Preliminary Report

of

The Hakuhō Maru Cruise KH-69-4

(IBP Cruise)

August 12 - November 13, 1969

The North and Equatorial Pacific Ocean

Ocean Research Institute

University of Tokyo

1970

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ERRATA

The figure on page 56 should be replaced with the figure on page 58.

On page 35, line 7, 24.666 should be 34.666.

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The Hakuhō Maru Cruise KH-69-4

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The North and Equatorial Pacific Ocean

By

The Scientific Members of the Expedition

Edited by

Ryuzo Marumo

Introduction

The main themes of the present cruise are two: firstly, studies on the productivity of lower trophic levels, including bacteria, phytoplankton, zooplankton, micronekton etc., and on the metabolism and food chain in the North, Central, and Equatorial Pacific Ocean; and secondly, studies on the biogeography in the same areas.

Our research works were carried out in success as previously scheduled, owing to close cooperation of all members aboard.

These works are recognized as an integral part of International Biological Programme (IBP), because some principal knowledge on marine productivity in different climatic regions is expected to be obtained from the present research covering extensive latitudes from the subarctic region to the tropical region in the Pacific.

The R/V Hakuhō Maru fortunately had opportunities to visit three most beautiful islands in the Pacific, Hawaii, Tahiti and Western Samoa, and we were cordially welcome by governments and peoples there. I, on the behalf of scientists and crews aboard, would like to express our hearty thanks for their warm hospitality and kind consideration which made a great contribution to the achievement of our research. Thanks are also extended to all crew members of the Hakuhō Maru for their helpful coorperation throughout the long cruise of 94 days.

Ryuzo Marumo
Chief Scientist

Contents

Cruise itinerary

	Arrival	Departure
Tokyo		Aug. 12, 1969
Hilo, Hawaii	Sep. 13	Sep. 18
Papeete, Tahiti	Oct. 8	Oct. 13
Apia, Western Samoa	Oct. 24	Oct. 26
Tokyo	Nov. 13	

Scientists aboard

MARUMO, Ryuzo Chief Scientist	Ocean Res. Inst., Univ. of Tokyo	Zooplankton
TAGA, Nobuo	Ocean Res. Inst., Univ. of Tokyo	Bacteria
HATTORI, Akihiko	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
NEMOTO, Takahisa	Ocean Res. Inst., Univ. of Tokyo	Zooplankton
FUJITA, Yoshihiko	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
MARUYAMA, Yoshiharu	Ocean Res. Inst., Univ. of Tokyo	Bacteria
ISHII, Takeo	Ocean Res. Inst., Univ. of Tokyo	Population dynamics
MURANO, Masaaki	Ocean Res. Inst., Univ. of Tokyo	Zooplankton
WADA, Eitaro	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
NAKAI, Toshisuke	Ocean Res. Inst., Univ. of Tokyo	Physical oceanography
HASUMOTO, Hiroshi	Ocean Res. Inst., Univ. of Tokyo	Zooplankton
EBATA, Toshio	Ocean Res. Inst., Univ. of Tokyo	Biochemistry
MATSUDA, Osamu	Ocean Res. Inst., Univ. of Tokyo	Bacteria
TERAZAKI, Makoto	Ocean Res. Inst., Univ. of Tokyo	Zooplankton
LEE, Su Bu	Ocean Res. Inst., Univ. of Tokyo	Zooplankton
OGURA, Norio	Fac. of Science, Tokyo Metropolitan Univ.	Chemistry
NAKAMOTO, Nobutada	Fac. of Science, Tokyo Metropolitan Univ.	Biochemistry
TAKAHASHI, Masayuki	Fac. of Science, Tokyo Kyoiku Univ.	Primary production
MORITA, Jiro	Far Seas Fish. Res. Lab.	Population dynamics
SATAKE, Ken-ichi	Water Res. Lab., Nagoya Univ.	Primary production
UCHIDA, Aritsune	Food Res. Inst., Kyoto Univ.	Bacteria
KAWADA, Izumi	Dep. of Fisheries, Kyoto Univ.	Bacteria
OZAWA, Takakazu	Dep. of Fisheries, Kyushu Univ.	Fish larvae
ASAOKA, Osamu	Nagasaki Marine Observatory	Phytoplankton
MOTODA, Shigeru	Fac. of Fisheries, Hokkaido Univ.	Zooplankton
NISHIZAWA, Satoshi	Fac. of Fisheries, Hokkaido Univ.	Seston
KOTORI Moriyuki	Fac. of Fisheries, Hokkaido Univ.	Zooplankton
OKADA, Naotaka	Dep. of Geology, Hokkaido Univ.	Nanoplankton

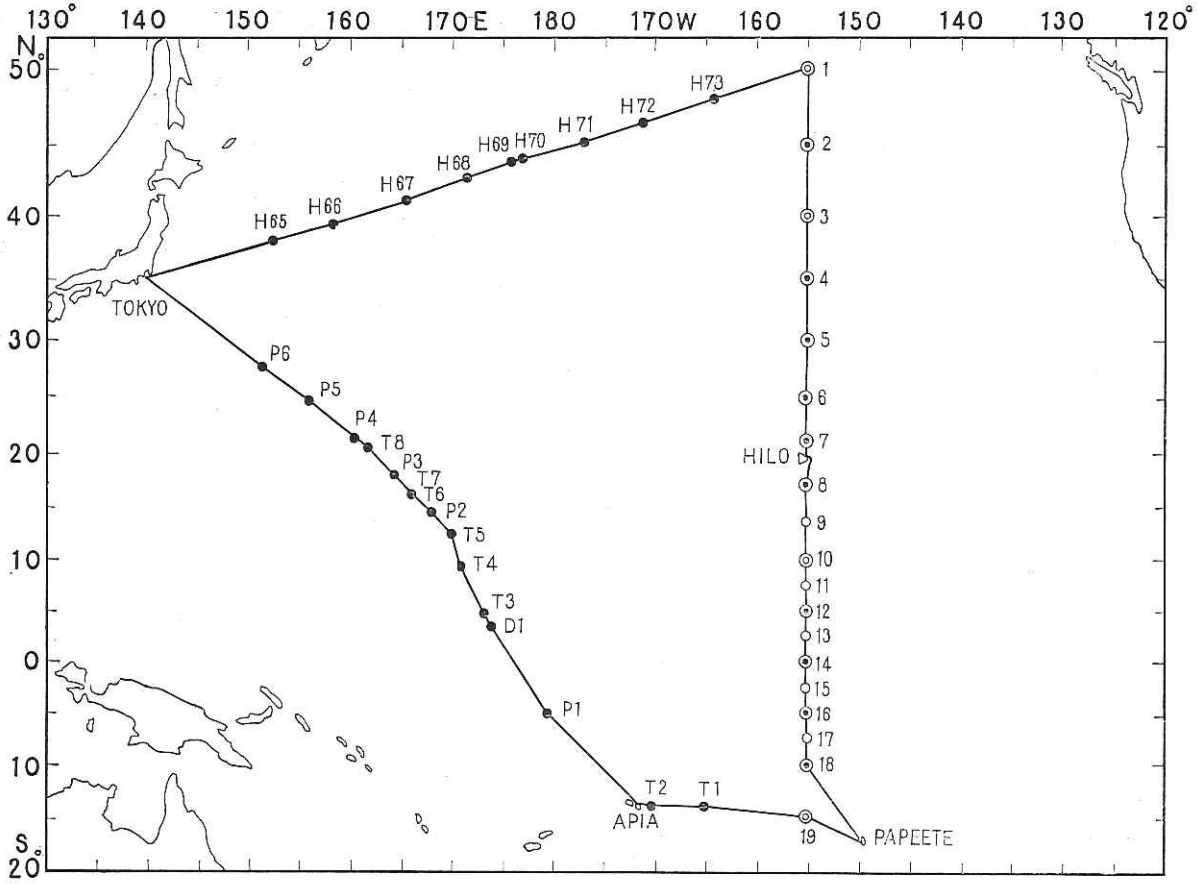

Fig. 1. Track chart of Cruise KH-69-4. ◎: 5-day station, ⊙: 18-hour station, ○: 5-hour station, H & P: Plankton station, T: *Trichodesmium* station

Outline of the research

The present study has two main themes, namely productivity and metabolism, and biogeography in the North, Central and Equatorial Pacific, as shown in Introduction, including the following research programmes.

1. Studies on dissolved organic compounds
2. Studies on distribution, metabolism and isotope ratio of nitrogenous compounds
3. Ecological studies on microorganisms with special reference to their distribution and activities of organic-matter decomposition and nitrogen fixation
4. Biochemical studies on photosynthesis and respiration
5. Taxonomy, distribution and production of phytoplankton and seston
6. Taxonomy, distribution and production and decomposition of zooplankton and micronekton
7. Distribution ecology of fish larvae
8. Studies on counting the echo pattern of individual fish, and on distribution ecology of tuna
9. Oceanographical observations in the North, Central and Equatorial Pacific Ocean

The research was carried out throughout the whole cruise course, but the emphasis was laid on observations along 155°W (Fig. 1). In this section, 4 large (5-day) stations, 10 middle (18-hour) stations and 5 small (5-hour) stations were occupied. At large stations all main items of observations were taken (refer to the following table) and variabilities were also measured for some physical, chemical, biological and biochemical elements. Each of these stations was occupied in different water masses such as St. 1 in the Pacific Subarctic Water, St. 3 in the mixing area of the Pacific Subarctic Water and the Western North Pacific Central Water, St. 10 in the northern part of the equatorial water and St. 19 in the southern part of the same water. Five small stations were supplementally occupied between 20°N and 10°S to study in detail the productivity and hydrography in the complicated equatorial current system. BT obsearvations were taken at intervals of 30 nautical miles between 8°N and 5°S to draw a detailed picture on the Equatorial Undercurrent (Figs. 14 and 15).

Plankton was collected at 9 stations in the leg from Tokyo to St. 1, while plankton samplings at 6 stations and ecological researches on *Trichodesmium* at 8 stations were done in the leg from St. 19 to Tokyo (Fig. 1). BT observations were also achieved throughout the cruise especially in relation to fish detector survey (Figs. 14, 16 and 17).

Our research works aboard are divided into two categories; one being cooperative observations for basic hydrographic and biological environmental elements which will be principally important for analysis of data obtained and another being individual observations done by each scientist or each scientific group.

Data in the first category include water temperature, salinity, oxygen, pH,

phosphate–P, silicate–Si, nitrate–N, nitrite–N, ammonia–N, chlorophyll *a*, dissolved organic carbon (DOC), dissolved organic nitrogen (DON), dissolved organic phosphate (DOP), particulate–N and particulate–C. They are tabulated as data at Sts. 1～19 in Tables 1～19 and as BT data in Table 20, and illustrated as distribution profiles along 155°W in Figures 2～12 and as T–S diagrams at Sts. 1～19 in Figure 13. Data of DOP, particulate–N and particulate–C are not presented in this report, because the analysis is not yet finished.

Outline of 29 individual research works is reported, mainly concerning the procedures, including also results and discussion in some works. Completed manuscripts on these works will be separately published later.

Items of observations

Station	1 L	2 M	3 L	4 M	5 M	6 M	7 M	8 M	9 S	10 L	11 S	12 M	13 S	14 M	15 S	16 M	17 S	18 M	19 L	Tokyo –St. 1	St. 1– St. 19	St. 19– Tokyo
Nansen-ORIT cast(1)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o			
STD–Rosette cast(2)												o	o	o	o	o	o	o				
Sampling by Van Dorn bottle ($25l \times 2$)	o	o	o	o	o	o	o	o		o		o		o		o		o	o			
Sampling by 500-l sampler	o		o							o									o			
BT observation	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
GEK observation	o	o	o	o	o	o	o	o	o	o								o	o			
Vertical haul by Norpac double net(3)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Oblique haul by ORI net(4)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Horizontal tow by ORI net(4)	o		o							o									o			
Surface tow by larva net(5)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Horizontal tow by MTD closing net(6)	o	o	o	o	o	o	o	o		o		o		o		o		o	o			o
Vertical haul by Petersen-type closing net(7)	o		o							o									o			
Oblique haul by Benthos-type multiple net										o									o			
Surface tow by MTD shark-type high-speed sampler(8)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
Surface tow by MTD VI-type high-speed sampler(9)	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
In situ experiment(10)	o		o							o									o			
Measurement by underwater photometer(11)	o		o	o		o		o		o		o		o		o		o	o			
Measurement by underwater camera			o	o	o	o	o	o		o		o		o		o		o	o			
Measurement by PDR	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o

L: 5–day station, M: 18–hour station, S: 5–hour station

Refer to item 23 for (1), 3 for (2), 19(2) for (3), 19(1) for (4), 21 for (5), 20(1) for (6), 20(2) for (7), 20(3) for (8), 19(3) for 9, 6 and 11 for (10) and 5 for (11), respectively.

1. Water masses, current systems and phytoplankton communities along 155°W

by

R. Marumo, T. Nakai and H. Hasumoto

(1) Water masses (Figs. 2~5)

In the surface water at Sts. 1 and 2 is distributed the Pacific Subarctic Water of low temperature less than 15°C and low salinity less than 33‰.

The Western North Pacific Central Water exists in the area between Sts. 4 and 7. The North Pacific Intermediate Water is widely distributed at depths from 400m to 600m between Sts. 2 and 7, being clearly indicated by salinity minimum layer.

Around St. 10, forming a southern boundary of the North Equatorial Current, the thermocline elevates up to the extremely shallow layer of 75m, indicating a steep vertical gradient of 0.3°C per meter. The distributional pattern of temperature around the equator corresponds well the current system there, while salinity and oxygen contents in this area show complicated distributions (Figs. 14 and 15). A vertical spreading of the thermocline in the equatorial area indicates the existence of the Equatorial Undercurrent at depths from 60m to 220m at St. 14.

A saline water of more than 35‰ is formed in the upper layer around St. 5 in the North Pacific, and extends southwards to 15°N, while another saline water of more than 36‰ is formed in the upper layer around St. 19 in the South Pacific and extends northwards to the equator.

The South Pacific Intermediate Water is indicated by a salinity minimum layer at the depth of about 700m around Sts. 18 and 19.

The Antarctic Bottom Water is indicated in a layer about 4000m deep by the high content of dissolved oxygen more than 4m*l*/*l*.

Water masses along 155°W are distinguished from their characters of temperature, salinity, dissolved oxygen content etc. (Figs. 2~13), as follows:

Water mass	Station
The Pacific Subarctic Water	1, 2
Mixture of the Pacific Subarctic Water and the Western North Pacific Central Water	3
The Western North Pacific Central Water	8
Boundary of the Western North Pacific Central Water and the equatorial water	4~7
The equatorial water	9~19

(2) Current systems

Patterns of current systems along 155°W were obtained on the basis of eastern and western current components calculated by the dynamic computation. The Equatorial Undercurrent was found at depths from 60m to 220m between 1.5°N and 1.5°S from the results of BT and STD observations (Figs. 14 and 15).

Current systems along 155°W are as follows:

(a) The Pacific Subarctic Current streams eastwards in the area north of 45°N (Sts. 1 and 2).

(b) The North Pacific Current streams eastwards between 45°N and 25°N. The current is strong, forming a part of the Kuroshio Extension in the

northern part (45°N~35°N, Sts. 2~4), while it is weak in the southern part (35°N~25°N, Sts. 4~6).

(c) The North Equatorial Current streams westwards between 25°N and 10°N. The current is weaker and deeper in the northern part (25°N~17°N, Sts. 6~8) and stronger and shallower in the southern part (17°N~10°N, Sts. 8~10).

(d) The Equatorial Counter Current streams easterly between 10°N and 5°N (Sts. 10~12).

(e) The South Equatorial Current streams westwards in the area south of 5°N (Sts. 12~19). There exists the Equatorial Undercurrent just below the equator. The current in the southern area (5°S~15°S, Sts. 16~19) forms a part of the South Pacific circulation.

(3) Phytoplankton communities with reference to water-mass distribution

Plankton samples were taken by vertical haul from a depth of 150m to the surface with Norpac double net composed of fine (0.09mm) and coarse (0.33mm) meshes (refer to item 19-(2)).

The Pacific Subarctic Water (Sts. 1 and 2) was characterized by the appearance of typical cold-water diatom community such as *Chaetoceros atlanticus*, *Corethron hystrix*, and *Thalassiothrix longissima*.

In the Western Pacific Central Water (Sts. 4~7), a diatom, *Hemiaulus hauckii*, was dominant, and pelagic blue-green algae including *Trichodesmium thiebauti*, *Katagnymene spiralis* and *Richelia intracellularis* (endophytic to *Rhizosolenia styliformis*, *R. acuminata*, and *R. cylindrus*, and epiphytic to *Chaetoceros compressus*) appear abundantly.

The Pacific equatorial water was characterized by the prevalence of diatoms such as *Chaetoceros atlanticus* v. *neapolitana*, *Planktoniella sol*, *Rhizosolenia bergonii* and *Thalassiothrix longissima*, while pelagic blue-green algae were hardly found there.

2. BT observations in the tropical and subtropical regions

by

A. Hattori and T. Nakai

Depth profiles of temperature in the tropical and subtropical regions were examined at 30~60 nautical mile intervals down to 250m by BT. Figures 14 and 15 were drawn on the basis of these observations supplemented with data obtained by routine Nansen casts (deeper than 250m).

3. STD observations in the equatorial region

by

T. Nakai, H. Hasumoto, E Wada and A. Hattori

The vertical distribution of salinity and temperature was measured at every station between 5°N and 10°S along the 155°W by a HYTECH Model 9006 STD Measuring System (Fig. 15). The water samples were simultaneously collected with Rosette Multi Sampler (Model RMS-12) and used for measurements of activities for nitrogen metabolism.

4. Measurement of droop value of GEK on the geomagnetic equator

by

T. Nakai and H. Hasumoto

Existing droop correction chart is only available for GEK measurement at a ship speed of 10 knots in the adjacent seas of Japan.

Accurate data of GEK droop values on the geomagnetic equator were obtained aboard Hakuhō Maru in order to make a droop correction chart available for all over the sea at different speeds.

Data obtained are as follows:

Date	Nov. 1, 1969
Position of measurement	3°36′N, 173°40′E
Depth	4875m
Length of electrode	120m
Ship speed (kt)	Droop value (cm)
13	166
10	264
6	424

5. Measurement of underwater irradiance

by

K. Satake, M. Takahashi, N. Nakamoto and Y. Fujita

Relative light intensities in subsurface layers were measured by a selenium underwater photometer fitted with a neutral filter. The relative light intensity I at a depth z can be represented by the equation:

$$I = I_0 \, e^{-kz},$$

where I_0 is the light intensity at the surface, and k the attenuation coefficient of the ambient water.

High values of k such as 0.067, 0.079 and 0.084 were observed at 50°N, 10°N and 40°N (155°W). These values are comparable with those reported for the Oyashio region. In other areas the values of k were smaller than 0.05. Assuming that the photosynthetic growth of phytoplankton is compensated at 1% of the surface illumination, the depth of the euphotic zone is roughly 70～115m.

6. Nitrogen metabolism

by

A. Hattori and E. Wada

(1) Assimilation of inorganic nitrogenous compounds

Activities of nitrogen assimilation in photic layers were measured on board by incubating the water samples, which had been collected by Van Dorn bottles from various depths, for several hours with ^{15}N labeled ammonia, nitrite or nitrate. At Sts. 1, 3, 10 and 19, the so-called *in situ* method was also adopted (refer to item 11).

(2) Oxidation and reduction of inorganic nitrogenous compounds

The rates of oxidation or reduction of ammonia, nitrite and nitrate were measured by following the change in concentrations of nitrite in the presence

and absence of added N-compounds.

(3) Denitrification

At Sts. 4, 10 and 19, the denitrification activity was examined with the water samples collected from O_2-depleted layers. After exposing to ^{15}N-nitrate for several days, dissolved gasses were extracted and saved for mass spectrometric analysis of ^{15}N- content.

(4) Nitrogen fixation

At Sts. 1, 3, 10 and 19, the activity for nitrogen fixation was measured by using ^{15}N labeled N_2. Particulates were collected by filtration and stored frozen state for mass spectrometric analysis.

(5) Counting of nitrifying, denitrifying and nitrite reducing bacteria

The numbers of nitrifying, denitrifying and nitrate reducing bacteria were estimated by growth analysis, end dilution method and plating method, respectively.

7. Natural ^{15}N abundance of dissolved substances and plankton

by

E. Wada and A. Hattori

The samples for analysis of natural ^{15}N abundance were collected in the following ways: (a) The water samples (100*l*) were taken by Van Dorn bottles from several depths (0, 500, 1000, 2000, 3000 and 4000m). Dissolved organic substances were precipitated by the addition of ferric chloride at pH 5. For nitrate, the samples were made approximately four fold concentrated by repetition of freezing and thawing. (b) Plankton samples were collected by Norpac nets or ORI nets. These samples were stored in frozen state.

8. Variability of environmental factors

by

A. Hattori, E. Wada, N. Ogura and H. Okada

At Sts. 1, 3, 10 and 19, hydrographic casts with Nansen bottles were made down to 300m every morning for 5 days to measure the variability of temperature, salinity, and concentrations of dissolved oxygen, ammonia, nitrite, nitrate, phosphate, dissolved organic carbon and nitrogen, and particulate matter.

9. Distribution of dissolved organic carbon and physicochemical properties of dissolved organic matter

by

N. Ogura

In addition to routine measurements of vertical distribution of dissolved organic carbon (Fig. 11), amounts of dissolved organic carbon of surface waters were determined throughout the cruise. The water samples, collected at intervals of 60 nautical miles (30 nautical mile interval in the tropical area), were filtered through Whatman GFC glass fiber filters. Five m*l* aliquots of filtrates were placed in glass ampoules with potassium persulfate. Before sealing the ampoules, dissolved CO_2 was removed by thorough bubbling of the sample with

N_2 gas.

The concentration of dissolved organic carbon was estimated from the amounts of evolved CO_2 which were measured afterwards by an infrared gas analyzer. Dextrose was used as a reference.

Sea water samples of about 1000*l* collected at four stations (St. 1, 10m deep, St. 3, 800m deep, St. 10, 200m deep and St. 19, 3000m deep) were filtered through GFC filters. The filtrates were adjusted to pH 2 with HCl and ferric chloride solution was added (20-mg Fe/*l*). After stirring, the solution was adjusted to pH 5 with NaOH. After standing 24 hours, precipitates of $Fe(OH)_3$ were collected and stored in a deep freezer.

Dissolved organic matter coprecipitated with $Fe(OH)_3$ was separated and examined for its elementary composition, optical properties and other physicochemical properties.

10. Photosynthesis and related reactions

by

Y. Fujita and T. Ebata

(1) Distribution of photosynthetic pigments

At all large and middle stations, spectrophotometric analysis of photosynthetic pigments was carried out using the samples obtained from various depths down to 200m. The ratios of carotenoids *vs.* chlorophylls in the samples obtained from deeper layers were generally higher than those obtained from the layer of chlorophyll maximum.

(2) Photosynthesis with chromatic lights

At Sts. 1 and 3, chlorophyll *a* (680mμ)-and carotenoids (502mμ)-sensitized photosynthetic activities were measured with samples obtained from various depths by an oxygen electron technique. The apparent quantum efficiency of the carotenoids-sensitized photosynthesis was slightly higher in the samples obtained from deeper layers than in those from shallower layers.

(3) Light-induced oxygen uptake

At Sts. 1, 3 and 10, it was found that samples which contained a large amount of non-living pigmented materials showed often a light-induced oxygen uptake. Analysis of the reaction indicated that (a) the light-energy absorbed by chlorophyll pigments induces the reaction, and that (b) the activity is largely attributable to the chlorophyll pigments contained in non-living materials. We infer that the reaction observed is identical with the "Krasnovskii" reaction, a photochemical oxido-reduction by chlorophyll pigments.

(4) Collection and isolation of phytoplankton

Culture and isolation of phytoplankton strains were attempted on board. More than 10 strains of diatoms and several strains of blue-green algae were obtained as unialgal culture.

11. Depth profile of photosynthetic productivity

by

M. Takahashi, K. Satake and N. Nakamoto

Depth profiles of photosynthetic productivity were examined by *in situ* and

tank method at Sts. 1, 2, 3, 6, 10, 12, 14, 18 and 19 (underlined one shows the station where *in situ* experiments were undertaken). ^{14}C labeled carbonate was used as a tracer. The glass bottles filled with water samples from various depths were held from noon to sunset at the depths from where the waters had been collected. In addition, the water samples were kept at three depths which were different from their original ones to see the difference in ability of light utilization. With the same samples, the light dependence of phtosynthesis was simultaneously examined on board by the tank method. The sample bottles were illuminated for 3 hours with a bank of daylight fluorescent lamps; the light intensities were adjusted by covering the bottles with dark blue nets.

12. Chlorophyll distribution, photosynthetic activity and the number and size distribution of particles

by
N. Nakamoto

In addition to routine measurements of vertical distribution of chlorophylls (Fig. 12), the surface waters were collected at 60 nautical mile intervals (30 nautical miles in the tropical area)to see horizontal distribution of chlorophylls. The samples were filtered through Whatman GFC filters coated with $MgCO_3$ immediately after sampling, and the amounts of chlorophylls in collected materials were determined on board by the method of Yentsch and Menzel.

The daily variations of chlorophylls and photosynthetic activity of phytoplankton were measured with the samples collected at several stations. Enrichment cultures were carried out on board at different temperatures between 10° and 30°C.

The number and size distribution of particles in sea water were measured by a Coulter Counter at several stations.

13. Assimilation and decomposition of glucose

by
M. Takahashi and K. Satake

The microbial activities of seawater for assimilation and decomposition of glucose were estimated at Sts. 1, 3, 5, 7, 10, 12, 14, 16, 18 and 19 by using uniformly ^{14}C labeled D-glucose. The sample waters (100m*l* each) were incubated for 3 hours with 60μg glucose (0.5μ Ci). Assimilation activity was calculated from amounts of radiocarbon incorporated into particulate matter which was collected on HA Millipore filters. After adding 1m*l* of 20% HCl, the filtrates were aerated with CO_2-free air, and CO_2 was trapped in 1/5N $Ba(OH)_2$. $BaCO_3$ formed was collected on a Millipore filter and its radioactivity was measured by a 2π gas-flow counter.

14. Vertical distribution of particulate proteins, chlorophylls, ribonucleic and deoxyribonucleic acids

by
M. Takahashi

For the estimation of a total biomass, the water samples were collected from various depths (from surface to near bottom) at Sts. 1~8, 10, 12, 14, 16, 18 and 19. Particulate materials were collected on Gelman filters, and amounts of chlorophyll *a*, proteins, ribonucleic and deoxyribonucleic acids were determined by the method of Iwamura et al. (1967, 1969). Chlorophyll *a* was abundant at surface layers shallower than 200m, and the other three were distributed ubiquitously through the whole water column. In the subtropical and tropical areas, concentrations of nucleic acids and proteins in the water samples deeper than 200m were comparable with or sometimes exceeded those observed in the surface waters. This work was carried out in collaboration with Dr. S. Ichimura and Miss H. Nagai.

15. Distribution and properties of carbohydrates, proteins, lipids, chlorophylls and bulk organic matter

by
K. Satake

At four stations, 500 to 1000*l* of waters were collected from three layers between the surface and the depths of 1000~3000m for the analysis of carbohydrates, proteins and lipids. Particulate materials were collected on Whatman GFC glass fiber filters and the filters were stored in frozen state.

Particulate materials were also collected from water samples obtained from various depths down to 200m. Analysis will be made afterwards with respect to chlorophylls, their derivatives, carbonate carbon and organic carbon in collaboration with Dr. Y. Saijo. With aliquots of the same samples, size distribution of organic matter was also examined.

16. Particulate organic matter

by
S. Nishizawa

Two hundred and eighty samples in total of suspended particulate material were collected from various depths down to the vicinity of the bottom at 14 stations in the eastern Pacific along 155°W line from 50°N to 15°S. One third of the total was duplicated samples, and one fourth triplicated ones. Each sample water was filtered on board immediately after sampling through a glass fiber filter, and the filter was stored at −20°C with the residue. Elemental analysis of these samples for particulate carbon and nitrogen are now under progress. A series of samples composed of one of the triplicates will be subjected to decomposition process that will last at least 100 days at room temperature with an initial inoculum of a few m*l* of raw surface seawater.

An additional program of skimming the surface skin of the ocean was performed. Although this was done at only one station at the equator, the obtained

results show that a high concentration of dissolved and particulate organic matter occurs just at the sea surface. Unique communities were also identified from the skimmer samples. This work was undertaken in collaboration with Drs. N. Taga, N. Ogura and R. Marumo.

17. Distribution of phytoplankton

by

O. Asaoka and R. Marumo

Horizontal and vertical distributions of phytoplankton were investigated for specific levels with special reference to diatoms, dinoflagellates, cyanophytes and tintinids. The water samples were collected at all stations by Van Dorn bottles from various depths down to 1000m. The samples of phytoplankton were quantitatively collected on HA Millipore filters and inspected on board under microscope. Aliquots of the sample waters were subjected to formalin treatment and saved for later detailed examinations. In addition, the samples of surface waters were collected at 60 nautical mile intervals throughout the cruise, and at 30 nautical mile intervals in the tropical area. The samples were processed and inspected in the same way as above. A part of the samples was sent to Mr. M. Ōwada, Maizuru Marine Observatory.

18. Nanoplankton

by

H. Okada

The water samples were collected at 60 nautical mile intervals throughout the cruise and at 30 nautical mile intervals in the tropical area for systematic studies and morphological examination of nanoplankton. In addition, a number of water samples were collected along subphotic water columns, and the feature of disintegration and surface erosion of coccoliths were investigated in connection with that of deep-sea sediments.

The water samples previously filtered through 150-mesh brass net, were filtered through Millipore filters. The filters were rinsed and dried, and examined afterwards by a phase-contrast, electron or scanning microscope.

The results are summarized as follows: (a) The population of nanoplankton is highest at photic layers in the northern part of the Pacific (1×10^5 cells/l or more). In the temperate area, waters are less populated (5×10^2 cells/l). Intermediate numbers were found in the tropical area (1×10^4 cells/l on an average). (b) Although the population density is high in the northern Pacific, the specific composition is quite simple; it consists mainly of three species, which are restricted to the upper euphotic layer. In the tropical area, more than 60 species are found. The local variation of specific composition is common. (c) In the tropical area, the upper layer (0～100m) is occupied by diverse flora of nanoplankton. In lower layers, the flora becomes monotonous; only a few species with peculiarly shaped coccoliths are found.

19. Sampling of zooplankton·····I

by

T. Nemoto, M. Murano, M. Terazaki and Su Bu Lee

(1) ORI net tow

One of the two main themes of the expeditionary Cruise KH-69-4 was biogeographical studies on macroplankton and micronekton in the North Pacific Ocean. It was hoped that the sampling would cover a wide area along tracks and the depth from the surface through deep water, but major effort of zooplankton sampling had to be centered along the longitude 155°W from the latitude 50°N to the latitude 15°S, since the observation stations for other joint programs were occupied on this longitude, taking sufficient time of operation. Supplementary sampling was made during eastward and westward legs to and from 155°W.

At four of 19 stations on 155°W, the ship stopped for 5 days at each station to complete a series of observation and experiments on hydrography, chemsitry, bacteriology, and biology. At this opportunity a 160-cm ORI conical opening and closing net, made of 1.0-mm mesh filtering cloth, was towed obliquely through the layer of 0～1000m, and horizontally through the depths of 200, 400, 700, 1000, 1500 and 2000m (in wire out). The net was equipped with a TSK depth-distance meter on the mouth ring and a RGS flow-meter at the center of the mouth ring. On account of shortage of gears, simultaneous serial tows with several numbers of ORI nets were not adopted; the tow had to be done separately for each of the depths, taking about 9 hours for completion of successive 8 tows, The opening and closing mechanism by a double release system acted reliably, excepting a few cases. Such tows were repeated by day and by night, each twice at a station. Sixteen serial tows at each of 4 stations on 155°W were completed.

At other 15 stations on 155°W and also on the eastward and westward legs to and from 155°W, 34 surface tows and twenty-one 2000-m (wire out) oblique tows have been conducted.

The number of samples obtained by ORI-net tow amounted to 192 in total. The samples were preserved in 10% formalin seawater solution, and will be sorted on land into about 20 groups, *i. e.*, molluscs, chaetognaths, copepods, ostracods, isopods, amphipods, mysids, euphausiids, decapods and fish etc. and then each group is separately weighed in wet condition before being distributed to specialists. Some specimens contained in samples were picked up and kept alive on board for special experiments (refer to 22).

(2) Norpac net haul

As a standard method widely employed in CSK (Cooperative Study of the Kuroshio and Adjacent Regions) and other projects in the Pacific Ocean, 150 ～0-m vertical haul with a Norpac net was made at each station on 155°W. A 45-cm conical Norpac double net (the inner net made of 0.33-mm mesh cloth, the outer one made of 0.09-mm mesh cloth) was hauled from an estimated depth of 150 meters upward to the surface. Settling volume of the samples determined by Dr. R. Marumo on board has shown that the volume of total sum of fine and coarse mesh net samples was extraordinarily large in the subarctic water (50°N), and small around the North Equatorial Current (20～10°N). It again increased in the south of the South Equatorial Current, though remarkably

decreasing at 15°S. Mean ratio of fine mesh net samples to coarse mesh net samples was 11 : 3, except at 40°N where the cirriped larvae unusually occurred in a large number in the coarse mesh net (refer to 20–(2)).

(3) High-speed sampling with MTD VI sampler

A MTD VI high-speed sampler, 6.5cm in mouth diameter, 15cm in diameter of outer casing, installed with 0.33-mm mesh net and flow-meter, was towed at night at 10 knots for 30 minutes by paying out the wire cable as long as 75 meters. The sampling covered the whole courses, amounting to a total of 34 tows. The samples are placed for the examination of species composition as well as for carbon and nitrogen analysis. Effectiveness of this sampler can be compared with that of MTD shark high-speed sampler which was towed on this cruise at the same time (refer to 20–(3)).

20. Sampling of zooplankton……II

by
S. Motoda and M. Kotori

(1) Collection of zooplankton from several different depths in the upper 500 meters

The collection was designed to obtain comparable samples from different depths in the upper 500 meters. A detailed pattern of vertical distribution of animals would be useful to compare it with optical, physical or chemical structures of the sea, for discussing the depth preference of animals and, in turn, their metabolic effects on the substances in the water. For the simultanous horizontal tows with a number (ten nets in the first tow, then 9 nets) of MTD horizontal closing nets, 56cm in mouth diameter, made of 0.35-mm mesh filtering cloth, positioned at different depths, were employed. Such serial tows were completed at 15 stations on 155°W, and at 4 of 15 stations the samplings covered daytime and night. The number of obtained samples amounted to a total of 159, excepting failed samplings. An aliquot subsample was filtered through a glass-fiber filter and kept frozen for later determination of dry weight, carbon and nitrogen. The remainders were preserved in 10% formalin seawater solution for identification.

Biomass as expressed in wet weight of the samples was normally rich in the upper layer down to 100-m depth, becoming very poor in the lower layer of 200-m thickness. In the subarctic water (St. 1, 50°N) an extremely high concentration of *Calanus plumchrus* at the 20~50-m depth in daytime was characteristic. This maximum layer of *Calanus* biomass moved up to the surface at night. At St. 3 (40°N) the population in the shallow layer was almost entirely composed of cirriped larvae. They swarmed around 60 meters in daytime, and migrated up to 30 meters or therearound at night.

Mean biomass through the upper 500 meters was as large as 400~200g/1000 m^3 in the subarctic water (50°N), while it was less than 40g/1000m^3 in the southern region (35°N~13°30′N). An increase in biomass (75g/1000m^3) at 10°N, where the upwelling water was suggested by the temperature and salinity distributions, was due to a large mass of solitary salps and colonical firebodies at 25~74 meters. Around the equator (2°30′N~2°30′S) the biomass again increased (57g/1000m^3). The biomass was extremely poor at 15°S (16g/1000m^3). General tend-

ency of variation in biomass along 155°W was coincident with the results obtained by 0～150-m vertical haul (refer to 19–(2)), except at 10°N.

(2) Divided vertical hauls with a fine mesh closing net

A 80-cm Peterson closing net, made of 1.0-mm mesh cloth, was hauled from 4000m to 3000m, from 3000m to 2000m, from 2000m to 1000m, from 1000m to 500m, from 500m to 150m, and from 150m to the surface, at 4 stations on 155°W. This was for obtaining small-sized organisms from shallow through deep waters separately for various depths. During the haul the ship was mancuvered to keep the wire cable in nearly vertical position by operating the bow thruster. The net was closed, after it had been hauled for a desired distance, by striking of a messenger weight without stopping the haul. The messenger weight was lowered at a calculated time to reach the release on the net just at the desired depth (haul at 1m/sec, messenger sinking at 3m/sec). It took usually about 7 hours to complete a series of 6 hauls. Specimens obtained were very small in number, especially in deep haul, so that they were preserved without any preliminary processing.

(3) High-speed sampling with MTD shark sampler

While the ship was underway, a MTD shark high-speed sampler, 15cm in mouth diameter, 30cm in diameter of outer casing, installed with a 0.35-mm mesh net and a flow-meter, was towed at night at 10 knots for 20 minutes by paying out the wire cable as long as 150 meters. The sampler supposedly ran through a few meters below the sea surface, but anyway the water flowing behind the stern was the water that had been stirred by the motion of the ship's propellers. A total sum of 41 samples was obtained during the sail on the whole courses.

On 155°W the biomass (in wet weight) was more than 100g/1000m^3 at 50°N (cf. 983g/1000m^3 at 50°N, 155°W at the surface at night, MTD horizontal net), decreasing to less than 42～5g/1000m^3 in the south (44°24′N～2°23′N). An increase in biomass (116g/1000m^3) was shown also at 1°S as in the Norpac net data and in the MTD horizontal net data, though the increase was less than in this case. The biomass at 14°55′S was extremely poor (3.6g/1000m^3) coinciding with the Norpac and MTD net data.

A quarter aliquot of the sample was filtered through a glass-fiber filter and kept in cold storage for later analysis of dry weight, carbon and nitrogen. Other parts were preserved in 10% formalin seawater solution. Sometimes several individuals of a certain species were picked up from the samples for determination of dry weight, carbon and nitrogen of an individual body.

21. Sampling of fish larvae

by

T. Ozawa

For studying regional distribution of fish larvae in the North and Equatorial Pacific Ocean, efforts were made for collecting fish larvae, not limited to commercially important species, during the cruise whenever opportunities were available. With a 160-cm larva net, 0.5-mm mesh size, surface tows were made for 20 minutes at a speed of 2 knots every night while underway, 71 tows in total. At 4 stations on 155°W, in addition, tows were made through the surface

water and in the layers above, at and below the thermocline in daytime and at night, 32 tows in total. With special interests in the subtropical convergence of the North Pacific which is a suggested barrier of distribution of mesopelagic fish, surface and oblique tows (450-m wire out) were made at night with a 3.0-mm mesh net, 160-cm in mouth diameter, at 3 knots in the convergence and adjacent areas, 10 tows in total. Some collections of fish larvae were supplemented from the samples taken by horizontal tow with the MTD closing nets through a certain depth. Specimens of fish larvae were all preserved in 10% formalin solution for later identification.

22. Experimental works on zooplankton

by

R. Marumo and T. Nemoto

When appropriate specimens of zooplankton were available from the samples, mostly from the samples taken by 0~2000m ORI net oblique tow, they were placed to various kinds of laboratory experiments on board. Experiments and participants are as follows:

(1) Chlorophyll in the stomach contents of zooplankton (T. Nemoto)

The quantity of chlorophyll pigments (principally chlorophyll *a* and phaeophytin-type pigments) in the stomach and fecal pellets of zooplankton was measured by fluorometric method.

(2) Fecundity of macrozooplankton (T. Nemoto)

The weight, number of eggs in the body or in the porchs of gravid females were examined for macrozooplankton mainly of euphausiids and decapods.

(3) Excretion of inorganic nitrogen and phosphate from zooplankton (T. Nemoto, A. Hattori, K. Satake, E. Wada and N. Nakamoto)

Rates of excretion of nitrogen and phosphate from several species of zooplankton, belonging to euphausiids, copepods and decapods were measured on board.

(4) Carotenoids and chemical composition of chaetognaths (M. Tarazaki)

The quantity of carotenoid pigments in the body of deep sea chaetognaths was measured by Shimadzu Recording Spectrophotometer D40R. After leaving a ship, chemical composition of the frozen samples is analyzed in our seminar.

(5) Grazing and respiration of copepods (Su Bu Lee)

The amount and size fraction of phytoplankton taken by zooplankton were measured by using a Coulter Counter, and the diurnal change of O_2 consumed by various species of zooplankton was measured continuously with an oxygen recorder.

23. Distribution and biochemical activities of heterotrophic bacteria

by

N. Taga

In order to clarify the distributional mode of total bacterial biomass and the viable heterotrophic bacteria, the vertical seawater samples were collected at 19 stations along the longitude 155°W by using the Nansen bottles and the sterile ORIT-type samplers (Taga, 1968).

A 100-m*l* portion of seawater sample of the Nansen bottle was filtered through a sterile Millipore filter (GS–25mm) for the estimation of total bacterial biomass. The filter was rinsed and dried at 80°C and clarified on a slide glass by a small amount of the Cargille's immersion oil (R. P. Cargille Labo. Inc.), then the bacteria on it were directly counted by the phase-contrast microscope. For the viable counting of heterotrophic bacteria, duplicate 10 to 50-m*l* portions of seawater sample of the ORIT sampler were also filtered through sterilized Millipore filters (HA–45mm). The inoculated filters were placed on the agar plates of Medium PPES–II (Taga, 1968) in Petri dishes and incubated at 18°C for two weeks before colonies on filters were counted. The vertical distribution profile of bacterial population in the investigated area is expected to be represented in near future.

On the other hand, thousands of heterotrophic bacterial strains were purely isolated from the plates after counting procedures. These strains are now under examination as to their taxonomical and biochemical properties.

24. Microbial aspects of nitrogen fixation in sea water

by

Y. Maruyama

In order to clarify the fact of nitrogen fixation in sea water, the occurrence of nitrogen-fixing bactria in sea water was exmined in this cruise, and the over-all activity of nitrogen fixation of the seawater samples was measured.

Horizontal and vertical distributions of bacteria growing on two different kinds of non-nitrogenous media were investigated at 20 stations. A larger bacterial population in sea water column was found in the areas of latitudes 5°N and 40°N. The bacterial number in these stations was about 10^3 cells in 100m*l* of sea water. On the contrary, a smaller density of bacterial biomass was found in the areas of latitude 50°N and of latitudes 25° to 20°N, and in the southern Pacific area.

The number of the bacteria attached to plankton was counted at 4 stations. In most cases, the population of bacteria attached to plankton was much larger than that of free-living bacteria in sea water. It was also found that almost all of the bacteria attached to a blue-green alga, *Trichodesmium*, were able to grow on non-nitrogenous media.

At several stations, the activity of nitrogen fixation in seawater samples, which were collected from the layers of surface and the depths of 100 and 400m, was measured by both of the acetylene reduction and tritium methods. These experiments are now being continued in the laboratory.

25. Ecological aspects of bacterial flora attached to plankton

by

O. Matsuda and N. Taga

Any approach has not been made up to the present in order to know the basic mode of the microbial flora attached to plankton and/or associated with them in sea water. In this cruise, some ecological observations were made in

regard to the flora of heterotrophic bacteria attached to plankton.

Plankton samples were collected at 14 stations by using the Norpac double net, made of two kinds of bolting cloth XX 13 (0.09-mm mesh) and GG 54 (0.33-mm mesh). Two different sizes of plankton samples were obtained fractionally at the same time by vertical hauls of this net in the depths from 150 to 100m and from 50 to 0m. Plankton samples of large size were mainly composed of zooplankton, while those of small size were composed of phytoplankton, including smaller zooplankton in some cases.

After homogenizing a part of each plankton sample with the fixed volume of sterilized seawater mixture of 3 ppm Tween 80 in a sterilized blender, the enumeration and isolation of the attached bacteria was made by inoculating the mixture sample on the nutrient agar plates.

As a general result of approximate estimation, it was found that the population of attached bacteria on plankton was sufficiently large in comparison with that of freely suspended bacteria in seaweter column from the surface to the depth of 150m. Particularly at 9 stations, the bacterial population on plankton was obviously larger than that in the seawater samples.

Some other examinations are now continued in the laboratory with special reference to the biochemical and taxonomical properties of the isolated bacteria in this investigation.

26. Mineralization of organic matter by microorganisms

by

A. Uchida and I. Kawada

In order to evaluate the activity of microorganisms in the process of mineralization of organic matter in the water columns in the Pacific Ocean, the present authors carried out the direct estimation of the mineralization activity of sea water at the main stations by use of uniformly labeled ^{14}C-glucose and uniformly labeled ^{14}C-alanine as the substrates. The method by Kadota, Hata and Miyoshi (1966) was employed after being modified slightly.

The data obtained indicate that, in most of the stations, more than 90% of the mineralization activity of organic matter is found in the depths of less than 1000m, the activity being decreased with increase of depth. In the deeper water the activity was hardly detected at all the stations investigated.

About 0.1~2.0mg carbon per m^3 of sea water per day was mineralized in the upper layers. These values are approximately the same to that reported by Rittenberg (1963).

27. Distribution of chromogenic bacteria

by

I. Kawada and A. Uchida

The relation between the distribution of chromogenic bacteria and environmental factors in water columns at various stations in the North and Equatorial Pacific Ocean was examined. The sampling and counting were performed by the method essentially the same as described by Kawada (1969).

It was found that chromogenic bacteria at the stations examined were

generally small in number as compared with aerobic heterotrophic bacteria, and that most of the chromogenic bacteria were distributed in the water of less than 200m in depth; the maximum population of them was generally found at the surface layer of water column. In the deeper water, few chromogenic bacteria were found.

Detailed analysis of the relation between the distribution of chromogenic bacteria and environmental factors in the sea is now in progress.

28. Counting the echo patterns of individual fish by pattern analysis method

by
T. Ishii

The fish detector project was conducted during this cruise for three objects as follows: 1) collection of the records of fish detector; 2) development of the program and system for counting the echo of fish; 3) direct counting of the echo patterns of large-sized individual fish such as tuna, using the pattern analysis technique with the digital computer in order to furnish quantitative information for the population dynamics.

For this project, four attachment devices were built (FFP–AD–O and FFP–AD–I by Sanken Elec. Co.; and FFP–AD–II and FFP–AD–III by Kokusai Elec. Corp.), and they were inserted between the fish detector (Sanken Elec. Co., TU–32) and the computer (FACOM 270–20).

The records of the fish detector were obtained at 47 stations (Sts. F–1～F–47) as shown below:

1) Tokyo — St. 1: 3 stations (daytime)
2) St. 1 — Hilo: 5 stations (at intervals of 5° in latitude, daytime)
3) Hilo — St. 18: 21 stations (at intervals of 2.5° in latitude, daytime, morning and evening)
4) St. 18 — Apia: 9 stations (daytime)
5) Apia — Tokyo: 9 stations (daytime)

The echo signals were recorded in the magnetic tape by the data recorder (TEAC Co., R–351F) at the ship speed of 4 or 6 knots for 45 minutes at each station. These records of echo signals are very useful for the analysis of the latitudinal variation in the number of the echo pulses or echo patterns to evaluate the variation of population density, and for designing the standard mask to recognize and count the echo patterns. These recordings were carried out in consideration of the experimental design so that it is possible to analyze the variation of echo pattern within a day.

The program and system were completed for the record of echo pulse and for recognition and counting of pattern by the computer (FACOM 270–20) on board the R/V Hakuhō Maru. These programs were written by FASP for analysis in each process as follows;

Program 1: In each transmission of ultrasound, the time from the transmission to the receiving of the echo pulse is stored on the magnetic core memory (real time process, Level 8).

Program 2: The transmission of the data from the core memory to the magnetic drum (Level 9).

Program 3: The punch-out of the data from the magnetic drum to the paper tape in the type of pure binal for the pattern analysis.

Program 4: The punch-out of the data for the printing by the offline typewriter.

Program 5: The pattern analysis of echo in the case of offline system, and the input readings from the paper tape punched by the program 3.

Program 6: The pattern analysis of echo in the on-line real time process.

Besides these programs, some programs were provided for the setting of initial condition and the connection of main programs.

For counting the echo patterns by the data obtained in this cruise, in the first step, the data of the time of receiving echo pulse were converted from analog to digital and was punched out on the paper tape by Programs 1, 2 and 3.

From the test of program about counting of echo pattern in some examples, it was found possible to count directly the echo patterns by this system though there are a few problems to be solved. The counting of echo patterns from the records obtained during this cruise is left for the future work.

The author wishes to express his thanks to Mr. T. Igarashi, the operator of computer, for his help throughout the work.

29. Relationship between the acoustic scattering layer and the swimming layer of tuna

by
J. Morita

For ecological studies of tuna, it is a useful way to analyze the movement of the swimming layer and its relation to the acoustic scattering layer (SL or DSL) which is considered to be formed by some species of plankton. These plankton organisms might be very important for the bait of tuna. However, because of the difficulty of the direct sampling of organisms in these layers, the acoustic survey has been undertaken for the collection of the information in some countries, but only several papers have been published.

Along 155°W in this cruise, SL survey was carried out to study the acoustic property and its relation to the swimming layer of species like tuna.

The reflection loss of these layers was measured by a fish detector (Sanken SU-32, Frequency 28KHz, pulse length 0.7 or 2.0 msec.). These records were collected at a ship speed of 9 knots under way, and less than 4 knots at oceanographic observational stations. The observed range of depth is 800m from the surface.

Except bad weather condition, the reflection loss was measured as follows:

Tokyo — St. 1	noon and sun set
St. 1 — St. 19	noon and midnight
St. 19 — Apia	noon and midnight
Apia — 5°S	noon
5°S — 5°N	0900, noon and 1500
5°N — 15°N	noon

At 4 large stations (Sts. 1, 3, 10 and 19), 24-hour observations were carried out and data were obtained at an interval of 15 or 30 minutes with two pulse

length (0.7 and 2.0 msec.).

The results are summarized as follows: (1) There was the significant difference in the reflection loss, among five areas (Area I: 50°N~30°N, Area II: 30°N ~11°N, Area III: 11°N~5°N, Area IV: 5°N~7°S and Area V: 7°S~15°S). (2) From the result of 24-hour observations, the reflection loss of SL in daytime was different from that by night. (3) The pulse length (0.7 or 2.0 msec.) gave an effect on the value of the reflection loss. (4) SL in Area V was rather obscure than that in other areas by records of the fish detector. (5) In Area V, a phenomenon was noticed. Namely, at first the image showed a scattering layer, but then it was separated one by one into individual fish. The mean depth of this layer was 220m and the thickness of the layer was about 50m.

Results of detailed analysis on the relation between SL and the swimming layer of species like tuna will be discussed in the further report.

Explanation of data

Data from Nansen and Van Dorn casts (Tables 1~19)

1-N: Nansen cast at St. 1

2-V: Van Dorn cast at St. 2

Latitude, Longitude: mean position of the beginning and the end of observation

Depth: reading of PDR without correction

Current: measured by GEK

Wind, Sea, Swell, Weather: observed simultaneously with Nansen cast

* : value doubtful

( ): interpolated or extrapolated

D (N): depth observed in Nansen cast

S (‰): measured by T. Nakai, A. Uchida, H. Hasumoto, M. Kotori, I. Kawada, T. Terazaki, O. Matsuda and Su Bu Lee with Auto Lab Model 601 MK III inductive salinometer

D (V): depth observed in Van Dorn cast

D (S): standard depth interpolated in Nansen cast

O_2 (ml/l): measured by M. Murano by the method described in Manual of Oceanographic Observations (Oceanographical Society of Japan, 1963)

pH: measured by Y. Maruyama, A. Uchida, I. Kawada and O. Matsuda by Hitachi-Horiba type F-5 pH Meter

PO_4^{-3}-P* (μg atoms/l): measured by N. Nakamoto by the method of Murphy and Riley (Anal. Chem. Acta, **27**, 31, 1962)

SiO_2-Si* (μg atoms/l): measured by Y. Fujita and T. Ebata by the method described in a Manual of Oceanographic Observations (Oceanographical Society of Japan, 1963)

NO^-_3-N (μg atoms/l): measured by A. Hattori, E. Wada and M. Takahashi by the method of Wood, Armstrong and Richards (J. Mar. Biol. Ass., U. K., **47**, 23, 1967)

NO^-_2-N* (μg atoms/l): measured by A. Hattori, E. Wada and M. Takahashi by the method of Bendschneider and Robinson (J. Mar. Res., **11**, 87, 1952)

NH^+_4-N (μg atoms/l): measured by N. Ogura by the method of Sagi (Ocean. Mag., **13**, 43, 1966) modified by A. Hattori and E. Wada (unpublished)

DON (Dissolved organic nitrogen, μg atoms/l): measured by K. Satake and Y. Saijo by the UV oxidation method of Armstrong, Williams and Strickland (Nature, **211**, 481, 1966)

DOP** (Dissolved organic phosphate): measured by K. Satake and Y. Saijo by the UV oxidation method of Armstrong, Williams and Strickland (Nature, **211**, 481, 1966)

DOC (Dissolved organic carbon, mg/l): measured by N. Ogura by the method of Menzel and Vaccaro (Limnol. Oceanog., **9**, 138, 1964)

Chl. (Chlorophyll *a*, μg/m^3): measured by N. Nakamoto by the fluorometric method of Yentsch and Menzel (Deep-Sea Res., **10**, 221, 1963)

Particulate nitrogen** and particulate carbon**: measured by S. Nishizawa by combustion method

* Standard solutions of phosphate, silicate and nitrite were kindly provided by Dr. K. Sugawara, Sagami Chemical Research Center.

** These data are not presented in this report.

Data from BT observations (Table 20)

T (°C) at max. dep.: reading at the deepest point on BT trace

SLD (m): surface layer depth, thickness of surface isothermal layer

Table 1. Data from Nansen and Van Dorn casts at St. 1.

Station	Cast	Latitude	Longitude	Date	Ship time													
1	1–N	50–00N	155–01W	Aug. 22, 1969	07:49～11:24	Depth 4815m	Current 225°, 0.3kt	Transp.	19m	Air temp. 14.2°C								
	1–V	49–57N	155–01W	Aug. 22, 1969	12:30～16:53	Wind NW–3	Sea	NW–3	Swell	NNW–2	Weather	cloudy						

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P (	SiO_2–Si	NO_3–N μg atoms/l	NO_2–N	NH_4–N	DON)	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
0	12.05	32.604	24.75	6.28	100	7.96	1.09	22.5	10.1	0.16	0.80	7.3	0.98	0	256	0	12.05	32.604	24.75
10	(11.90)	608	77	6.28	100	8.00	1.09	22.5	10.1	0.16	0.52	8.4	0.86	10	311	10	11.90	608	77
20	11.83	597	78	6.37	101	8.00	1.11	25.0	11.7	0.15	0.43	10.1	0.80	20	276	20	11.83	597	78
30	11.78	593	79	6.31	100	7.81	1.12	25.0	10.5	0.15	0.43	10.0	1.06	30	373	30	11.78	593	79
49	5.65	801	25.90	7.24	101	7.85	1.48	35.0	15.8	0.22	0.66	10.9	0.93	50	227	50	5.60	803	25.90
74	4.00	834	26.09			7.94	1.61	36.0	16.7	0.78	0.35	9.9	0.99	75	288	75	3.99	835	26.09
98	3.95	842	10	7.09	96	7.96	1.63	38.0	18.3	0.00	0.41	10.7	0.95	100	89.4	100	3.94	843	10
123	3.81	33.027	26	6.14	83	7.89	1.88	43.0	22.0	0.00	0.35	11.0	0.81	125	20.0	125	3.81	33.100	27
147	4.05	468	59	4.51	61	7.78	2.37	55.5	28.2	0.00	0.29	9.0	0.79	150	17.5	150	4.05	475	60
196	4.00	673	70	3.58	49	7.66	2.65	66.0	32.1	0.00	0.37	13.7	0.90	227	6.2	200	3.99	682	77
291	3.78	899	96	1.22	17	7.44	3.20	91.0	41.0	0.00	0.41	9.6	0.70	410	1.6	300	3.77	911	97
385	3.68	34.029	27.07	1.01	14	7.48	3.30	102.0	43.2	0.00	0.35	11.7	0.72	593	1.8	400	3.67	34.043	27.09
477	3.60	110	15	1.09	15	7.49	3.28	115.0	43.8	0.00	0.39	15.2	0.72	786	3.2	500	3.58	124	16
569	3.45	(171)	21	0.55	7	7.55	3.30	119.0	44.0	0.00	0.30	7.5	0.72	959	1.1	600	3.42	190	25
757	3.19	276	32	0.55	7	7.58	3.40	132.0	43.8	0.00	0.35	8.4	0.54	1414		800	3.11	299	35
953	2.89	365	41	0.84	11	7.52	3.27	141.0	42.9	0.00	0.45	11.3	0.75	1898		1000	2.80	379	44
1106	2.68	410	47	0.68	9	7.38	3.28	141.0	44.9	0.00	0.51	11.8	0.54	2878		1200	2.55	434	50
1388	2.35	480	56	1.36	18	7.66	3.23	155.0	41.4	0.00	0.48	6.7	0.70	3871		1500	2.27	501	58
1862	2.01	560	65	1.85	24	7.64	3.15	160.0	36.5	0.00	0.51	10.5	0.60			2000	1.94	580	67
2335	1.78	615	70	2.44	32	7.63	3.06	160.0	37.6	0.00	0.52	9.0	0.50			2500	1.71	624	72
2810	1.64	637	73	2.86	37	7.77	2.88	156.0	33.3*	0.00	0.23	8.6	0.63			3000	1.62	648	74
3276	1.55	661	77	2.99	39	7.72	2.74	153.5	35.4	0.00	0.37	9.9	0.55			3500	1.52	668	78
3765	1.50	672	78	3.63	47	7.81	2.61	156.0	33.2	0.00	0.35	6.2	0.56			4000	1.52	675	78
4244	1.55	(675)	78	3.72	48	7.76	2.65	154.5	26.7	0.00	0.48	6.2	0.58			4500	(1.55)	(678)	(78)

Table 2. Data from Nansen and Van Dorn casts at St. 2.

Station	Cast	Latitude	Longitude	Date	Ship time															
2	2-N	45-03N	155-57W	Aug. 28～29, 1969	20:30～01:10	Depth	5400m	Current	79°, 0.4kt	Transp.		Air temp.	17.2°C							
	2-V	45-04N	154-53W	Aug. 29, 1969	03:55～09:27	Wind	SW-6	Sea	SW-5	Swell	W-6	Weather	cloudy							

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4-P	SiO_2-Si	NO_3-N	NO_2-N	NH_4-N	DON	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
							(		μg atoms/l				)						
0	15.55	32.795	24.18	5.98	102	8.01	0.63	23.5	2.4	0.02	0.70		1.05	0	333	0	15.55	32.795	24.18
11	15.29	794	23	6.04	103	8.08	0.64	38.5	1.9	0.035	0.90		0.90	10	309	10	15.30	794	23
21	15.25	794	24	5.98	102	8.10	0.64	17.8	2.0	0.02	0.62		0.71	20	307	20	15.25	794	24
32	10.32	891	25.29	7.22	112	8.07	0.66	30.0	3.4	0.18	0.63		0.80	30	288	30	11.00	883	25.15
53	7.44	939	76	6.94	101	8.03	0.94	34.5	5.1	0.07	0.91		0.79	50	357	50	7.70	934	72
80	6.15	33.010	99	6.92	98	8.00	1.11	34.0	5.2	0.74	0.64		0.70	75	252	75	6.28	994	96
105	6.26	166	26.10	6.69	95	7.97	1.14	29.5	5.3	0.035	0.62		0.66	100	108	100	6.18	33.115	26.07
132	6.64	516	33	6.17	89	7.98	1.23	31.0	10.6	0.00	0.62		0.68	125	13.3	125	6.58	370	22
158	6.91	813	52	5.81	84	7.97	1.35	39.5	14.0	0.00	0.50		0.78	150	14.6	150	6.89	790	50
211	6.05	823	64	4.75	68	7.87	1.89	47.5	21.7	0.00	0.86		0.68	200	9.1	200	6.31	821	61
316	4.94	899	84	2.75	38	7.68	2.53	71.5	28.8	0.00	0.66		0.64	482	8.2	300	5.06	882	81
421	4.29	988	99	2.02	28	7.62	2.90	91.5	32.2	0.01	0.47		0.75	728	4.9	400	4.40	966	95
526	3.89	34.105	27.12	1.23	17	7.56	3.14	106.0	38.2	0.00	0.41		0.69	979	2.6	500	3.98	34.077	27.07
630	3.65	186	20	0.89	12	7.54	3.27	120.0	38.2	0.00	0.40		0.64	1230	4.2	600	3.72	163	18
839	3.24	320	35	1.30	17	7.54	3.31	132.5	39.1	0.03	0.41		0.72	1496		800	3.32	295	32
1046	2.88	406	45	0.63	8	7.54	3.34	146.0	40.0	0.02	0.46		0.64	2004		1000	2.94	389	42
1215	2.72	458	49	0.61	8	7.53	3.31	151.5	40.0	0.035	0.40		0.63	3024		1200	2.73	455	49
1500	2.34	524	59	1.14	16	7.55	3.36	169.0	39.1	0.02	0.62		0.51	4052		1500	2.34	524	59
1982	1.96	607	69	1.25	16	7.60	3.19	169.0	38.3	0.00	0.37		0.55			2000	1.94	608	69
2458	1.72	644	73	1.93	25	7.67	2.98	167.8	35.3	0.00	0.46		0.50			2500	1.70	649	74
2924	1.60	669	77	2.68	35	7.74	2.90	165.0	34.4	0.02	0.47		0.45			3000	1.59	672	77
3376	1.53	684	78	2.94	38	7.76	2.76	160.0	33.8	0.00	0.48		0.46			3500	1.51	687	79
3830	1.48	692	79	3.27	42	7.79	2.65	166.0	32.3	0.00	0.10		0.56			4000	1.49	693	79
4295	1.54	696	79	3.31	43	7.78	2.74	157.5	32.1	0.00	0.64		0.60			4500	1.56	698	79
4958	1.60	703	79	3.35	43	7.80	2.73	160.0	31.0	0.00	0.65		0.51			5000	(1.60)	(703)	(79)

Table 3. Data from Nansen and Van Dorn casts at St. 3.

Station	Cast	Latitude	Longitude	Date	Ship time														
3	3–N	39–59N	155–00W	Aug. 30, 1969	17:45～21:45	Depth 4950m	Current 10°, 0.1kt	Transp. 34m	Air temp. 21.2°C
	3–V	39–59N	154–57W	Aug. 30～31, 1969	23:00～03:14	Wind SSW–6	Sea SSW–5	Swell WSW–5	Weather cloudy

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P	SiO_2–Si	NO_3–N	NO_2–N	NH_4–N	DON	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
							(		μg atoms/l			)							
0	20.8	33.754	23.63	5.26	99	7.96	0.21	2.5	0.0	0.00	1.73	10.1	0.94	0	73.5	0	20.8	33.754	23.63
10	20.69	750	66	5.22	98	8.00	0.21	2.0	0.0	0.00	1.52	9.7	1.04	10	108	10	20.69	750	66
19	20.69	753	66	5.28	99	8.02	0.21	1.5	0.0	0.00	0.48	10.4	0.86	20	73.7	20	20.69	753	66
29	13.48	729	25.34	6.64	110	8.03	0.21	2.0	0.0	0.00	1.24	9.5	0.95	30	143	30	13.40	729	25.36
48	12.36	743	58	6.50	105	8.03	0.23	1.5	0.0	0.00	0.41	7.8	0.92	50	154	50	12.18	748	61
72	10.98	803	88	6.14	97	7.99	0.54	5.0	0.6	0.00	0.90	8.3	0.79	75	404	75	10.89	808	89
96	10.32	833	26.01	5.97	93	7.97	0.54	8.5	3.6	0.615	0.82	7.0	0.79	100	330	100	10.20	835	26.03
120	9.93	853	09	5.98	93	7.97	0.56	9.5	2.2	1.05	0.72	6.4	0.71	118	79.4	125	9.93	860	09
144	9.91	909	13	5.95	92	7.97	0.55	10.0	1.6	0.58	1.12	7.5	0.79	141	36.0	150	9.90	930	15
191	9.77	34.015	25	5.65	87	7.95	0.82	14.8	7.8	0.30	1.09	8.9	0.71	188	9.1	200	9.71	34.027	27
287	8.68	043	45	5.05	76	7.88	1.15	30.5	13.6	0.00	1.03	10.1	0.69	377	4.4	300	8.50	038	46
382	7.28	001	63	4.19	61	7.78	1.86	44.6	14.0	0.055	0.98	9.9	0.62	567	3.9	400	6.99	33.998	66
477	5.81	33.985	81	3.47	49	7.67	1.90	64.0	17.6	0.00	1.19	13.7	0.62	757	4.1	500	5.54	988	83
572	4.79	34.004	94	2.33	32	7.59	2.80	80.0	32.2	0.00	1.14	5.3	0.57	948	1.1	600	4.59	34.018	97
762	3.85	147	27.16	1.45	20	7.49	3.12	110.0	35.0	0.02	1.80	9.3	0.74	1400		800	3.77	182	27.19
953	3.42	295	31	0.58	8	7.44	3.42	132.5	38.6	0.03	1.12	6.1	0.60	1871		1000	3.33	326	34
1156	2.97	395	44	0.71	9	7.25	3.48	146.0	43.0	0.01	0.48	8.2	0.57	2820		1200	2.90	415	47
1443	2.52	485	55	0.80	11	7.31	3.43	157.5	43.8	0.00	0.66	8.8	0.79	3776		1500	2.47	500	56
1924	2.04	591	68	1.30	17	7.38	3.26	168.0	41.6	0.00	0.90	8.8	0.71	4544		2000	2.00	605	69
2402	1.74	637	74	2.13	28	7.47	3.15	173.0	36.2	0.00	1.20	10.7	0.52			2500	1.70	640	74
2880	1.58	656	76	2.78	36	7.55	3.02	164.0	38.0	0.00	1.17	12.1	0.45			3000	1.55	661	76
3356	1.51	680	79	3.10	40	7.60	2.65	160.3	32.8*	0.00	0.70	10.5	0.64			3500	1.49	689	79
3831	1.46	699	80	3.24	42	7.63	2.84	153.5	35.2	0.00	0.83	10.8	0.62			4000	1.48	702	80
4306	1.53	703	80	3.41	44	7.65	2.87	156.2	35.2	0.00	0.48	12.7	0.51			4500	1.55	703	80
4683	1.57	701	80	3.32	43	7.67	2.78	160.3	34.3	0.00	0.81	10.4	0.63						

Table 4. Data from Nansen and Van Dorn casts at St. 4.

Station	Cast	Latitude	Longitude	Date	Ship time														
4	4–N	34–59N	155–01W	Sep. 5～6, 1969	21:20～02:00	Depth 5720m	Current 275°, 0.3kt	Transp. 30m(45°)	Air temp. 22.0°C
	4–V	34–59N	155–00W	Sep. 6, 1969	02:00～07:10	Wind W–1	Sea W–1	Swell SSE–2	Weather fine

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P (	SiO_2–Si	NO_3–N μg atoms/l	NO_2–N	NH_4–N	DON)	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
0	23.7	34.923	23.70	4.97	99	8.02	0.09	7.5	0.0	0.00	1.14		1.19	0	77.9	0	23.7	34.923	23.70
10	23.39	918	79	5.03	99	8.05	0.02	6.0	0.0	0.00	0.23		0.98	10	75.0	10	23.39	918	79
20	23.21	914	82	5.00	98	8.07	0.10	7.0	0.0	0.00	0.41		0.92	20	81.7	20	23.21	914	82
29	21.50	780	24.22	5.29	101	8.07	0.09	7.5	0.0	0.00	0.29		0.94	30	81.4	30	21.30	760	24.25
48	17.39	462	25.04	5.75	103	8.07	0.12	8.0	0.0	0.00	0.21		0.90	50	77.7	50	17.25	459	25.06
72	15.40	445	48	6.02	104	8.08	0.10	8.0	0.0	0.00	0.14		0.80	75	251	75	15.22	446	52
96	14.44	476	70	5.83	98	8.08	0.16	8.0	0.0	0.00	0.37		0.73	100	241	100	14.20	473	75
120	13.64	398	82	5.65	94	8.05	0.24	9.5	0.0	0.28	1.06		0.66	125	200	125	13.55	390	83
144	13.25	359	89	5.52	91	8.04	0.37	10.0	0.0	0.17	0.25		0.73	150	140	150	13.13	348	89
192	12.40	286	99	5.46	89	8.03	0.50	11.3	0.0	0.00	0.65		0.66	200	17.8	200	12.30	281	26.00
287	11.14	251	26.20	5.12	81	7.97	0.78	19.0	0.6	0.08	0.28		0.55	383	6.0	300	10.92	239	22
382	9.49	134	39	4.72	72	7.91	1.20	30.0	1.6	0.07	0.21		0.57	572	0.9	400	9.18	115	42
477	7.64	038	60	3.91	62	7.83	1.70	47.5	14.9	0.01	0.23		0.59	762	0.8	500	7.20	016	64
572	5.83	33.977	79	2.95	42	7.71	2.35	66.0	17.6	0.00	0.04		0.53	951	0.9	600	5.47	33.982	84
760	4.26	34.099	27.06	1.87	26	7.58	2.98	105.0	22.9	0.00	0.23		0.56	1419		800	4.08	34.141	27.13
948	3.60	277	28	0.46	6	7.51	3.26	133.0	34.6	0.07	0.23		0.62	2892		1000	3.48	318	33
1153	3.13	415	43	0.26	3	7.33	3.37	157.5	35.6	0.01	0.12		0.62	3839		1200	3.07	431	45
1440	2.68	515	56	0.55	7	7.37	3.28	157.5	40.2	0.00	0.17		0.73	3785		1500	2.60	530	57
1919	2.04	610	69	1.37	18	7.47	3.18	176.0	37.6	0.00	0.26		0.69	4730		2000	1.99	620	70
2393	1.73	656	74	2.08	27	7.52	3.00	180.0	32.2	0.00	0.41		0.52			2500	1.70	661	75
2874	1.59	679	77	2.73	35	7.60	2.88	169.0	35.2	0.00	0.26		0.44			3000	1.53	681	77
3350	1.50	689	79	3.06	39	7.64	2.73	169.0	30.2	0.00	0.55		0.60			3500	1.49	692	79
3826	1.48	699	79	3.41	44	7.67	2.71	165.0	37.1	0.01	0.15		0.68			4000	1.50	700	79
4295	1.53	701	79	3.42	44	7.70	2.73	162.0	30.2	0.01	0.28		0.50			4500	1.58	702	79
5255	1.61	705	79	3.63	47	7.73	2.56	160.0	23.8	0.00	0.12		0.61			5000	1.60	704	79

Tabld 5. Data from Nansen and Van Dorn casts at St. 5.

Station	Cast	Latitude	Longitude	Date	Ship time															
5	5-N	29-58N	155-03W	Sep. 8, 1969	02:10～06:50	Depth 5550m	Current undetecfed	Transp. 42m	Air temp. 22.9°C
	5-V	29-59N	155-01W	Sep. 8, 1969	06:55～12:56	Wind SW-2	Sea	SW-1	Swell N-2	Weather fine

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4-P	SiO_2-Si	NO_3-N	NO_2-N	NH_4-N	DON	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
							(		μg atoms/l			)							
0	24.5	35.258	23.71	4.86	98	7.95	0.00	7.5	0.0	0.00	0.35		1.19	0	94.8	0	24.5	35.258	23.71
10	24.25	263	79	4.83	97	8.16	0.00	2.5	0.0	0.00	0.21		1.12	10	94.6	10	24.25	263	79
20	24.16	258	82	4.84	97	8.16	0.02	3.5	0.0	0.00	0.15		1.03	20	91.2	20	24.16	258	82
29	24.08	271	86	4.85	97	8.19	0.02	4.5	0.0	0.00	0.15		1.00	30	90.1	30	24.07	272	86
48	23.38	321	24.10	5.00	99	8.18	0.02	4.0	0.0	0.00	0.14		0.98	50	89.2	50	23.25	321	24.13
73	19.31	010	97	5.58	103	8.17	0.04	5.0	0.0	0.00	0.03		0.78	75	139	75	19.10	000	25.02
96	17.66	34.915	25.31	5.31	95	8.16	0.07	5.0	0.0	0.01	0.12		0.80	100	235	100	17.40	34.895	37
120	16.58	808	49	4.97	88	8.13	0.17	7.0	1.1	0.31	0.10		0.74	125	279	125	16.45	794	51
144	15.85	727	60	4.98	86	8.11	0.19	7.0	2.5	0.12	0.21		0.69	150	144	150	15.68	683	60
191	14.06	484	80	4.87	82	8.07	0.38	8.7	5.9	0.03	0.14		0.67	175	84.8	200	13.84	465	83
285	11.72	316	26.12	4.80	77	8.03	0.85	17.6	10.2	0.05	0.11		0.60	200	8.7	300	11.42	298	26.17
378	9.71	188	39	4.73	73	7.95	1.24	24.0	15.6	0.04	0.12		0.66	350	2.5	400	9.28	154	44
471	7.76	069	60	3.99	59	7.86	1.63	39.5	23.6	0.02	0.14		0.69	526	1.8	500	7.05	043	68
565	5.79	028	84	2.60	37	7.71	2.42	62.1	32.4	0.04	0.23		0.57	704	1.5	600	5.40	031	88
756	4.34	178	27.13	1.14	16	7.58	3.01	98.9	36.3	0.01	0.06		0.67	882		800	4.18	229	27.18
949	3.71	373	35	0.47	6	7.52	3.16	114.8	38.7	0.08	0.07		0.56	1190		1000	3.60	411	38
1144	3.28	494	48	1.03	14	7.51	3.16	124.7	40.0	0.00	0.12		0.52	1667		1200	3.17	512	51
1433	2.73	573	59	1.78	24	7.58	3.04	137.9	39.7	0.01	0.10		0.65	2621		1500	2.63	585	61
1910	2.10	622	69	2.40	31	7.62	2.96	151.5	38.1	0.00	0.21		0.63	3573		2000	2.01	639	71
2385	1.78	659	74	2.38	31	7.66	2.84	165.5	36.0	0.01	0.06		0.57	5003		2500	1.72	663	75
2862	1.61	678	77	2.98	39	7.72	2.78	152.5	34.2	0.00	0.14		0.52			3000	1.59	681	78
3338	1.53	690	79	3.07	40	7.75	2.67	148.0	34.0	0.00	0.00		0.60			3500	1.52	692	79
3815	1.51	694	79	3.37	43	7.77	2.64	143.0	33.9	0.00	0.14		0.71			4000	1.51	696	79
4291	1.53	698	79	3.41	44	7.79	2.59	143.0	35.4	0.00	0.06		0.55			4500	1.53	699	79
5242	1.56	702	79	3.67	47	7.79	2.48	136.0	28.0	0.00	0.21		0.62			5000	1.56	702	79

Table 6. Data from Nansen and Van Dorn casts at St. 6.

Station	Cast	Latitude	Longitude	Date	Ship time																
6	6–N	24–59N	155–01W	Sep. 9～10, 1969	22:04～03:10	Depth	4830m	Current	133°, 0.3kt	Transp.	38m (5°)	Air temp.	23.8°C								
	6–V	24–58N	155–02W	Sep. 10, 1969	03:15～08:40	Wind	E–4	Sea	E–2	Swell	ESE–2	Weather	cloudy								

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P	SiO_2–Si	NO_3–N	NO_2–N	NH_4–N	DON	DOC (mg/l)	D(V) (m)	Chl. (mg/m³)	D(S) (m)	T (°C)	S (‰)	σt
							(		μg atoms/l			)							
0	25.3	34.962	23.26	4.72	96	8.05	0.00	9.0	0.2	0.00	0.29		1.23	0	203	0	25.3	34.962	23.26
10	25.43	957	20	4.76	97	8.12	0.01	9.0	0.3	0.00	0.33		1.28	10	210	10	25.43	957	20
19	25.43	956	20	4.75	97	8.14	0.02	13.0	0.2	0.00	0.17		1.19	20	230	20	25.43	956	20
29	25.43	956	20	4.76	97	8.15	0.04	8.2	0.6	0.00	0.23		1.20	30	198	30	25.43	956	20
48	25.43	984	22	4.79	98	8.16	0.06	14.8	0.2	0.00	0.10		1.06	50	289	50	25.43	988	22
71	23.75	35.104	81	5.18	103	8.16	0.01	10.0	0.3	0.00	0.15		1.06	75	225	75	23.40	35.103	92
95	21.25	079	24.52	5.09	97	8.15	0.00	2.3	0.3	0.00	0.07		0.89	100	252	100	21.00	079	24.57
119	20.00	080	85	4.74	89	8.12	0.05	2.8	0.6	0.04	0.19		0.86	125	8.9	125	19.82	076	89
143	19.28	048	02	4.63	86	8.11	0.00	5.0	1.3	0.05	0.04		0.85	150	44.7	150	19.12	040	25.05
190	17.62	34.944	25.35	4.88	88	8.10	0.03	12.5	2.0	0.03	0.19		0.80	175	10.1	200	17.25	34.900	40
284	13.31	395	88	4.60	76	8.00	0.56	16.2	8.7	0.02	0.26		0.76	200	17.2	300	12.65	320	96
378	9.90	106	26.30	4.39	68	7.88	1.09	25.5	16.4	0.01	0.14		0.68	421	1.6	400	9.35	082	26.37
472	7.69	045	60	3.68	54	7.77	1.86	38.3	25.0	0.00	0.32		0.69	612	0.9	500	7.11	039	67
567	6.10	052	82	2.08	30	7.63	2.31	48.8	33.7	0.00	0.12		0.72	805	0.4	600	5.75	093	90
769	4.75	272	27.16	1.07	15	7.51	3.01	66.8	39.8	0.00	0.10		0.68	1005	1.6	800	4.63	320	27.20
954	4.15	457	37	1.45	20	7.53	2.96	69.5	40.4	0.09	0.10		0.64	1458		1000	4.02	483	40
1135	3.66	527	48	1.53	21	7.38	2.97	80.0	36.2	0.00	0.15		0.64	1944		1200	3.51	541	50
1419	3.00	573	57	1.83	24	7.41	2.90	90.0	35.3	0.00	0.37		0.66	2915		1500	2.87	588	59
1893	2.26	624	68	2.21	29	7.49	2.82	137.5	37.0	0.00	0.29		0.72	3884		2000	2.14	632	69
2365	1.80	652	74	2.54	33	7.51	2.65	148.0	36.4	0.00	0.21		0.57	4368		2500	1.74	660	75
2839	1.60	676	77	3.16	41	7.59	2.82	147.0	34.4	0.00	0.19		0.53			3000	1.56	680	77
3313	1.50	689	79	3.20	41	7.64	2.53	144.0	34.0	0.00	0.40		0.53			3500	1.48	693	79
3786	1.47	699	79	3.62	47	7.66	2.66	142.0	31.8*	0.00	0.43		0.55			4000	1.49	699	79
4259	1.51	700	79	3.54	46	7.71	2.41	140.5	34.1	0.00	0.26		0.46			4500	(1.53)	(701)	79

Table 7. Data from Nansen and Van Dorn casts at St. 7.

Station	Cast	Latitude	Longitude	Date	Ship time															
7	7–N	20–59N	154–59W	Sep. 11,	1969	15:05～19:35	Depth	5670m	Current	55°, 0.5kt	Transp.	35m<	Air temp.	25.6°C						
	7–V	20–59N	155–00W	Sep. 11～12,	1969	19:33～03:37	Wind	ESE–5	Sea	ESE–4	Swell	SSE–3	Weather	cloudy						

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P	SiO_2–Si	NO_3–N	NO_2–N	NH_4–N	DON	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
							(		μg atoms/l			)							
0	26.0	24.666	22.81	4.59	95	7.96	0.02	10.2	0.1	0.00	0.52		1.24	0	114	0	26.0	34.666	22.81
10	25.96	663	82	4.65	96	8.03	0.08	10.5	0.0	0.00	0.37		1.06	10	86.5	10	25.96	663	82
19	25.95	663	82	4.71	97	8.08	0.02	10.2	0.0	0.00	0.43		0.99	20	77.5	20	25.95	663	82
29	25.92	703	86	4.68	96	8.12	0.10	9.7	0.0	0.00	0.28		1.15	30	108	30	25.92	708	86
48	25.78	851	23.01	4.72	97	8.14	0.10	10.5	0.2	0.00	0.44		1.06	50	96.6	50	25.72	880	23.06
72	24.51	35.002	51	5.07	102	8.15	0.04	10.5	0.1	0.00	0.48		1.08	75	213	75	24.35	35.005	57
96	23.00	004	24.00	5.09	100	8.15	0.06	10.5	0.1	0.00	0.29		1.04	100	240	100	22.70	000	24.05
120	21.36	34.949	40	4.57	87	8.10	0.24	9.7	0.3	0.06	0.41		0.82	125	129	125	21.15	34.951	44
144	20.36	975	67	4.38	82	8.08	0.23	8.0	1.0	0.06	0.24		0.83	150	51.7	150	20.10	972	74
192	18.00	776	25.13	4.03	73	8.03	0.46	14.5	4.4	0.095	0.48		0.72	161	47.0	200	17.50	710	25.19
287	11.29	213	26.13	3.35	53	7.80	1.47	26.5	17.9	0.03	0.21		0.58	200	26.0	300	10.77	183	26.21
383	8.40	091	52	3.47	52	7.78	1.84	36.5	21.0	0.02	0.35		0.62	240	5.5	400	7.87	080	60
479	6.22	063	82	2.07	30	7.63	2.54	65.4	32.2	0.01	0.24		0.59	372	2.5	500	6.00	082	85
575	5.48	219	27.03	0.91	13	7.53	3.04	76.5	34.9	0.06	0.26		0.54	561	1.8	600	5.31	253	27.07
768	4.69	430	29	0.93	13	7.53	3.14	92.0	37.5	0.06	0.29		0.64	751	1.8	800	4.59	449	32
963	4.10	512	41	1.13	15	7.49	3.11	101.0	39.4	0.15	0.29		0.47	942	1.7	1000	4.00	522	45
1163	3.47	558	52	1.68	23	7.41	3.19	108.0	40.3	0.02	0.07		0.43	1452		1200	3.39	561	53
1462	2.84	591	60	2.12	28	7.47	3.11	122.5	40.1	0.00	0.21		0.48	2535		1500	2.75	598	61
1947	2.16	640	69	2.54	33	7.52	3.00	135.0	39.8	0.00	0.19		0.46	2903		2000	2.09	641	70
2432	1.77	662	75	2.85	37	7.56	2.91	147.8	36.2	0.00	0.14		0.50	3871		2500	1.73	664	76
2917	1.60	680	77	3.09	40	7.61	2.82	142.5	37.1	0.00	0.19		0.43	4838		3000	1.59	681	77
3402	1.51	(690)	79	3.33	43	7.64	2.70	138.0	35.5	0.00	0.07		0.49			3500	1.50	692	79
3888	1.46	(698)	79	3.66	47	7.66	2.64	135.0	35.8	0.00	0.11		0.51			4000	1.47	701	79
4372	1.49	705	79	3.62	47	7.70	2.59	130.5	34.2	0.00	0.06		0.53			4500	1.50	705	79
5341	1.54	(707)	79	4.00	52	7.72	2.53	131.2	35.6	0.00	0.07		0.54			5000	1.53	707	79

Table 8. Data from Nansen and Van Dorn casts at St. 8.

Statin	Cast	Latitude	Longitude	Date	Ship time															
8	8–N	17–01N	155–03W	Sep. 19, 1969	08:30～12:33	Depth 4700m		Current 38°, 0.2kt		Transp.			Air temp. 26.8°C							
	8–V	17–01N	155–08W	Sep. 19, 1969	15:10～18:52	Wind ENE–6		Sea ENE–4		Swell E–5			Weather cloudy							
D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P (	SiO_2–Si	NO_3–N μg atoms/l	NO_2–N	NH_4–N	DON)	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt	
0	26.1	34.597	22.74	4.63	96	7.96	0.07	12.5	0.1	0.00	0.70	21.6	1.29	0	63.3	0	26.1	34.597	22.74	
10	26.12	595	74	4.64	96	8.06	0.11	12.5	0.0	0.00	0.18	12.1	1.13	10	58.6	10	26.12	595	74	
19	26.12	595	74	4.62	96	8.09	0.10	13.0	0.0	0.00	0.19		0.95	20	39.8	20	26.12	595	74	
28	26.12	595	74	4.65	96	8.11	0.06	12.5	0.1	0.00	0.21	10.5	0.97	30	43.4	30	26.12	595	74	
47	26.12	604	74	4.65	96	8.11	0.08	11.0	0.0	0.00	0.21	12.8	0.95	50	60.8	50	26.12	606	74	
70	25.29	760	23.10	5.05	103	8.13	0.02	11.4	0.0	0.00	0.29	12.3	0.94	75	114	75	24.70	795	23.30	
94	23.21	937	86	5.09	100	8.14	0.07	7.3	0.0	0.00	0.29	11.8	0.86	100	155	100	22.90	973	97	
117	22.04	35.021	24.26	4.81	90	8.11	0.02	13.0	0.0	0.00	0.12	11.0	0.83	125	165	125	21.63	35.043	24.38	
140	20.62	046	66	4.53	83	8.08	0.12	11.4	0.5	0.12	0.28	12.5	0.75	150	97.6	150	20.00	030	81	
163	19.03	34.977	25.02	4.35	86	8.06	0.29	13.5	1.3	0.06	0.29		0.68	166	71.2	175	18.40	34.936	25.15	
186	17.69	864	27	4.32	77	8.02	0.38	13.5	3.6	0.03	0.32	10.9	0.64	200	13.3	200	16.50	790	49	
278	10.66	249	26.27	2.77	44	7.78	1.75	36.5	21.1	0.05	0.14	8.9	0.58	380	3.0	300	10.28	250	26.34	
370	9.45	529	70	0.69	11	7.58	2.71	47.0	29.8	0.06	0.18	11.1	0.57	578	2.3	400	9.00	535	78	
465	7.85	511	94	0.40	6	7.53	2.91	65.2	35.6	0.05	0.18	13.5	0.62	766	2.3	500	7.39	487	99	
561	6.65	461	27.06	0.63	9	7.51	3.10	77.1	37.5	0.05	0.11	17.9	0.70	959	1.4	600	6.31	468	27.12	
757	5.35	509	26	0.78	11	7.51	3.11	98.8	40.1	0.04	0.25	14.3	0.65	1392		800	5.18	515	30	
994	4.44	542	40	1.00	14	7.48	3.21	110.5	40.8	0.04	0.21	9.0	0.67	1858		1000	4.42	544	41	
1185	3.80	585	51	1.19	16	7.49	3.16	126.0	38.4	0.03	0.18	9.2	0.53	2799		1200	3.77	586	52	
1473	3.00	610	60	1.54	21	7.50	3.18	137.8	40.1	0.02	0.23	7.0	0.60	3740		1500	2.95	612	60	
1953	2.23	645	70	2.08	27	7.53	3.06	150.8	36.4	0.02	0.14	10.7	0.68			2000	2.19	649	70	
2435	1.84	677	75	2.50	33	7.56	2.96	156.3	36.5	0.02	0.28	12.3	0.53			2500	1.81	680	76	
2916	1.65	693	78	2.89	37	7.61	2.86	159.5	33.2	0.01	0.26	7.7	0.53			3000	1.62	699	78	
3400	1.54	702	79	3.09	40	7.64	2.82	164.2	35.6	0.01	0.29	8.1	0.59			3500	1.52	703	79	
3885	1.46	(709)	80	3.41	44	7.66	2.75	152.2	32.9	0.00	0.18	8.7	0.67			4000	1.46	710	80	
4368	1.47	718	81	3.60	46	7.72	2.55	146.9	33.6	0.00	0.15	8.7	0.64			4500	(1.47)	(719)	81	

Table 9. Data from Nansen and Van Dorn casts at St. 9.

Station	Cast	Latitude	Longitude	Date	Ship time														
9	9–N	13–27N	155–02W	Sep. 21, 1969	01:50～03:00	Depth 5400m	Current 295°, 0.7kt	Transp. 26m<	Air temp. 25.2°C										
						Wind E–5	Sea E–4	Swell ENE–4	Weather cloudy										
D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P (	SiO_2–Si	NO_3–N μg atoms/l	NO_2–N	NH_4–N	DON)	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
0	26.9	34.339	22.27	4.62	97	8.09	0.18	3.5	0.5	0.04	0.32		1.21	0	35.5	0	26.9	34.339	22.27
10	26.92	312	24	4.61	96	8.12	0.16	4.0	0.0	0.00	0.29		1.03	10	37.9	10	26.92	312	24
20	26.91	327	25	4.65	97	8.13	0.13	3.5	0.0	0.00	0.18		0.83	20		20	26.91	327	25
29	26.94	329	25	4.63	97	8.15	0.13	4.0	0.0	0.00	0.18		0.94	30	32.2	30	26.94	330	25
48	26.90	438	34	4.68	98	8.15	0.15	4.5	0.0	0.00	0.14		0.94	50	41.5	50	26.90	442	35
72	26.84	471	39	4.65	97	8.15	0.15	4.5	0.0	0.02	0.21		0.80	75	69.3	75	26.83	470	39
96	23.82	384	23.26	4.88	97	8.13	0.17	4.0	0.0	0.00	0.18		0.88	100	158	100	23.25	388	23.43
119	19.43	471	24.53	4.15	76	8.02	0.51	7.2	1.7	0.21	0.25		0.69	125	239	125	18.20	470	24.95
143	15.05	468	25.58	1.43	24	7.76	1.83	16.8	21.9	0.10	0.17		0.65	150	118	150	14.33	485	25.73
166	12.96	625	26.13	0.69	11	7.68	2.30	23.5	27.4	0.20	0.12		0.61	175	79.2	175	12.28	633	26.27
190	11.63	642	41	0.40	6	7.58	2.55	28.0	29.2	0.00	0.21		0.69	200	30.9	200	11.42	650	45
283	10.47	715	67	0.21	3	7.54	2.61	30.5	30.5	0.02	0.15		0.76			300	10.29	713	70
376	9.48	680	82	0.23	4	7.51	2.78	35.3	31.1	0.02	0.19		0.58			400	9.26	661	84
470	8.57	610	91	0.26	4	7.53	2.90	44.7	34.2	0.02	0.22		0.65			500	8.25	594	95
563	7.60	563	27.01	0.33	5	7.50	3.06	45.9	34.2	0.02	0.19		0.74			600	7.21	553	27.06
753	5.92	530	22	0.87*	12*	7.49	3.25	59.5	40.6	0.04	0.21		0.73			800	5.62	352	25
943	4.90	547	36	0.72	10	7.49	3.29	71.7	40.8	0.04	0.18		0.70			1000	(4.70)	(558)	(38)

Table 10. Data from Nansen and Van Dorn casts at St. 10.

Station	Cast	Latitude	Longitude	Date	Ship time															
10	10–N	10–01N	155–00W	Sep. 22, 1969	01:20～05:37	Depth 5170m	Current 232°, 1.0kt	Transp. 32m(31°)	Air temp. 25.2°C											
	10–V	10–01N	155–03W	Sep. 22, 1969	08:18～12:12	Wind ENE–2	Sea ENE–2	Swell SE–3	Weather fine											

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P	SiO_2–Si	NO_3–N	NO_2–N	NH_4–N	DON	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
							(		μg atoms/l			)							
0	27.7	33.837	21.64	4.57	97	8.02	0.26	2.5	0.0	0.00	0.17	9.6	1.01	0	154	0	27.7	33.837	21.64
10	27.76	840	63	4.57	97	8.07	0.23	8.2	0.0	0.00	0.19	12.5	0.93	10	146	10	27.76	840	63
19	27.73	903	69	4.65	98	8.11	0.20	10.2	0.0	0.00	0.14	23.9	0.91	20	107	20	27.73	906	69
29	27.75	938	71	4.57	97	8.12	0.24	12.0	0.0	0.00	0.19	10.8	0.93	30	239	30	27.75	940	71
48	22.47	34.529	23.76	4.54	88	8.00	0.44	15.0	0.6	0.02	0.54	11.7	0.86	50	91.9	50	21.60	34.528	24.00
72	14.82	419	25.59	2.65	45	7.78	1.46	23.3	14.0	0.32	0.33	10.1	0.60	75	50.6	75	14.20	423	25.72
96	12.56	571	26.17	1.01*	17	7.58	2.32	37.2	26.1	0.08	0.65	4.2	0.65	100	38.8	100	12.39	610	26.23
119	11.81	714	42	0.33	5	7.55	2.52	37.8	27.2	0.01	0.43	10.5	0.60	125	4.2	125	11.65	715	46
143	11.30	717	52	0.30	5	7.50	2.62	33.0	28.7	0.01	0.30	13.4	0.59	150	2.7	150	11.22	723	54
166	11.00	733	59	0.33	5	7.50	2.61	33.0	29.8	0.04	0.24	12.3	0.63	175	6.8	175	10.86	734	62
190	10.64	737	65	0.41	7	7.51	2.62	43.3	27.0	0.00	0.32	7.3	0.62	200	3.6	200	10.52	736	67
282	9.80	731	80	0.48	8	7.50	2.62	45.0	28.7	0.01	0.21	9.6	0.58	367	2.2	300	9.66	720	81
373	9.06	(680)	88	0.39	6	7.51	2.82	49.5	31.9	0.05	0.10	8.7	0.60	550	2.5	400	8.88	665	88
464	8.33	629	96	0.41	6	7.48	2.91	55.2	32.1	0.01	0.06	6.7	0.48	734	0.7	500	8.00	610	99
556	7.39	589	27.06	0.36	5	7.46	3.15	64.2	33.5	0.00	0.10	12.6	0.49	917	1.0	600	7.00	578	27.11
744	5.81	553	25	0.71	10	7.46	3.23	87.0	35.9	0.02	0.10	11.5	0.56	1464		800	5.50	554	28
934	4.80	565	38	0.97	14	7.48	3.31	99.0	41.4	0.04	0.14	9.9	0.54	1936		1000	4.53	573	41
1147	4.00	593	49	1.40	19	7.48	3.21	112.8	40.8	0.00	0.22	12.9	0.50	2884		1200	3.86	600	52
1436	3.30	610	57	1.63	22	7.52	3.11	129.0	39.6	0.02	0.15	9.2	0.61	3830		1500	3.13	618	59
1913	2.32	650	69	2.12	28	7.55	2.96	152.0	39.3	0.05	0.15	11.6	0.74	4778		2000	2.22	659	71
2393	1.90	684	75	2.53	33	7.58	2.88	164.0	37.8	0.02	0.19	13.1	0.51			2500	1.86	685	76
2870	1.75	687	77	2.88	37	7.62	2.85	114.0	37.4	0.00	0.11	13.3	0.43			3000	1.70	690	78
3352	1.58	695	79	3.10	40	7.64	2.77	170.3	36.4	0.02	0.15	12.1	0.58			3500	1.52	698	79
3834	1.44	705	80	3.62	47	7.66	2.65	156.5	35.1	0.00	0.14	10.1	0.58			4000	1.41	706	80
4317	1.37	(707)	81	4.03	52	7.71	2.49	141.0	34.7	0.04	0.15	13.1	0.52			4500	1.38	708	81
4800	1.40	708	81	4.02	52	7.71	2.52	143.2	33.0	0.02	0.14	11.1	0.62			5000	(1.43)	(710)	(81)

Table 11. Data from Nansen and Van Dorn casts at St. 11.

Station	Cast	Latitude	Longitude	Date	Ship time														
11	11-N	7-28N	154-49W	Sep. 27, 1969	11:10~12:30	Depth 5120m	Current		Transp.		Air temp. 26.0°C								
						Wind SSW-4	Sea	SSW-3	Swell	NE-3	Weather	rainy							
D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4-P (	SiO_2-Si	NO_3-N μg atoms/l	NO_2-N	NH_4-N	DON)	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
0	28.7	33.752	21.24	4.44	96	8.09	0.18	7.5	0.0	0.00	0.51		1.15	0	61.7	0	28.7	33.752	21.24
10	28.83	34.270	60	4.45	96	8.11	0.18	8.1	0.0	0.00	0.79		0.96	10	80.4	10	28.83	34.270	60
19	29.02	518	73	4.48	97	8.13	0.20	8.1	0.0	0.00	0.34		0.83	20		20	29.02	560	75
28	28.94	669	84	4.47	97	8.12	0.20	8.9	0.0	0.00	0.21		0.90	30	135	30	28.94	702	88
47	28.86	766	95	4.49	98	8.13	0.24	6.5	0.0	0.00	0.34		0.83	50	210	50	28.85	775	96
71	28.42	802	22.13	4.49	97	8.13	0.22	6.5	0.0	0.00	0.48		0.84	75	238	75	27.45	802	22.45
94	21.07	708	24.24	4.09	78	8.01	0.51	11.8	2.5	0.20	0.34		0.75	101	228	100	19.55	630	24.63
118	15.31	583	25.60	2.44	42	7.83	1.39	26.0	15.0	0.22	0.34		0.67	126	170	125	14.50	584	25.79
142	12.84	601	26.13	1.34	22	7.69	2.02	32.8	24.1	0.03	0.33		0.59	151	136	150	12 20	616	26.27
165	11.27	648	44	1.10	18	7.62	2.24	42.1	28.8	0.01	0.34		0.57	176	25.7	175	10.91	662	55
189	10.61	678	61	1.17	18	7.60	2.42	42.1	30.8	0.00	0.37		0.57	201	10.5	200	10.41	681	65
284	9.48	679	81	1.31	20	7.63	2.38	45.8	30.8	0.00	0.29		0.52			300	9.34	676	83
379	8.75	652	91	1.28	19	7.62	2.55	49.5	32.8	0.00	0.32		0.50			400	8.62	644	93
474	8.11	618	98	0.95	14	7.59	2.72	55.3	35.4	0.00	0.29		0.52			500	7.92	610	27.00
570	7.35	589	27.07	0.69	10	7.55	3.00	61.7	36.8	0.00	0.18		0.55			600	7.11	582	10
761	5.91	564	24	0.94	13	7.55	3.10	84.4	38.1	0.00	0.25		0.63			800	5.69	561	28
953	4.96	556	36	1.30	18	7.57	3.10	110.9	38.2	0.00	0.21		0.60			1000	(4.76)	(557)	(38)

Table 12. Data from Nansen and Van Dorn casts at St. 12.

Station	Cast	Latitude	Longitude	Date	Ship time															
12	12–N	4–53N	155–05W	Sep. 28, 1969	05:59～09:40	Depth 4650m	Current		Transp. 23m		Air temp. 26.9°C									
	12–V	4–55N	155–03W	Sep. 28, 1969	11:40～17:25	Wind SSE–5	Sea	SSE–4	Swell	SE–3	Weather	cloudy								
D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P (	SiO_2–Si	NO_3–N μg atoms/l	NO_2–N	NH_4–N	DON)	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt	
0	27.7	35.005	22.52	4.51	96	8.03	0.26	11.5	1.0	0.06	0.51		1.11	0	155	0	27.7	35.005	22.52	
10	27.82	000	48	4.59	98	8.06	0.29	9.8	1.2	0.07	0.37		0.87	10	147	10	27.82	000	48	
19	27.84	004	48	4.61	99	8.07	0.30	8.7	1.2	0.07	0.32		0.78	20	158	20	27.84	004	48	
28	27.85	000	48	4.56	97	8.08	0.29	9.8	1.2	0.07	0.28		0.84	30	162	30	27.85	000	48	
47	27.84	006	48	4.56	97	8.09	0.30	9.8	1.2	0.08	0.22		0.89	50	180	50	27.84	006	48	
71	27.78	010	50	4.55	97	8.09	0.29	9.8	1.2	0.08	0.21		0.80	75	205	55	27.72	013	50	
94	27.53	051	61	4.47	95	8.10	0.37	9.2	2.2	0.15	0.26		0.78	100	153	170	27.40	053	65	
118	25.93	045	23.11	3.82	79	8.04	0.55	9.8	5.6	0.95	0.10		0.66	125	114	125	25.28	038	23.31	
141	22.99	34.964	94	3.31	65	7.99	0.75	13.9	9.1	0.16	0.22		0.61	150	67.3	150	20.50	34.900	24.58	
165	17.30	773	25.29	2.61	67	7.86	1.23	22.8	16.3	0.01	0.14		0.55	167	30.4	175	16.40	730	25.47	
188	15.17	693	71	2.60	45	7.80	1.50	27.9	19.4	0.01	0.29		0.62	200	18.7	200	13.95	650	95	
281	9.64	683	26.79	2.00	31	7.65	2.18	39.0	29.1	0.00	0.14		0.55	371	2.8	300	9.41	680	26.83	
373	8.97	669	88	1.45	22	7.58	2.52	44.3	33.8	0.01	0.28		0.58	571		400	8.82	662	92	
467	8.41	644	96	1.30	20	7.56	2.60	48.5	35.0	0.04	0.28		0.52	761	1.3	500	8.20	636	98	
562	7.61	612	27.05	0.85	13	7.51	2.95	57.5	38.1	0.00	0.19		0.51	952	1.5	600	7.25	602	27.10	
752	5.73	565	28	1.67	24	7.54	2.97	73.6	38.5	0.00	0.15		0.53	1420		800	5.43	562	30	
956	4.75	570	39	1.86	26	7.60	3.05	89.5	37.5	0.01	0.28		0.54	1894		1000	4.59	575	41	
1147	4.06	591	49	1.94	27	7.60	3.05	105.6	37.4	0.01	0.23		0.57	2841		1200	3.90	595	50	
1434	3.28	611	58	2.00	27	7.60	3.17	130.0	38.9	0.00	0.51		0.55	3787		1500	3.12	615	59	
1913	2.46	646	68	2.34	31	7.64	3.04	141.2	37.5	0.00	0.29		0.54			2000	2.38	652	69	
2391	1.95	676	74	2.67	35	7.66	2.97	156.8	36.8	0.00	0.23		0.57			2500	1.91	679	75	
2873	1.80	685	76	2.92	38	7.72	2.84	151.2	35.6	0.07	0.28		0.49			3000	1.71	689	77	
3346	1.55	701	79	3.33	43	7.74	2.78	151.2	35.9	0.01	0.26		0.57			3500	1.48	702	80	
3823	1.38	707	81	3.87	50	7.78	2.67	149.3	34.9	0.00	0.29		0.56			4000	1.38	709	81	
4300	1.40	712	81	3.96	51	7.80	2.62	144.5	32.3	0.00	0.29		0.52			4500	(1.42)	(714)	(81)	

Table 13. Data from Nansen and Van Dorn casts at St. 13.

Station	Cast	Latitude	Longitude	Date	Ship time													
13	13–N	2–27N	154–55W	Sep. 29, 1969	18:45~20:03	Depth 4820m	Current		Transp.		Air temp. 26.4°C							
						Wind SSW–4	Sea	SSW–2	Swell	S–3	Weather	cloudy						
D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P (	SiO_2–Si	NO_3–N μg atoms/l	NO_2–N	NH_4–N	DON)	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
0	26.8	34.963	22.77	4.58	96	8.02	0.36	4.5	2.6	0.10	0.58		1.10	0	151	0	26.8	34.963	22.77
10	26.84	969	77	4.64	97	8.03	0.37	4.5	2.8	0.11	0.32		0.88	10	254	10	26.84	969	77
19	26.82	976	77	4.75	100	8.03	0.35	5.5	2.8	0.11	0.29		0.86	20		20	26.82	976	77
28	26.83	962	77	4.65	98	8.04	0.35	5.5	2.7	0.11	0.28		0.75	30	242	30	26.83	961	77
47	26.78	958	78	4.63	97	8.05	0.36	4.5	2.8	0.11	0.23		0.82	50	246	50	26.77	958	78
71	26.72	953	79	4.57	96	8.05	0.35	4.5	2.9	0.13	0.25		0.80	75	237	75	26.70	950	79
94	25.92	970	23.06	4.39	91	8.03	0.50	5.5	4.3	0.14	0.57		0.74	100	237	100	25.75	35.010	23.15
117	25.28	35.086	35	4.14	85	8.02	0.60	5.5	6.3	0.94	0.37		0.70	126	104	125	25.03	135	46
141	23.62	061	81	3.63	72	7.99	0.74	6.3	9.6	1.25	0.29		0.63	149	131	150	19.00	34.840	24.94
164	13.67	34.727	26.07	2.60	44	7.83	1.54	24.5	21.0	0.00	0.14		0.54	173	45.1	175	12.65	800	26.33
187	12.28	856	44	1.51	25	7.70	2.05	28.5	26.2	0.00	0.21		0.52	196	19.5	200	12.09	860	49
280	11.48	826	58	1.19	19	7.67	2.21	31.5	27.9	0.00	0.12		0.49			300	11.36	817	59
373	10.60	763	70	1.65	26	7.66	2.21	34.3	30.2	0.00	0.11		0.49			400	10.19	735	74
467	9.19	669	85	1.32	20	7.62	2.53	43.7	33.9	0.00	0.14		0.49			500	8.82	655	91
562	8.05	627	27.00	0.78	13	7.58	2.91	54.7	36.9	0.00	0.12		0.60			600	7.54	611	27.06
753	5.77	560	26	1.69	24	7.58	3.00	76.7	35.4	0.00	0.11		0.52			800	5.43	550	30
944	4.84	555	37	1.95	27	7.59	3.03	89.6	33.4	0.00	0.11		0.58			1000	(4.72)	(560)	(38)

Table 14. Data from Nansen and Van Dorn casts at St. 14.

Station	Cast	Latitude	Longitude	Date	Ship time
14	14–N	0–00	154–54W	Sep. 30, 1969	15:50～20:18
	14–V	0–01N	154–55W	Sep. 30, 1969	20:12～23:59

Depth 4675m Current Transp. 29m (4°) Air temp. 27.3°C
Wind calm Sea 0 Swell SE–2 Weather fine

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P	SiO_2–Si	NO_3–N	NO_2–N	NH_4–N	DON	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
							(		μg atoms/l			)							
0	28.3	35.100	22.40	4.57	99	8.01	0.40	11.6	2.8	0.11	0.61		0.81	0	105	0	28.3	35.100	22.40
10	26.58	055	92	4.61	96	8.05	0.41	9.2	3.0	0.11	0.26		0.75	10	114	10	26.58	055	92
19	26.32	055	23.00	4.62	96	8.06	0.43	12.2	3.3	0.13	0.22		0.65	20	131	20	26.30	055	23.00
28	26.04	071	09	4.41	92	8.06	0.46	11.8	4.1	0.19	0.12		0.67	30	165	30	26.02	078	10
47	25.58	106	28	4.17	86	8.05	0.54	11.8	5.3	0.23	0.18		0.65	50	273	50	25.50	107	29
71	25.08	111	43	3.83	78	8.05	0.60	12.6	6.7	0.32	0.15		0.55	75	284	75	25.00	112	46
95	23.41	072	90	3.24	64	8.01	0.77	12.6	9.2	0.22	0.12		0.51	100	226	100	22.75	070	24.09
119	19.56	184	24.97	3.11	58	7.98	0.91	15.4	10.7	0.03	0.14		0.53	125	95.9	125	19.10	260	25.22
142	17.74	024	25.38	3.19	57	7.96	1.02	17.4	12.5	0.01	0.08		0.54	152	38.4	150	17.30	075	52
166	16.31	069	75	3.26	57	7.93	1.14	21.6	14.5	0.00	0.15		0.53	178	11.3	175	15.70	010	84
190	14.30	009	26.14	3.08	52	7.89	1.36	21.8	17.0	0.00	0.10		0.48	200	11.0	200	13.90	040	26.26
285	11.86	34.850	52	1.28	21	7.74	2.18	33.2	23.6	0.00	0.10		0.45	384	2.5	300	11.65	34.840	55
380	10.62	774	70	1.03	16	7.65	2.47	41.0	33.0	0.00	0.11		0.45	567	2.3	400	10.18	752	75
475	8.82	670	92	0.84	13	7.61	2.80	52.0	35.2	0.00	0.06		0.57	749	0.9	500	8.56	655	95
570	7.81	618	27.03	1.13	17	7.59	2.89	60.2	36.0	0.00	0.10		0.64	932		600	7.47	604	27.06
760	5.70	555	26	2.14	30	7.59	3.02	77.8	38.0	0.00	0.14		0.60	1511		800	5.42	552	30
951	4.74	552	37	2.06	29	7.60	3.07	84.0	38.8	0.00	0.08		0.56	1983		1000	4.56	558	40
1148	3.99	577	48	2.18	30	7.66	3.08	104.0	39.8	0.00	0.22		0.57	2927		1200	3.92	581	49
1435	3.23	599	57	2.21	30	7.64	3.22	115.0	40.5	0.00	0.10		0.59	3866		1500	3.09	607	59
1912	2.40	631	68	2.53	33	7.66	3.13	143.0	40.1	0.00	0.06		0.63			2000	2.29	637	69
2389	1.94	654	73	2.83	37	7.68	3.21	151.0	38.9	0.00	0.10		0.48			2500	1.89	659	74
2864	1.72	670	76	3.14	41	7.70	3.04	153.0	35.2	0.00	0.06		0.60			3000	1.70	672	76
3344	1.60	675	77	3.49	45	7.72	2.58	157.0	34.8	0.00	0.15		0.69			3500	1.55	680	78
3818	1.42	692	79	3.75	48	7.76	2.56	153.0	34.1	0.00	0.14		0.54			4000	1.39	699	80
4294	1.38	707	81	3.95	51	7.77	2.79	143.0	35.8	0.00	0.23		0.63			4500	(1.40)	(710)	(81)

Table 15. Data from Nansen and Van Dorn casts at St. 15.

Station	Cast	Latitude	Longitude	Date	Ship time														
15	15-N	2-36S	154-53W	Oct. 2, 1969	04:20~05:40	Depth	4820m	Current		Transp.		Air temp.	25.2°C						
						Wind	E-4	Sea	E-2	Swell	SE-2	Weather	fine						

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4-P (	SiO_2-Si	NO_3-N μg atoms/l	NO_2-N	NH_4-N	DON)	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
0	26.5	35.203	23.06	4.60	96	7.98	0.49	4.2	4.1	0.12	0.19		1.46	0	187	0	26.5	35.203	23.06
9	26.51	191	05	4.56	95	8.00	0.42	4.2	4.3	0.16	0.08		1.59	10	232	10	26.51	191	05
18	26.49	190	05	4.60	96	8.00	0.45	4.2	4.1	0.15	0.08		1.51	20		20	26.49	190	05
27	26.42	188	07	4.56	95	8.01	0.46	3.8	4.3	0.17	0.00		1.16	30	252	30	26.38	188	08
46	26.25	203	13	4.53	94	8.01	0.45	4.2	4.4	0.20	0.11		0.79	50	295	50	26.21	203	14
69	26.17	191	15	4.44	92	8.02	0.50	4.2	4.9	0.23	0.18		0.79	75	273	75	26.17	193	15
92	26.15	213	17	4.41	92	8.02	0.57	4.2	5.2	0.28	0.18		0.84	99	197	100	26.19	226	17
115	26.28	(250)	17	4.29	89	8.02	0.55	4.2	5.4	0.43	0.10		0.74	123	218	125	26.30	270	17
138	26.31	308	18	4.28	89	8.02	0.59	4.2	6.0	0.53	0.12		0.76	148	278	150	25.64	750	73
161	20.28	646	25.14	3.14	59	7.92	1.01	6.8	12.4	0.41	0.01		0.66	173	70.4	175	17.45	460	25.78
183	15.72	252	26.02	2.57	45	7.82	1.49	8.2	17.2	0.01	0.06		0.59	197	8.6	200	14.20	060	26.12
274	11.36	34.828	60	1.79	29	7.71	2.10	27.9	24.4	0.00	0.07		0.53			300	11.08	34.816	64
366	10.65	788	70	2.16	34	7.68	2.06	27.9	28.3	0.00	0.07		0.50			400	10.39	775	74
456	9.89	739	79	1.84	29	7.65	2.25	32.0	28.8	0.00	0.01		0.49			500	9.05	691	88
547	8.10	645	27.01	0.71	11	7.53	2.97	48.3	35.9	0.00	0.08		0.54			600	7.31	610	27.08
731	5.81	562	27	1.77	25	7.56	2.97	64.5	38.0	0.00	0.07		0.59			800	5.28	554	32
917	4.67	555	38	2.20	31	7.58	3.03	83.5	38.1	0.00	0.18		0.56			1000	(4.40)	(560)	42

Table 16. Data from Nansen and Van Dorn casts at St. 16.

Station	Cast	Latitude	Longitude	Date	Ship time															
16	16–N	05–01S	155–00W	Oct. 2～3, 1969	23:15～03:00	Depth 4550m	Current			Transp. 29m (12°)		Air temp. 26.8°C								
	16–V	05–01S	155–04W	Oct. 3, 1969	03:00～08:10	Wind E–4	Sea	E–2		Swell E–2		Weather fine								

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4–P	SiO_2–Si	NO_3–N	NO_2–N	NH_4–N	DON	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
							(		μg atoms/l				)						
0	27.6	35.445	22.88	4.65	99	8.04	0.29	5.4	0.1	0.00	0.43		1.22	0	171	0	27.6	35.445	22.88
10	27.67	445	87	4.66	100	8.06	0.43	6.7	3.1	0.07	0.23		1.13	10	167	10	27.67	445	87
19	27.62	439	86	4.85	103	8.06	0.39	5.4	1.9	0.07	0.29		1.13	20	172	20	27.62	439	86
28	27.58	(436)	88	4.69	100	8.07	0.30	4.2	0.2	0.08	0.26		1.37	30	148	30	27.57	436	88
47	27.50	431	92	4.71	100	8.07	0.34	4.8	0.3	0.07	0.29		1.19	50	160	50	27.50	431	92
71	27.42	436	94	4.66	99	8.08	0.37	7.2	1.2	0.09	0.28		1.00	75	154	75	27.40	450	94
95	26.79	402	23.11	4.51	95	8.05	0.58	7.2	4.8	0.17	0.25		1.12	100	144	100	26.60	410	23.11
119	25.79	374	39	4.33	90	8.04	0.57	7.8	4.4	0.38	0.28		0.72	125	113	125	25.65	550	58
142	25.20	36.135	24.16	3.93	81	8.04	0.64	6.7	3.8	0.64	0.28		0.72	150		150	24.50	36.230	24.46
166	21.68	35.978	99	3.92	76	8.01	0.57	8.4	2.0	0.85	0.18		0.70	195	33.7	175	20.80	35.830	25.48
189	19.00	575	25.48	3.08	57	7.92	1.05	8.4	8.2	0.17	0.29		0.60	200	34.6	200	17.85	450	68
283	12.14	34.911	26.52	0.78	13	7.68	2.28	28.0	24.9	0.06	0.04		0.61	382	1.1	300	11.65	34.870	26.57
377	9.87	757	83	1.93	30	7.65	2.20	28.4	27.7	0.05	0.18		0.56	556		400	9.62	741	84
471	8.78	679	93	2.10	32	7.65	2.27	34.8	30.9	0.08	0.29		0.50	730	0.8	500	8.37	654	96
566	7.58	607	27.05	2.39	35	7.63	2.36	43.0	31.7	0.05	0.14		0.43	904		600	7.21	592	27.08
759	5.72	558	26	1.80	26	7.57	2.85	62.8	36.8	0.04	0.00		0.49			800	5.45	557	18
980	4.53	558	40	2.35	33	7.64	2.76	79.4	36.9	0.03	0.19		0.47			1000	4.48	560	41
1168	3.78	592	27.51	2.46	34	7.63	2.92	96.2	37.5	0.03	0.18		0.50			1200	3.66	595	52
1452	3.03	618		2.55	34	7.63	3.04	117.0	36.3	0.17	0.11		0.51			1500	2.95	621	61
1926	2.34	651	68	2.80	37	7.65	2.91	132.0	34.5	0.10	0.10		0.54			2000	2.26	656	69
2401	1.94	673	73	3.02	39	7.68	2.89	142.0	34.6	0.04	0.21		0.50			2500	1.90	678	74
2878	1.74	690	77	3.36	44	7.70	2.78	142.0	35.0	0.01	0.12		0.54			3000	1.70	693	78
3359	1.58	700	79	3.66	47	7.71	2.76	138.0	35.4	0.03	0.21		0.48			3500	1.50	702	80
3840	1.39	708	81	3.94	51	7.74	2.66	132.0	34.1	0.02	0.18		0.51			4000	(1.35)	(710)	(81)

Table 17. Data from Nansen and Van Dorn casts at St. 17.

Station	Cast	Latitude	Longitude	Date	Ship time														
17	17–N	7–32S	155–00W	Oct. 4, 1969	09:20～10:40	Depth 5300m	Current		Transp. 26m (31°)		Air temp. 28.1°C								
						Wind ESE–4	Sea	ESE–3	Swell E–2		Weather fine								
D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	PH	PO_4–P (	SiO_2–Si	NO_3–N μg atoms/l	NO_2–N	NH_4–N	DON)	DOC (mg/l)	D(V) (m)	Chl. ($\mu g/m^3$)	D(S) (m)	T (°C)	S (‰)	σt
0	28.0	35.516	22.81	4.57	98	8.06	0.36	4.0	3.1	0.04	0.37		0.99	0	144	0	28.0	35.516	22.81
10	27.96	514	82	4.60	99	8.10	0.41	3.1	2.7	0.06	0.26		0.87	10	136	10	27.96	514	82
19	27.94	526	84	4.61	99	8.11	0.43	3.1	2.7	0.07	0.23		0.87	20		20	27.94	526	84
29	27.93	524	84	4.63	99	8.12	0.39	2.5	2.7	0.06	0.21		0.88	30	159	30	27.93	524	84
48	27.90	540	85	4.60	99	8.12	0.47	3.4	2.7	0.06	0.25		0.89	50	185	50	27.90	540	85
72	27.81	525	87	4.59	98	8.12	0.38	3.4	2.8	0.06	0.19		0.80	75	214	75	27.80	525	87
95	27.78	522	88	4.53	97	8.13	0.47	3.1	2.9	0.09	0.21		0.75	100	209	100	27.80	580	92
119	28.10	36.010	23.15	4.35	94	8.17	0.32	1.9	0.0	0.07	0.19		0.88	125	93.2	125	28.08	36.075	23.20
142	26.58	146	74	3.97	84	8.14	0.49	1.3	1.3	1.31	0.06		0.85	150	80.3	150	24.95	290	24.35
165	23.01	204	24.87	3.89	77	8.09	0.51	4.5	3.2	0.04	0.08		0.67	175	43.9	175	22.38	145	25.01
188	21.48	032	25.18	3.84	74	8.06	0.60	9.3	4.2	0.00	0.07		0.69	200	23.5	200	20.30	35.905	39
279	13.71	34.984	26.25	2.12	36	7.84	1.67	15.5	17.6	0.00	0.07		0.52			300	12.75	34.912	26.40
371	9.95	762	80	2.14	33	7.74	2.18	26.2	23.8	0.00	0.04		0.52			400	9.16	720	90
464	8.05	648	27.02	2.10	31	7.72	2.39	36.9	26.0	0.00	0.10		0.46			500	7.68	622	27.06
559	7.24	604	10	2.51	37	7.69	2.40	41.0	30.3	0.00	0.11		0.59			600	6.96	601	14
750	5.98	582	25	1.82	26	7.63	2.85	57.4	32.2	0.00	0.10		0.53			800	5.70	579	28
939	4.96	566	37	2.03	28	7.62	2.98	76.7	31.0	0.00	0.01		0.46			1000	(4.67)	(565)	(39)

Table 18. Data from Nansen and Van Dorn casts at St. 18.

Station	Cast	Latitude	Longitude	Date	Ship time															
18	18-N	10-04S	154-54W	Oct. 5, 1969	05:45~10:45	Depth 4650m	Current 280°, 0.1kt	Transp. 25m (0°)	Air temp. 27.5°C											
	18-V	10-03S	154-55W	Oct. 5, 1969	12:00~17:10	Wind ESE-4	Sea ESE-3	Swell SE-3	Weather fine											

D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	pH	PO_4-P	SiO_2-Si	NO_3-N	NO_2-N	NH_4-N	DON	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt
							(		μg atoms/l				)						
0	28.4	35.797	22.86	4.53	98	7.80	0.31	7.0	0.6	0.00	0.55	15.2	1.13	0	108	0	28.4	35.797	22.86
10	28.46	806	85	4.56	99	8.07	0.39	7.0	0.9	0.02	0.55		0.82	10	120	10	28.46	806	85
20	28.46	805	85	4.67	101	8.12	0.38	7.0	0.9	0.03	0.40		0.77	20	130	20	28.46	805	85
30	28.47	810	88	4.58	99	8.14	0.37	6.5	0.9	0.04	0.26		0.82	30	139	30	28.47	810	88
49	28.34	984	23.05	4.57	99	8.17	0.34	8.6	0.3	0.03	0.19	11.5	0.88	50	175	50	28.33	995	23.06
74	28.17	36.059	15	4.49	97	8.18	0.32	8.6	0.1	0.00	0.21		0.86	75	203	75	28.17	36.059	15
98	28.02	058	19	4.39	95	8.18	0.37	7.0	0.1	0.08	0.23		0.78	100	230	100	28.01	059	19
122	26.19	244	95	4.35	91	8.15	0.40	7.5	0.2	0.16	0.15		0.71	125	175	125	25.05	248	24.03
147	24.93	307	24.36	4.12	84	8.13	0.48	7.5	1.3	0.85	0.15	9.3	0.73	150	137	150	24.85	308	38
171	23.13	258	87	3.95	78	8.10	0.54	8.6	2.0	0.06	0.15	9.5	0.66	175	104	175	22.96	236	88
195	22.17	102	25.04	3.92	76	8.08	0.62	7.5	2.6	0.03	0.21	9.4	0.64	200	42.6	200	22.02	050	25.05
289	15.07	35.087	26.04	3.09	53	7.92	1.21	12.4	9.7	0.04	0.11	10.3	(1.69)	417	3.4	300	14.22	35.006	26.17
382	10.07	34.718	74	2.29	36	7.75	2.26	23.8	18.0	0.02	0.11	16.7	0.55	602	8.1	400	9.53	34.693	81
475	7.93	615	27.00	2.50	37	7.70	2.53	31.0	23.4	0.03	0.08	12.3	0.48	787	3.3	500	7.58	600	27.05
569	6.77	568	14	2.78	40	7.68	2.65	34.8	23.7	0.00	0.14	13.2	0.58	962	1.8	600	6.48	555	17
759	5.49	538	28	2.50	35	7.63	2.94	47.2	30.2	0.02	0.14		0.53	1528		800	5.23	538	30
953	4.62	553	39	2.64	37	7.63	3.15	57.2	31.0	0.00	0.15	12.2	0.66	2012		1000	4.34	555	41
1147	3.91	576	49	2.71	37	7.64	3.23	66.7	31.8	0.00	0.15	10.1	0.60	2979		1200	3.75	580	51
1434	3.12	604	59	2.85	38	7.66	3.44	76.8	32.6	0.00	0.12	15.9	0.58	3945		1500	3.01	612	60
1911	2.32	646	70	3.24	43	7.68	3.34	129.0	32.0	0.00	0.10	19.5	0.51			2000	2.23	654	71
2387	1.94	680	74	3.37	44	7.70	3.37	136.5	32.0	0.00	0.12	13.7	0.56			2500	1.86	680	76
2864	1.75	694	77	3.51	46	7.72	3.39	140.3	30.4	0.00	0.10	14.0	0.47			3000	1.70	697	78
3341	1.60	704	79	3.70	48	7.73	3.45	144.5	27.8	0.00	0.14	8.9	0.54			3500	1.53	714	80
3818	1.42	(712)	80	4.03	52	7.73	3.25	136.5	26.7	0.00	0.14	8.6	0.57			4000	1.39	722	82
4295	1.35	720	82	4.23	54	7.76	3.20	136.5	25.3	0.00	0.14	8.6	0.60			4500	(1.33)	(730)	(83)

Table 19. Data from Nansen and Van Dorn casts at St. 19.

Station	Cast	Latitude	Longitude	Date	Ship time															
19	19–N	14–59S	155–00W	Oct. 14, 1969	16:50～21:15	Depth 4460m	Current 312°, 0.5kt	Transp. 47 (10°)	Air temp. 25.7°C											
	19–V	14–57S	155–01W	Oct. 14～15, 1969	21:05～02:00	Wind SSE–4	Sea SSE–3	Swell SSE–3	Weather cloudy											
D(N) (m)	T (°C)	S (‰)	σt	O_2 (ml/l)	O_2Sat (%)	PH	PO_4–P (	SiO_2–Si	NO_3–N μg atoms/l	NO_2–N	NH_4–N	DON)	DOC (mg/l)	D(V) (m)	Chl. (μg/m³)	D(S) (m)	T (°C)	S (‰)	σt	
0	28.3	35.980	23.06	4.46	97	7.98	0.40	1.4	0.0	0.00	0.55	9.2	1.35	0	41.0	0	28.3	35.980	23.06	
10	28.52	983	22.99	4.46	97	8.04	0.33	3.3	0.0	0.00	0.36	8.7	1.10	10	36.8	10	28.52	983	22.99	
20	28.27	981	23.07	4.49	97	8.07	0.34	2.9	0.0	0.00	0.32	10.8	1.06	20	41.9	20	28.27	981	23.07	
30	28.16	971	09	4.52	98	8.10	0.31	3.3	0.0	0.00	0.33	13.7	1.04	30	35.3	30	28.16	971	09	
50	27.64	998	29	4.60	98	8.11	0.32	2.9	0.0	0.00	0.25	12.0	1.21	50	32.8	50	27.64	998	29	
74	27.39	36.046	40	4.61	98	8.13	0.29	2.9	0.0	0.00	0.47		0.98	75	40.6	75	27.35	36.046	41	
99	26.74	020	59	4.58	97	8.13	0.44	3.9	0.0	0.00	0.21	7.5	0.94	100	70.8	100	26.61	020	64	
123	25.53	130	24.05	4.47	92	8.11	0.42	3.9	0.4	0.00	0.28	8.1	0.74	125	98.1	125	25.50	132	24.06	
147	24.42	158	42	4.09	83	8.10	0.43	3.9	1.2	0.20	0.33	9.0	0.63	150	165	150	24.38	158	43	
171	23.27	140	75	3.93	78	8.07	0.58	4.3	2.6	0.06	0.03	9.9	0.66	175	84.6	175	23.18	130	76	
195	22.13	35.970	94	3.89	76	8.07	0.49	6.0	3.0	0.03	0.30	7.8	0.65	200	42.2	200	21.97	35.960	97	
289	16.90	302	25.79	3.98	71	7.99	0.91	6.5	6.2	0.00	0.28	8.8	(1.12)	424	1.3	300	16.08	214	25.91	
380	11.28	34.752	26.55	2.94	47	7.79	1.80	16.5	18.4	0.17	0.26	7.1	0.62	618	2.5	400	10.52	34.700	26.65	
473	8.33	565	92	3.15	47	7.75	2.16	27.9	22.3	0.15	0.28	9.0	0.56	801	0.8	500	7.76	522	96	
567	6.59	467	27.07	3.56	52	7.72	2.31	32.2	25.7	0.06	0.28		0.59	990	2.3	600	6.20	460	27.13	
768	5.00	497	30	3.48	49	7.72	2.57	52.1	33.1	0.07	0.32	8.7	0.56	1402		800	4.83	502	33	
951	4.13	528	42	3.22	44	7.67	2.91	72.9	33.7	0.12	0.55		0.56	1869		1000	4.02	535	44	
1156	3.65	564	51	3.15	43	7.67	3.01	83.5	36.3	0.01	0.00	8.6	0.55	2803		1200	3.54	571	52	
1441	2.97	604	60	3.20	43	7.68	3.04	98.2	35.7	0.05	0.32		0.61	3737		1500	2.87	611	61	
1921	2.33	649	69	3.38	44	7.69	3.21	115.7	34.2	0.03	0.19	8.9	0.63	4110		2000	2.28	653	70	
2397	1.98	673	74	3.47	45	7.71	3.27	126.0	32.8	0.03	0.57	10.1	0.61			2500	1.92	679	74	
2871	1.77	696	77	3.70	48	7.72	3.19	127.0	33.4	0.00	0.19	10.6	0.54			3000	1.71	698	78	
3347	1.58	705	79	3.91	50	7.74	3.21	128.8	31.2	0.02	0.21	10.4	0.59			3500	1.53	708	80	
3818	1.48	716	81	4.08	52	7.74	3.07	126.2	31.2	0.01	0.11	7.4	0.73			4000	1.45	718	81	
4105	1.44	720	81	4.18	54	7.75	3.07	126.2	31.2	0.03	0.28	5.4	0.63							

Table 20. Data from BT observations.

Station	Date	Ship time	Lat.	Long.	Temp. (°C)												Max. Dep. (m)	Temp. (°C)	SLD (m)
					0(m)	10	20	30	50	75	100	125	150	175	200	250			
H-65	Aug. 14	21 : 39	38-10N	152-39E	23.3	23.3	23.1	22.7	18.6	17.1	15.7	14.9	14.3	13.8	13.2	12.7	282	11.5	28
H-66	Aug. 15	20 : 33	39-31N	158-42E	20.2	19.6	18.6	18.0	11.5	10.3	9.8	9.2	8.1	7.6	7.1	6.5	285	5.8	24
H-67	Aug. 16	19 : 05	41-00N	165-03E	20.1	19.9	16.6	12.8	11.0	9.6	8.1	7.7	7.4	6.9	6.8	6.3	272	5.8	10
H-68	Aug. 17	20 : 08	42-32N	171-15E	16.8	16.8	15.9	12.1	10.8	9.9	8.8	8.2	7.8	7.7	7.7	7.7	260	7.6	10
H-70	Aug. 18	19 : 07	43-46N	176-38E	20.1	20.1	19.6	15.6	13.4	12.7	12.2	11.9	11.4	10.5	10.3	9.1	256	9.0	18
H-71	Aug. 18	20 : 13	44-56N	176-58W	16.0	15.6	13.7	9.1	7.3	6.8	6.0	5.8	6.1	6.1	6.6	5.5	264	5.3	14
H-72	Aug. 19	20 : 03	46-21N	170-40W	15.7	15.5	12.7	8.6	6.7	5.8	5.1	4.8	5.1	5.2	5.1	4.7	268	4.6	13
H-73	Aug. 20	20 : 35	47-54N	164-11W	14.5	14.2	14.2	8.8	5.6	4.9	4.6	4.6	5.0	5.0	5.1	5.0	263	4.9	23
H-74	Aug. 21	19 : 04	49-26N	157-39W	12.5	12.4	12.4	8.6	6.0	4.6	4.5	4.5	4.6	4.5	4.5	4.3	262	4.3	15
1-1	Aug. 22	06 : 32	50-00N	155-00W	11.9	11.9	11.9	11.8	5.6	4.4	4.2	4.2	4.4	4.3	4.3	4.3	265	4.3	35
1-2	Aug. 23	05 : 20	49-58N	154-59W	12.0	11.9	11.9	11.8	6.4	4.3	4.0	4.0	4.2	4.2	4.2	4.2			35
1-3	Aug. 24	05 : 05	49-49N	154-38W	11.8	11.8	11.8	11.8	5.7	4.1	4.0	3.9	4.2	4.1	4.0	4.0	280	3.7	34
1-4	Aug. 25	06 : 25	49-58N	155-21W	11.9	11.9	11.9	11.9	6.6	4.2	4.1	4.0	4.4	4.3	4.3	4.2	260	4.1	37
1-5	Aug. 26	06 : 40	50-02N	155-14W	12.0	11.9	11.9	11.9	6.8	4.2	4.1	4.0	4.3	4.2	4.1	4.1	257	4.0	38
1-6	Aug. 27	05 : 25	49-45N	154-37W	12.2	12.2	12.2	12.1	6.0	4.4	4.3	4.2	4.4	4.4	4.3	4.3	272	4.2	33
2	Aug. 28	20 : 30	45-03N	155-00W	15.3	15.3	15.3	11.1	7.6	6.2	6.3	6.7	7.0	6.7	6.2	5.9			21
3-1	Aug. 30	17 : 51	39-59N	155-01W	20.8	20.8	20.7	15.1	12.8	11.4	10.4	10.0	9.9	9.7	9.7	9.5	268	9.0	27
3-2	Aug. 31	03 : 19	39-59N	154-56W	20.7	20.7	20.7	16.9	12.6	11.2	10.5	10.0	9.9	9.6	9.9	9.3	278	8.6	28
3-3	Sep 1	08 : 00	40-00N	154-30W	21.0	21.0	21.0	20.9	12.5	11.0	10.4	10.0	10.1	10.1	10.1	9.5	278	8.8	30
3-4	Sep. 2	06 : 00	40-.5N	154-53W	20.7	20.7	20.6	15.5	12.0	10.1	10.2	10.0	10.0	10.0	9.6	9.0	(300)	(7.7)	28
3-5	Sep. 3	05 : 03	40-01N	155-00W	21.0	20.7	20.5	16.8	12.3	11.2	10.4	10.0	10.1	9.9	9.7	8.8	267	8.8	28
3-6	Sep. 4	06 : 22	40-04N	154-54W	21.2	21.0	20.7	19.4	17.4	10.4	10.2	10.2	10.2	10.2	10.1	9.2	(270)	(9.1)	28
4	Sep. 5	22 : 10	34-59N	155-00W	23.5	23.2	23.1	18.8	16.9	14.9	14.0	13.5	13.0	12.5	12.2	11.5	265	11.3	26
5	Sep. 8	02 : 10	29-58N	155-05W	24.3	23.9	23.7	23.6	23.0	19.0	17.4	16.3	15.3	14.1	13.3	11.8	257	11.6	(50)

Table 20. Data from BT observations(Continued).

Station	Date	Ship time	Lat.	Long.	Temp. (°C)												Max. Dep.	Temp.	SLD
					0(m)	10	20	30	50	75	100	125	150	175	200	250	(m)	(°C)	(m)
6	Sep. 9	22 : 23	24–57N	154–59W	25.4	25.4	25.4	25.4	25.4	23.4	20.8	19.6	18.6	17.9	16.9	14.3	257	13.8	60
7	Sep. 11	15 : 10	20–59N	154–59W	26.0	26.0	25.9	25.9	25.6	24.2	22.4	21.0	19.7	18.6	17.0	12.8	258	12.0	37
8	Sep. 19	08 : 27	17–00N	155–01W	26.1	26.1	26.1	26.1	26.1	25.9	23.2	21.7	19.9	18.5	16.6	11.1	265	10.7	75
9	Sep. 21	01 : 40	13–28N	155–01W	26.9	26.8	26.8	26.8	26.8	26.7	23.4	17.6	13.9	12.1	11.4	10.7	255	10.6	88
10–1	Sep. 22	01 : 35	10–02N	155–00W	27.6	27.7	27.6	27.6	24.1	13.7	12.3	11.4	11.0	10.5	10.3	9.7	217	9.5	42
10–2	Sep. 23	05 : 20	09–57N	155–00W	27.8	27.8	27.8	27.8	20.9	12.4	11.7	11.2	10.8	10.5	10.2	9.8	255	9.8	38
10–3	Sep. 24	05 : 38	10–05N	155–10W	27.6	27.7	27.7	26.1	18.6	13.6	12.3	11.6	11.2	10.8	10.4	9.8	265	9.6	25
10–4	Sep. 25	04 : 56	10–02N	155–20W	27.7	27.6	27.6	27.6	23.0	13.3	12.5	11.5	11.2	10.7	10.4	9.8	263	9.7	38
11	Sep. 27	11 : 02	07–28N	154–50W	28.9	28.9	28.9	28.8	28.7	28.0	20.8	14.3	12.1	10.8	10.3	9.6	255	9.6	65
7°N	Sep. 27	18 : 30	07–00N	154–47W	28.8	28.8	29.0	28.9	28.9	28.2	22.4	15.8	17.7	10.9	10.3		244	9.9	65
6.5°N	Sep. 27	21 : 10	06–30N	154–50W	28.7	28.7	28.9	28.9	28.8	28.0	23.5	19.9	14.6	12.8	11.2	9.7	257	9.5	72
6°N	Sep. 28	00 : 40	05–58N	154–56W	28.9	28.9	28.9	28.9	28.9	28.7	25.1	22.9	16.2	13.2	12.0	10.1	257	9.6	80
5.5°N	Sep. 28	03 : 12	05–25N	154–00W	28.6	28.5	28.5	28.5	28.4	27.1	26.5	24.7	20.3	14.9	12.1	9.9	284	9.0	64
12	Sep. 28	05 : 52	04–52N	155–05W	27.8	27.8	27.8	27.8	27.8	27.6	27.4	24.8	19.1	15.8	13.6	9.7	264	9.5	104
4.5°N	Sep. 29	06 : 25	04–30N	154–36W	28.0	27.9	27.9	27.9	27.9	27.2	26.6	25.9	23.0	16.3	12.7	10.0	(265)	(9.5)	61
4°N	Sep. 29	09 : 30	04–00N	154–34W	26.9	26.9	26.9	26.9	26.9	26.9	26.7	26.2	25.0	14.4	11.3	10.7	(265)	(10.6)	138
3.5°N	Sep. 29	12 : 40	03–36N	154–34W	27.0	27.0	27.0	27.0	27.0	26.9	26.7	26.5	25.1	13.7	12.1	11.3	264	11.0	136
3°N	Sep. 29	15 : 00	02–58N	154–36W	26.9	26.9	26.9	26.9	26.8	26.7	26.1	25.2	21.5	12.9	12.2	11.7	(300)	(10.9)	95
13	Sep. 29	18 : 47	02–28N	154–54W	26.8	26.8	26.8	26.8	26.8	26.8	25.8	24.8	15.6	12.3	12.0	11.6	253	11.5	87
2°N	Sep. 30	03 : 45	02–00N	155–02W	26.7	26.7	26.8	26.8	26.7	26.5	25.6	25.3	16.2	13.0	12.2	11.8	272	11.4	84
1.5°N	Sep. 30	06 : 05	01–35N	155–01W	26.7	26.7	26.7	26.7	26.1	25.9	25.7	24.2	14.2	13.1	12.2	11.7	292	11.0	54
1°N	Sep. 30	09 : 25	01–00N	155–03W	27.0	27.0	26.9	26.7	26.1	25.5	24.5	24.2	16.2	14.3	12.7	12.0	272	11.5	(70)
0.5°N	Sep. 30	11 : 50	00–33N	155–01W	27.4	26.4	26.3	26.2	25.7	25.1	23.8	20.0	16.3	14.3	13.5	11.9	272	11.0	(70)
14	Sep. 30	15 : 42	00–00	154–54W	26.8	26.8	26.2	26.9	25.5	24.5	21.1	19.3	17.0	15.0	13.6	12.3			(72)

Table 20. Data from BT observations(Continued).

Station	Date		Ship time	Lat.	Long.	Temp. (°C)												Max. Dep.	Temp.	SLD
						0(m)	10	20	30	50	75	100	125	150	175	200	250	(m)	(°C)	(m)
0.5°S	Oct.	1	16 : 50	00-30S	155-06W	27.4	26.5	26.4	26.0	25.5	25.2	24.6	22.0	17.7	15.2	13.7		241	12.3	(90)
1°S	Oct.	1	19 : 28	00-59S	155-05W	26.6	26.3	26.1	25.8	25.5	25.4	25.6	23.6	17.1	14.8	12.8	12.1	286	11.3	101
1.5°S	Oct.	1	23 : 32	01-30S	155-06W	26.6	26.5	26.2	26.1	25.9	25.9	25.9	25.9	21.6	15.9	13.2	12.0	(260)	(11.5)	130
2°S	Oct.	2	01 : 53	02-03S	154-59W	26.5	26.5	26.4	26.3	26.2	26.2	26.2	26.2	21.7	15.7	12.3	11.6	252	11.6	126
15	Oct.	2	04 : 23	02-36S	154-53W	26.5	26.5	26.5	26.4	26.3	26.2	26.3	26.3	21.8	16.4	12.2	11.5	254	11.3	134
3°S	Oct.	2	12 : 55	03-00S	154-56W	27.5	27.6	27.6	27.5	27.4	26.8	26.6	26.6	24.3	14.1	12.3	11.2	262	10.9	94
3.5°S	Oct.	2	15 : 15	03-30S	154-57W	28.1	27.7	27.6	27.6	27.6	27.7	27.2	26.4	26.6	17.8	14.1		217	13.1	113
4°S	Oct.	2	17 : 13	03-56S	154-58W	27.9	27.8	27.5	27.5	27.4	27.4	27.1	26.4	20.6	18.3	14.9	11.8	281	9.9	109
4.5°S	Oct.	2	20 : 35	04-30S	154-59W	27.7	27.7	27.6	27.5	27.5	27.2	27.1	26.0	23.1	18.9	16.2	11.5	(261)	(11.0)	116
16-1	Oct.	2	23 : 25	05-00S	155-00W	27.6	27.6	27.6	27.5	27.5	27.4	26.5	25.7	24.1	19.8	18.0	12.6	254	12.1	76
16-2	Oct.	3	09 : 14	04-59S	155-08W	27.6	27.5	27.5	27.5	27.5	27.5	26.7	25.7	25.1	21.2	17.1	12.4			80
17	Oct.	4	09 : 15	07-32S	154-59W	28.0	27.9	27.9	27.9	27.9	27.8	28.2	27.7	25.7	22.6	20.6	15.0	261	13.0	88
18	Oct.	5	05 : 57	10-05S	154-54W	28.4	28.4	28.4	28.4	28.4	28.2	28.1	26.0	24.5	22.9	21.4	17.3	270	14.4	100
19-1	Oct.	14	16 : 38	15-00S	155-00W	28.6	28.5	28.3	28.2	27.8	27.5	27.0	25.5	23.9	22.9	21.7	18.3	260	17.5	99
19-2	Oct.	15	05 : 12	14-55S	155-02W	28.1	28.1	28.1	28.1	27.7	27.5	27.1	25.5	24.1	23.0	22.0	18.7	261	17.6	92
19-3	Oct.	17	05 : 35	14-36S	155-05W	28.4	28.2	28.2	28.2	27.6	27.2	27.0	25.2	23.9	23.1	22.3	18.8	260	17.8	45
T-1	Oct.	22	11 : 05	14-38S	165-27W	28.3	28.3	28.3	28.2	28.0	27.6	26.4	25.4	24.1	23.4	22.3	19.0			70
5°S	Oct.	30	00 : 32	05-01S	179-08E	29.8	29.7	29.7	29.7	29.0	28.9	28.7	27.3	25.0	22.1	18.0	13.4	260	12.6	36
4.5°S	Oct.	30	03 : 24	04-30S	178-50E	29.9	30.0	30.0	29.9	29.8	29.0	28.6	28.0	27.7	22.5	18.0	12.0	270	10.6	55
4°S	Oct.	30	06 : 10	03-49S	178-30E	29.8	29.8	29.8	29.7	29.7	29.5	28.9	28.3	26.8	23.4	20.3	12.1	270	10.9	70
3.5°S	Oct.	30	07 : 50	03-30S	178-19E	29.8	29.8	29.8	29.8	29.8	29.5	29.0	27.9	25.4	20.5	17.3	11.4	270	10.2	83
3°S	Oct.	30	11 : 03	02-59S	178-05E	30.1	29.8	29.8	29.7	29.7	29.7	28.9	28.0							80
2.5°S	Oct.	30	13 : 38	02-30S	177-49E	30.1	29.7	29.7	29.6	29.5	29.5	29.3	27.8	25.0	19.2	14.2	10.8	257	10.7	100
2°S	Oct.	30	16 : 23	02-01S	177-32E	29.8	29.6	29.5	29.5	29.4	29.4	29.2	28.1	26.5	21.9	16.2	11.4	290	10.9	118

Table 20. Data from BT observations(Continued):

Station	Date	Ship time	Lat.	Long.	Temp. (°C)												Max. Dep.	Temp.	SLD
					0(m)	10	20	30	50	75	100	125	150	175	200	250	(m)	(°C)	(m)
1.5°S	Oct. 30	18 : 55	01-31S	177-09E	29.5	29.4	29.3	29.3	29.2	29.2	29.1	27.4	23.1	19.4	14.8	11.5	260	11.3	100
1°S	Oct. 30	22 : 20	01-01S	176-50E	29.3	29.3	29.2	29.1	29.1	29.1	28.8	27.2	21.8	18.4	16.6	12.1	280	11.3	105
0.5°S	Oct. 31	01 : 10	00-30S	176-30E	29.1	29.1	29.0	28.9	28.8	28.7	28.6	26.3	24.1	18.9	15.3	11.9			110
0°	Oct. 31	03 : 55	0-00	175-12E	28.9	29.0	28.9	28.8	28.8	28.8	28.1	23.9	20.7	17.9	16.1	12.1	270	10.7	80
0.5°N	Oct. 31	06 : 08	0-31N	175-46E	29.1	29.1	29.1	29.0	29.0	28.8	28.6	27.4	21.2	17.4	13.8	12.1	270	10.7	85
1°N	Oct. 31	08 : 30	1-00N	175-29E	29.2	29.1	29.1	29.1	29.1	28.8	28.1	26.3	22.5	16.3	15.0	11.9	280	11.2	80
1.5°N	Oct. 31	12 : 00	1-32N	175-09E	29.8	29.6	29.6	29.6	29.5	28.8	28.3	26.3	21.8	16.5	15.9	11.6	258	11.5	50
2°N	Oct. 31	14 : 30	2-00N	174-52E	30.1	29.6	29.6	29.6	29.6	29.1	28.5	26.7	19.9	16.2	14.4	11.8	285	11.1	55
2.5°N	Oct. 31	17 : 50	2-29N	174-40E	29.8	29.6	29.6	29.6	29.6	29.0	28.2	25.9	22.8	18.0			180	16.7	55
3°N	Oct. 31	21 : 05	3-02N	174-10E	29.8	29.7	29.7	29.7	29.7	29.1	27.7	24.7	21.1	14.8	13.0	11.4	(290)	(10.6)	60
3.5°N	Nov. 1	00 : 05	3-30N	173-52E	29.9	29.9	29.8	29.8	29.8	29.7	28.7	27.0	24.6	20.6	14.4	11.4	(290)	(10.4)	70
4°N	Nov. 1	05 : 16	4-04N	173-30E	29.7	29.8	29.8	29.8	29.8	29.5	28.3	25.2	22.3	15.8	13.0	10.2	(290)	(10.0)	70
4.5°N	Nov. 1	08 : 00	4-35N	173-16E	29.8	29.8	29.8	29.9	30.1	29.7	27.5	24.8	21.5	15.8	13.3	10.2	(300)	(8.8)	75
5°N	Nov. 1	13 : 15	5-00N	173-02E	29.9	29.8	29.9	29.7	29.0	27.7	25.9	23.3	18.7	15.0	12.2	9.9	(290)	(8.9)	30
5.5°N	Nov. 1	16 : 43	5-30N	172-39E	30.1	30.1	29.9	29.9	29.7	27.7	24.4	22.3	19.9	14.0	11.5	9.8	(300)	(8.8)	53
6°N	Nov. 1	20 : 00	5-59N	172-18E	29.3	29.4	29.4	29.3	28.3	27.7	25.1	24.0	16.2	13.3	11.3	10.2	(300)	(9.0)	20
6.5°N	Nov. 1	23 : 15	6-30N	172-10E	29.8	29.8	29.9	29.9	29.9	27.6	23.7	20.0	15.6	12.4	11.3	10.0	(300)	(8.9)	68
7°N	Nov. 2	01 : 54	7-00N	172-00E	29.6	29.6	29.6	29.6	29.6	28.3	23.3	16.8	12.8	11.3	10.7	9.8	(295)	(8.8)	60
7.5°N	Nov. 2	04 : 55	7-30N	171-46E	29.4	29.5	29.5	29.6	29.3	27.1	24.4	16.0	12.3	11.6	10.8	9.8	(295)	(9.2)	45
8°N	Nov. 2	07 : 33	8-00N	171-29E	29.2	29.2	29.2	29.3	28.7	26.3	22.0	17.2	12.6	11.3	10.8	10.1	280	9.7	48
8.5°N	Nov. 2	10 : 42	8-28N	171-13E	29.0	28.9	28.9	28.8	28.6	26.4	20.0	15.8	12.0	11.1	10.7	10.1	(300)	(9.2)	50
9°N	Nov. 2	12 : 38	9-00N	171-09E	29.1	29.0	29.0	29.0	29.0	24.7	19.3	14.6	12.5	11.5	11.0	10.3	(290)	(9.4)	56
T-4	Nov. 2	14 : 28	9-21N	171-03E	28.9	28.9	28.9	28.9	28.9	21.8	19.0	15.8	11.9	10.6	10.3		243	9.9	70
9.5°N	Nov. 2	17 : 03	9-30N	170-59E	29.0	29.0	29.1	29.1	29.1	25.4	18.1	14.5	11.6	11.0	10.8	10.1	(290)	(9.5)	70

Table 20. Data from BT observations(Continued).

Station	Date	Ship time	Lat.	Long.	Temp. (°C)												Max. Dep.	Temp.	SLD
					0(m)	10	20	30	50	75	100	125	150	175	200	250	(m)	(°C)	(m)
10°N	Nov. 2	19 : 15	10-01N	170-51E	29.1	29.1	29.1	29.1	29.0	26.1	19.4	14.0	12.1	10.9	10.6	9.9	285	9.2	55
11°N	Nov. 3	00 : 30	11-00N	170-32E	29.0	29.0	29.0	29.0	28.9	26.8	20.7	14.5	11.7	10.4	10.2	9.8	(300)	(9.0)	60
12°N	Nov. 3	05 : 00	12-00N	170-10E	28.6	28.6	28.6	28.6	28.6	28.6	26.0	21.0	18.0	15.5	12.9	10.7	(300)	(9.1)	75
T-5	Nov. 3	10 : 55	12-51N	169-43E	28.5	28.5	28.5	28.5	28.5	28.2	25.5	21.0	17.7	14.8	13.2		238	11.4	80
14°N	Nov. 3	18 : 13	14-00N	168-25E	29.0	28.9	28.8	28.8	28.7	28.7	27.0	25.2	23.6	20.3	16.0	11.4	280	10.0	90
P_2	Nov. 3	21 : 36	14-28N	167-52E	28.9	28.7	28.6	28.6	28.6	28.6	26.5	24.5	22.8	20.6	18.1		231	15.1	78
15°N	Nov. 4	00 : 48	15-00N	167-23E	28.5	28.5	28.5	28.5	28.5	28.5	27.5	25.7	23.0	19.2	16.9	13.3	(300)	(9.8)	93
T-6	Nov. 4	09 : 01	16-22N	166-01E	28.8	28.8	28.8	28.8	28.7	28.7	27.5	25.8	24.1	21.9	19.3	15.1	260	14.4	87
T-7	Nov. 4	12 : 02	16-44N	165-36E	28.9	28.9	28.9	28.9	28.9	28.9	26.5	24.8	22.9	20.7	19.0		242	16.0	80
P_3	Nov. 4	21 : 04	18-00N	164-18E	28.8	28.8	28.8	28.8	28.8	27.5	25.6	24.0	21.8	19.9	18.1	15.8	(290)	(12.5)	68
	Nov. 5	08 : 39	19-42N	162-16E	28.6	28.6	28.6	28.6	28.6	27.2	26.1	24.8	23.2	21.0	19.8	16.7	(300)	(13.4)	70
T-8	Nov. 5	13 : 02	20-24N	161-28E	28.8	28.8	28.8	28.8	28.8	28.8	26.5	23.8	22.4	20.8	19.0		245	16.9	80
P_4	Nov. 5	21 : 26	21-30N	160-10E	28.9	28.9	28.9	28.9	28.9	25.6	23.1	21.6	19.1	18.2	17.3	15.7	266	14.8	55
	Nov. 6	08 : 58	23-05N	158-13E	28.0	28.0	28.0	28.0	28.0	25.0	21.0	19.2	18.4	17.7	17.4	16.6	(290)	(15.6)	70
P_5	Nov. 6	21 : 11	24-52N	155-49E	26.9	26.9	26.8	26.8	26.7	23.1	20.6	18.6	17.9	17.2	17.0	16.0	(290)	(14.5)	62
	Nov. 7	09 : 03	26-26N	153-30E	26.2	26.2	26.2	26.2	26.2	23.5	21.3	19.3	18.2	17.5	17.1	16.2	(285)	(15.1)	68
P_6	Nov. 7	21 : 25	27-44N	151-00E	25.4	25.4	25.4	25.4	25.4	25.4	20.9	19.5	18.6	17.9	17.4	16.7	275	16.0	77

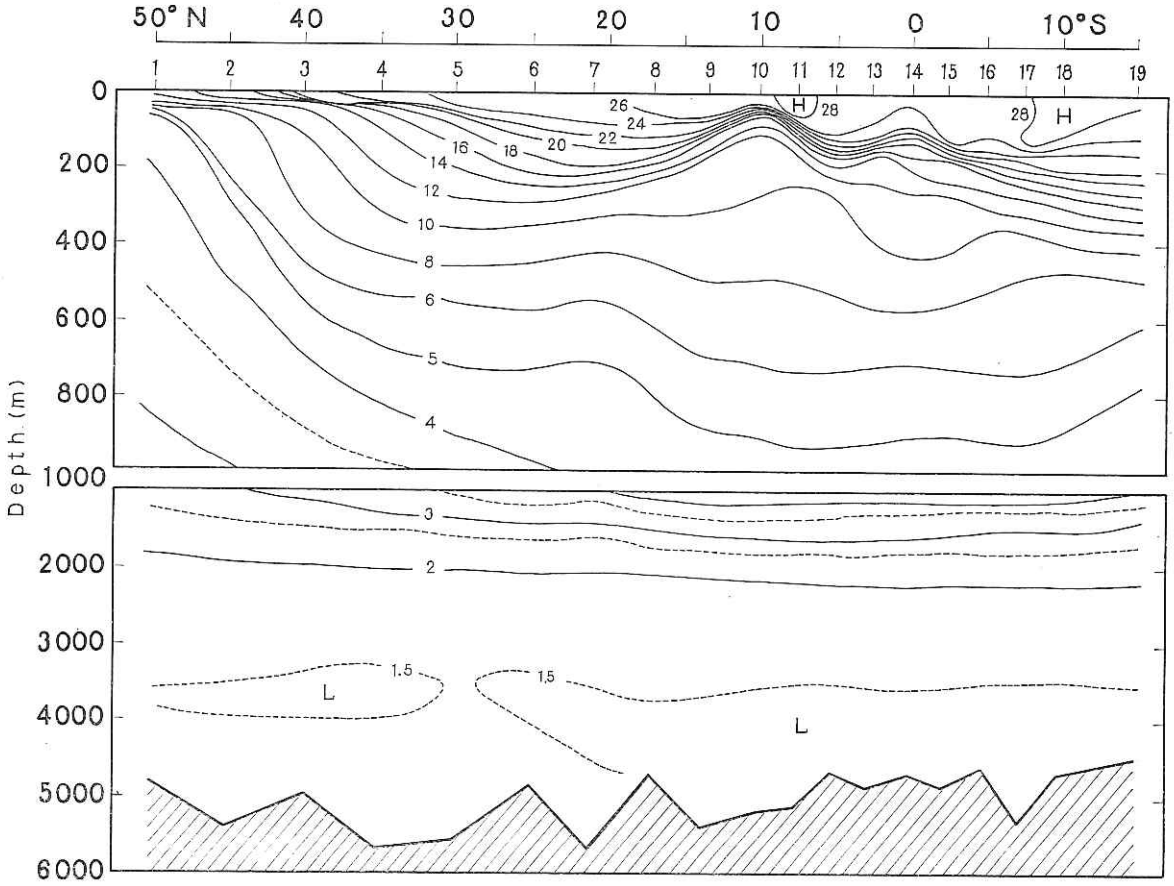

Fig. 2. Distribution profile of water temperature(°C) along 155°w

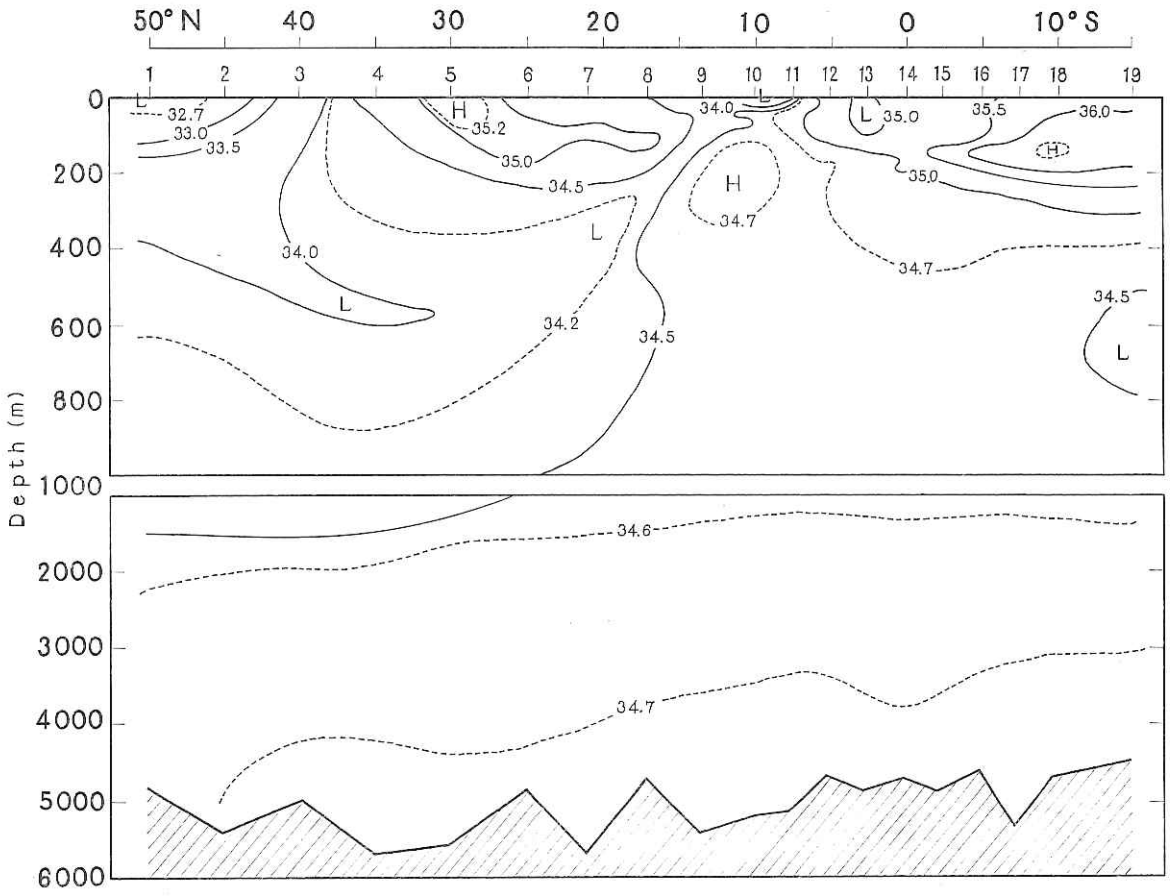

Fig. 3. Distribution profile of salinity(‰) along 155°w.

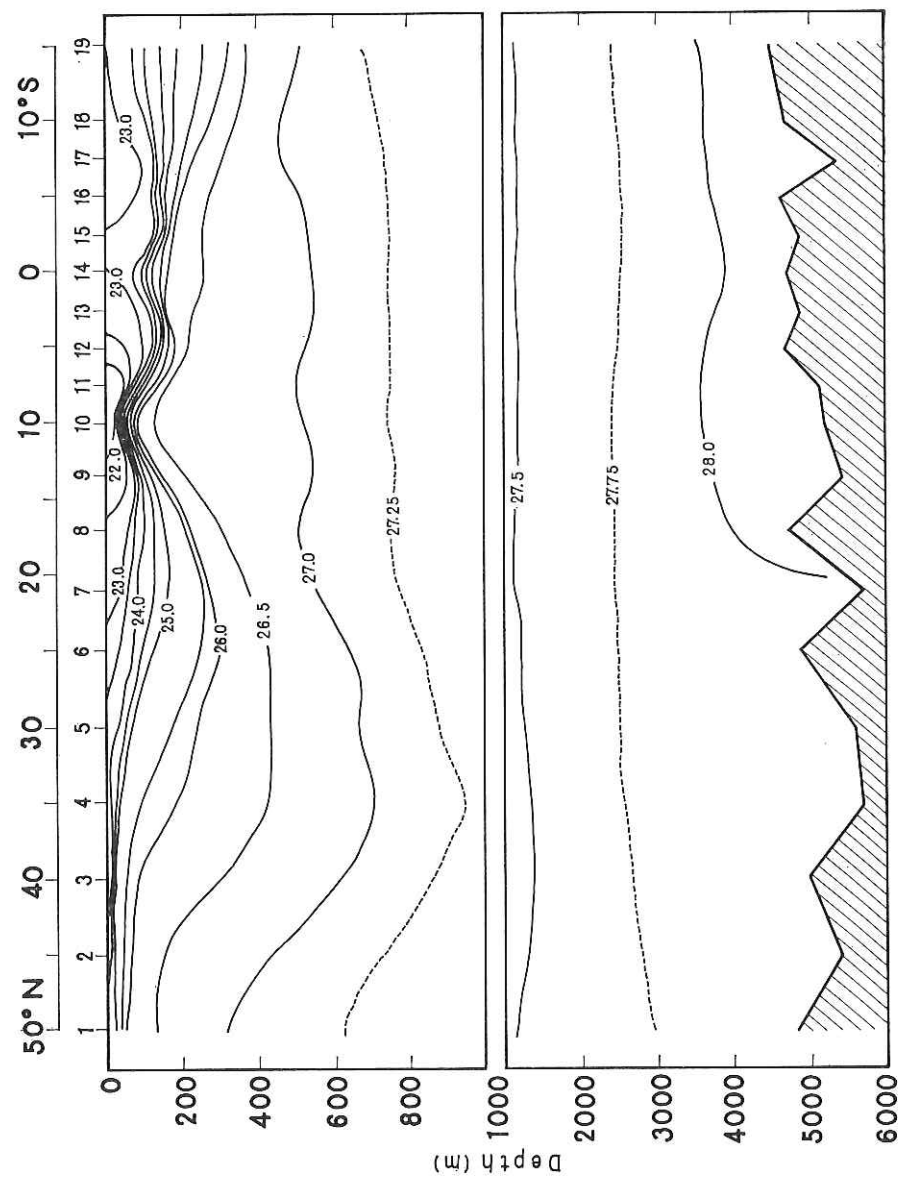

Fig. 4. Distribution profile of σ_t along 155°W.

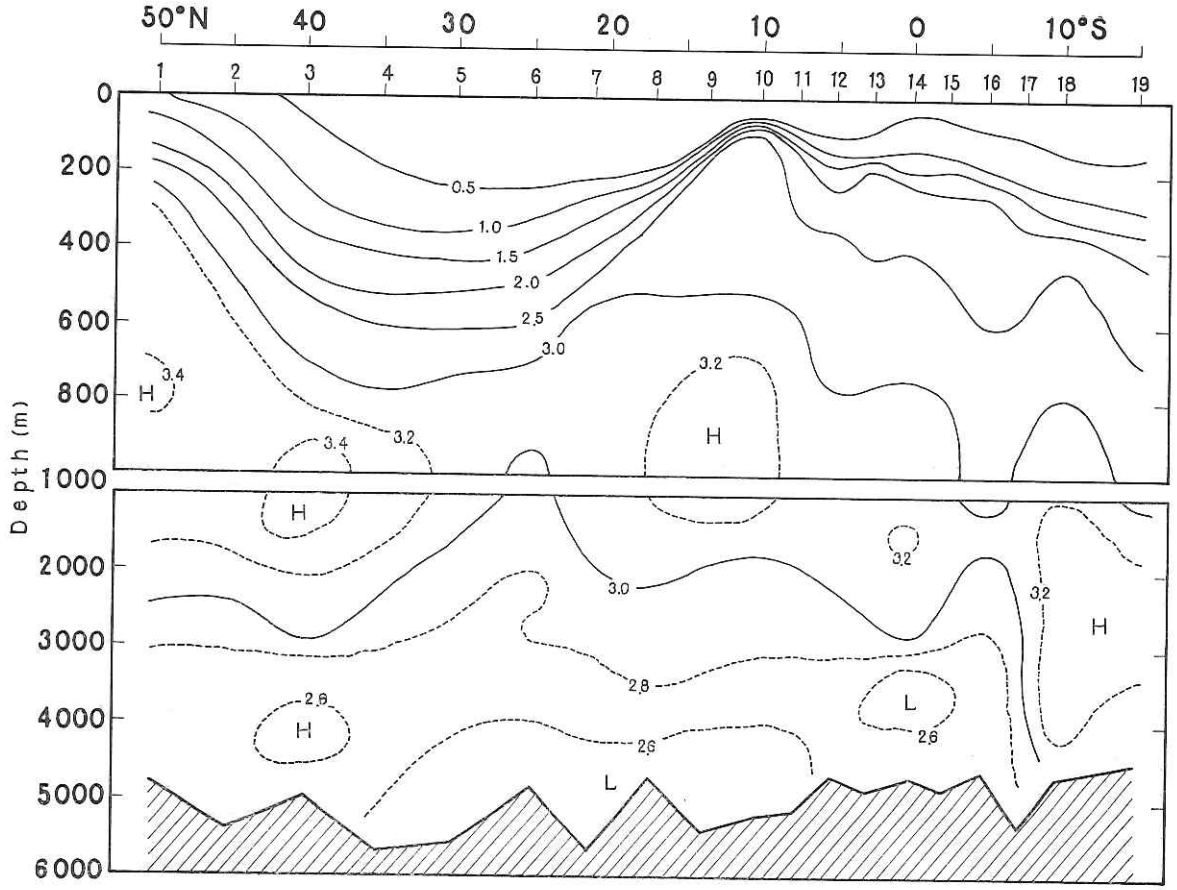

Fig. 5. Distribution profile of dissolved oxygen(m*l*/*l*) along 155°w.

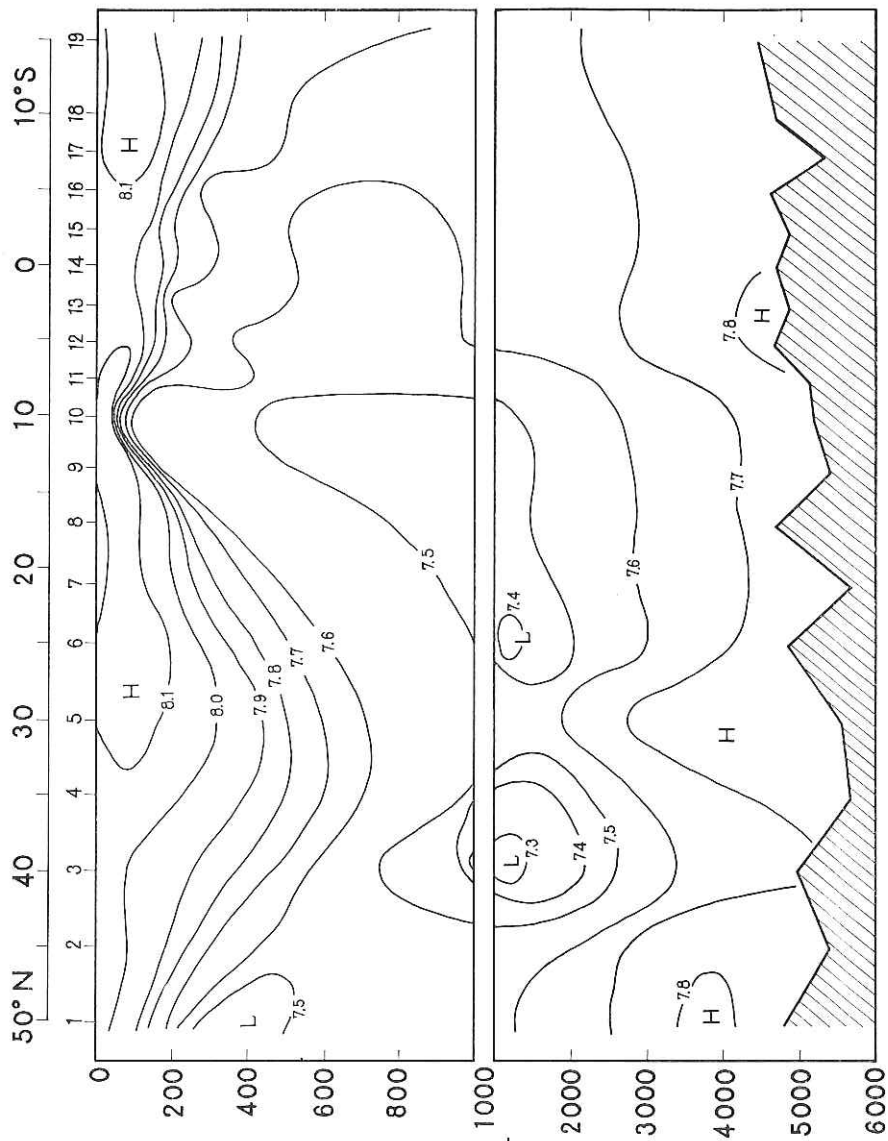

Fig. 6. Distribution profile of pH along 155°w.

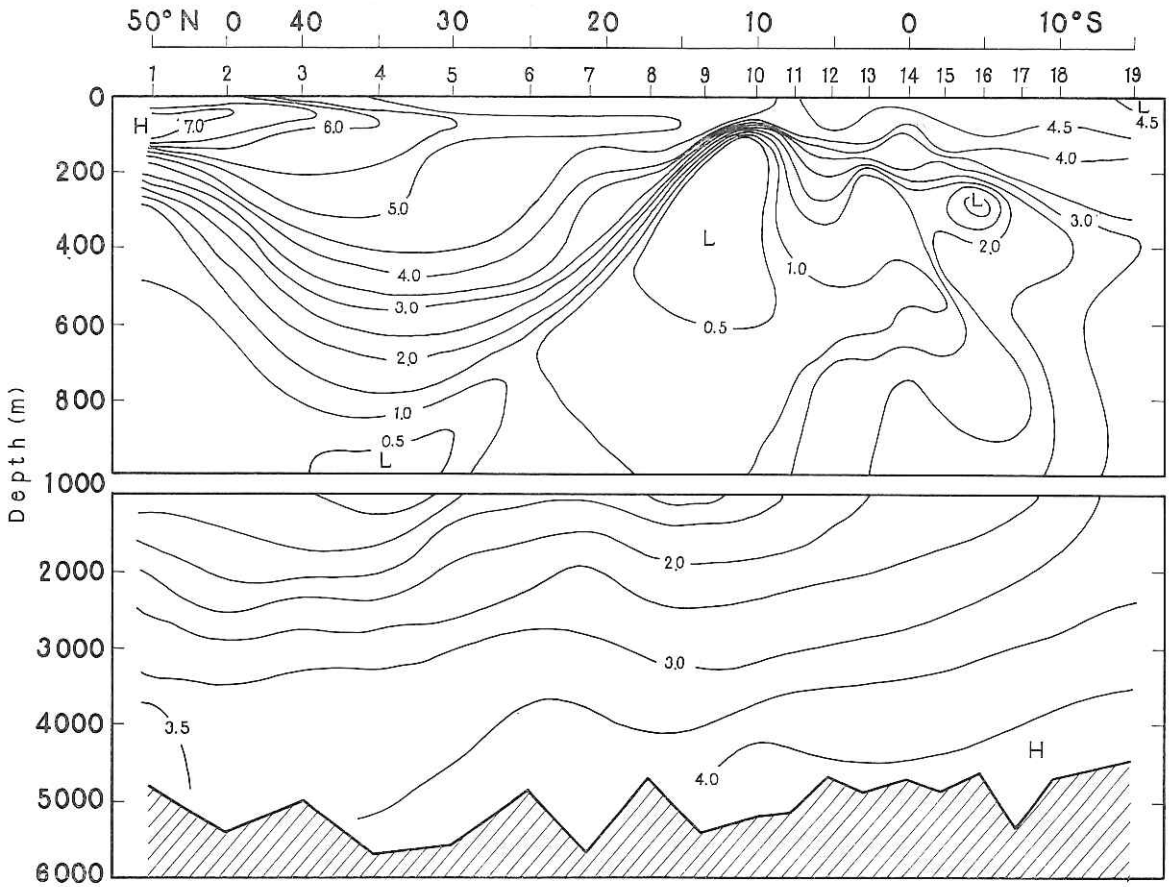

Fig. 7. Distribution profile of phosphate-P(μg atoms/l) along 155°w.

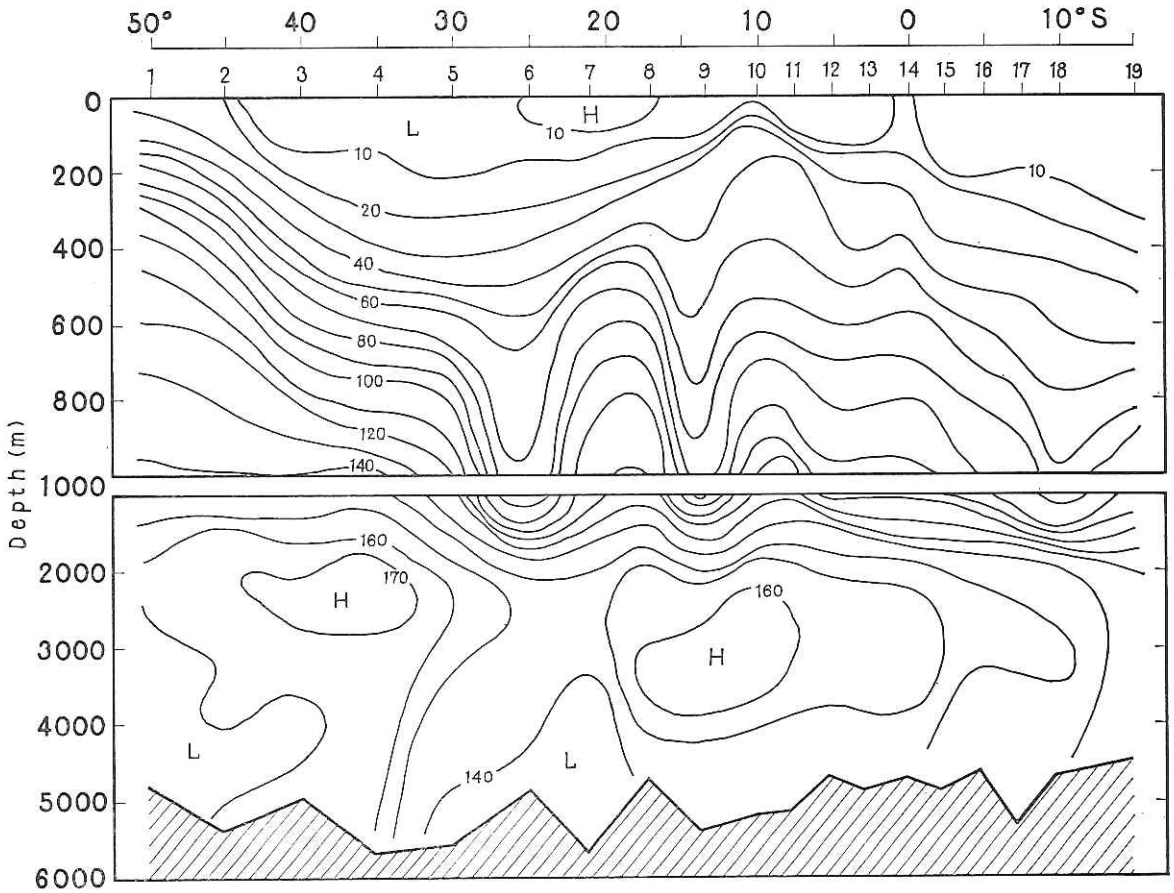

Fig. 8. Distribution profile of silicate-Si(μg atoms/l) along 155°w.

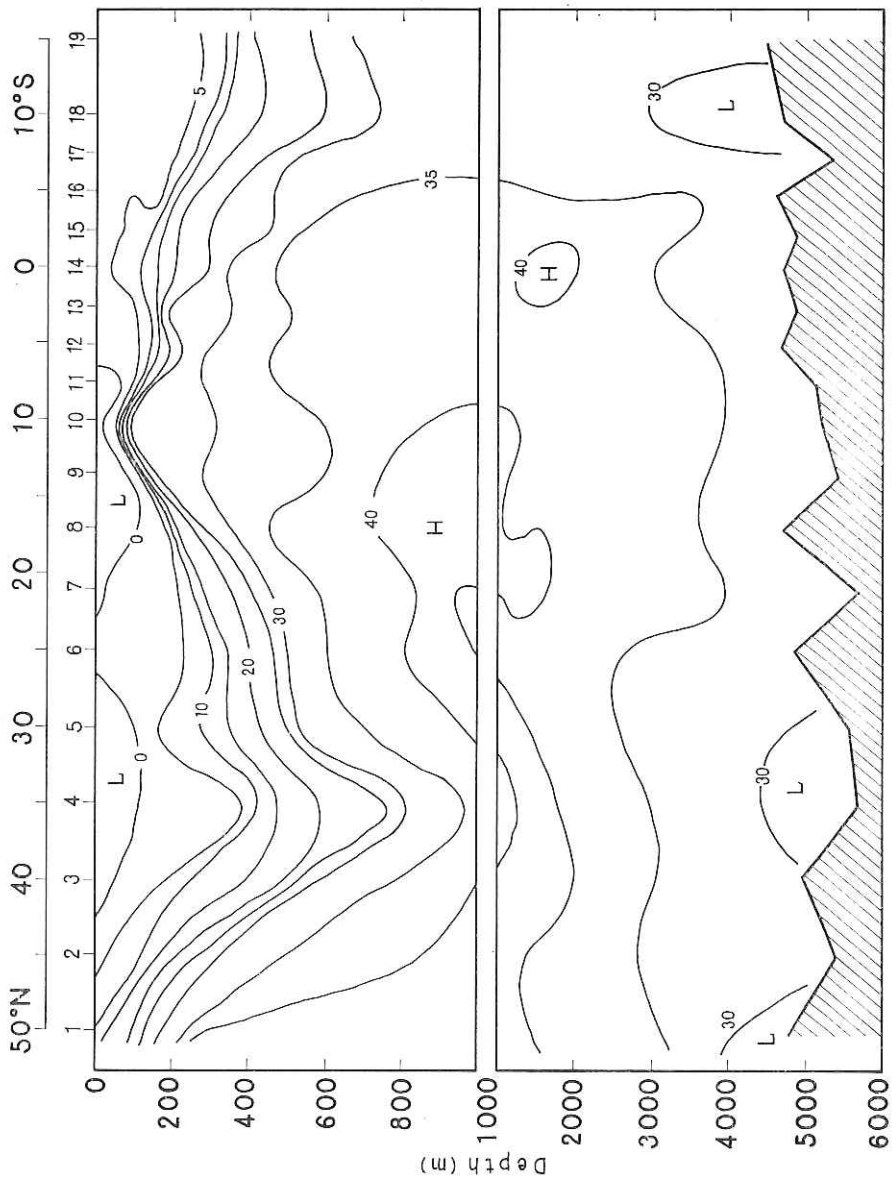

Fig. 9. Distribution profile of NO_3-N (μg atoms/l) along 155°w.

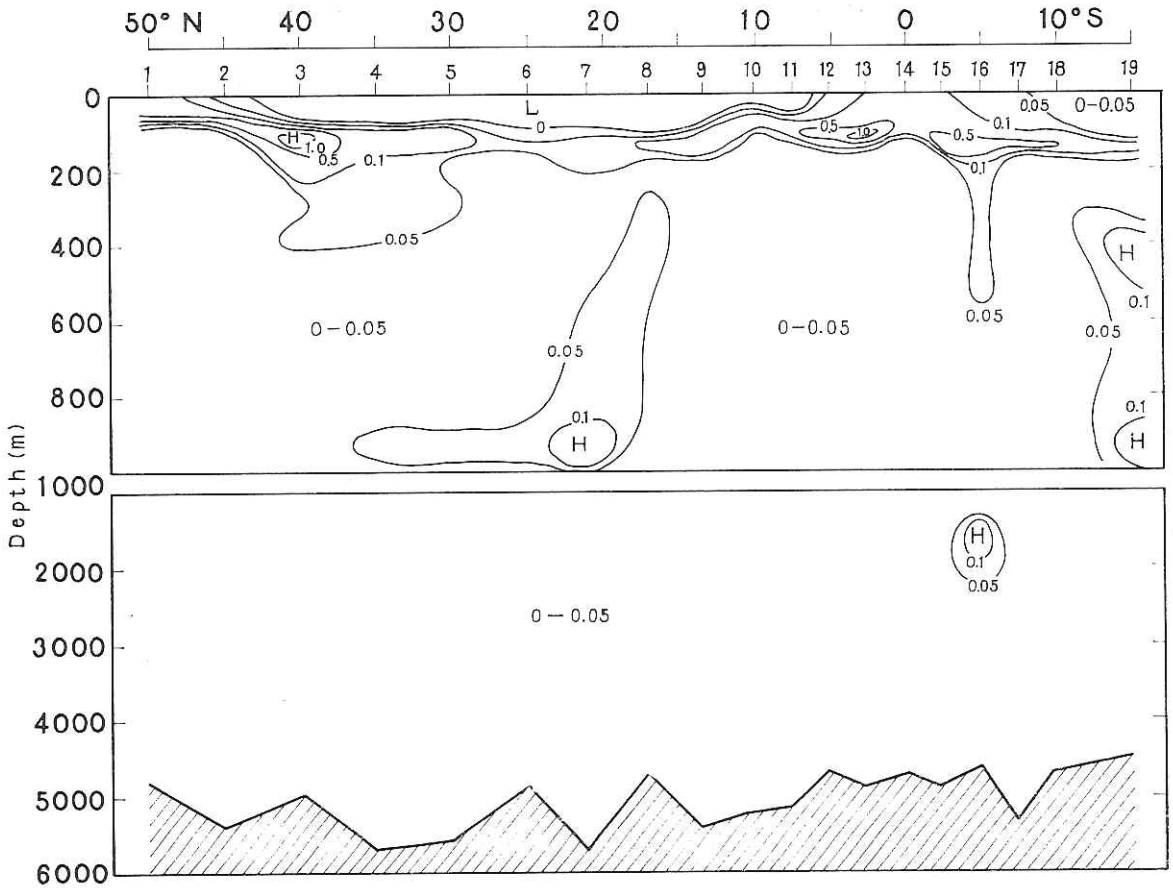

Fig. 10. Distribution profile of NO_2-N (μg atoms/l) along 155°w.

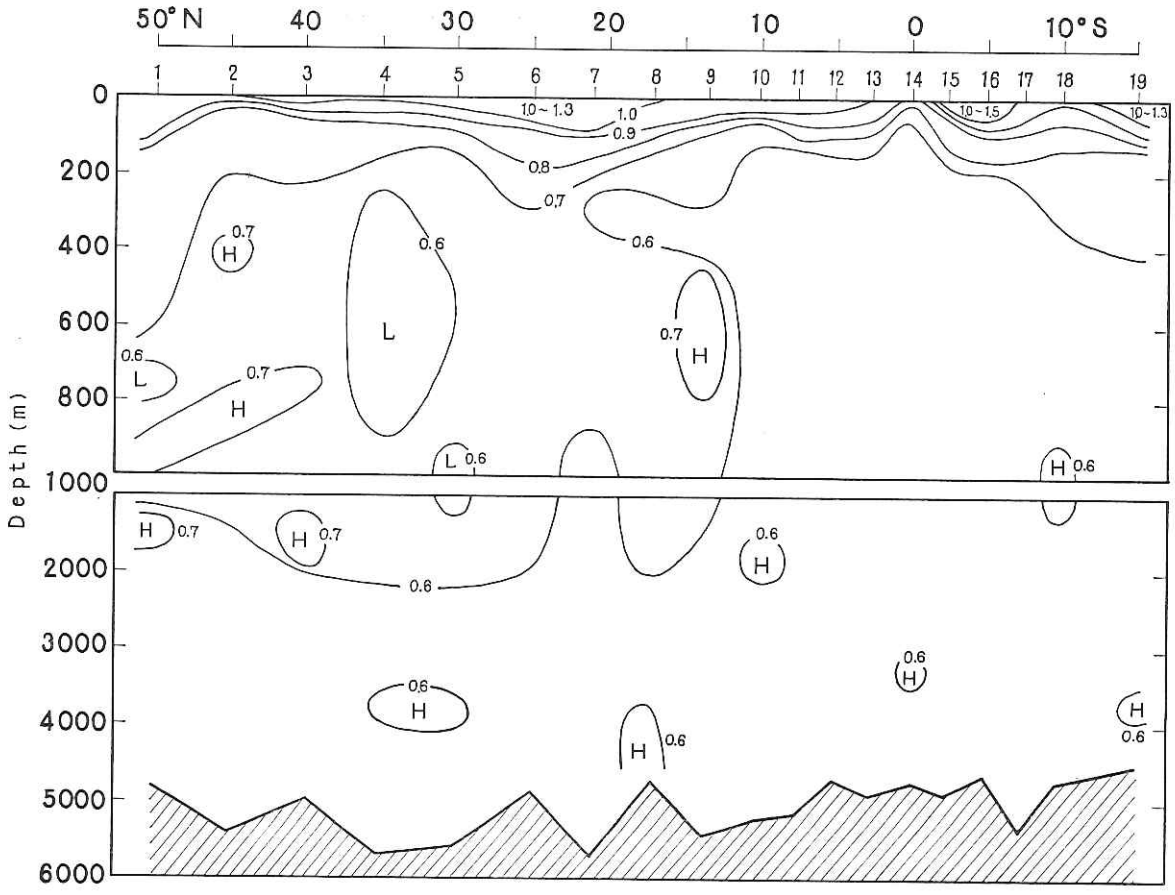

Fig. 11. Distribution profile of dissolved organic carbon (mg/*l*) along 155°w.

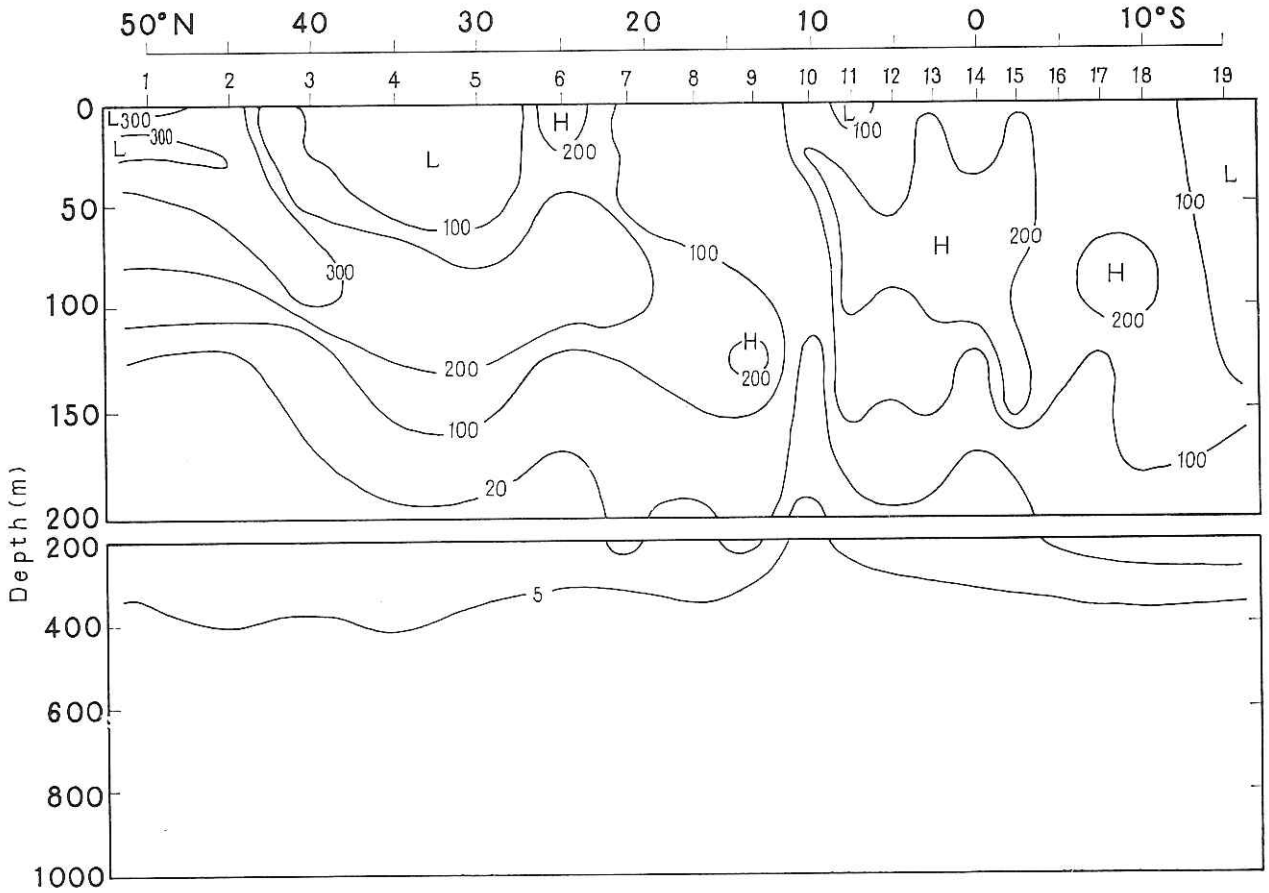

Fig. 12. Distribution profile of chlorophyll *a* ($\mu g/m^3$) along 155°w.

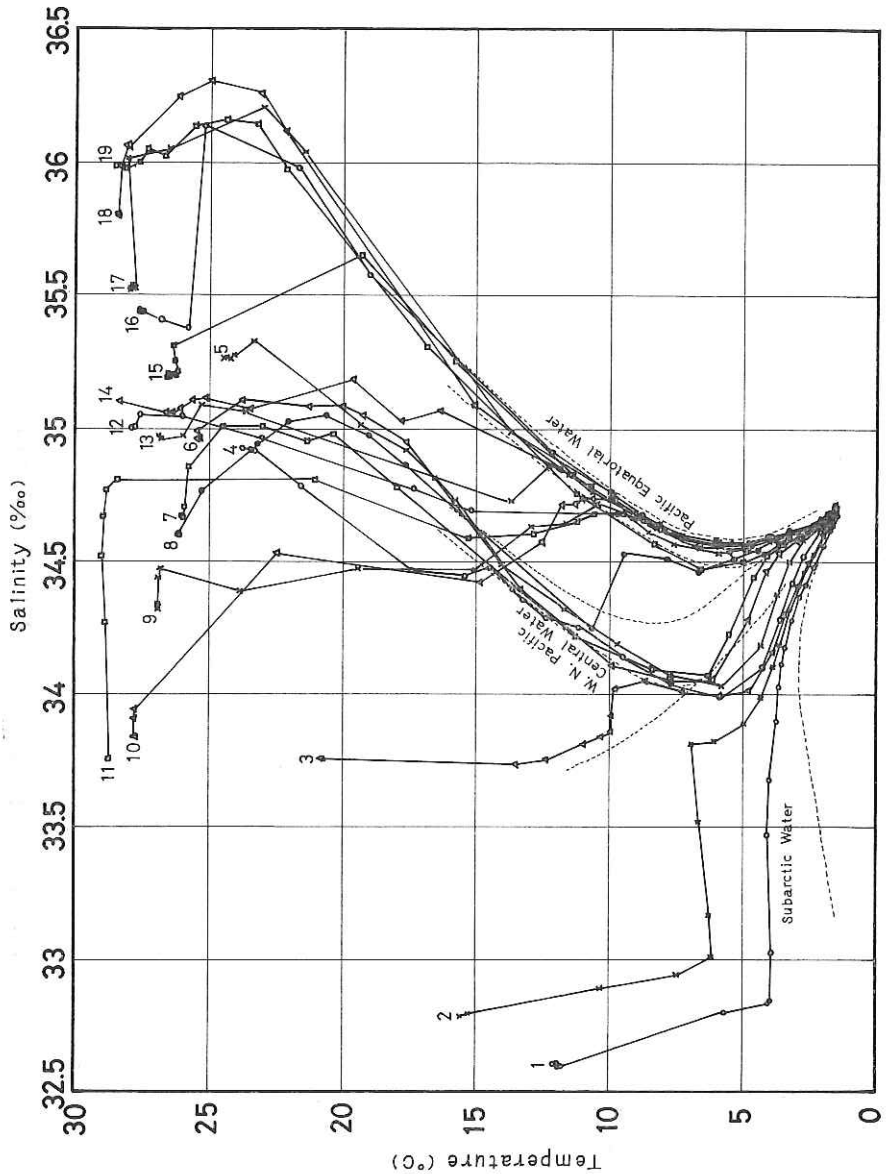

Fig. 13. T-S diagrams at Sts. 1~19.

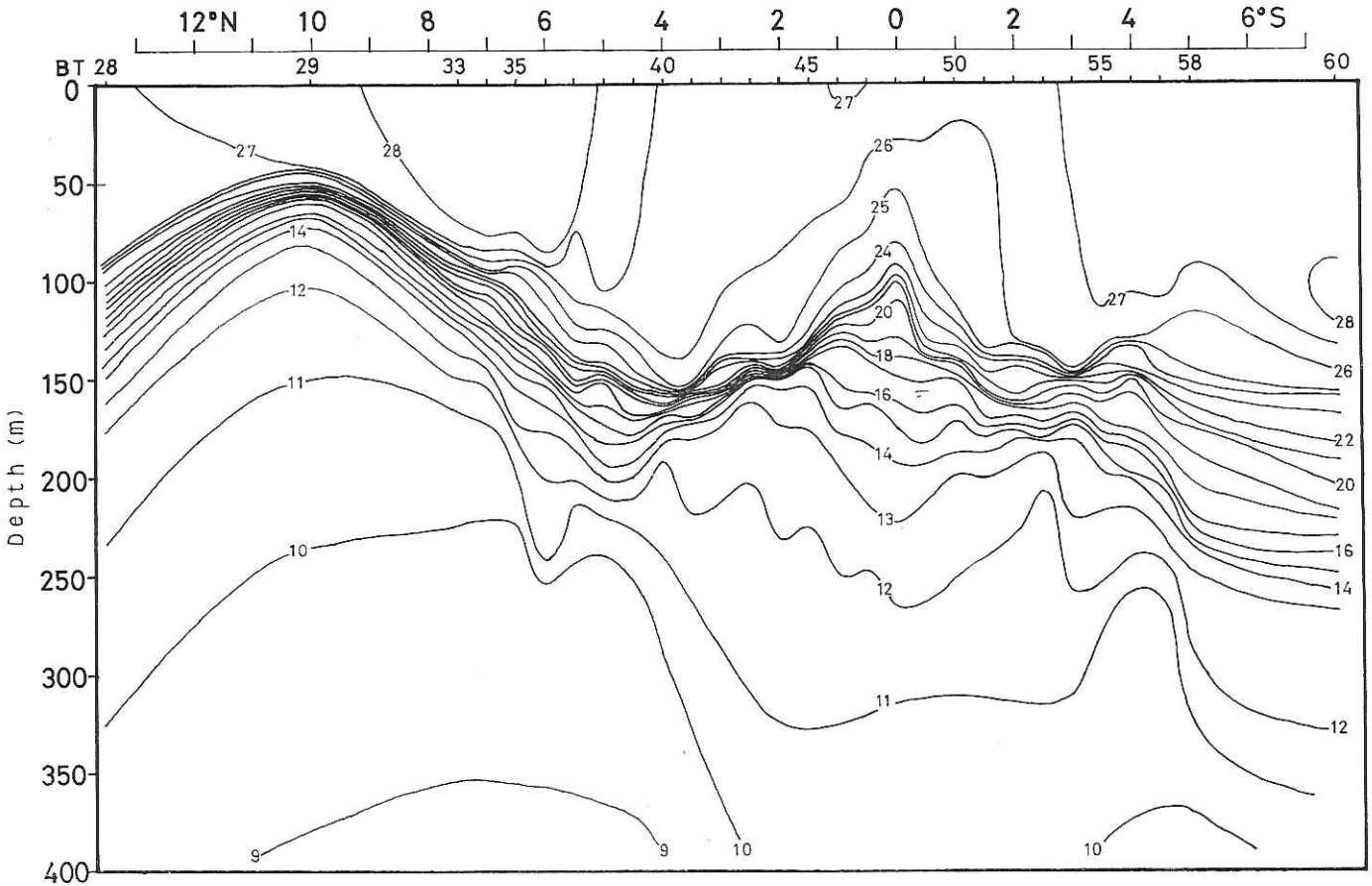

Fig. 14. Temperature distribution profile in the equatorial region.

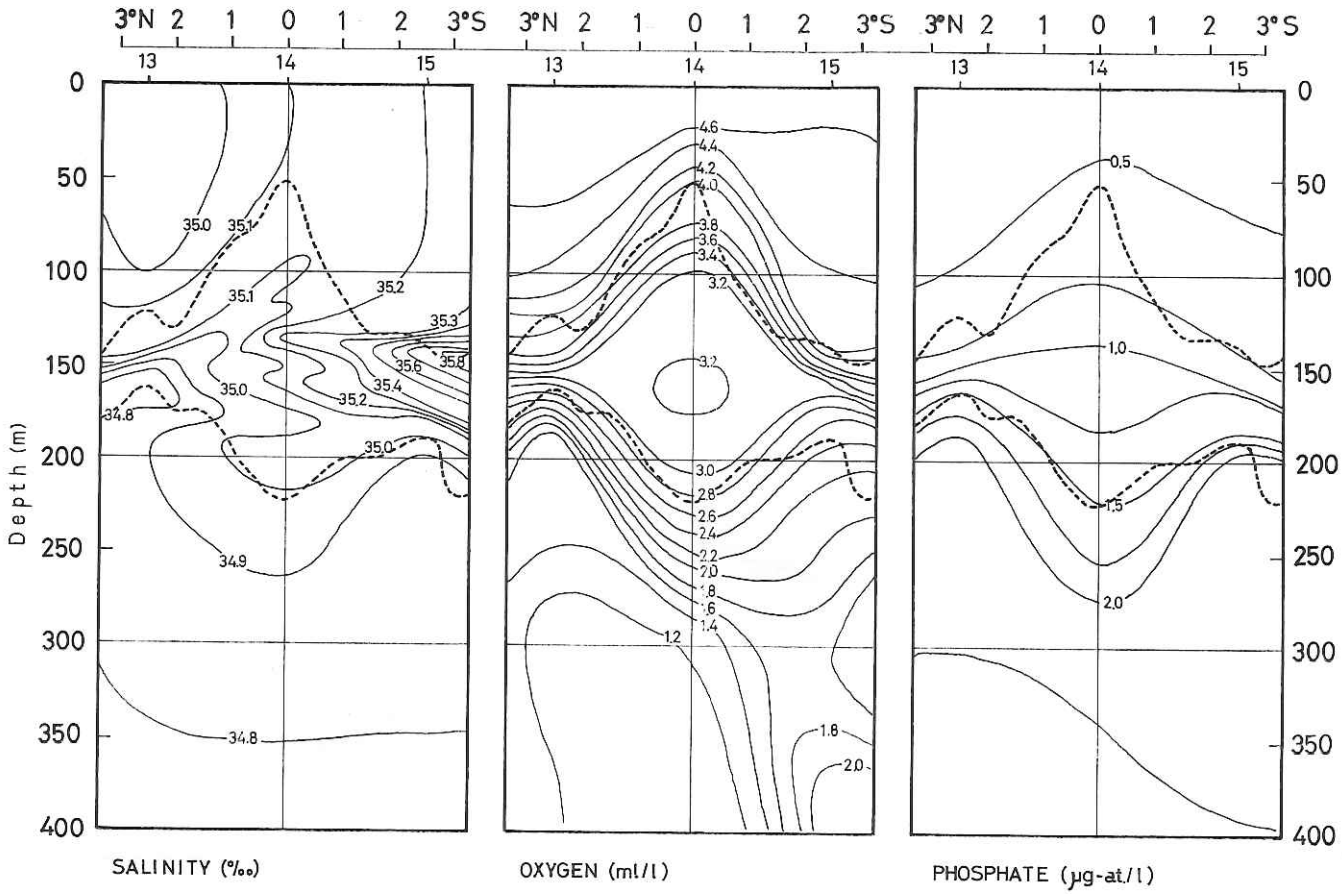

Fig. 15. Distribution profiles of salinity, dissolved oxygen and phosphate-P in the equatorial region. Broken lines show isothermal lines of 25°C and 13°C.

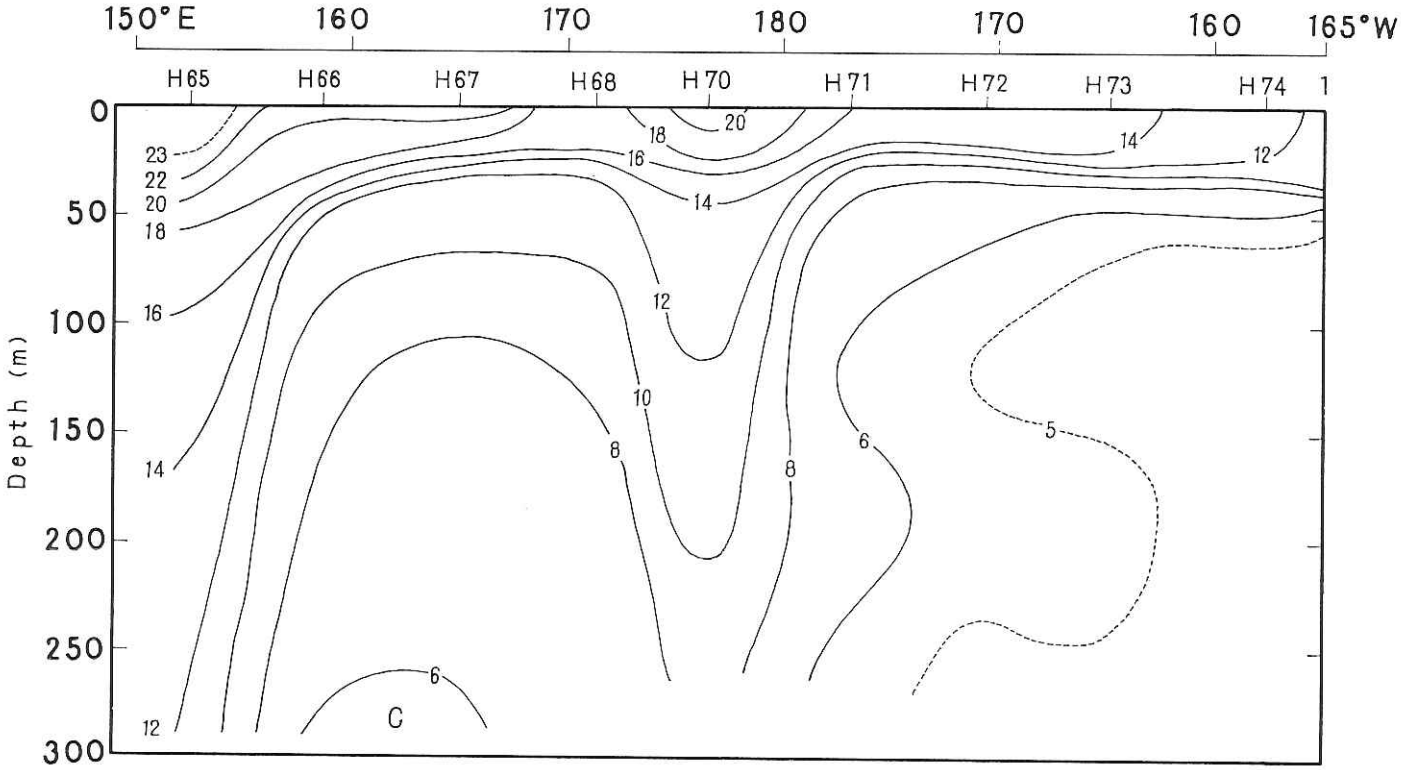

Fig. 16. Temperature distribution profile from Tokyo to St. 1.

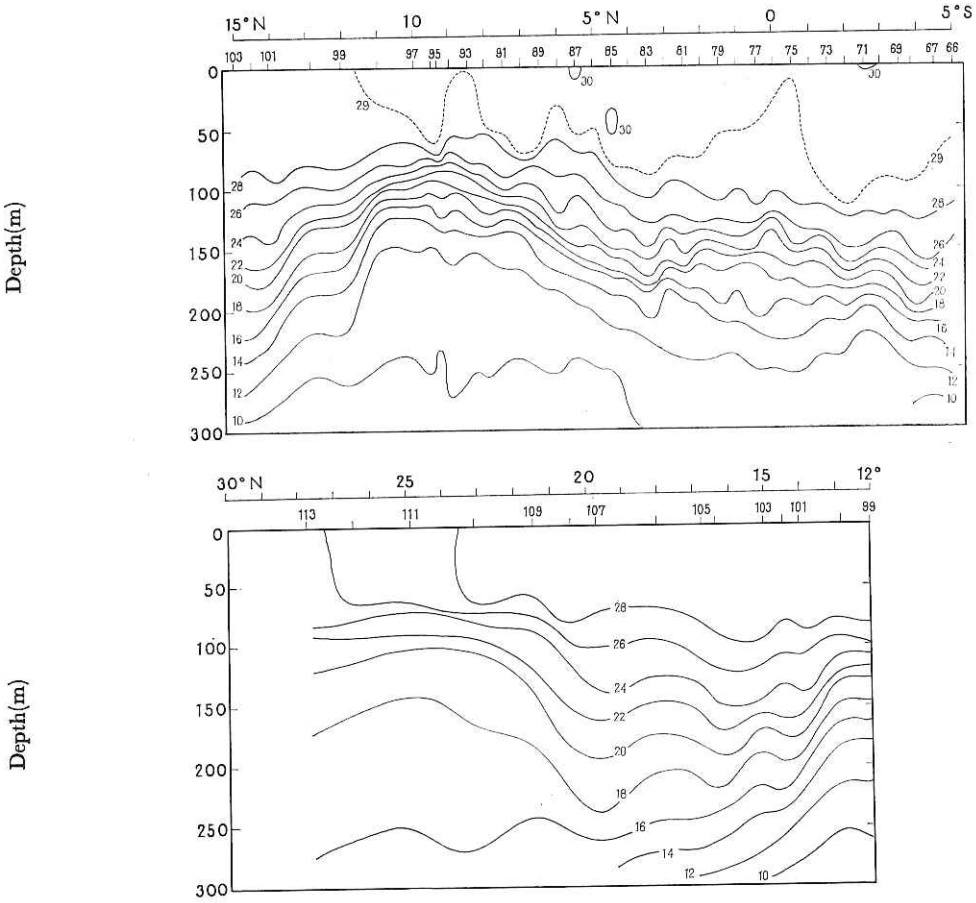

Fig. 17. Temperature distribution profile from St. 19 to Tokyo.