.46E+00	1.45E+00	1.32E+00
554.8	4.22E+00	6.88E+00	3.24E+00	3.27E+00	1.89E+00	1.81E+00
578.9	4.29E+00	7.05E+00	3.41E+00	3.54E+00	2.05E+00	2.01E+00
595.3	4.34E+00	7.94E+00	4.02E+00	3.43E+00	2.07E+00	2.09E+00
614.7	4.07E+00	7.76E+00	4.03E+00	3.14E+00	1.92E+00	1.95E+00
633.8	3.77E+00	7.21E+00	3.72E+00	2.75E+00	1.74E+00	1.74E+00
650.6	2.73E+00	5.16E+00	2.83E+00	1.91E+00	1.51E+00	1.17E+00
677.7	2.67E+00	4.47E+00	1.67E+00	1.71E+00	6.85E-01	9.26E-01
694.5	2.74E+00	5.04E+00	2.70E+00	2.11E+00	1.33E+00	1.35E+00
T-E	8.92E+02	1.61E+03	7.76E+02	6.28E+02	3.78E+02	3.61E+02
Wave Length (nm)	Station					
	7	8	9	10	11	12
	$(\mu\text{W cm}^{-2} \text{ nm}^{-1})$					
402.4	2.13E-01	1.00E-01	1.36E-01	4.67E-02	8.78E-02	1.32E-01
418.8	2.20E-01	9.08E-02	1.30E-01	4.21E-02	8.06E-02	1.09E-01
438.8	4.48E-01	1.26E-01	1.83E-01	5.49E-02	1.58E-01	1.59E-01
455.9	5.50E-01	1.49E-01	2.22E-01	5.16E-02	1.93E-01	2.00E-01
473.3	7.49E-01	2.05E-01	3.07E-01	8.01E-02	2.55E-01	2.62E-01
496.6	8.03E-01	2.60E-01	3.64E-01	9.82E-02	2.78E-01	3.35E-01
516.2	8.69E-01	3.24E-01	4.46E-01	1.22E-01	3.04E-01	4.19E-01
535.1	1.10E+00	4.70E-01	6.47E-01	1.85E-01	4.43E-01	5.33E-01
554.8	1.47E+00	6.02E-01	7.99E-01	2.33E-01	5.05E-01	6.36E-01
578.9	1.79E+00	7.27E-01	9.62E-01	2.92E-01	5.76E-01	6.90E-01
595.3	2.00E+00	7.74E-01	1.10E+00	3.34E-01	6.78E-01	7.28E-01
614.7	1.82E+00	6.91E-01	9.83E-01	3.07E-01	5.43E-01	6.22E-01
633.8	1.64E+00	6.02E-01	8.64E-01	2.64E-01	5.33E-01	5.92E-01
650.6	9.93E-01	4.34E-01	5.66E-01	1.91E-01	2.97E-01	4.84E-01
677.7	8.41E-01	3.10E-01	4.40E-01	1.19E-01	3.12E-01	3.42E-01
694.5	1.24E+00	4.82E-01	6.50E-01	2.09E-01	3.84E-01	5.01E-01
T-E	3.19E+02	1.21E+02	1.68E+02	5.00E+01	1.07E+02	1.29E+02

T-E: Total energy ( $\mu\text{W cm}^{-2}$ )

Wave Length (nm)	Station					
	1	2	3	4	5	6
	(quanta $\text{cm}^{-2} \text{nm}^{-1} \text{sec}^{-1}$ )					
402.4	1.68E+12	3.02E+12	3.52E+12	1.10E+12	7.24E+11	6.00E+11
418.8	2.02E+12	3.32E+12	1.22E+12	1.25E+12	6.57E+11	6.44E+11
438.8	3.45E+12	6.03E+12	2.36E+12	2.04E+12	9.65E+11	1.02E+12
455.9	4.36E+12	8.28E+12	3.55E+12	2.44E+12	1.35E+12	1.28E+12
473.3	5.56E+12	1.12E+13	5.74E+12	3.15E+12	1.92E+12	1.72E+12
496.6	6.02E+12	1.16E+13	5.81E+12	3.54E+12	2.32E+12	1.96E+12
516.2	6.52E+12	1.12E+13	5.03E+12	4.21E+12	2.86E+12	2.27E+12
535.1	7.73E+12	1.38E+13	6.71E+12	5.39E+12	3.17E+12	2.90E+12
554.8	9.36E+12	1.52E+13	7.19E+12	7.23E+12	4.19E+12	4.00E+12
578.9	9.62E+12	1.58E+13	7.64E+12	7.94E+12	3.49E+12	4.50E+12
595.3	9.84E+12	1.80E+13	9.10E+12	7.78E+12	4.68E+12	4.73E+12
514.7	9.32E+12	1.78E+13	9.24E+12	7.19E+12	4.41E+12	4.46E+12
633.8	8.73E+12	1.67E+13	8.61E+12	6.38E+12	4.02E+12	4.02E+12
650.6	6.40E+12	1.21E+13	6.62E+12	4.47E+12	3.54E+12	2.74E+12
677.7	6.31E+12	1.06E+13	3.96E+12	4.05E+12	1.62E+12	2.19E+12
694.5	6.55E+12	1.21E+13	6.47E+12	5.04E+12	3.18E+12	3.24E+12
T-Q	2.55E+15	4.59E+15	2.23E+15	1.81E+15	1.09E+15	1.05E+15

Wave Length (nm)	Station					
	7	8	9	10	11	12
	(quanta $\text{cm}^{-2} \text{nm}^{-1} \text{sec}^{-1}$ )					
402.4	4.30E+11	2.02E+11	2.74E+11	9.40E+10	1.77E+11	2.66E+11
418.8	4.49E+11	1.85E+11	2.66E+11	8.58E+10	1.64E+11	2.21E+11
438.8	9.24E+11	2.60E+11	3.78E+11	1.13E+11	3.72E+11	3.28E+11
455.9	1.15E+12	3.12E+11	4.65E+11	1.08E+11	4.02E+11	4.18E+11
473.3	1.58E+12	4.33E+11	6.49E+11	1.69E+11	5.40E+11	5.54E+11
496.6	1.72E+12	5.57E+11	7.79E+11	2.10E+11	5.94E+11	7.18E+11
516.2	1.88E+12	7.02E+11	9.65E+11	2.64E+11	6.58E+11	9.07E+11
535.1	2.41E+12	1.03E+12	1.42E+12	4.05E+11	9.70E+11	1.17E+12
554.8	3.25E+12	1.33E+12	1.77E+12	5.15E+11	1.12E+12	1.41E+12
578.9	4.00E+12	1.63E+12	2.15E+12	6.55E+11	1.29E+12	1.55E+12
595.3	4.53E+12	1.75E+12	2.48E+12	7.57E+11	1.54E+12	1.65E+12
614.7	4.16E+12	1.58E+12	2.25E+12	7.02E+11	1.24E+12	1.42E+12
633.8	3.79E+12	1.39E+12	2.00E+12	6.13E+11	1.24E+12	1.37E+12
650.6	2.32E+12	1.02E+12	1.33E+12	4.48E+11	6.96E+11	1.13E+12
677.7	1.99E+12	7.33E+11	1.04E+12	2.81E+11	7.39E+11	8.09E+11
694.5	2.96E+12	1.12E+12	1.55E+12	4.99E+11	9.19E+11	1.20E+12
T-Q	9.30E+14	3.55E+14	4.91E+14	1.47E+14	3.11E+14	3.74E+14

T-Q: Total quanta (quanta  $\text{cm}^{-2} \text{sec}^{-1}$ )

C. Biological data: Chlorophyll a and pheopigments ( $\text{mg m}^{-2}$ )  
(Robineau)

Date	Julian	Sample	Size	Number of samples	CHL.a	SD	SE	Pheo	SD
Feb 21	52	open	GF/F	3	5.00	3.50	2.02	3.48	0.61
Feb 21	52	open	5 $\mu\text{m}$	3	5.30	2.07	1.20	2.52	0.36
Feb 21	52	open	0.4 $\mu\text{m}$	3	7.20	1.14	0.66	2.91	0.20
Feb 21	52	open	0.4-5 $\mu\text{m}$	1	2.23			0.39	
Feb 21	52	natural	GF/F	3	4.30	0.74	0.43	0.74	0.13
Feb 21	52	natural	5 $\mu\text{m}$	3	5.75	1.28	0.74	0.99	0.22
Feb 21	52	natural	0.4 $\mu\text{m}$	3	6.11	1.31	0.76	1.06	0.23
Feb 21	52	natural	0.4-5 $\mu\text{m}$	1	0.36			0.07	
Feb 24	55	open	GF/F	1	10.21			3.48	
Feb 24	55	open	5 $\mu\text{m}$	1	9.03			missing	
Feb 24	55	open	0.4 $\mu\text{m}$	1	19.54			0.75	
Feb 24	55	open	0.4-5 $\mu\text{m}$	1	10.51			0.75	
Feb 24	55	natural	GF/F	1	19.87			0.74	
Feb 24	55	natural	5 $\mu\text{m}$	1	7.95			0.38	
Feb 24	55	natural	0.4 $\mu\text{m}$	1	14.74			1.06	
Feb 24	55	natural	0.4-5 $\mu\text{m}$	1	6.79			0.05	
Feb 27	58	open	GF/F	3	14.15	0.26	0.15	0.79	0.24
Feb 27	58	open	5 $\mu\text{m}$	3	10.43	1.99	1.15	0.80	
Feb 27	58	open	0.4 $\mu\text{m}$	3	14.04	0.41	0.24	1.23	0.66
Feb 27	58	open	0.4-5 $\mu\text{m}$	1	3.61			0.43	
Feb 27	58	natural	GF/F	3	38.25	1.96	1.13	2.98	1.56
Feb 27	58	natural	5 $\mu\text{m}$	3	40.87	4.72	2.73	1.69	
Feb 27	58	natural	0.4 $\mu\text{m}$	3	41.92	1.48	0.85	1.71	0.00
Feb 27	58	natural	0.4-5 $\mu\text{m}$	1	1.05			0.02	
Mar 02	62	open	GF/F	3	7.79	0.28	0.16	0.32	0.10
Mar 02	62	open	5 $\mu\text{m}$	3	7.18	0.27	0.16	0.20	0.16
Mar 02	62	open	0.4 $\mu\text{m}$	3	7.34	0.00	0.00	0.51	0.11
Mar 02	62	open	0.4-5 $\mu\text{m}$	1	0.16			0.31	
Mar 02	62	natural	GF/F	4	24.72	0.98	0.49	4.34	2.16
Mar 02	62	natural	5 $\mu\text{m}$	4	21.38	0.83	0.42	2.72	0.03
Mar 02	62	natural	0.4 $\mu\text{m}$	4	25.29	1.55	0.78	3.68	0.91
Mar 02	62	natural	0.4-5 $\mu\text{m}$	1	3.91			0.96	
Mar 05	65	open	GF/F	1	1.16			1.72	
Mar 05	65	open	5 $\mu\text{m}$	1	0.70			1.33	
Mar 05	65	open	0.4 $\mu\text{m}$	1	1.28			1.97	
Mar 05	65	open	0.4-5 $\mu\text{m}$	1	0.58			0.64	
Mar 05	65	natural	GF/F	2	33.88	4.01	2.84	6.59	0.05
Mar 05	65	natural	5 $\mu\text{m}$	2	27.85	4.27	3.02	4.16	1.38
Mar 05	65	natural	0.4 $\mu\text{m}$	2	35.90	4.45	3.15	7.03	0.06
Mar 05	65	natural	0.4-5 $\mu\text{m}$	1	8.05			2.87	
Mar 09	69	open	GF/F	1	6.81			1.03	
Mar 09	69	open	5 $\mu\text{m}$	1	5.87			0.62	
Mar 09	69	open	0.4 $\mu\text{m}$	1	6.81			0.89	
Mar 09	69	open	0.4-5 $\mu\text{m}$	1	0.94			0.27	

Mar 09	69	natural	GF/F	3	23.63	0.07	0.04	5.50	0.67
Mar 09	69	natural	5 $\mu$ m	3	22.38	0.71	0.41	5.07	0.42
Mar 09	69	natural	0.4 $\mu$ m	3	24.84	1.18	0.68	6.14	0.00
Mar 09	69	natural	0.4-5um	1	2.46			1.07	
Mar 12	72	open	GF/F	1	5.35			1.28	
Mar 12	72	open	5 $\mu$ m	1	3.67			0.79	
Mar 12	72	open	0.4 $\mu$ m	1	4.72			2.72	
Mar 12	72	open	0.4-5um	1	1.05			1.93	
Mar 12	72	natural	GF/F	2	22.32	1.10	0.78	4.04	1.10
Mar 12	72	natural	5 $\mu$ m	2	19.10	2.59	1.83	4.42	1.38
Mar 12	72	natural	0.4 $\mu$ m	2	21.14	1.81	1.28	5.02	1.20
Mar 12	72	natural	0.4-5um	1	2.04			0.60	
Mar 16	76	open	GF/F	1	8.70			1.04	
Mar 16	76	open	5 $\mu$ m	1	7.86			0.52	
Mar 16	76	open	0.4 $\mu$ m	1	8.91			1.23	
Mar 16	76	open	0.4-5um	1	1.05			0.71	
Mar 16	76	natural	GF/F	2	22.80	2.36	1.67	3.77	1.70
Mar 16	76	natural	5 $\mu$ m	2	20.52	3.07	2.17	2.42	0.00
Mar 16	76	natural	0.4 $\mu$ m	2	22.25	1.34	0.95	4.73	2.31
Mar 16	76	natural	0.4-5um	1	1.73			2.31	

D. Biological data: Chlorophyll a concentration ( $\text{mg m}^{-3}$ ) at the natural and open site with algal carbon:chlorophyll a ratio and algal carbon:nitrogen ratio. (Suzuki and Kudoh)

Julian Day	Date	Chlorophyll a		C:CHL a	C:N
		Natural	Open		
52	Feb 21	131	172	nd	nd
55	Feb 24	547	281	nd	nd
58	Feb 27	1,050	389	nd	nd
62	Mar 2	656	190	nd	nd
65	Mar 5	932	31.9	nd	nd
69	Mar 9	650	187	7.23	4.23
70	Mar 10	nd	nd	7.24	5.03
71	Mar 11	nd	nd	10.7	6.00
72	Mar 12	614	147	11.3	6.06
73	Mar 13	nd	nd	22.0	5.96
74	Mar 14	nd	nd	nd	4.49
76	Mar 16	627	239	nd	nd
77	Mar 17	nd	nd	12.7	5.84
78	Mar 18	nd	nd	13.0	4.76
79	Mar 19	nd	nd	19.4	4.98

E. Biological data: Cell numbers (upper row; cells ml<sup>-1</sup>) and cell carbon (lower row; ugC ml<sup>-1</sup>) of dominant ice algae at the natural site. (Kudoh)

Species	Date					
	Feb 25	Feb 28	Mar 2	Mar 5	Mar 9	Mar 21
Diatoms						
Centric						
<u>Dentonula</u>						
<u>confervacea</u>	20391	32745	26684	9768	66045	9102
	1988	3193	2602	953	6441	888
<u>Melosira</u>						
<u>hyperborea</u>	0	333	0	0	0	0
	0	209	0	0	0	0
Pennate						
<u>Entomoneisalata</u>	59	70	89	70	0	222
(= <u>Amphipora</u> )	16	19	25	19	0	61
<u>Navicula</u>						
<u>septentrionalis</u>	2964	2539	636	3178	259	2775
	97	171	21	104	8.5	91
<u>Naviculatransitans</u>						
<u>v. derasa</u>	74	22	148	33	37	0
	6.5	1.9	13	2.9	2.3	0
<u>Navicula</u>						
<u>vanhoeffenii</u>	0	0	141	100	370	0
	0	0	24	17	62	0
<u>Naviculapelagica</u>						
	6072	21127	28039	6338	740	1665
	122	423	562	127	15	33
<u>Navicula</u> sp.						
	1210	3552	2231	26	37	0
	49	145	91	1.1	1.5	0
<u>Pinnularia</u>						
<u>quadratarea</u>	0	0	30	14	0	74
	0	0	13.3	6.2	0	33
other						
Naviculaceae	0.3	0.1	0	0.5	0	na
	11	2.9	0	5.9	0	3.4
<u>Nitzschia</u>						
<u>cylindrus</u>	2428	5231	307	248	0	925
	64	138	8.1	6.6	0	24
<u>Nitzschia frigida</u>						
	230	511	236	0	0	296
	12	27	12	0	0	15
Flagellates						
Euglenophyceae						
	0	0	0	0	74	74
	0	0	0	0	39	39
Microflagellates						
(<20 μm)	1476	1961	422	0	2590	74
	145	192	42	0	254	7.3
Nonoflagellates						
(>20 μm)	1288	4551	1709	744	1424	1295
	101	357	134	58	112	102

- F. Biological data: Dark respiration rate (DR) and net photosynthetic rates ( $\text{mg O}_2 [\text{mg CHL a}]^{-1} \text{h}^{-1}$ ) determined at several light levels with ice algae collected from the natural and open site. (Suzuki)

	Light Intensity ( $\text{micro mole quanta m}^{-2} \text{s}^{-1}$ )					
	DR	2.0	3.0	4.5	10	25
<b>Natural Site</b>						
Feb. 28	-0.064	0.003	-	-	-	0.814
Mar. 5	-0.024	-0.006	-	-	-	0.820
Mar. 8	-0.128	-0.103	0.027	0.146	0.451	1.293
Mar. 18	-0.116	0.123	-	-	-	1.248
<b>Open Site</b>						
Mar. 1	-0.121	-0.096	-	-	-	1.032
Mar. 4	-0.016	-0.012	-	-	-	0.962
Mar. 13	-0.157	-0.072	-0.034	0.210	0.334	0.878
Mar. 18	-0.137	0.046	-	-	-	1.359

G. Biological data: Nutrient data ( $\mu\text{M}$ ). Mean of duplicate determination with one standard deviation. Water samples from 1, 2.5, 5, and 7.5 m depth were collected by C. Michel on February 21, 26, 29, March 3, 6, 10, 13, 17, and 20, 1992. Water samples from sediment traps placed at 0.5, 2.5, and 7.5 m were collected by C. Michel after recovery on February 25, March 2, 5, 9, 12, 16, 19, and 23, 1992. (Kasai & Taguchi)

Date	Sample	NO3-N		NO2-N		P04-P		SiO2-S	
Feb 21	1 m	7.10	1.40	0.46	3.03	0.62	0.33	15.32	5.09
Feb 21	2.5 m	5.08	0.57	0.25	0.14	1.03	0.88	9.67	6.15
Feb 21	5 m	9.75	0.21	0.37	23.7	1.10	11.9	17.28	4.40
Feb 21	7.5 m	9.68	0.05	0.36	28.7	0.93	11.4	18.56	4.02
Feb 25	open ice algae	16.94	1.66	0.68	3.02	17.55	na	59.54	1.86
Feb 25	cover ice algae	18.48	1.49	0.64	1.32	16.25	na	58.24	1.21
Feb 26	day-0 control	23.60	0.30	0.79	0.23	1.15	0.91	67.68	0.06
Feb 26	day-0 Silicate	23.54	0.42	0.79	0.82	0.81	1.10	231.70	na
Feb 26	day-0 Phosphate	26.64	1.15	0.80	0.08	25.00	na	74.96	na
Feb 26	day-0 Nitrate	413.90	na	0.77	0.85	0.74	na	82.11	3.26
Feb 26	day-0 Ammonium	1.72	na	0.78	1.14	0.07	na	69.34	1.68
Feb 26	1 m	4.51	0.64	0.15	62.9	0.48	6.65	10.18	5.90
Feb 26	2.5 m	6.50	0.02	0.30	37.1	0.83	9.67	12.87	5.05
Feb 26	5 m	9.50	3.11	0.48	17.0	0.66	54.7	18.18	4.18
Feb 26	7.5 m	10.51	0.90	0.43	25.9	1.08	7.23	18.55	4.15
Feb 26	0 m	16.89	1.60	0.69	0.28	1.40	1.25	51.93	0.39
Feb 26	1 m	7.90	0.49	0.35	0.68	1.59	0.82	17.38	0.37
Feb 26	3 m	9.05	0.43	0.33	1.11	1.71	2.36	17.76	0.20
Feb 26	6 m	9.35	0.07	0.33	0.39	1.38	1.67	18.52	na
Feb 26	9 m	9.34	0.99	0.38	0.22	1.15	0.91	18.33	0.71
Feb 26	0 m	17.48	1.20	0.82	0.47	2.78	na	15.18	na
Feb 26	1 m	8.31	0.32	0.50	2.26	1.31	na	4.66	na
Feb 26	3 m	8.21	0.80	0.38	1.77	1.20	0.50	22.50	4.55
Feb 26	6 m	9.21	1.03	0.34	3.43	1.69	0.86	20.74	4.87
Feb 26	9 m	9.30	1.67	0.38	3.23	1.29	0.58	20.57	4.62
Feb 27	open ice algae	46.28	2.42	0.20	19.5	0.90	0.71	29.39	2.09
Feb 27	cover ice algae	16.68	0.15	0.12	63.2	1.37	1.50	27.32	2.20
Feb 27	water	9.44	0.96	0.10	80.85	1.30	0.54	21.56	2.60

Feb 29	1 m	9.81	0.35	0.46	14.7	0.77	2.87	28.15	2.29
Feb 29	2.5 m	9.14	0.79	0.38	23.3	1.09	2.42	19.77	2.45
Feb 29	5.0 m	9.21	2.15	0.29	22.9	1.09	0.41	19.28	2.83
Feb 29	7.5 m	0.13	0.10	0.26	26.5	1.03	1.99	18.82	2.74
Mar 01	4-01	20.38	0.47	0.13	49.22	0.19	21.9	66.93	2.26
Mar 01	4-02	18.57	0.27	0.76	8.35	0.41	10.3	66.04	na
Mar 01	4-03	20.43	0.05	0.76	6.36	0.14	26.3	292.70	na
Mar 01	4-04	20.16	0.77	0.74	6.21	0.39	11.3	298.40	na
Mar 01	4-05	15.28	0.13	0.75	6.24	22.7	na	69.53	na
Mar 01	4-06	14.96	0.57	0.76	5.28	23.4	na	63.44	2.18
Mar 01	4-07	265.0	na	0.74	4.19	0.24	na	66.14	1.94
Mar 01	4-08	275.0	na	0.78	5.27	0.22	16.6	65.58	2.65
Mar 01	4-09	21.95	na	0.75	5.20	0.10	31.4	67.37	1.67
Mar 01	4-10	21.46	0.35	0.75	4.90	0.23	15.4	68.59	1.89
Mar 02	open ice algae	12.64	0.12	0.52	5.65	0.90	2.92	31.06	4.94
Mar 02	cover ice algae	15.41	0.58	0.60	4.92	0.84	2.90	39.12	3.26
Mar 02	water	9.31	0.48	0.42	7.67	1.04	1.87	29.40	4.27
Mar 02	0.5 m	2.40	3.34	0.31	10.68	0.93	1.60	8.47	1.33
Mar 02	0.5 m	2.32	2.18	0.34	10.82	1.07	0.09	6.22	6.63
Mar 02	2.5 m	2.67	2.38	0.33	11.09	0.88	1.13	9.71	3.56
Mar 02	7.5 m	2.95	2.24	0.28	25.57	0.96	0.23	7.81	3.77
Mar 02	7.5 m	3.62	1.99	0.39	7.83	1.30	0.42	11.73	0.85
Mar 03	1.0 m	9.21	0.86	0.55	6.06	0.99	0.31	21.97	0.48
Mar 03	2.5 m	9.22	0.53	0.44	5.39	0.95	0.30	21.12	4.38
Mar 03	5.0 m	9.22	0.16	0.37	5.01	1.03	0.58	20.39	4.95
Mar 03	7.5 m	9.48	0.98	0.43	5.54	1.11	0.49	23.77	4.71
Mar 05	open ice algae	20.41	0.37	0.87	0.80	2.40	4.36	55.12	0.24
Mar 05	cover ice algae	13.49	0.37	0.57	1.52	1.52	2.01	25.91	2.05
Mar 05	8-01	20.08	0.20	0.85	0.44	0.19	7.24	53.97	0.32
Mar 05	8-02	19.10	0.79	0.89	1.43	0.09	12.1	50.43	1.62
Mar 05	8-03								
Mar 05	8-04	19.61	1.10	0.81	1.50	0.21	11.3	272.3	na
Mar 05	8-05	0.34	19.8	0.42	2.96	19.8	na	13.73	na
Mar 05	8-06	0.14	5.35	0.18	13.49	20.0	na	11.37	5.24
Mar 05	8-07	290.4	na	0.89	1.65	1.04	na	50.57	1.19
Mar 05	8-08	282.5	na	0.90	1.51	0.38	5.16	51.88	2.85
Mar 05	8-09	20.53	na	0.85	3.02	0.22	9.32	51.00	2.16
Mar 05	8-10	22.37	0.27	0.86	1.20	0.31	6.48	54.63	0.65
Mar 05	0.5 m	3.68	1.26	0.38	2.77	0.82	0.50	16.54	2.57
Mar 05	2.5 m	4.44	0.74	0.33	3.36	0.73	0.57	19.13	3.11
Mar 05	7.5 m	4.73	0.60	0.40	2.88	0.82	0.18	18.56	2.59

Mar 06	1.0 m	12.13	0.25	0.63	0.18	1.28	1.79	33.65	0.27
Mar 06	2.5 m	10.73	0.33	0.52	1.53	1.35	1.08	26.87	0.06
Mar 06	5.0 m	9.59	0.08	0.43	0.12	1.21	0.71	22.97	1.44
Mar 06	7.5 m	9.52	1.04	0.41	1.09	1.33	0.34	22.04	1.79
Mar 09	12-01	17.60	0.20	0.88	0.01	0.96	2.20	48.82	1.21
Mar 09	12-02	17.48	0.89	0.84	0.24	1.24	1.65	47.97	1.55
Mar 09	12-03	16.73	0.54	0.90	0.10	0.72	1.93	230.0	na
Mar 09	12-04	13.37	1.16	0.93	0.32	2.72	0.37	242.5	na
Mar 09	12-05	0.90	2.58	0.17	0.85	22.6	na	0.00	na
Mar 09	12-06	0.32	7.71	0.22	3.01	28.3	na	3.14	28.9
Mar 09	12-07	251.9	na	1.01	0.89	1.34	na	47.07	2.05
Mar 09	12-08	285.5	na	0.97	0.57	1.09	12.7	50.23	2.63
Mar 09	12-09	20.46	na	0.96	0.69	1.39	2.19	52.12	3.51
Mar 09	12-10	22.4	0.07	0.94	0.32	1.49	1.41	54.16	1.33
Mar 09	open ice algae	34.26	0.15	1.22	0.86	2.78	na	61.58	4.08
Mar 09	cover ice algae	28.53	0.51	0.98	1.05	1.52	na	61.64	3.78
Mar 09	water	14.16	0.04	0.71	0.11	1.07	0.51	39.00	3.58
Mar 09	0.5 m	4.93	0.81	0.56	0.50	0.95	0.67	33.96	0.62
Mar 09	2.5 m	7.92	0.06	0.52	1.59	0.96	1.13	43.14	1.53
Mar 09	7.5 m	8.60	0.05	0.51	2.26	1.43	0.42	40.13	0.31
Mar 12	open ice algae	3.91	0.14	0.12	17.38	0.57	0.09	25.09	0.06
Mar 12	cover ice algae	7.35	0.33	0.21	10.01	0.83	0.36	30.40	0.25
Mar 12	water	20.25	0.77	0.73	2.56	1.17	1.15	52.33	0.07
Mar 12	A-0.5 m	4.29	0.10	0.25	2.84	0.72	0.83	na	na
Mar 12	A-2.5 m	6.57	0.21	0.31	5.88	0.88	0.53	93.36	na
Mar 12	A-7.5 m	10.15	0.59	0.36	1.66	0.97	0.50	73.08	na
Mar 12	B-0.5 m	2.94	2.4	0.28	1.91	1.24	0.32	116.6	na
Mar 12	B-2.5 m	3.60	1.28	0.29	0.59	1.17	0.64	152.4	na
Mar 12	B-7.5 m	4.27	1.56	0.36	3.18	1.23	0.78	136.5	na
Mar 13	16-01	13.53	0.85	0.77	2.23	0.43	1.35	30.90	1.05
Mar 13	16-02	16.59	0.03	0.76	1.62	0.65	0.80	37.17	0.23
Mar 13	16-03	3.83	2.42	0.45	4.63	26.7	na	182.0	na
Mar 13	16-04	0.41	0.58	0.14	8.46	1.54	na	135.8	na
Mar 13	16-05	0.58	5.61	0.10	2.67	na	na	5.54	na
Mar 13	16-06	0.09	38.3	0.07	5.28	205.3	na	0.53	29.9
Mar 13	16-07	261.7	na	0.79	1.09	1.15	na	24.54	0.67
Mar 13	16-08	273.7	na	0.83	1.66	1.60	3.03	37.46	0.35
Mar 13	16-09	19.97	na	0.77	1.58	6.05	na	37.16	0.01
Mar 13	16-10	22.00	0.75	0.77	0.82	1.22	na	42.47	0.20
Mar 13	1.0 m	9.90	0.20	0.39	1.93	1.05	1.05	24.60	0.47
Mar 13	2.5 m	10.43	1.42	0.39	1.33	1.03	0.59	24.76	0.77
Mar 13	5.0 m	9.66	0.22	0.33	6.73	1.39	0.36	20.85	0.22
Mar 13	7.5 m	10.16	1.90	0.29	10.4	1.17	1.46	22.16	0.18

Mar 16	A-0.5 m	6.96	15.2	0.34	7.74	1.17	1.89	84.73	5.75
Mar 16	A-2.5 m	10.81	5.04	0.41	4.82	1.01	1.90	32.29	0.50
Mar 16	A-7.5 m	11.49	2.74	0.38	1.17	1.04	1.54	36.61	0.55
Mar 16	B-0.5 m	2.46	5.93	0.38	0.91	1.42	0.60	155.7	na
Mar 16	B-2.5 m	2.87	2.95	0.27	0.91	1.21	0.66	167.6	na
Mar 16	B-7.5 m	3.09	2.38	0.36	0.73	1.18	0.55	159.0	na
Mar 17	20-01	3.01	0.08	0.57	1.04	0.12	7.55	13.54	0.48
Mar 17	20-02	10.99	0.73	0.74	0.04	0.14	2.06	25.84	0.14
Mar 17	20-03	0.30	6.82	0.14	7.60	24.9	na	101.8	na
Mar 17	20-04	0.08	0.82	0.10	0.56	13.4	na	65.96	na
Mar 17	20-05	0.02	36.4	0.10	4.08	na	na	2.03	na
Mar 17	20-06	0.00	na	0.08	0.86	19.45	na	0.48	39.5
Mar 17	20-07	242.1	na	0.71	0.97	0.87	na	1.53	13.0
Mar 17	20-08	253.3	na	0.48	1.10	1.13	5.79	25.17	0.50
Mar 17	20-09	1.15	na	0.08	12.0	1.90	na	0.98	21.4
Mar 17	20-10	20.37	1.01	0.76	0.97	0.30	na	35.12	0.78
Mar 17	1.0 m	9.16	1.02	0.36	1.65	0.94	0.19	23.79	1.01
Mar 17	2.5 m	9.15	1.69	0.34	2.05	0.95	0.70	20.32	1.48
Mar 17	5.0 m	9.75	1.05	0.33	16.9	1.04	0.43	21.34	0.80
Mar 17	7.5 m	10.55	1.42	0.33	17.9	1.17	1.20	22.84	0.57
Mar 20	1.0 m	8.95	0.39	0.36	2.91	0.85	0.70	23.09	0.80
Mar 20	2.5 m	8.42	0.53	0.31	2.15	0.93	0.77	21.48	1.02
Mar 20	5.0 m	9.24	1.17	0.28	1.43	1.01	na	21.38	0.37
Mar 20	7.5 m	10.78	1.53	0.30	2.93	1.21	0.41	24.66	0.47
Mar 22	0.0 m	19.85	0.91	0.80	0.84	0.52	0.07	37.20	0.60
Mar 24	T-24 15NO3	53.92	na	0.85	1.42	17.6	na	86.89	na
Mar 24	T-24 15NH4	na	na	1.10	1.18	19.36	na	87.65	na

H. Biological data: Particulate organic carbon and nitrogen, chlorophyll a, and pheopigments in a water column (Michel)

Date	Sample	Depth (m)	Volume (ml)	Carbon (mgC m <sup>-3</sup> )	Nitrogen (mgN m <sup>-3</sup> )	Volume (ml)	Chi a (mg m <sup>-3</sup> )	Pheo (mg m <sup>-3</sup> )
Feb 21	N1-1	1.0	1000	47.4	13.5	500	4.76	1.38
Feb 21	N1-2	2.5	1000	41.4	7.9	500	2.47	0.717
Feb 21	N1-2	2.5	1000	59.6	16.6	500	2.85	0.828
Feb 21	N1-3	5.0	na	na	na	500	1.12	0.324
Feb 21	N1-3	5.0	na	na	na	500	1.08	0.314
Feb 21	N1-4	7.5	na	na	na	500	0.827	0.240
Feb 26	N2-1	1.0	250	238	52.1	250	9.87	1.97
Feb 26	N2-1	1.0	250	missing		250	9.17	1.32
Feb 26	N2-2	2.5	250	missing		250	3.19	0.337
Feb 26	N2-2	2.5	250	missing		250	2.32	1.79
Feb 26	N2-3	5.0	250	109	19.1	250	0.369	0.247
Feb 26	N2-3	5.0	250	95.1	21.2	250	0.583	0.455
Feb 26	N2-4	7.5	350	76.2	15.4	350	0.575	0.387
Feb 26	N2-4	7.5	350	missing		350	0.575	0.307
Feb 29	N3-1	1.0	350	394	73.5	300	7.93	4.16
Feb 29	N3-1	1.0	350	340	73.4	missing		
Feb 29	N3-2	2.5	300	184	25.2	300	1.82	0.235
Feb 29	N3-2	2.5	300	167	20.3	300	1.78	0.420
Feb 29	N3-3	5.0	300	107	23.6	300	0.939	0.277
Feb 29	N3-3	5.0	300	81.8	17.3	300	0.870	0.350
Feb 29	N3-4	7.5	350	88.5	18.4	350	0.777	0.225
Feb 29	N3-4	7.5	350	127	27.5	350	0.879	0.251
Mar 03	N4-1	1.0	300	184	45.8	300	3.34	0.577
Mar 03	N4-1	1.0	300	missing		300	3.49	0.425
Mar 03	N4-2	2.5	300	141	46.1	300	3.11	0.266
Mar 03	N4-2	2.5	300	185	44.4	300	3.11	0.217
Mar 03	N4-3	5.0	300	169	23.4	300	1.34	0.295
Mar 03	N4-3	5.0	300	165	31.8	300	1.34	0.295
Mar 03	N4-4	7.5	300	118	21.9	300	0.920	0.225
Mar 03	N4-4	7.5	300	112	19.5	300	0.848	0.391
Mar 06	N5-1	1.0	300	347	72.6	300	9.95	1.77
Mar 06	N5-1	1.0	300	328	87.8	300	10.5	1.38
Mar 06	N5-2	2.5	300	236	46.9	300	2.05	0.537
Mar 06	N5-2	2.5	300	224	52.1	300	2.05	0.537
Mar 06	N5-3	5.0	350	168	28.8	350	2.64	0.387
Mar 06	N5-3	5.0	350	239	43.4	350	2.80	0.266
Mar 06	N5-4	7.5	350	160	46.7	350	1.46	0.299
Mar 06	N5-4	7.5	350	123	39.9	350	1.43	0.247

Mar 10	N6-1	1.0	500	89.7	30.1	300	1.06	0.294
Mar 10	N6-1	1.0	500	110	33.0	300	1.12	0.232
Mar 10	N6-2	2.5	500	114	28.9	350	0.935	0.267
Mar 10	N6-2	2.5	500	106	25.4	350	1.06	0.227
Mar 10	N6-3	5.0	1000	78.2	17.2	350	1.33	0.233
Mar 10	N6-3	5.0	750	89.0	26.2	350	1.21	0.238
Mar 10	N6-4	7.5	750	106	16.8	350	1.16	0.279
Mar 10	N6-4	7.5	750	104	18.0	350	1.06	0.372
Mar 13	N7-1	1.0	1000	186	36.0	300	1.94	0.562
Mar 13	N7-1	1.0	1000	189	37.9	300	1.97	0.524
Mar 13	N7-2	2.5	1000	198	47.2	300	4.25	0.548
Mar 13	N7-2	2.5	1000	186	37.9	300	3.87	0.682
Mar 13	N7-3	5.0	1000	92.7	23.4	300	0.870	0.341
Mar 13	N7-3	5.0	1000	92.1	23.8	300	0.870	0.341
Mar 13	N7-4	7.5	1000	91.3	25.3	300	0.664	0.222
Mar 13	N7-4	7.5	1000	missing		300	0.664	0.222
Mar 17	N8-1	1.0	1000	146	25.6	300	2.28	0.514
Mar 17	N8-1	1.0	1000	129	31.8	300	2.35	0.536
Mar 17	N8-2	2.5	750	151	25.0	300	1.58	0.384
Mar 17	N8-2	2.5	750	137	24.5	300	1.48	0.340
Mar 17	N8-3	5.0	750	110	20.5	300	2.32	0.280
Mar 17	N8-3	5.0	750	116	28.7	300	2.32	0.280
Mar 17	N8-4	7.5	750	76.1	19.3	300	0.933	0.226
Mar 17	N8-4	7.5	750	75.0	10.4	300	0.882	0.226
Mar 20	N9-1	1.0	500	224	47.1	300	7.57	1.45
Mar 20	N9-1	1.0	500	223	54.2	300	7.64	1.29
Mar 20	N9-2	2.5	500	262	69.2	300	2.54	0.0030
Mar 20	N9-2	2.5	500	251	51.7	300	2.51	0.188
Mar 20	N9-3	5.0	500	219	51.2	300	8.22	0.0
Mar 20	N9-3	5.0	500	197	44.6	300	7.64	0.0
Mar 20	N9-4	7.5	750	91.4	18.0	300	1.67	0.337
Mar 20	N9-4	7.5	750	99.0	23.8	300	1.74	0.239

H. Biological data: sediment traps. P and T series present the results of size fractionation. H, and V series present the results of experiments with preservative. Series T1-T8 from 1 to 3 was used to follow the seasonal change of pigments.  
(Michel)

Date	Sample	Depth (m)	Volume (ml)	Carbon (mgC m <sup>-3</sup> )	Nitrogen (mgN m <sup>-3</sup> )	Volume (ml)	Chl a (mg m <sup>-3</sup> )	Pheo (mg m <sup>-3</sup> )
Feb 02	T1-1	0.5	388	366	63.9	388	5.02	3.18
Feb 02	T1-1	0.5	388	366	64.9	388	5.46	2.30
Feb 02	T1-2	2.5	388	326	59.0	388	2.64	0.0088
Feb 02	T1-2	2.5	388	312	51.0	388	2.11	1.14
Feb 02	T1-3	7.5	410	403	63.5	410	4.75	3.42
Feb 02	T1-3	7.5	200	418	59.2	410	4.43	3.60
Mar 02	T2-1	0.5	203	284	48.9	406	4.79	1.78
Mar 02	T2-1	0.5	203	795	129	203	5.80	2.46
Mar 02	T2-2	2.5	195	742	137	195	5.05	1.38
Mar 02	T2-2	2.5	195	542	86.5	195	4.56	2.23
Mar 02	T2-3	7.5	197	481	81.0	197	7.16	6.74
Mar 02	T2-3	7.5	197	606	105	197	6.94	4.40
Mar 02	T2-4	0.5	203	835	157	203	4.38	2.14
Mar 02	T2-4	0.5	203	1092	162	203	4.72	1.54
Mar 02	T2-5	2.5	195	976	195	195	5.83	2.14
Mar 02	T2-5	2.5	195	772	143	195	6.46	1.24
Mar 02	T2-6	7.5	195	712	127	195	4.35	2.98
Mar 02	T2-6	7.5	195	765	139	195	4.56	2.68
Mar 05	T3-1	0.5	206	441	83.6	206	7.08	2.20
Mar 05	T3-1	0.5	206	501	70.2	206	6.36	2.06
Mar 05	T3-2	2.5	203	420	72.1	203	6.62	2.35
Mar 05	T3-2	2.5	203	374	64.9	203	6.79	3.13
Mar 05	T3-3	7.5	206	324	56.8	206	5.09	2.76
Mar 05	T3-3	7.5	206	326	49.5	206	4.48	3.72
Mar 05	T3-4	0.5	203	656	104	203	2.70	1.48
Mar 05	T3-4	0.5	203	783	134	203	2.80	1.33
Mar 05	T3-5	2.5	206	486	67.5	206	5.09	2.76
Mar 05	T3-5	2.5	206	575	73.4	206	5.25	2.31
Mar 05	T3-6	7.5	206	431	83.5	206	5.47	3.51
Mar 05	T3-6	7.5	206	511	85.2	206	6.14	3.78
Mar 09	T4-1	0.5	412	426	81.8	206	7.41	1.72
Mar 09	T4-1	0.5	412	434	84.7	206	7.74	1.39
Mar 09	T4-2	2.5	406	408	75.9	203	7.07	1.76
Mar 09	T4-2	2.5	406	380	65.3	203	6.96	2.09
Mar 09	T4-2	2.5	406	424	78.6			
Mar 09	T4-3	7.5	418	510	101	209	6.00	6.10
Mar 09	T4-3	7.5	418	506	101	209	6.54	4.15
Mar 09	T4-4	0.5	412	447	69.2	206	5.53	2.25
Mar 09	T4-4	0.5	412	missing		206	5.56	2.22
Mar 09	T4-5	2.5	412	561	105	206	6.58	2.84

Mar 09	T4-5	2.5	412	427	83.7	206	6.69	3.87
Mar 09	T4-6	7.5	412	482	80.6	206	5.53	4.60
Mar 09	T4-6	7.5	412	504	81.8	206	5.67	4.18
Mar 12	T5-1	0.5	425	371	61.6	212.5	4.45	2.54
Mar 12	T5-1	0.5	425	missing		212.5	4.61	2.31
Mar 12	T5-2	2.5	418	398	72.7	209	4.03	2.65
Mar 12	T5-2	2.5	418	385	56.2	209	4.47	1.86
Mar 12	T5-3	7.5	418	325	58.1	209	4.77	3.63
Mar 12	T5-3	7.5	418	341	69.3	209	4.93	2.91
Mar 12	T5-4	0.5	412	396	64.2	206	3.10	2.32
Mar 12	T5-4	0.5	412	364	71.3	206	2.99	2.44
Mar 12	T5-5	2.5	418	321	54.8	209	3.54	2.22
Mar 12	T5-5	2.5	418	missing		209	3.27	2.21
Mar 12	T5-6	7.5	418	358	62.1	209	4.20	3.40
Mar 12	T5-6	7.5	418	361	59.1	209	4.03	3.35
Mar 16	T6-1	0.5	418	429	90.0	209	6.05	2.25
Mar 16	T6-1	0.5	418	442	88.1	209	6.00	3.00
Mar 16	T6-2	2.5	418	383	78.5	209	4.85	1.69
Mar 16	T6-2	2.5	418	476	92.0	209	4.96	2.35
Mar 16	T6-3	7.5	418	345	65.5	209	4.63	3.95
Mar 16	T6-3	7.5	418	351	62.7	209	4.58	3.51
Mar 16	T6-4	0.5	418	389	67.2	209	4.25	4.33
Mar 16	T6-4	0.5	418	440	78.9	209	4.09	3.93
Mar 16	T6-5	2.5	418	352	58.8	209	3.32	3.92
Mar 16	T6-5	2.5	418	278	48.8	209	3.27	2.50
Mar 16	T6-6	7.5	418	341	59.6	209	3.38	2.74
Mar 16	T6-6	7.5	418	309	49.6	209	2.83	1.95
Mar 19	T7-1	0.5	418	645	124	missing		
Mar 19	T7-1	0.5	418	614	118	missing		
Mar 19	T7-2	2.5	418	423	74.2	209	14.2	2.70
Mar 19	T7-2	2.5	418	424	78.6	209	13.1	2.74
Mar 19	T7-3	7.5	416	364	59.9	209	7.63	2.35
Mar 19	T7-3	7.5	416	351	55.4	209	7.85	2.28
Mar 19	T7-4	0.5	416	474	88.7	209	11.7	1.99
Mar 19	T7-4	0.5	416	496	97.3	209	11.0	1.51
Mar 19	T7-5	2.5	416	457	85.0	209	12.0	2.41
Mar 19	T7-5	2.5	416	448	82.5	209	12.7	2.36
Mar 19	T7-6	7.5	416	297	42.6	209	6.38	1.78
Mar 19	T7-6	7.5	416	287	47.6	209	6.70	1.66
Mar 23	T8-1	0.5	103	1241	243	103	38.6	0.370
Mar 23	T8-1	0.5	103	1146	214	103	39.1	0.0
Mar 23	T8-2	2.5	209	1088	216	104.5	46.4	1.70
Mar 23	T8-2	2.5	209	1085	206	104.5	47.2	1.40
Mar 23	T8-3	7.5	209	663	118	104.5	16.0	2.96
Mar 23	T8-3	7.5	209	730	139	104.5	16.9	4.20

Mar 23	T8-4	0.5	206	822	156	103	24.8	2.31
Mar 23	T8-4	0.5	206	835	161	103	24.4	1.65
Mar 23	T8-5	2.5	206	881	166	103	22.7	2.24
Mar 23	T8-5	2.5	206	missing		103	24.4	2.19
Mar 23	T8-6	7.5	209	508	88.2	104.5	20.3	5.35
Mar 23	T8-6	7.5	209	685	120	104.5	20.5	4.87
Mar 04	P1N	2.5	217	428	58.0	missing		
Mar 04	P1A	2.5	217	833	56.0	missing		

I. Biological data: Vertical profiles of fluorescence determined on March 21 and 22, 1992. (Therriault)

Depth Temperature Salinity Sigma-t Fluorescence Transmissivity  
(m) (°C) (ppt) (%)

FILENAME: JAP01L.DAT  
DATE: 1992-03-20  
TIME: 23:28:56

DEPTH	TEMP	SAL	SIGMA T	FLUO	TRANSMIS
1.19	-0.92	31.53	25.34	54.82	53.21
1.27	-0.88	31.55	25.35	61.18	53.28
1.37	-0.85	31.57	25.37	57.81	53.88
1.43	-0.85	31.60	25.39	49.91	54.39
1.56	-0.84	31.64	25.42	40.96	54.81
1.64	-0.84	31.67	25.45	36.40	55.05
1.72	-0.85	31.72	25.49	35.06	55.09
1.80	-0.86	31.79	25.55	34.73	55.04
1.87	-0.86	31.83	25.58	36.59	54.84
1.90	-0.86	31.83	25.58	37.32	54.60
2.06	-0.86	31.86	25.60	40.11	54.22
2.19	-0.86	31.91	25.65	44.08	53.63
2.27	-0.85	31.95	25.67	45.93	52.88
2.40	-0.84	31.95	25.67	56.01	52.18
2.48	-0.83	31.96	25.68	67.33	51.84
2.56	-0.83	31.97	25.69	69.87	51.70
2.64	-0.83	31.97	25.69	69.15	51.46
2.79	-0.83	31.96	25.69	62.78	51.15
2.90	-0.83	31.97	25.70	59.38	51.02
2.93	-0.83	31.97	25.70	64.17	51.09
3.11	-0.85	31.98	25.70	64.36	51.13
3.24	-0.87	32.00	25.71	61.16	51.11
3.29	-0.87	32.00	25.72	59.70	51.08
3.43	-0.88	32.01	25.73	57.71	51.06
3.45	-0.87	32.01	25.73	61.59	51.12
3.61	-0.88	32.01	25.73	67.93	51.20
3.64	-0.88	32.03	25.74	65.22	51.30
3.74	-0.89	32.04	25.75	57.56	51.41
3.79	-0.89	32.05	25.76	54.73	51.44
3.95	-0.90	32.04	25.75	55.14	51.52
3.98	-0.90	32.03	25.74	54.77	51.68
4.14	-0.91	32.03	25.74	53.72	51.76
4.27	-0.91	32.03	25.74	53.99	51.74
4.32	-0.91	32.04	25.75	57.72	51.75
4.45	-0.91	32.05	25.76	56.54	51.90
4.61	-0.92	32.06	25.77	52.49	52.04
4.69	-0.93	32.06	25.77	51.31	52.09
4.79	-0.93	32.05	25.76	48.49	52.24
4.87	-0.93	32.06	25.76	48.80	52.39
4.98	-0.93	32.07	25.77	51.23	52.48
5.11	-0.93	32.07	25.78	50.70	52.55
5.16	-0.94	32.07	25.78	49.81	52.56
5.35	-0.94	32.07	25.78	48.14	52.64
5.37	-0.94	32.07	25.78	47.18	52.77
5.40	-0.95	32.06	25.77	47.09	52.87
5.56	-0.96	32.05	25.77	43.74	53.01
5.61	-0.96	32.07	25.78	40.24	53.23
5.72	-0.97	32.08	25.78	42.16	53.46
5.77	-0.97	32.08	25.78	44.53	53.62
5.79	-0.97	32.07	25.78	44.04	53.78

FILENAME: JAP01L.DAT  
 DATE: 1992-03-20  
 TIME: 23:28:56

DEPTH	TEMP	SAL	SIGMA T	FLUO	TRANSMIS
5.93	-0.98	32.07	25.78	42.37	53.99
5.95	-0.98	32.08	25.79	38.75	54.19
6.11	-0.99	32.09	25.80	35.27	54.39
6.29	-1.00	32.09	25.80	34.83	54.58
6.32	-1.01	32.08	25.79	37.25	54.81
6.45	-1.03	32.07	25.78	38.53	55.23
6.61	-1.05	32.09	25.79	38.42	55.61
6.69	-1.06	32.10	25.80	35.94	55.70
6.85	-1.06	32.08	25.80	31.95	55.77
7.03	-1.06	32.08	25.79	31.13	55.87
7.14	-1.06	32.07	25.78	32.36	55.95
7.27	-1.07	32.07	25.78	35.31	56.02
7.29	-1.08	32.09	25.80	36.45	56.04
7.43	-1.09	32.10	25.81	32.58	56.02
7.50	-1.10	32.11	25.81	30.66	56.01
7.66	-1.11	32.11	25.82	32.12	56.08
7.77	-1.11	32.11	25.82	31.02	56.18
7.79	-1.12	32.11	25.82	28.84	56.13
7.82	-1.13	32.12	25.82	29.02	56.04
7.95	-1.13	32.13	25.83	30.24	56.00
8.00	-1.12	32.13	25.83	30.34	56.00
8.14	-1.10	32.12	25.82	29.79	56.01
8.29	-1.08	32.12	25.82	29.31	56.00
8.40	-1.07	32.12	25.82	28.03	55.93
8.50	-1.06	32.12	25.82	26.94	55.79
8.56	-1.05	32.13	25.83	26.55	55.65
8.69	-1.05	32.12	25.82	26.67	55.57
8.82	-1.05	32.13	25.83	27.63	55.50
8.98	-1.04	32.13	25.83	27.70	55.40
9.16	-1.04	32.13	25.83	26.38	55.28
9.27	-1.04	32.14	25.83	26.23	55.21
9.32	-1.03	32.13	25.82	26.65	55.19
9.48	-1.02	32.11	25.81	26.28	55.16
9.66	-1.01	32.11	25.81	25.92	55.04
9.77	-1.00	32.13	25.83	25.21	54.95
9.93	-1.00	32.12	25.82	25.29	54.89
10.06	-1.00	32.11	25.82	25.92	54.81
10.14	-1.00	32.11	25.81	25.81	54.78

FILENAME: JAP02L.DAT  
 DATE: 1992-03-20  
 TIME: 23:56:56

DEPTH	TEMP	SAL	SIGMA T	FLUO	TRANSMIS
1.27	-0.84	31.59	25.38	37.55	53.13
1.37	-0.82	31.57	25.36	35.78	53.37
1.43	-0.82	31.60	25.39	37.08	53.76
1.61	-0.83	31.71	25.48	38.49	54.06
1.64	-0.85	31.83	25.58	37.55	53.83
1.74	-0.86	31.88	25.62	35.51	53.42
2.01	-0.85	31.92	25.65	33.57	52.73
2.27	-0.84	31.95	25.68	33.14	51.61
2.40	-0.84	31.96	25.68	33.15	50.80
2.51	-0.82	31.97	25.69	36.53	50.37
2.77	-0.82	31.98	25.70	42.94	50.15
2.79	-0.83	31.98	25.70	46.22	50.18
3.06	-0.85	31.98	25.70	48.39	50.34
3.19	-0.86	31.99	25.71	51.58	50.47
3.40	-0.87	32.00	25.72	55.12	50.47
3.51	-0.87	32.02	25.74	57.50	50.42
3.66	-0.88	32.02	25.74	56.18	50.53
3.69	-0.88	32.02	25.73	56.37	50.69
3.87	-0.88	32.02	25.74	55.89	50.78
4.22	-0.89	32.03	25.75	49.63	50.90
4.32	-0.90	32.04	25.75	44.96	51.02
4.45	-0.91	32.04	25.75	43.97	51.13
4.58	-0.92	32.05	25.76	46.77	51.19
4.79	-0.92	32.05	25.76	51.54	51.27
4.93	-0.93	32.05	25.75	53.50	51.30
5.03	-0.94	32.07	25.77	50.22	51.36
5.11	-0.94	32.07	25.77	48.92	51.60
5.40	-0.94	32.06	25.77	52.50	51.80
5.50	-0.95	32.07	25.78	51.06	52.05
5.53	-0.96	32.07	25.78	44.87	52.42
5.69	-0.97	32.06	25.77	43.02	52.74
5.95	-0.98	32.07	25.78	46.27	53.02
5.98	-0.98	32.08	25.78	45.93	53.33
6.35	-1.00	32.07	25.78	42.27	53.76
6.77	-1.03	32.06	25.78	37.52	54.31
7.16	-1.06	32.08	25.79	33.85	54.69
7.27	-1.07	32.09	25.80	32.11	54.84
7.32	-1.08	32.09	25.80	31.38	55.01
7.64	-1.09	32.09	25.80	32.56	55.08
7.79	-1.10	32.10	25.81	32.41	55.01
8.00	-1.10	32.12	25.82	32.37	54.91
8.19	-1.10	32.14	25.84	31.10	54.80
8.32	-1.09	32.15	25.84	27.31	54.78
8.64	-1.08	32.13	25.84	27.04	54.71
8.66	-1.07	32.14	25.84	28.95	54.53
8.69	-1.05	32.15	25.84	27.76	54.46
8.98	-1.04	32.15	25.84	26.07	54.34
9.14	-1.04	32.15	25.84	26.43	54.18
9.16	-1.03	32.14	25.84	27.30	54.22
9.43	-1.03	32.12	25.83	27.08	54.25

FILENAME: JAP02L.DAT  
DATE: 1992-03-20  
TIME: 23:56:56

DEPTH	TEMP	SAL	SIGMA T	FLUO	TRANSMIS
9.53	-1.02	32.13	25.83	26.32	54.16
9.66	-1.02	32.13	25.83	26.22	54.06
9.93	-1.01	32.13	25.82	25.85	53.94
10.06	-1.00	32.13	25.83	25.18	53.80
10.35	-1.00	32.13	25.83	25.31	53.69
10.48	-1.00	32.12	25.82	25.97	53.57
10.50	-1.00	32.13	25.83	26.07	53.45

FILENAME: JAP04L.DAT  
 DATE: 1992-03-21  
 TIME: 16:06:43

DEPTH	TEMP	SAL	SIGMA T	FLUO	TRANSMIS
1.01	-0.88	31.53	25.34	100.00	33.50
1.35	-0.86	31.70	25.47	85.40	36.32
1.66	-0.85	31.82	25.57	56.61	37.46
1.69	-0.85	31.88	25.62	38.47	37.32
2.03	-0.84	31.89	25.63	31.78	36.87
2.14	-0.84	31.90	25.64	28.99	36.62
2.45	-0.85	31.92	25.65	28.16	36.50
2.53	-0.86	31.95	25.67	33.91	36.57
2.98	-0.87	31.98	25.70	42.25	36.90
3.01	-0.88	32.00	25.72	40.43	37.41
3.43	-0.88	31.99	25.71	36.56	38.01
3.48	-0.89	32.00	25.72	37.63	38.42
3.87	-0.90	32.00	25.72	40.79	38.78
3.98	-0.90	32.01	25.73	37.68	39.17
4.43	-0.91	32.02	25.74	31.14	39.50
4.48	-0.92	32.03	25.74	36.48	39.88
4.93	-0.93	32.03	25.74	43.13	40.37
4.95	-0.93	32.03	25.74	39.60	40.92
5.43	-0.94	32.03	25.74	36.20	41.50
5.48	-0.96	32.05	25.76	36.02	42.06
5.53	-0.98	32.06	25.77	37.79	42.59
6.06	-0.99	32.05	25.76	35.23	43.10
6.61	-1.00	32.04	25.76	24.44	43.72
7.03	-1.03	32.05	25.76	16.95	44.28
7.16	-1.06	32.07	25.78	14.97	44.61
7.58	-1.07	32.10	25.81	13.96	44.88
7.74	-1.07	32.12	25.82	13.88	45.09
7.98	-1.06	32.12	25.82	12.71	45.31
8.24	-1.04	32.11	25.81	10.71	45.42
8.82	-1.04	32.11	25.81	8.99	45.39
8.95	-1.03	32.12	25.82	7.75	45.37
9.40	-1.03	32.11	25.81	7.47	45.39
9.48	-1.02	32.11	25.81	8.43	45.45
10.00	-1.02	32.12	25.82	8.69	45.52
10.06	-1.02	32.12	25.82	6.64	45.56

FILENAME: JAP05L.DAT  
 DATE: 1992-03-21  
 TIME: 16:20:00

DEPTH	TEMP	SAL	SIGMA T	FLUO	TRANSMIS
1.06	-0.83	31.60	25.39	100.00	52.90
1.24	-0.84	31.68	25.46	100.00	53.39
1.30	-0.85	31.76	25.52	89.20	52.77
1.80	-0.84	31.85	25.60	58.47	50.77
2.19	-0.84	31.91	25.65	30.66	49.18
2.22	-0.85	31.93	25.66	25.14	48.56
2.64	-0.86	31.95	25.68	29.17	48.09
2.72	-0.87	31.97	25.69	29.36	48.03
3.06	-0.87	31.99	25.71	32.17	48.41
3.16	-0.86	31.99	25.71	43.99	48.82
3.48	-0.86	31.98	25.70	51.37	49.16
3.53	-0.87	31.99	25.71	50.54	49.39
3.93	-0.89	32.00	25.72	54.98	49.66
4.32	-0.91	32.01	25.73	56.70	49.85
4.40	-0.91	32.02	25.74	53.65	49.96
4.74	-0.92	32.03	25.74	51.58	50.19
4.85	-0.92	32.02	25.74	40.80	50.43
5.22	-0.92	32.02	25.74	30.63	50.73
5.27	-0.93	32.02	25.74	26.26	51.16
5.64	-0.94	32.02	25.74	30.47	51.69
5.69	-0.96	32.03	25.75	39.97	52.03
5.72	-0.97	32.04	25.76	39.03	52.22
6.08	-0.98	32.05	25.76	34.59	52.48
6.19	-0.99	32.05	25.76	34.44	52.79
6.61	-1.01	32.05	25.76	37.06	53.20
7.06	-1.04	32.06	25.77	36.99	53.52
7.08	-1.06	32.07	25.78	28.70	53.67
7.48	-1.07	32.08	25.79	18.34	53.78
7.53	-1.08	32.09	25.80	15.95	53.86
7.64	-1.08	32.10	25.81	18.61	53.96
8.06	-1.08	32.11	25.81	17.35	53.98
8.48	-1.06	32.11	25.81	13.98	53.84
8.85	-1.05	32.12	25.82	11.09	53.67
8.95	-1.04	32.13	25.83	9.23	53.52
9.29	-1.03	32.13	25.83	8.74	53.40
9.35	-1.02	32.12	25.82	8.55	53.30
9.58	-1.02	32.12	25.82	8.46	53.24
9.79	-1.01	32.11	25.82	6.84	53.16
10.27	-1.01	32.11	25.81	5.38	53.03
10.37	-1.01	32.12	25.82	5.60	52.96

FILENAME: JAP06L.DAT  
 DATE: 1992-03-21  
 TIME: 21:09:02

DEPTH	TEMP	SAL	SIGMA T	FLUO	TRANSMIS
1.37	-0.89	31.87	25.61	100.00	49.06
1.43	-0.89	31.89	25.64	81.05	49.69
1.87	-0.89	31.94	25.67	45.83	48.82
1.95	-0.89	31.97	25.70	26.80	47.74
2.35	-0.89	31.98	25.70	21.37	47.29
2.37	-0.88	31.98	25.70	21.48	47.06
2.69	-0.88	31.98	25.71	27.57	46.77
2.82	-0.88	31.99	25.72	32.73	46.65
2.93	-0.87	32.02	25.73	42.40	46.74
3.29	-0.86	32.02	25.73	52.89	46.99
3.74	-0.85	32.01	25.73	55.01	47.38
3.82	-0.85	32.01	25.73	48.01	47.72
4.22	-0.86	32.01	25.73	43.55	48.04
4.24	-0.87	32.02	25.73	45.46	48.36
4.61	-0.88	32.03	25.74	42.93	48.58
4.72	-0.89	32.03	25.75	40.47	48.76
4.77	-0.90	32.04	25.75	43.61	48.95
5.14	-0.90	32.04	25.76	44.13	49.19
5.61	-0.91	32.05	25.76	42.04	49.44
5.69	-0.91	32.06	25.77	42.41	49.65
6.08	-0.91	32.07	25.77	43.54	49.91
6.14	-0.91	32.05	25.76	44.34	50.34
6.58	-0.92	32.02	25.73	36.52	50.90
6.69	-0.93	32.00	25.72	24.21	51.36
7.00	-0.95	32.01	25.72	20.94	51.73
7.08	-0.99	32.03	25.74	25.42	52.00
7.50	-1.02	32.05	25.76	30.62	52.13
7.53	-1.04	32.07	25.78	27.64	52.26
7.98	-1.04	32.09	25.79	19.61	52.42
8.06	-1.04	32.10	25.80	15.43	52.53
8.21	-1.03	32.12	25.82	13.19	52.60
8.58	-1.02	32.12	25.82	10.48	52.67
9.06	-1.00	32.11	25.81	9.11	52.73
9.45	-0.99	32.10	25.81	9.89	52.64
9.53	-0.99	32.11	25.81	11.96	52.41
9.87	-0.99	32.12	25.82	13.13	52.16

## J. Biological data: Zooplankton abundance (Hattori)

Date	Time Duration	Depth (m)	Species	Abundance (Individuals m <sup>-3</sup> )
Feb 25	1840-1850	0	Mysidacea	0.129
			Copepoda	268
			Total	268
	1855-1905	1	Hydromedusae	0.129
			Mysidacea	0.129
			Copepoda	137
			Total	137
	1909-1919	3	Hydromedusae	0.387
			Chaetognatha	0.129
			Mysidacea	0.258
			Cumacea	0.129
			Copepoda	85.9
			Total	87.0
	1924-1934	6	Hydromedusae	0.903
			Chaetognatha	0.129
			Mysidacea	0.129
			Copepoda	104
			Total	106
1937-1947	9	Hydromedusae	0.645	
		Chaetognatha	0.129	
		Mysidacea	0.129	
		Amphipoda	0.129	
		Copepoda	36.9	
		Total	38.5	
Feb 25	2235-2245	0	Hydromedusae	1.03
			Mysidacea	0.903
			Copepoda	76.5
			Total	78.5
Feb 25	2252-2302	1	Hydromedusae	0.516
			Copepoda	51.5
			Total	52.7
Feb 25	2307-2317	3	Hydromedusae	0.645
			Copepoda	51.5
			Total	52.7
Feb 25	2323-2333	6	Hydromedusae	1.16
			Mysidacea	0.387
			Cumacea	0.258
			Copepoda	211
			Total	214

Feb 26	0232-0242	0	Hydromedusae	0.516
			Mysidacea	2.58
			Copepoda	112
			Total	115
Feb 26	0245-0255	1	Hydromedusae	0.258
			Mysidacea	1.29
			Copepoda	61.8
			Total	63.4
Feb 26	0300-0310	3	Hydromedusae	0.774
			Mysidacea	0.516
			Copepoda	100
			Total	102
Feb 26	0312-0322	6	Hydromedusae	2.45
			Mysidae	0.387
			Copepoda	56.5
			Total	59.7
Feb 26	0327-0337	9	Hydromedusae	1.16
			Mysidacea	0.387
			Copepoda	242
			Total	244
Feb 26	0655-0705	0	Hydromedusae	1.16
			Mysidacea	0.258
			Copepoda	33.0
			Total	34.5
Feb 26	0708-0718	1	Hydromedusae	0.387
			Mysidacea	0.129
			Copepoda	9.29
			Total	9.87
Feb 26	0723-0733	3	Hydromedusae	0.258
			Copepoda	21.4
			Total	21.8
Feb 26	0736-0746	6	Hydromedusae	0.903
			Chaetognatha	0.129
			Copepoda	70.6
			Total	72.0
Feb 26	0752-0802	9	Hydromedusae	1.68
			Chaetognatha	0.129
			Copepoda	404
			Total	406
Feb 26	1133-1143	0	Hydromedusae	0.387
			Copepoda	24.0
			Total	24.4
Feb 26	1146-1156	1	Hydromedusae	0.258
			Copepoda	14.5
			Total	14.8

Feb 26	1200-1210	3	Hydromedusae	0.516
			Copepoda	30.8
			Total	31.5
Feb 26	1213-1223	6	Hydromedusae	1.03
			Copepoda	121
			Total	123
Feb 26	1227-1237	9	Hydromedusae	0.774
			Chaetognatha	0.129
			Copepoda	390
			Total	391
Feb 26	1537-1547	0	Hydromedusae	0.129
			Copepoda	38.1
			Total	38.3
Feb 26	1551-1601	1	Copepoda	7.87
			Total	7.87
Feb 26	1605-1615	3	Hydromedusae	0.258
			Copepoda	38.3
			Total	38.8
Feb 26	1619-1629	6	Hydromedusae	0.516
			Copepoda	216
			Total	217
Feb 26	1632-1642	9	Hydromedusae	2.32
			Copepoda	321
			Total	324
Feb 26	2020-2030	0	Hydromedusae	0.129
			Mysidacea	1.68
			Copepoda	385
			Total	387
Feb 26	2035-2039	1	Hydromedusae	0.806
			Mysidacea	2.42
			Copepoda	445
			Total	449
Feb 26	2100-2110	3	Hydromedusae	0.903
			Mysidacea	0.129
			Amphipoda	0.129
			Copepoda	77.4
			Total	78.8
Feb 26	2114-2124	6	Hydromedusae	1.16
			Mysidacea	0.129
			Copepoda	174
			Total	176

Feb 26	2134-2144	9	Hydromedusae	0.516
			Mysidacea	0.129
			Copepoda	103
			Total	105
Mar 23	1445-1455	0	Hydromedusae	6.45
			Copepoda	1.42
			Total	7.87
Mar 23	1458-1508	1	Hydromedusae	7.36
			Copepoda	3.74
			Total	11.1
Mar 23	1511-1521	3	Hydromedusae	6.71
			Copepoda	21.0
			Total	27.7
Mar 23	1525-1525	6	Hydromedusae	13.3
			Copepoda	68.1
			Total	81.4
Mar 23	1537-1547	9	Hydromedusae	5.81
			Copepoda	80.0
			Total	85.8
Mar 23	1706-1716	0	Hydromedusae	8.90
			Copepoda	4.00
			Total	12.9
Mar 23	1719-1729	1	Hydromedusae	6.07
			Cirripedia	0.129
			Copepoda	5.94
			Total	12.1
Mar 23	1734-1744	3	Hydromedusae	12.3
			Copepoda	36.6
			Total	48.9
Mar 23	1747-1757	6	Hydromedusae	1.03
			Copepoda	14.2
			Total	15.2
Mar 23	1800-1810	9	Hydromedusae	3.74
			Mysidacea	0.129
			Cumacea	0.258
			Copepoda	39.6
			Total	43.7
Mar 23	2042-2052	0	Hydromedusae	11.5
			Mysidacea	1.29
			Copepoda	128
			Total	141

Mar 23	2055-2105	1	Hydromedusae	3.48
			Mysidacea	1.29
			Copepoda	93.7
			Total	98.5
Mar 23	2108-2118	3	Hydromedusae	7.87
			Polychaeta	0.516
			Mysidacea	0.129
			Amphipoda	0.129
			Copepoda	105
			Total	114
Mar 23	2122-2132	6	Hydromedusae	11.2
			Polychaeta	0.129
			Mysidacea	0.129
			Cumacea	0.258
			Copepoda	47.0
			Total	58.7
Mar 23	2133-3143	9	Hydromedusae	2.97
			Mysidacea	0.258
			Cumacea	0.129
			Copepoda	10.8
			Total	14.2
Mar 24	0105-0115	0	Hydromedusae	6.07
			Copepoda	99.2
			Fish larvae	0.129
			Total	105
Mar 24	0118-0128	1	Hydromedusae	4.52
			Mysidacea	0.387
			Cumacea	0.258
			Copepoda	97.5
			Total	103
Mar 24	0132-0142	3	Hydromedusae	13.0
			Mysidacea	0.129
			Cumacea	0.258
			Copepoda	236
			Total	249
Mar 24	0145-0155	6	Hydromedusae	10.3
			Mysidacea	0.129
			Amphipoda	0.129
			Copepoda	46.6
			Total	57.2
Mar 24	0157-0207	9	Hydromedusae	1.42
			Mysidacea	0.645
			Cumacea	0.129
			Copepoda	10.1
			Total	12.3

Mar 24	0449-0459	0	Hydromedusae	8.13
			Cladocera	0.258
			Crripedia	0.129
			Copepoda	26.2
			Total	34.7
Mar 24	0500-0510	1	Hydromedusae	4.39
			Polychaeta	0.129
			Crripedia	0.258
			Mysidacea	0.129
			Copepoda	40.6
			Total	45.5
Mar 24	0513-0523	3	Hydromedusae	8.65
			Crripedia	0.258
			Copepoda	172
			Total	181
Mar 24	0526-0536	6	Hydromedusae	13.5
			Copepoda	174
			Total	188
Mar 24	0539-0549	9	Hydromedusae	2.07
			Mysidacea	0.129
			Copepoda	227
			Total	230
Mar 24	0931-0941	0	Hydromedusae	4.65
			Copepoda	8.52
			Total	13.2
Mar 24	0943-0953	1	No data	
Mar 24	0957-1007	3	Hydromedusae	6.58
			Copepoda	40.4
			Total	47.0
Mar 24	1010-1020	6	Hydromedusae	12.3
			Crripedia	0.516
			Copepoda	139
			Total	152
Mar 24	1023-1033	9	Hydromedusae	1.42
			Crripedia	0.258
			Copepoda	131
			Total	132
Mar 24	1343-1353	0	Hydromedusae	5.81
			Cladocera	0.129
			Copepoda	6.58
			Total	12.5
Mar 24	1355-1405	1	Hydromedusae	1.81
			Copepoda	4.52
			Total	6.32
Mar 24	1408-1418	3	Hydromedusae	5.94
			Copepoda	95.7
			Total	102
Mar 24	1421-1431	6	Hydromedusae	11.2
			Copepoda	211
			Total	222
Mar 24	1434-1444	9	Hydromedusae	2.71
			Copepoda	59.9
			Total	62.6

J. Biological data: Abundance of Neocalanusplumchrus (Hattori)

Date	Time Duration	Depth (m)	Stage and Abundance (Individuals m <sup>-3</sup> )			
			CV	CIV	CIII	CII
Feb 25	1840-1850	0	0	0.387	0.774	0
	1855-1905	1	0	0	0	0
	1909-1919	3	0	0	0.258	0
	1924-1934	6	0	0	0	0
	1937-1947	9	0	0	0	0
Feb 25	2235-2245	0	0	0	0	0
	2252-2302	1	0	0	0	0
	2307-2317	3	0	0	0	0
	2323-2333	6	0	0.129	0.516	0
	2339-1349	9	0	0	0.258	0
Feb 26	0232-0242	0	0	0.258	0.387	0
	0245-0255	1	0	0	0	0
	0300-0310	3	0	0.129	0.129	0
	0312-0322	6	0	0.258	0.129	0
	0327-0337	9	0	0.258	0.129	0
Feb 26	0655-0705	0	0	0	0	0
	0708-0718	1	0	0	0	0.258
	0723-0733	3	0	0.258	0	0
	0736-0746	6	0	0	0.129	0
	0752-0802	9	0	0	0	0
Feb 26	1133-1143	0	0	0	0	0
	1146-1156	1	0	0	0	0
	1200-1210	3	0	0	0	0
	1213-1223	6	0	0	0.387	0.258
	1227-1237	9	0	0	0.516	0
Feb 26	1537-1547	0	0	0	0	0
	1551-1601	1	0	0	0	0
	1605-1615	3	0	0	0	0
	1619-1629	6	0	0	0.387	0.129
	1632-1642	9	0	0.387	0.258	0.387
Feb 26	2020-2030	0	0	0.903	0.387	0.387
	2035-2039	1	0	0.806	0	1.613
	2100-2110	3	0	0	0	0
	2114-2124	6	0	0.129	0	0.258
	2134-2144	9	0	0	0	0
Mar 23	1445-1455	0	0	0	0	0
	1458-1508	1	0	0	0	0
	1511-1521	3	0	0	0	0
	1525-1535	6	0	0	0	0
	1537-1547	9	0	0	0.258	0

Mar 23	1706-1716	0	0	0	0	0
	1719-1729	1	0	0	0	0
	1734-1744	3	0	0	0	0
	1747-1757	6	0.129	0	0	0
	1800-1810	9	0	0	0.129	0
Mar 23	2042-2052	0	0	0	0.258	0
	2055-2105	1	0	0	0.258	0
	2108-2118	3	0	0.129	0.129	0
	2122-2132	6	0	0	0.258	0
	2133-3143	9	0	0	0	0
Mar 24	0105-0115	0	0	0	0	0
	0118-0128	1	0	0.129	0	0
	0132-0142	3	0	0.129	0	0
	0145-0155	6	0	0	0	0.129
	0157-0207	9	0	0	0	0
Mar 24	0449-0459	0	0	0.129	0	0
	0500-0510	1	0	0	0	0
	0513-0523	3	0	0.129	0.387	0.129
	0526-0536	6	0	0.129	0.129	0.258
	0539-0549	9	0.129	0.129	0.516	0
Mar 24	0931-0941	0	0	0	0	0
	0943-0953	1	no data			
	0957-1007	3	0	0.129	0.129	0.516
	1010-1020	6	0	0	0	1.032
	1023-1033	9	0	0	0	0
Mar 24	1343-1353	0	0	0	0.129	0.129
	1355-1405	1	0	0	0	0
	1408-1418	3	0	0	0	0
	1421-1431	6	0	0	0	0
	1434-1444	9	0	0.258	0.129	0

J. Biological data: Abundance of large form of Pseudocalanus  
spp. (Hottori)

Date	Time Duration	Depth (m)	Stage and Abundance (Individuals m <sup>-3</sup> )						
			F-CVI	M-CVI	F-CV	M-CV	F-CIV	F-CIV	CIII
Feb 25	1840-1850	0	14.5	2.58	24.3	12.9	2.07	0.516	0
	1855-1905	1	12.6	1.29	4.90	2.83	1.03	0	0.258
	1909-1919	3	3.87	1.81	2.58	3.87	0.258	0	0
	1924-1934	6	3.87	2.84	2.07	0.774	0.774	0	0
	1937-1947	9	4.39	1.29	1.55	0.387	0	0	0
Feb 25	2235-2245	0	7.23	3.10	4.90	4.90	0	0	0
	2252-2302	1	7.61	0.774	2.45	1.55	0	0	0
	2307-2317	3	8.00	2.32	1.81	0.903	0	0	0
	2323-2333	6	16.5	6.71	1.03	2.58	0	0	0
	2339-2349	9	7.23	3.36	0.774	1.81	0	0	0
Feb 26	0232-0242	0	18.3	2.07	5.42	2.84	0	0	0
	0245-0255	1	7.74	1.03	3.23	2.58	0	0	0
	0300-0310	3	9.03	4.13	2.84	4.13	0	0	0
	0312-0322	6	8.52	2.58	2.32	1.16	0	0	0
	0327-0337	9	21.7	8.26	5.68	8.26	0	0	0
Feb 26	0655-0705	0	1.55	0.774	3.87	3.23	0.387	0.129	0
	0708-0718	1	0.516	0.258	0.903	1.55	0	0	0
	0723-0733	3	1.16	1.42	1.16	1.42	0	0	0.129
	0736-0746	6	5.42	4.13	4.13	4.13	0.258	0	0
	0752-0802	9	56.1	30.5	23.2	19.6	0.516	0.516	0
Feb 26	1133-1143	0	1.94	1.29	1.42	1.55	0.258	0	0
	1146-1156	1	1.16	1.16	1.16	1.55	0	0	0
	1200-1210	3	4.26	1.81	3.61	3.34	0	0	0
	1213-1223	6	11.6	4.65	8.77	9.29	0.774	0.516	0
	1227-1237	9	25.8	16.0	10.3	16.0	1.55	0	0
Feb 26	1537-1547	0	2.97	1.81	2.71	5.03	0	0	0
	1551-1601	1	1.03	0.258	0.645	1.03	0	0	0
	1605-1615	3	2.32	1.94	5.42	6.32	0	0	0.516
	1619-1629	6	23.7	9.81	22.7	17.0	3.10	0	0
	1632-1642	9	29.4	20.6	9.29	9.29	2.58	0	0
Feb 26	2020-2030	0	48.8	24.3	75.9	64.0	3.61	0	0
	2035-2039	1	46.8	32.3	46.8	46.8	4.84	1.61	3.23
	2100-2110	3	10.6	4.90	5.42	5.68	0.258	0.258	0
	2114-2124	6	25.8	11.4	7.49	10.8	0.516	0.516	0
	2134-2144	9	19.6	8.26	8.00	5.16	0.258	0	0
Mar 23	1445-1455	0	0	0	0	0	0	0	0
	1458-1508	1	0	0	0	0	0	0	0
	1511-1521	3	0.387	0.258	1.29	0.774	0.645	0	0.129
	1525-1535	6	4.90	4.90	5.42	5.94	1.29	0	0.516
	1537-1547	9	10.1	3.36	7.48	3.61	0.774	0	0

Mar 23	1706-1716	0	0	0	0	0	0	0	0
	1719-1729	1	0	0	0.258	0.129	0	0	0
	1734-1744	3	1.29	1.29	1.42	2.97	0	0	0
	1747-1757	6	1.68	0.516	0.774	1.16	0	0	0
	1800-1810	9	3.36	2.84	2.45	2.07	0	0	0.129
Mar 23	2042-2052	0	7.74	4.90	5.42	8.00	1.55	1.03	1.03
	2055-2105	1	4.65	4.39	4.65	7.23	0.516	0.258	0.516
	2108-2118	3	3.10	3.10	3.87	7.23	1.55	1.29	0.258
	2122-2132	6	4.90	4.65	3.36	5.68	0.516	0.258	0
	2133-2143	9	0.903	0.903	1.03	1.29	0.258	0.129	0
Mar 24	0105-0115	0	4.13	5.68	8.52	9.81	4.13	2.58	0.258
	0118-0128	1	3.87	3.61	6.71	5.94	1.55	0	0
	0132-0142	3	12.1	7.48	9.55	12.4	1.03	0	0.258
	0145-0155	6	2.07	3.23	1.94	2.71	1.03	0.258	0.129
	0157-0207	9	1.16	0.387	0.129	0.129	0	0	0
Mar 24	0449-0459	0	0.129	0.258	0.774	1.29	0.516	0.258	0.387
	0500-0510	1	0.258	0.774	1.42	1.16	0.258	0.129	0.258
	0513-0523	3	10.6	7.74	6.97	11.9	1.29	1.55	0.516
	0526-0536	6	9.29	11.4	9.29	13.4	1.55	2.07	0
	0539-0549	9	10.3	14.5	12.4	18.1	2.58	0	0
Mar 24	0931-0941	0	0.258	0.258	0.258	1.03	0.129	0	0
	0943-0953	1	no data						
	0957-1007	3	1.55	1.94	0.903	3.23	0.774	0.645	0.129
	1010-1020	6	3.61	4.65	3.61	4.65	6.19	3.10	1.03
	1023-1033	9	6.71	5.16	9.29	6.45	2.32	1.55	0.258
Mar 24	1343-1353	0	0.129	0.258	0.774	0.645	0	0	0
	1355-1405	1	0.258	0	0.516	0.387	0.129	0	0.258
	1408-1418	3	2.58	4.39	3.10	5.94	0.774	0.516	0.774
	1421-1431	6	13.9	11.4	13.4	18.6	2.58	1.03	0
	1434-1444	9	8.13	6.58	6.07	5.29	0.129	0.129	0.129

J. Biological data: Abundance of small form of Pseudocalanus  
spp. (Hattori)

Date	Time Duration	Depth (m)	Stage and Abundance (Individuals m <sup>-3</sup> )						
			F-CVI	M-CVI	F-CV	M-CV	F-CIV	M-CIV	CIII
Feb 25	1840-1850	0	80.0	8.77	59.4	24.8	5.16	0.516	0
	1855-1905	1	48.0	4.39	23.7	10.3	0.258	0	0.258
	1909-1919	3	27.9	2.58	13.7	6.71	1.29	0	0
	1924-1934	6	49.5	6.19	12.9	4.90	0.258	0	0.258
	1937-1947	9	14.7	2.07	4.65	1.29	0.258	0	0
Feb 25	2235-2245	0	22.5	2.84	9.55	6.45	0.258	0	0
	2252-2302	1	23.0	1.03	5.68	1.68	0.129	0	0
	2307-2317	3	29.0	4.00	5.81	2.32	0	0	0
	2323-2333	6	102	15.0	18.1	7.23	0	0	0
	2339-2349	9	56.3	6.19	13.7	5.16	0.516	0	0
Feb 26	0232-0242	0	55.0	4.13	7.23	6.45	0	0	0
	0245-0255	1	18.7	1.94	6.45	2.58	0	0	0
	0300-0310	3	22.5	3.61	5.16	2.32	0	0	0
	0312-0322	6	21.2	2.19	6.45	2.32	0	0	0
	0327-0337	9	127	11.9	38.7	6.71	0	0	0
Feb 26	0655-0705	0	6.71	1.55	6.97	3.23	0.258	0.129	0
	0708-0818	1	1.29	0.258	1.55	0.387	0	0	0
	0723-0733	3	4.90	0.774	2.58	1.16	0.129	0	0
	0736-0746	6	18.1	3.36	7.74	1.81	0	0	0
	0752-0802	9	137	19.6	39.2	20.1	0	0	0
Feb 26	1133-1143	0	3.48	0.129	2.19	1.03	0	0	0
	1146-1156	1	3.74	0.129	1.29	1.29	0	0	0
	1200-1210	3	5.03	0.774	3.10	1.81	0	0	0
	1213-1223	6	36.4	1.55	19.4	13.4	0	0	0
	1227-1237	9	138	27.6	50.6	21.2	0.516	0	0
Feb 26	1537-1547	0	10.1	0.258	5.68	1.16	0	0	0
	1551-1601	1	0.903	0.387	0.903	0.258	0	0	0
	1605-1615	3	8.52	0.387	4.65	1.29	0	0	0.129
	1619-1629	6	53.2	7.74	30.2	11.4	0	0	0
	1632-1642	9	110	15.5	43.9	13.4	0	0	0
Feb 26	2020-2030	0	60.9	5.68	40.8	15.5	2.58	0	1.55
	2035-2039	1	93.5	3.23	4.03	21.0	0	0	0
	2100-2110	3	17.0	2.32	10.3	2.84	0	0	0
	2114-2124	6	53.7	3.10	7.48	4.13	0.516	0	0
	2134-2144	9	32.0	3.61	7.23	2.84	0	0	0
Mar 23	1445-1455	0	0.258	0	0.258	0.129	0	0.129	0
	1458-1508	1	0.129	0	0.129	0.645	0	0	0
	1511-1521	3	3.10	0.774	3.10	2.84	1.03	0.129	0
	1525-1535	6	10.8	4.65	10.1	6.45	1.03	0.774	0
	1537-1547	9	21.7	4.65	10.1	6.71	1.03	0.258	0

Mar 23	1706-1716	0	0.774	0.129	0.387	0	0.387	0	0
	1719-1729	1	0.387	0	0.387	0.387	0	0	0
	1734-1744	3	3.36	1.94	5.68	1.81	0.129	0	0.129
	1747-1757	6	2.45	0	1.94	1.16	0.258	0	0
	1800-1810	9	9.55	3.74	5.29	4.13	0	0	0
Mar 23	2042-2052	0	26.8	6.97	26.8	6.71	2.07	0.258	0.258
	2055-2105	1	19.4	2.32	11.9	4.13	1.03	0	0.516
	2108-2118	3	15.7	4.65	11.1	7.74	0	0	0
	2122-2132	6	10.2	2.07	4.77	2.97	0	0	0
	2133-2143	9	2.84	0	1.29	0.387	0	0	0
Mar 24	0105-0115	0	18.8	5.42	18.6	5.81	2.07	0.258	0
	0118-0128	1	23.0	6.71	16.0	3.36	0.774	0	0
	0132-0142	3	86.2	6.97	21.7	7.48	0	0	0
	0145-0155	6	16.3	2.58	8.65	3.36	0	0	0
	0157-0207	9	5.03	0.258	1.68	0.516	0	0	0
Mar 24	0449-0459	0	4.26	0.645	5.16	1.68	0.129	0	0.258
	0500-0510	1	7.87	2.45	6.84	2.07	0.258	0	0
	0513-0523	3	42.3	10.6	29.4	11.4	2.32	0	0
	0526-0536	6	56.8	11.4	23.7	10.3	0.516	0	0
	0539-0549	9	87.7	20.1	35.1	20.6	0	0	0
Mar 24	0931-0941	0	2.32	0.516	1.29	1.29	0	0	0
	0943-0953	1	no data						
	0957-1007	3	5.68	1.16	3.48	1.94	0	0	0
	1010-1020	6	40.8	12.9	29.4	19.1	3.10	0	0
	1023-1033	9	48.3	5.68	29.7	8.26	0	0	0
Mar 24	1343-1353	0	1.68	0.129	1.29	0.516	0	0	0
	1355-1405	1	0.645	0.129	0.129	0.258	0	0	0
	1408-1418	3	10.8	2.07	6.71	2.07	0.258	0	0
	1421-1431	6	67.1	12.4	36.6	11.4	0.516	0.516	0
	1434-1444	9	16.4	0.774	9.29	1.03	0	0	0

J. Biological data: Abundance of Eurytemoraherdmani (Hattori)

Date	Time Duration	Depth (m)	Stage and Abundance (individuals m <sup>-3</sup> )						
			F-CVI	M-CVI	F-CV	M-CV	F-CIV	M-CIV	CIII
Feb 25	1840-1850	0	0	0	0	0.516	1.03	0	0
	1855-1905	1	0	0	0.516	1.03	0	0	0
	1909-1919	3	0	0	0.258	0.774	0.258	0	0
	1924-1934	6	0	0.774	0	0.258	0	0	0
	1937-1947	9	0	0.129	0.129	0.129	0	0	0
Feb 25	2235-2245	0	0	0.774	0.258	0.774	0	0.516	0
	2252-2302	1	0.258	0.258	0.516	0.258	0.129	0	0
	2307-2317	3	0.258	0.903	0.516	1.03	0	0.516	0
	2323-2333	6	0	0	0	0	0	0	0
	2339-2349	9	0	0.258	0	0	0	0	0
Feb 26	0232-0242	0	0	0.516	1.29	1.55	0.774	0	0
	0245-0255	1	0	0.516	0	0.645	0.129	0	0
	0300-0310	3	0	0.258	0.516	0.258	0	0.258	0
	0312-0322	6	0	0	0	0	0	0	0
	0327-0337	9	0	0	0	0.516	0	0	0
Feb 26	0655-0705	0	0	0.258	0.129	0.516	0.258	0	0
	0708-0718	1	0	0	0	0	0	0	0
	0723-0733	3	0	0	0	0.129	0	0	0
	0736-0746	6	0	0	0	0.258	0	0	0
	0752-0802	9	0	0.516	0.516	1.55	0	0	0
Feb 26	1133-1143	0	0	0	0	0.387	0	0	0
	1146-1156	1	0	0	0	0	0	0	0
	1200-1210	3	0	0	0	0	0	0	0
	1213-1223	6	0	0.258	0	0.258	0	0	0
	1227-1237	9	0	0	0.516	1.03	1.55	0.516	0
Feb 26	1537-1547	0	0	0	0	0	0	0	0
	1551-1601	1	0	0	0	0	0	0	0
	1605-1615	3	0	0	0	0	0	0	0
	1619-1629	6	0	0	0	0	0	0	0
	1632-1642	9	0	0.516	1.03	2.58	0	0	0
Feb 26	2020-2030	0	0	1.03	1.03	5.68	1.03	1.03	0
	2035-2039	1	0	0	1.61	3.23	0	0	0
	2100-2110	3	0	0	0	1.81	0.258	0.258	0
	2114-2124	6	0	0	0.516	0	0.516	0	0
	2134-2144	9	0	0	0	0.516	0.258	0	0
Mar 23	1445-1455	0	0	0	0	0	0	0	0
	1458-1508	1	0	0	0	0	0	0	0
	1511-1521	3	0.129	0	0.258	0	0	0	0
	1525-1535	6	0.516	0	0.774	0.516	0.258	0	0
	1537-1547	9	0	0	0	0.258	0	0	0

Mar 23	1706-1716	0	0	0	0	0	0	0	0
	1719-1729	1	0	0	0.129	0	0	0	0
	1734-1744	3	0	0.129	0	0	0	0	0
	1747-1757	6	0	0.129	0	0	0	0	0
	1800-1810	9	0	0.258	0.258	0.258	0	0	0
Mar 23	2042-2052	0	0	1.29	1.03	0.516	0.258	0	0
	2055-2105	1	0	0.516	0.516	0.258	0	0	0
	2108-2118	3	0	0	0.258	0.516	0.258	0	0.258
	2122-2132	6	0.129	0.129	0.258	0.645	0	0	0
	2133-3143	9	0	0	0.129	0	0	0	0
Mar 24	0105-0115	0	0	0	0	0	0.516	0	0
	0118-0128	1	0	0.516	0.258	0.258	0	0	0
	0132-0142	3	0	0.258	0.258	0	0	0	0
	0145-0155	6	0.258	0.129	0	0.129	0	0	0.129
	0157-0207	9	0	0	0	0	0	0	0
Mar 24	0449-0459	0	0.129	0.129	0.387	0.258	0	0	0
	0500-0510	1	0.129	0.129	0.258	0	0	0.129	0
	0513-0523	3	0	0.258	0.516	1.03	0	0	0.258
	0526-0536	6	0	1.03	0	1.03	0	0	0
	0539-0549	9	0	1.03	0.516	0	0	0	0
Mar 24	0931-0941	0	0	0	0	0.129	0	0	0
	0943-0953	1	no data						
	0957-1007	3	0	0.387	0.645	0.516	0	0	0
	1010-1020	6	0	2.58	0.516	0	0	0	0
	1023-1033	9	0	0	0	0.258	0	0	0
Mar 24	1343-1353	0	0	0.129	0	0	0	0	0
	1355-1405	1	0	0	0	0	0	0	0
	1408-1418	3	0	0	0.258	0.258	0	0	0
	1421-1431	6	0	1.03	1.03	0	0	0	0
	1434-1444	9	0	0	0	0	0	0	0

J. Biological data: Abundance of Acartia longiremis (Hattori)

Date	Time Duration	Depth (m)	Stage and Abundance (individuals m <sup>-3</sup> )			
			F-CVI	M-CVI	F-CV	M-CV
Feb 25	1840-1850	0	12.9	9.81	0.516	0
	1855-1905	1	11.6	8.77	0	0
	1909-1919	3	8.26	6.71	0.258	0
	1924-1934	6	6.97	7.74	0.258	0
	1937-1947	9	1.42	2.07	0.258	0.129
Feb 25	2235-2245	0	6.45	2.84	0.774	0.258
	2252-2302	1	3.48	1.03	0	0
	2307-2317	3	11.7	5.81	0.129	0.129
	2323-2333	6	22.7	17.5	1.03	0
	2339-2349	9	2.58	3.10	0	0
Feb 26	0232-0242	0	2.84	1.29	0	0
	0245-0255	1	8.39	5.29	0.129	0
	0300-0310	3	22.2	18.8	0.516	0.258
	0312-0322	6	4.90	3.74	0.129	0.129
	0327-0337	9	4.65	3.10	0	0
Feb 26	0655-0705	0	0.774	0.516	0	0
	0708-0718	1	1.03	0.387	0	0
	0723-0733	3	3.03	2.19	0	0
	0736-0746	6	10.3	10.1	0	0
	0752-0802	9	23.7	25.9	1.03	0
Feb 26	1133-1143	0	1.68	0.903	0	0
	1146-1156	1	1.68	0.516	0.258	0.258
	1200-1210	3	4.52	2.07	0.129	0.129
	1213-1223	6	8.26	2.58	1.03	0.516
	1227-1237	9	35.6	24.8	2.07	1.03
Feb 26	1537-1547	0	3.36	4.39	0.129	0.258
	1551-1601	1	1.29	0.774	0	0.129
	1605-1615	3	5.03	0.903	0.258	0.129
	1619-1629	6	18.6	10.8	0	0.516
	1632-1643	9	26.3	24.3	2.58	0
Feb 26	2020-2030	0	18.6	8.26	0	0
	2035-2039	1	67.7	58.1	0	0
	2100-2110	3	8.77	5.42	0.258	0
	2114-2124	6	33.0	9.29	0.516	0.516
	2134-2144	9	5.94	5.42	0.258	0.258
Mar 23	1445-1455	0	0.129	0.129	0	0.129
	1458-1508	1	0.903	1.03	0.129	0.129
	1511-1521	3	1.42	2.58	0.645	0.516
	1525-1535	6	2.58	4.39	1.03	0.516
	1537-1547	9	1.81	4.13	0.258	1.03

Mar 23	1706-1716	0	0.387	1.42	0.258	0
	1719-1729	1	1.29	2.32	0	0.258
	1734-1744	3	4.77	7.87	1.42	1.42
	1747-1757	6	1.42	2.07	0.387	0.129
	1800-1810	9	1.68	2.07	0.387	0.387
Mar 23	2042-2052	0	11.4	12.1	0.516	0.258
	2055-2105	1	12.1	14.7	1.55	0.516
	2108-2118	3	16.8	20.1	2.84	1.55
	2122-2132	6	1.94	2.58	0.129	0.258
	2133-2143	9	0.645	0.129	0.129	0
Mar 24	0105-0115	0	5.16	6.19	0	0
	0118-0128	1	12.1	10.6	1.29	0
	0132-0142	3	33.8	28.6	2.07	1.55
	0145-0155	6	1.29	0.645	0.129	0.258
	0157-0207	9	0.129	0	0	0
Mar 24	04490459	0	5.29	3.10	0.129	0.129
	0500-0510	1	8.13	6.45	0.258	0.258
	0513-0523	3	14.2	14.7	1.29	1.03
	0526-0536	6	9.29	9.81	0.516	0.516
	0539-0549	9	1.55	0.516	0	0
Mar 24	0931-0941	0	0.387	0.516	0	0
	0943-0953	1	no data			
	0957-1007	3	6.45	8.13	1.16	0.903
	1010-1020	6	0	2.58	0.516	0
	1023-1033	9	1.55	4.65	0.258	0.258
Mar 24	1343-1353	0	0.129	0.516	0.129	0
	1355-1405	1	0.645	1.03	0	0
	1408-1414	3	22.7	28.6	3.10	0.774
	1421-1431	6	10.3	8.26	0	0
	1434-1444	9	1.42	4.00	0.129	0

J. Biological data: Abundance of Acartia omorii (Hattori)

Date	Time Duration	Depth (m)	Stage and Abundance (individuals m <sup>-3</sup> )			
			F-CVI	M-CVI	F-CV	M-CV
Feb 25	1840-1850	0	5.16	1.03	0	0
	1855-1905	1	3.10	1.29	0	0.774
	1909-1919	3	2.07	2.32	0	0
	1924-1934	6	1.03	1.55	0.774	0
	1937-1947	9	0.387	0.258	0.129	0.129
Feb 25	2235-2245	0	0.258	0.258	0	0
	2252-2302	1	0.129	0	0	0
	2307-2317	3	0.516	0	0	0
	2323-2333	6	0	0	0	0
	2339-2349	9	0.774	1.03	0	0
Feb 26	0232-0242	0	0.258	0	0	0
	0245-0255	1	0.387	0	0	0
	0300-0310	3	0	0.258	0	0
	0312-0322	6	0	0	0	0
	0327-0337	9	2.07	2.58	0	0
Feb 26	0655-0705	0	0.258	0.129	0	0
	0708-0718	1	0.129	0	0	0
	0723-0733	3	0.129	0.387	0	0
	0736-0746	6	0	0.774	0	0
	0752-0802	9	3.10	1.03	0	0
Feb 26	1133-1143	0	3.48	0.129	2.19	1.03
	1146-1156	1	0	0	0	0
	1200-1210	3	0	0	0	0
	1213-1223	6	0.516	0.516	0	0
	1227-1237	9	6.20	7.74	0	0
Feb 26	1537-1547	0	0.065	0	0	0
	1551-1601	1	0.258	0	0	0
	1605-1615	3	0	0	0	0
	1619-1629	6	4.13	2.58	0	0
	1632-1642	9	5.68	2.07	0	0
Feb 26	2020-2030	0	2.58	0.516	0	0
	2035-2039	1	3.23	1.61	0	0
	2100-2110	3	0.258	0.258	0	0
	2114-2124	6	2.07	1.55	0	0
	2134-2144	9	0.516	0.258	0	0
Mar 23	1445-1455	0	0	0	0	0
	1458-1508	1	0.258	0.258	0.129	0
	1511-1521	3	0	0	0	0
	1525-1535	6	0	0	0	0
	1537-1547	9	0.774	0.774	0	0

Mar 23	1706-1716	0	0	0	0	0
	1719-1729	1	0.129	0	0	0
	1734-1744	3	0	0.387	0	0
	1747-1757	6	0	0	0	0
	1800-1810	9	0.129	0.258	0	0
Mar 23	2042-2052	0	0	0.516	0	0
	2055-2105	1	0	0	0	0
	2108-2118	3	0.258	0.774	0.258	0
	2122-2132	6	0	0	0	0
	2133-2143	9	0	0	0	0
Mar 24	0105-0115	0	0	0	0	0
	0118-0128	1	0	0	0	0
	0132-0142	3	0.516	0	0	0
	0145-0155	6	0	0	0	0
	0157-0207	9	0	0	0	0
Mar 24	0449-0459	0	0.387	0.258	0	0
	0500-0510	1	0.258	0	0	0
	0513-0523	3	0	0	0.258	0
	0526-0536	6	0	0	0	0
	0539-0549	9	0	0	0	0
Mar 24	0931-0941	0	0	0	0	0
	0943-0953	1	no data			
	0957-1007	3	0	0	0	0
	1010-1020	6	0	0	0	0
	1023-1033	9	0	0	0	0
Mar 24	1343-1353	0	0	0	0	0
	1355-1405	1	0	0	0	0
	1408-1418	3	0	0	0	0
	1421-1431	6	0	0	0	0
	1434-1444	9	0	0	0	0

J. Biological data: Abundance of Oithona spp., Harpacticoida, and Temora sp. (Hattori)

Date	Time Duration	Depth (m)	<u>Oithona</u>	<u>Harpacticoida</u>	<u>Temora</u>
			(individuals m <sup>-3</sup> )		
Feb 25	1840-1850	0	0	0.645	0
	1855-1905	1	0	0.129	0
	1909-1919	3	0	0.258	0
	1924-1934	6	0	0.258	0
	1937-1947	9	0	1.16	0
Feb 25	2235-2245	0	0	1.68	0
	2252-2302	1	0	1.55	0
	2307-2317	3	0	1.16	0
	2323-2333	6	0	0.258	0
	2339-2349	9	0.516	0.903	0
Feb 26	0232-0242	0	0	0.258	0
	0245-0255	1	0	2.07	0
	0300-0310	3	0	2.84	0
	0312-0322	6	0.129	0.387	0
	0327-0337	9	0	0	0
Feb 26	0655-0705	0	0.258	1.03	0
	0708-0718	1	0.129	0.516	0
	0723-0733	3	0.129	0.129	0
	0736-0746	6	0	0	0
	0752-0802	9	0	0	0
Feb 26	1133-1143	0	0.129	0.516	0
	1146-1156	1	0	0.129	0
	1200-1210	3	0	0	0
	1213-1223	6	0.258	0	0
	1227-1237	9	1.03	0	0
Feb 26	1537-1547	0	0	0	0
	1551-1601	1	0	0	0
	1605-1615	3	0.258	0	0
	1619-1629	6	0	0	0
	1632-1642	9	0.516	0	0
Feb 26	2020-2030	0	0	0.387	0
	2035-2039	1	3.23	0	0
	2100-2110	3	0	0.516	0
	2114-2124	6	0	0.516	0
	2134-2144	9	0.516	2.58	0
Mar 23	1445-1455	0	0	0	0
	1458-1508	1	0	0	0
	1511-1521	3	0.387	0.258	0
	1525-1535	6	0	0.516	0
	1537-1547	9	0.774	0	0

Mar 23	1706-1716	0	0.258	0	0
	1719-1729	1	0.129	0.129	0
	1734-1744	3	0.645	0	0
	1747-1757	6	0	0	0
	1800-1810	9	0.129	0.129	0
Mar 23	2042-2052	0	0	0.516	0
	2055-2105	1	0.258	1.55	0
	2108-2118	3	0.258	1.29	0
	2122-2132	6	0.129	0.903	0
	2133-3143	9	0	0.774	0
Mar 24	0105-0115	0	0.516	0.774	0
	0118-0128	1	0	0.774	0
	0132-0142	3	0.774	2.58	0
	0145-0155	6	0	1.29	0
	0157-0207	9	0	0.645	0
Mar 24	0449-0459	0	0	0.129	0
	0500-0510	1	0.129	0.774	0
	0513-0523	3	0.258	0.774	0
	0526-0536	6	0	1.55	0.129
	0539-0549	9	0	1.03	0
Mar 24	0931-0941	0	0	0.129	0
	0943-0953	1	no data		
	0957-1007	3	0	0	0
	1010-1020	6	0	0	0
	1023-1033	9	0	0	0
Mar 24	1343-1353	0	0	0	0
	1355-1405	1	0	0.129	0
	1408-1418	3	0	0	0
	1421-1431	6	1.03	0	0
	1434-1444	9	0	0	0

J. Biological data: Abundance of Calanus pacificus, Mesocalanus tenuicornis, and Metridiapacifica (Hattori)

Date	Time Duration	Depth (m)	Calanus	Mesocalanus (individuals m <sup>-3</sup> )	Metridia
Feb 25	1840-1850	0	0	0.129	0
	1855-1905	1	0	0	0
	1909-1919	3	0	0	0
	1924-1934	6	0	0	0
	1937-1947	9	0	0	0
Feb 25	2235-2245	0	0	0	0
	2252-2302	1	0	0	0
	2307-2317	3	0	0.258	0
	2323-2333	6	0	0	0
	2339-2349	9	0	0	0
Feb 26	0232-0242	0	0	0	0
	0245-0255	1	0	0	0
	0300-0310	3	0	0	0
	0312-0322	6	0	0	0
	0327-0337	9	0	0	0
Feb 26	0655-0705	0	0	0	0.129
	0708-0718	1	0	0	0
	0723-0733	3	0	0	0
	0736-0746	6	0	0	0
	0752-0802	9	0	0	0
Feb 26	1133-1143	0	0	0.258	0
	1146-1156	1	0	0.129	0
	1200-1210	3	0	0.258	0
	1213-1223	6	0	0	0
	1227-1237	9	0	0	0
Feb 26	1537-1547	0	0.258	0	0
	1551-1601	1	0	0	0
	1605-1615	3	0	0.258	0
	1619-1629	6	0	0.129	0
	1632-1642	9	0	0	0
Feb 26	2020-2030	0	0	0	0
	2035-2039	1	0	0	0
	2100-2110	3	0	0	0
	2114-2124	6	0	0	0
	2134-2144	9	0	0	0
Mar 23	1445-1455	0	0.258	0	0
	1458-1508	1	0	0	0
	1511-1521	3	0.258	0	0
	1525-1535	6	0.258	0	0
	1537-1547	9	0.258	0	0

Mar 23	1706-1716	0	0	0	0
	1719-1729	1	0	0	0
	1734-1744	3	0	0	0
	1747-1757	6	0	0	0
	1800-1810	9	0	0	0
Mar 23	2042-2052	0	0	0	0
	2055-2105	1	0	0	0
	2108-2118	3	0	0	0
	2122-2132	6	0	0	0.129
	2133-2143	9	0	0	0
Mar 24	0105-0115	0	0	0	0
	0118-0128	1	0	0	0
	0132-0142	3	0	0	0
	0145-0155	6	0	0	0
	0157-0207	9	0	0	0
Mar 24	0449-0459	0	0	0	0
	0500-0510	1	0	0	0
	0513-0523	3	0	0	0.258
	0526-0536	6	0.129	0	0
	0539-0549	9	0	0.516	0
Mar 24	0931-0941	0	0	0	0
	0943-0953	1	no data		
	0957-1007	3	0	0	0
	1010-1020	6	0	0	0
	1023-1033	9	0	0	0
Mar 24	1343-1353	0	0	0	0
	1355-1405	1	0	0	0
	1408-1418	3	0	0	0
	1421-1431	6	0	0	0
	1434-1444	9	0	0	0

## K. Biological data: Zooplankton biomass (Saito)

Date	Time Duration	Depth (m)	Dry Weight (mg m <sup>-3</sup> )	Carbon (mg m <sup>-3</sup> )	Nitrogen (mg m <sup>-3</sup> )
Feb 25	1840-1850	0	3.99	1.64	0.330
	1855-1905	1	1.60	0.629	0.132
	1909-1919	3	0.880	0.320	0.067
	1924-1934	6	1.72	0.615	0.131
	1937-1947	9	0.857	0.218	0.048
Feb 25	2235-2245	0	1.39	0.469	0.097
	2252-2302	1	2.08	0.858	0.229
	2307-2317	3	0.939	0.278	0.058
	2323-2333	6	1.48	0.439	0.084
	2339-2349	9	1.51	0.428	0.089
Feb 26	0232-0242	0	1.56	0.475	0.099
	0245-0255	1	1.39	0.332	0.065
	0300-0310	3	1.41	0.441	0.089
	0312-0322	6	1.87	0.293	0.083
	0327-0337	9	3.02	1.07	0.225
Feb 26	0655-0705	0	1.17	0.283	0.056
	0708-0718	1	0.621	0.080	0.016
	0723-0733	3	0.975	0.167	0.032
	0736-0746	6	1.50	0.425	0.084
	0752-0802	9	4.70	1.73	0.365
Feb 26	1133-1143	0	0.636	0.129	0.024
	1146-1156	1	0.537	0.111	0.017
	1200-1210	3	0.771	0.206	0.035
	1213-1223	6	1.81	0.628	0.125
	1227-1237	9	2.66	0.983	0.199
	1244-1254	11	2.73	0.347	0.074
Feb 26	1537-1547	0	1.04	0.298	0.063
	1551-1601	1	1.85	0.074	0.014
	1605-1615	3	1.10	0.273	0.049
	1619-1629	6	2.77	0.973	0.200
	1632-1642	9	3.59	1.40	0.302
Feb 26	2020-2030	0	4.43	1.88	0.344
	2035-2039	1	4.06	1.15	0.233
	2100-2110	3	1.64	0.489	0.104
	2114-2124	6	2.51	0.861	0.183
	2134-2144	9	2.00	0.716	0.154
Mar 23	1445-1455	0	1.15		
	1458-1508	1	1.52		
	1511-1521	3	1.42		
	1525-1535	6	1.71		
	1537-1547	9	3.52		

Mar 23	1706-1716	0	1.29
	1719-1729	1	1.46
	1734-1744	3	1.32
	1747-1757	6	0.526
	1800-1810	9	1.72
Mar 23	2042-2052	0	2.87
	2055-2105	1	2.05
	2108-2118	3	2.11
	2122-2132	6	2.26
	2133-2143	9	0.284
Mar 24	0105-0115	0	1.77
	0118-0128	1	1.89
	0132-0142	3	2.90
	0145-0155	6	1.70
	0157-0207	9	0.699
Mar 24	0449-0459	0	1.36
	0500-0510	1	3.09
	0513-0523	3	2.45
	0526-0536	6	2.40
	0539-0549	9	2.43
Mar 24	0931-0941	0	1.33
	0943-0953	1	0.606
	0957-1007	3	1.95
	1010-1020	6	2.84
	1023-1033	9	2.06
Mar 24	1343-1353	0	0.117
	1355-1405	1	1.53
	1408-1418	3	2.53
	1421-1431	6	3.09
	1434-1444	9	1.46

L. Biological data: Ingestion rate of PSL (females of Pseudocalanus spp. large form), PSS (females of Pseudocalanus spp. small form), ACF (females of Acartia spp.), and ACM (males of Acartia spp.) (Saito)

Date	Time	Depth (m)	Ingestion Rate (ngPIGMENTS individual <sup>-1</sup> h <sup>-1</sup> )			
			PSL	PSS	ACF	ACM
Feb 25	1730	0	0.225 0.256	0.215	0.989	0.587
Feb 25	1745	1	0.330			
Feb 25	1759	3	0.702 0.600	0.349 0.423	0.518 0.592	0.629
Feb 25	1812	6	1.56 1.16	0.976 0.691	0.598	0.497
Feb 25	1827	9	1.96 1.58	1.07 1.65	0.775	0.429
Feb 25	2147	0	2.99 2.53	1.68 1.44	1.15	1.19
Feb 25	2157	1	1.18 1.30	0.765 0.882	1.12 1.08	1.17
Feb 25	2204	3	2.93 2.66	0.822 0.939	0.933 1.16	1.15
Feb 25	2213	6	1.42 1.18	0.805 1.24	1.07 1.08	0.657
Feb 25	2225	9	1.26 0.983	0.862 0.748	1.11	0.683
Feb 26	0145	0	2.09 3.68	1.74 1.87	1.87	1.41
Feb 26	0145	1	1.82 1.50	1.49 1.17	1.24 1.79	1.02
Feb 26	0150	3	1.28	0.728	1.49 0.778	0.884
Feb 26	0204	6	0.558	0.711	1.07	
Feb 26	0217	9	0.881	0.631	0.555	
Feb 26	0610	0	0.551	0.181	0.864	0.652
Feb 26	0620	1	1.48	1.09	1.22	
Feb 26	0628	3	0.151	0.184	0.555	0.469
Feb 26	0637	6	0.881 0783	0.480 0.231	0.642 0.888	0.629 0.575
Feb 26	0645	9	0.242	0.211 0.154	0.406	0.636
Feb 26	1044	0	0.102	0.087		
Feb 26	1102	1	0.242	0.034	0.296	
Feb 26	1108	3	0.600	0.168	0.259	0.167
Feb 26	1117	6	0.481 0.421	0.211 0.114	0.186	0.162
Feb 26	1125	9	0.200 0.200	0.134 0.154	0.186 0.110	0.162

Feb 26	1458	0		0.735	0.888	
Feb 26	1505	1			0.337	0.603
					0.683	
Feb 26	1514	3	0.246	0.114	0.432	0.263
Feb 26	1522	6	0.221	0.195	0.203	0.120
				0.402		
Feb 26	1530	9	0.319	0.215	0.408	0.230
				0.309		
Feb 26	1938	0	2.11	2.29	1.37	1.14
			3.12			
Feb 26	1946	1	2.64	1.96	0.95	0.845
			2.42	1.98	1.19	1.03
Feb 26	1955	3	1.58	1.65	0.752	0.697
				0.882	0.778	
Feb 26	2003	6	2.11	1.63	0.691	0.779
			2.26	1.65		
Feb 26	2011	9	2.43	2.05	0.987	0.870
				1.61		
Mar 24	1402	3			0.431	
Mar 24	1411	6		0.200	0.275	
Mar 24	1420	9	0.020	0.077	0.234	
				0.042		
Mar 24	1642	3		0.848	0.872	
Mar 24	1650	6		0.074	0.431	
Mar 24	1657	9	0.154	0.081	0.134	
			0.468	0.162		
Mar 24	2008	0	2.95	1.52	1.47	
			3.23	2.11	1.39	
Mar 24	2011	1	2.66	2.31	1.62	
			3.19		1.57	
Mar 24	2019	3	2.73	1.51	1.59	
Mar 24	2026	6	1.27	1.73	1.04	
Mar 25	0027	0	2.92	1.90	1.76	
			2.79	1.75	1.24	
Mar 25	0034	1	2.52	2.16	2.29	
			2.37	2.45		
Mar 25	0042	3	1.99	1.63	1.06	
			1.79	1.88	2.73	
Mar 25	0050	6	2.45	1.36	1.35	
				1.56		
Mar 25	0058	9	1.64	0.855		
Mar 25	0407	0		1.90		
Mar 25	0422	3	1.83	1.50	0.985	
			1.82	1.54	1.09	
Mar 25	0431	6	1.79	1.08		
				1.57		
Mar 25	0440	9	1.29	1.24	1.69	
				1.11		

Mar 25	0907	3	1.25	0.725	0.418
Mar 25	0915	6	0.638	0.799	0.756
			1.21	0.732	
Mar 25	0923	9	0.134	0.222	
				0.130	
Mar 25	1320	3		0.201	0.461
Mar 25	1327	6	0.448	0.472	0.484
			0.438	0.391	
Mar 25	1335	9	0.154	0.211	0.093
				0.172	

M. Biological data: Day-time and night-time densities of the copepodites and adults of the principal copepod species sampled at the 0.5 and 1 m layer under the ice of Saroma-ko Lagoon (Individuals  $m^{-3}$ ) (Fortier)

## DayTime

Date	<u>Acartia spp.</u>							<u>Pseudocalanus spp.</u>							<u>Oithona spp.</u>						
	I	II	III	IV	V	M	F	I	II	III	IV	V	M	F	I	II	III	IV	V	M	F
24 Feb. 1992	3.4	2.5	1.0	2.2	4.6	4.6	3.2	53.6	10.0	5.2	5.8	11.2	2.2	4.5	2.6	1.9	11.9	3.5	1.5	0.0	7.8
25	3.4	2.2	1.4	2.9	3.8	2.3	3.8	41.0	8.2	6.9	2.9	10.7	2.3	2.1	0.8	3.7	27.5	6.8	2.8	0.0	18.0
27	3.2	5.9	2.2	1.1	2.6	2.2	5.1	183.1	31.4	20.0	7.2	14.2	1.0	6.1	8.1	8.1	38.3	16.7	8.6	0.0	34.6
28	1.6	20.4	4.7	9.5	19.7	17.4	21.9	341.8	52.9	40.2	14.7	36.6	12.6	21.1	28.2	8.6	46.4	22.8	20.5	7.1	94.4
29	11.1	6.6	2.2	7.9	8.5	12.6	24.5	235.6	37.6	23.3	11.1	45.6	5.5	20.4	2.8	8.3	37.1	11.6	18.8	1.1	34.6
1 March 1993	14.5	5.4	1.8	5.4	22.7	30.5	47.1	254.7	86.8	44.6	29.1	77.5	11.5	48.2	10.8	28.9	52.4	14.4	45.1	1.8	70.5
2	3.0	1.7	0.7	0.0	1.4	5.1	4.0	31.2	7.9	5.8	2.9	8.9	1.7	6.6	1.0	2.0	17.0	5.7	4.7	0.7	13.5
3	8.6	4.3	5.9	3.8	5.1	4.1	4.1	106.9	21.2	10.6	3.4	5.9	0.6	4.1	10.8	1.7	33.2	16.4	40.5	2.6	61.2
4	3.8	0.6	0.6	0.0	0.8	1.4	1.9	90.8	12.9	3.9	2.0	8.3	0.2	1.2	0.6	3.8	46.6	27.6	23.8	0.0	39.7
8	7.6	3.1	0.7	0.0	0.7	0.7	0.9	36.8	3.6	3.2	0.3	3.6	0.1	0.8	0.3	0.3	21.7	13.5	22.4	1.3	24.4
9	4.4	3.1	1.3	0.6	1.3	3.7	5.3	80.4	20.5	4.5	2.6	9.4	0.8	2.8	6.9	3.4	21.3	12.9	49.0	0.6	47.6
10	7.1	2.2	0.0	0.0	0.1	4.7	3.1	109.6	8.8	3.9	1.8	4.4	0.1	1.2	8.8	12.1	25.8	18.1	28.5	0.0	50.4
11	3.8	2.7	0.0	1.0	2.6	5.9	6.5	56.3	9.9	4.8	1.6	9.3	1.3	4.3	0.0	17.0	22.2	7.9	13.4	1.0	29.8
12	4.1	3.1	2.2	0.9	0.2	2.0	2.0	104.6	8.5	3.8	2.5	6.1	2.1	2.6	9.6	1.3	14.1	12.9	30.1	0.0	26.0
13	3.5	1.5	0.1	1.0	1.4	3.7	5.0	99.6	23.3	7.3	3.7	10.8	1.2	2.9	0.0	2.9	11.1	9.6	18.4	0.0	28.6
14	8.2	9.2	4.4	5.0	4.1	3.6	2.6	179.2	39.4	12.5	3.7	14.9	3.4	5.3	1.9	1.9	30.9	14.5	19.4	0.0	32.9
18	3.1	0.8	0.9	0.0	1.3	0.6	1.3	129.0	33.3	8.1	3.1	5.9	0.4	2.1	16.4	14.8	38.5	22.4	43.9	0.2	58.6
19	1.1	7.7	1.4	1.1	0.2	0.4	0.5	103.6	26.5	1.7	3.7	0.8	0.2	0.3	32.9	8.8	52.9	50.9	74.1	1.2	76.4
20	4.9	2.9	1.0	2.2	8.6	8.5	4.3	18.7	4.4	3.0	1.9	3.5	0.2	0.7	16.4	12.1	46.9	13.2	31.9	1.3	34.6
24	12.3	4.7	3.6	6.2	10.6	20.4	11.0	21.8	4.8	4.2	2.8	8.8	0.5	2.4	24.7	8.6	41.6	21.9	63.3	1.6	44.0

## Nighttime

Date	<u>Acartia spp.</u>							<u>Pseudocalanus spp.</u>							<u>Oithona spp.</u>						
	I	II	III	IV	V	M	F	I	II	III	IV	V	M	F	I	II	III	IV	V	M	F
27 Feb. 1994	3.8	4.3	2.2	8.7	18.4	46.1	64.7	221.8	88.0	74.3	65.4	268.3	18.3	200.8							
29	7.5	0.0	0.0	0.0	11.5	33.2	39.4	419.6	122.2	86.1	143.5	401.8	34.3	319.1	0.0	0.0	5.4	23.8	16.9	3.8	35.4
1 March 1994	8.1	2.7	0.0	8.1	2.7	27.5	38.3	407.0	94.3	97.0	57.1	274.9	8.4	184.9	0.0	0.0	29.7	2.7	18.9	10.8	48.5
2	9.0	3.6	0.0	3.6	32.7	54.8	69.3	353.3	109.4	122.8	86.9	31.7	221.8	144.4	0.0	5.4	25.1	17.9	44.8	0.0	73.5
3	0.0	2.7	10.8	0.0	7.4	26.3	51.0	152.0	37.7	41.6	37.9	74.4	9.9	68.8	0.0	2.7	14.8	12.1	16.1	0.0	25.0
8	7.3	4.1	2.0	2.0	2.2	33.3	39.7	143.7	60.5	82.5	64.7	217.1	18.8	168.6	3.2	6.5	32.3	14.5	19.4	0.0	48.8
10	4.8	9.2	3.2	1.6	4.0	28.5	29.2	169.5	29.4	37.1	45.4	148.3	14.7	117.1	4.3	12.4	16.7	17.8	23.7	0.0	37.1
11	2.7	1.4	0.0	1.4	3.6	46.4	56.0	147.5	29.5	23.4	34.2	100.3	11.4	98.2	0.0	0.0	10.2	4.8	32.6	0.0	18.2
12	1.4	2.7	2.7	5.4	4.7	45.7	36.6	59.2	43.0	40.4	41.9	128.9	12.8	104.4	1.6	3.2	10.0	9.7	17.8	1.4	6.7
18	12.9	12.5	5.1	25.8	22.1	68.2	31.6	382.9	156.7	53.6	25.3	20.1	4.7	14.4	32.3	32.8	108.3	61.0	109.4	0.0	65.8
23	2.7	9.6	3.1	15.4	39.0	93.8	37.2	70.7	49.2	42.8	45.6	116.3	6.1	67.6	2.7	1.6	36.9	27.3	78.8	7.6	54.2

N. Biological data: The ichthyoplankton assemblages sampled at the second channel linking Saroma-ko Lagoon to the Sea of Okhotsk during the period from February 27 to March 19, 1992. (Fortier)

Date	Time	TowTime	Tidal phase	Exterior Flowmeter	Interior Flowmeter	<u>Ammodytes</u> sp.	<u>Lumpenus sagitta</u>	<u>Cottidae</u>	<u>T. calcogramma</u>	<u>P. monopterygius</u>	<u>Agonidae</u>	<u>Liparis tanakai</u>	<u>Stichaeus nozawai</u>	<u>Gadus macrocephalus</u>	Eggs
28-fevr	14:00	10m	Ebb			2									7
28-fevr	14:30	30m	Ebb			1	1								35
29-fevr	10:30	30m	Flood			66		5	1						1
01-mars	15:00	30m	Ebb			3		1							1
02-mars	10:55	30m	Flood												2
02-mars	19:20	30m	Ebb			9	2	1							
03-mars		30m				2	1	1							
04-mars	10:30	30m	Flood			8				1					
04-mars	12:30	30m	Ebb												
08-mars	16:30	20m	Flood	23204	2008										
08-mars	21:35	20m	Ebb	11300	10540	2	1	2							
09-mars	16:25	20m	Flood	21600	18730	2	2	5			1	1			2
09-mars	21:30	20m	Ebb	11580	10590	2	4	1							
10-mars	19:30	20m	Flood	3840	3500	4		1							
12-mars	15:30	20m	Ebb	12390	11611	1	6	1							
13-mars	15:30	20m	Ebb	15878	17920	2	10								1
14-mars	08:00	20m	Flood	8870	8360	56	2	1							
14-mars	14:00	20m	Ebb	19650	1770	3	21								
19-mars	13:30	20m	Flood	20855	22099	11									
19-mars	19:30	20m	Ebb	14610	16790	4	10								
23-mars	11:30	20m	Ebb			3	14	1							
23-mars	16:30	20m	Flood			4	28								
05-mars	11:00	20m	Flood	13370	12508	7									
05-mars	11:30	20m	Flood	16143	14810	4									
05-mars	12:00	20m	Flood	18730	16884	27									
05-mars	12:30	20m	Flood	19775	17359										
05-mars	13:00	20m	Flood	20979	18689										
05-mars	13:30	20m	Flood	20988	18812	4									
05-mars	14:00	20m	Flood	21524	19237	57									
05-mars	14:30	20m	Flood	20142	18637	56									
05-mars	15:00	20m	Flood	20813	17792	14									
05-mars	15:30	20m	Flood	16495	13890	23									
05-mars	16:00	20m	Flood	13657	11037	67									
05-mars	16:30	20m	Flood	4185	3852	25									
05-mars	17:00	20m	Ebb	8300	7488	17									
05-mars	17:30	20m	Ebb	12760	11068	15	1	1							



