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Radioactivity Survey of the mid Pacific Area, 1962

II Scientific Report (Shoyo-Maru)

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AUGUST 1963

RADIOACTIVITY SURVEY OF THE MID PACIFIC AREA, 1962

II SCIENTIFIC REPORT

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Radioactivity in Air and Rainwater

* Yuzuru SUZUKI

1. Gross β - activity in Air

a. Dry filter paper method

The air sampler was carefully placed on the compass deck, in order to avoid contamination by sea water, and was continuously operated during the entire cruise. Dust samples were collected on Whatman #41 filter paper (5.5 cmØ), every 24 hours. Suction volume of the sampler was approximately 30 ℓm^3/min.

To measure the activity of the samples, an end window type GM counter with a DC-1C scaler was used. The distance between the mica window (1.46 mg/cm^2 thick) and the samples was approximately 1 cm. The counting efficiency, calibrated with ^{95}Zr-^{95}Nb, was 6.6%. Results obtained are shown in Table 1.

b. Gummed paper method

Sampling for fallout in the air by this method was also carried out on the compass deck. The samples were collected after the paper was exposed for approximately 24 hours. Measurements of the gross β-activity on the gummed paper samples were not conducted aboard the ship.

2. Gross β -activity in Rainwater

Rainwater was collected by using funnels (100 cm^2 surface area) which were placed in polyethylene or glass bottles set on the compass deck. 10-100 ml of the samples collected were evaporated on a porcelain plate, then placed on a counting dish. Measurement for gross β-activity were conducted in the same manner described in paragraph 1a. Results obtained are shown in Table 2.

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*National Institute of Radiological Sciences

Table. 1 Gross β-activity in Air

Date	Suction Time Hrs.Mins	Suction Volume (M^3)	Activity cpm/m^3	Activity $\mu\mu c$ /m^3	Weather
29, Jul.	23.35	36.92	0.09±0.06	0.3±0.2	cloudy
30,	20.00	36.79	0.20±0.09	0.7±0.3	clear
31,	20.00	31.20	0.45±0.08	1.6±0.3	clear
1, Aug.	20.45	37.35	0.20±0.08	0.7±0.3	cloudy
2,	10.45	42.75	0.55±0.09	1.9±0.3	cloudy
3,	10.10	18.30	0.23±0.14	0.8±0.5	cloudy
4,	10.20	18.60	0.23±0.12	0.8±0.4	cloudy
5,	10.30	18.90	0.58±0.17	2.0±0.6	clear
6,	11.00	19.80	0.17±0.14	0.6±0.5	cloudy
7,	23.25	42.15	0.38±0.08	1.3±0.3	cloudy
8,	22.20	40.20	0.20±0.09	0.7±0.2	cloudy
9,	25.25	45.75	0.23±0.09	0.8±0.2	cloudy
14,	23.45	42.75	0.23±0.08	0.8±0.3	clear
15,	21.15	38.25	0.15±0.08	0.5±0.2	clear
16,	25.15	45.45	0.29±0.12	1.0±0.4	cloudy
17,	23.20	42.00	0.09±0.08	0.3±0.2	cloudy
18,	24.40	45.40	0.15±0.08	0.5±0.2	cloudy
19,	24.00	43.20	0.29±0.09	1.0±0.2	clear
20,	24.00	43.20	0.17±0.07	0.6±0.2	cloudy
21,	24.20	43.80	0.49±0.08	1.7±0.2	clear
22,	24.00	43.20	0.29±0.07	1.0±0.2	cloudy
23,	24.00	43.20	0.38±0.07	1.3±0.2	clear
24,	24.00	38.88	0.41±0.09	1.4±0.2	cloudy
25,	24.00	38.88	1.60±0.08	5.5±0.3	cloudy
26,	24.00	38.88	0.69±0.09	2.4±0.2	clear
27,	24.00	38.88	0.03±0.06	0.1±0.2	cloudy
28,	24.00	38.88	0.12±0.07	0.4±0.2	cloudy
29,	24.00	38.88	0.49±0.07	1.7±0.2	cloudy
30,	24.00	38.88	0.43±0.07	1.5±0.2	clear
31,	24.00	38.88	0.49±0.08	1.7±0.2	clear
1, Sep.	25.00	40.50	0.41±0.08	1.4±0.2	clear (Honolulu)
2,	26.00	41.92	0.58±0.08	2.0±0.2	clear (Honolulu)
6,	21.30	38.70	0.52±0.08	1.8±0.2	cloudy
7,	24.30	52.92	0.49±0.08	1.7±0.2	cloudy
8,	24.15	50.94	0.75±0.08	2.6±0.2	cloudy
9,	24.15	53.84	0.26±0.07	0.9±0.2	cloudy
10,	24.30	49.98	0.12±0.07	0.4±0.2	cloudy
11,	24.15	43.65	1.71±0.08	5.9±0.2	cloudy
12,	24.15	43.65	1.30±0.07	4.5±0.2	cloudy
13,	24.30	44.10	0.81±0.07	2.8±0.2	cloudy
14,	24.30	44.10	0.64±0.03	2.2±0.1	cloudy
15,	24.30	44.10	0.46±0.03	1.6±0.1	rain cloudy
16,	24.30	44.10	0.84±0.06	2.9±0.2	cloudy

Table 2. Gross β-Activity in Rain Water

Sampling Date	Location		Rainfall (mm)	Activity (cpm/mℓ)	($\mu\mu c$/mℓ)
31, Jul.	34°-51.3 N	160°-17.0 E	1.7	0.04±0.01	0.25±0.08
4, Aug.	29°-50.5 N	175°-45.0 W	1.8	0.12±0.02	0.66±0.12
14,	14°-55.0 N	169°-34.0 W	1.2	0.05±0.01	0.28±0.05
16,	08°-03.7 N	164°-50.5 W	19.6	0.05±0.01	0.37±0.08
17,	06°-45.0 N	165°-01.5 W	3.3	0.08±0.01	0.43±0.07
17,	06°-08.5 N	164°-56.0 W	13.2	0.04±0.03	0.18±0.17
19,	00°-52.0 S	165°-02.0 W	0.9	0.17±0.02	0.09±0.12
25,	-----	-----	0.4	0.99±0.03	7.01±0.20
25,	04°-21.0 N	156°-57.0 W	0.2	0.03±0.01	0.23±0.07
26,	06°-04.0 N	165°-52.0 W	2.1	0.11±0.01	0.78±0.09
26,	08°-00.0 N	157°-0.00 W	5.6	0.04±0.01	0.28±0.08
27,	09°-32.0 N	157°-06.5 W	1.0	0.11±0.01	0.77±0.10
27,	10°-18.0 N	157°-13.0 W	1.0	0.11±0.01	0.77±0.10
30,	18°-45.0 N	157°-54.0 W	0.4	0.20±0.02	1.43±0.17
4, Sep.	24°-46.5 N	165°-14.0 W	0.2	0.42±0.03	3.06±0.21
9,	30°-10.0 N	179°-05.2 W	1.7	0.15±0.01	1.08±0.10
9,	30°-57.4 N	177°-30.2 E	3.0	0.06±0.01	0.40±0.07
9,	31°-03.0 N	176°-18.0 E	98.0	0.03±0.01	0.19±0.07
11,	33°-17.0 N	165°-40.0 E	1.2	0.20±0.01	1.42±0.09
13,	34°+33.0 N	156°-00.0 E	0.5	0.28±0.01	1.99±0.07
14,	34°-42.0 N	151°-42.8 E	0.5	0.67±0.02	4.80±0.15
15,	34°-55.0 N	147°-31.0 E	2.0	0.48±0.01	3.42±0.10

^{89}Sr, ^{90}Sr and ^{137}Cs in Rain Water

* Yukio KATSURAGI

a) Preparation of samples.

The amount of rain water collected aboard the observation ship was mostly less than one liter for each rain fall. Therefore, water samples which were collected on closer dates and location were combined and the analyses were done on the composite samples.

b) Methods of radiochemical analyses

Water sample was evaporated to about 20 ml in a beaker. After the solution was acidified with hydrochloric acid, carriers of Fe, Sr, and Cs were added. pH of the solution was adjusted to 8 with ammonia solution to separate iron hydroxide by filtration. Iron hydroxide was dissolved again with hydrochloric acid and the residue was digested twice with a small amount of diluted hydrochloric acid. The filtrate was combined and pH of the solution was adjusted again to 8 with ammonium hydroxide to separate iron hydroxide.

After iron hydroxide was filtered, pH of the filtrate was adjusted to 9 with sodium carbonate to precipitate alkaline earth carbonate. After calcium was separated by using the fuming nitric acid method and barium and radium were removed as chromate precipitate, ^{90}Sr and ^{89}Sr were counted. Nitric acid was added to the filtrate from the carbonate and ^{137}Cs was separated by the addition of solid ammonium molybdophosphate. ^{137}Cs was counted with a γ ray spectrometer.

c) β counter

A low back ground window-less gas flow counter whose counting efficiency was 38% and the back ground was 0.9--1.0 cpm, was used for ^{90}Sr and ^{89}Sr determination.

d) The results of determination

Table 1·3 shows the results of determination of ^{90}Sr, ^{89}Sr and ^{137}Cs in rain water. The counting was done 14th-15th September, 1962 and the value of ^{89}Sr was reduced to that on the 1st July 1962.

*Meteorological Research Institute

Table 1 . 3 ^{90}Sr, ^{89}Sr and ^{137}Cs in Rain Water.

Sample No.	Location	Date	Amount of Precipitation (mm)	Sample volume (ml)	^{90}Sr $\mu\mu c/m^2$	^{90}Sr $\mu\mu c/\ell$	^{89}Sr	^{137}Cs	$^{89}Sr/^{90}Sr$	$^{137}Cs/$
1	29°37'N 174°55'W	4 Aug. '62	3.0	350	30	10	-		-	
2	14°12'N 161°57.5 W	14 Aug. '62	3.3	360						
	08°03.7'N 164°50.5'W	16 Aug. '62	50	880						
	"	"	"	200	106	1.5	30.6		20	
	07°09.7'N 164°08.5'W	17 Aug. '62	17.5	570						
	"	"	"	460						
3	08°00'N 157°00'W	26 Aug. '62	7.7	240						
	"	"	"	330	232	23.2	-		-	
		30 Aug. '62 3 Sept. '62	2.3	410						
4	31°06'N 176°53'E	10 Sept. '62	100	1780	240	2.4	50.5		21	

Measurement of Environmental Radiation and Exposure Dose

*Masaharu OKANO

The main objectives of measuring environmental radiation was to keep the ships personnel from undur exposure to the dangerous effects of external nuclear radiation and to provide future references for other measurements of radiation contamination.

Two types of scintillation counters were used as the environmental radiation monitor. One was an ordinary scintillation counter with a sodium iodide crystal, 1 1/2" in diameter and 1 1/2" long, with the discrimination level set at approximately 20 KeV of the electron energy value. This instrument was placed at the starboard side of the bridge, and the counts printed on paper every 15 minutes. The other scintillation counter was used for exposure dose monitoring. This type had a specially designed shield surrounding the crystal to correct energy characteristics. With this device, a dose rate as low as 0.1 μr/hr in the energy range of 0.1 MeV to 2 MeV could be measured by simply reading the counting rate. The dose rate in the chart room during measurements made with this instrument was 0.7-1.0 μr/hr, excluding cosmic radiation and contamination of the detector head.

Other surveys were made of radioactive contamination on the survey vessel using the scintillation counter. These values are shown in Table 1.

In order to measure total exposure doses during the surveys on the ship, pocket dosimeters and the glass dosimeters were used. The values found are shown in Table 2.

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* Institute of Physical and Chemical Research

Table 1. γ-radiation on the survey vessel

Measurement sites	Counting rate (cpm)(1.5"x1.5" NaI(Tl))	Survey meter reading(μr/hr)	Exposure dose (μr/hr)
Environmental radiation monitor site	400-450	1.5	
Scintillation probe site	400-600	1.5	
Quarter deck	400-600		0.8
Navigation deck	650		
Starboard & port bridge	550	2.0	
Wheel house	530		1.1
Inside of 5cm Pb shield	210	0.5	0.0
Inside of store room	640		
Outside of store room	400		
In sea water	200-300		
Tokyo Bay 1m depth	245		
Tokyo Bay 5m depth	235		
Tokyo Bay 10m depth	232		
Bottom of Tokyo Bay	840		
During landing at Honolulu harbour	1200		1.4
During landing at Tokyo harbour	1100		1.3

Table 2. The total investiga

Site	I
Refrigeration room	
Passage inside boat	
Store room	
Enginers room	
Galley	
Engine room	
Management room	
Crew quarters	
Wireless room	
Chart room	
Saloon	

meter ng(μr/hr)	Exposure dose (μr/hr)
	0.8
	1.1
	0.0
	1.4
	1.3

Table 2. The total exposure doses during the investigation on the survey vessel.

Site	Dose (pocket dosimeter) (mr)	Dose (glass dosimeter) (mr)
Refrigeration room	10	
Passage inside boat	10	30
Store room	6	2
Enginers room	9	
Galley	6	25
Engine room	5	20
Management room	?	25
Crew quarters	11	20
Wireless room	7	0
Chart room	15	0
Saloon	10	25

Gross β-activity of Sea Water

*Masaru SHIOZAKI

1. Experiments and Measurements

About 5 liters of sea water were collected at each station using a 10 liter polyethylene bucket or surface water sampler made of rubber. As soon as the sample was taken, concentrated hydrochloric acid was added at a rate of 1 ml of HCl per liter of sea water. A 2 liter portion of the acidified sea water was transferred to a 3 liter glass beaker, then 10 mg of Fe^{3+} and 10 mg of Ba^{2+} added as carriers and 3 g of ammonium chloride added to each sample as the buffer agent. After the sample was neutralized with a 1:1 ammonium hydroxide solution using phenolphthalein as the internal indicator, it was boiled. Precipitates of barium sulfate and ferric hydroxide were completely settled, then filtered on filter paper (2.5 cm diameter). The precipitates on the filter paper were dried under an infrared lamp then counted with a GM counter. Counting efficiency was determined by comparing the count rate of the Ra-D, E standard at the same geometry as the sample with its predetermined disintegrating rate. The values of 32.8 and 35.2% were obtained. Mica window thickness of the GM counter was 1.4 - 1.6 mg/cm^2 and the background count 12 cpm when the GM tube was shielded by 5 cm of lead.

2. Results

Results obtained are shown in Table 1.

Horizontal distribution of gross β-activity of surface water is shown in Fig. 1. Relation between gross β-activity of surface water and location represented by latitude are shown in Fig. 2. In the South Equatorial Current area, gross β-activity is relatively low in comparison with other regions.

In the Equatorial Counter Current region, radioactivity increases abruptly, however, there is no difference of gross β- activity between the Equatorial Counter Current and North Equatorial Current.

The trend of distribution of gross β-activity is

*Hydrographic Division, Maritime Safety Board Agency.

affected by the behavior of radioactive material in the atmosphere which is affected by atmospheric phenomena. The high radioactivity of the Equatorial Counter Current is due to the fact that the location of the Equatorial Counter Current coincides with that of the climatic equator, thus the amount of precipitation is large in this area during the period of nuclear tests.

Sampling Date	Station No.
27 Aug. 62	35
	37
28 Aug. 62	39
	40
29 Aug. 62	41
	42
30 Aug. 62	43
	44

Table 1. Gross β-Activity of Surface Sea Water

Honolulu - Christmas Is. - Honolulu

Sampling Date	Station No.	Location	Activity cpm/ℓ	Activity dpm/ℓ
14 Aug. 62	-	16-38.8'N 160-38.8'W	0.3±0.3	0.4±0.4
15 Aug. 62	8	13-26.0'N 162-28.0'W	-0.2±0.3	-0.3±0.4
16 Aug. 62	10	10-22.0'N 163-53.0'W	2.5±0.3	3.2±0.4
	11	8-36.0'N 164-08.5'W	2.0±0.3	2.5±0.3
17 Aug. 62	12	7-09.7'N 164-08.5'W	2.0±0.3	2.6±0.4
	13	6-10.8'N 164-57.3'W	0.3±0.3	0.4±0.4
18 Aug. 62	14	4-32.0'N 165-24.0'W	1.0±0.3	1.2±0.4
	15	3-47.0'N 165-30.5'W	0.3±0.3	0.4±0.4
19 Aug. 62	16	1-08.8'N 165-09.0'W	0.9±0.3	1.2±0.4
	17	0-15.5'N 165-04.5'W	0.8±0.3	1.2±0.4
20 Aug. 62	18	1-55.0'S 165-00.0'W	0.6±0.3	0.8±0.4
21 Aug. 62	20	0-00.0' 162-35.0'W	0.4±0.3	0.6±0.4
	21	1-01.5'N 161-23.0'W	0.3±0.3	0.4±0.4
22 Aug. 62	23	1-55.0'N 160-25.0'W	0.0±0.3	0.0±0.4
	24	1-28.5'N 160-26.0'W	0.8±0.3	1.1±0.4
23 Aug. 62	25	0.06.5'N 158-57.0'W	1.0±0.3	1.4±0.4
	26	0.46.0'S 158-10.0'W	0.5±0.3	0.7±0.4
24 Aug. 62	27	2-00.0'S 157-00.0'W	0.4±0.3	0.5±0.4
	28	0-01.5'N 157-10.0'W	0.2±0.3	0.3±0.4
25 Aug. 62	29	1-35.4'N 157-24.0'W	0.7±0.3	1.0±0.4
	30	2-07.5'N 157-34.0'W	0.4±0.3	0.5±0.4
26 Aug. 62	31	4-15.5'N 156-57.0'W	0.9±0.3	1.3±0.4
	33	5-43.5'N 156-49.0'W	1.8±0.3	2.5±0.4

Sampling Date	Station No.	Location	Activity cpm/ℓ	Activity dpm/ℓ
27 Aug. 62	35	8-16.0'N 157-03.0'W	1.1±0.3	1.6±0.4
	37	9-49.0'N 157-12.0'W	0.9±0.3	1.2±0.4
28 Aug. 62	39	11-53.0'N 157-28.0'W	1.6±0.3	2.1±0.4
	40	13-28.0'N 157-48.4'W	1.9±0.3	2.6±0.4
29 Aug. 62	41	15-43.0'N 158-04.0'W	0.9±0.3	1.2±0.4
	42	16-41.5'N 157-55.6'W	1.3±0.3	1.6±0.4
30 Aug. 62	43	18-57.0'N 157-54.0'W	1.8±0.3	2.5±0.3
	44	19-54.0'N 157-45.3'W	1.1±0.3	1.5±0.4

aterial in the
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Counter Current
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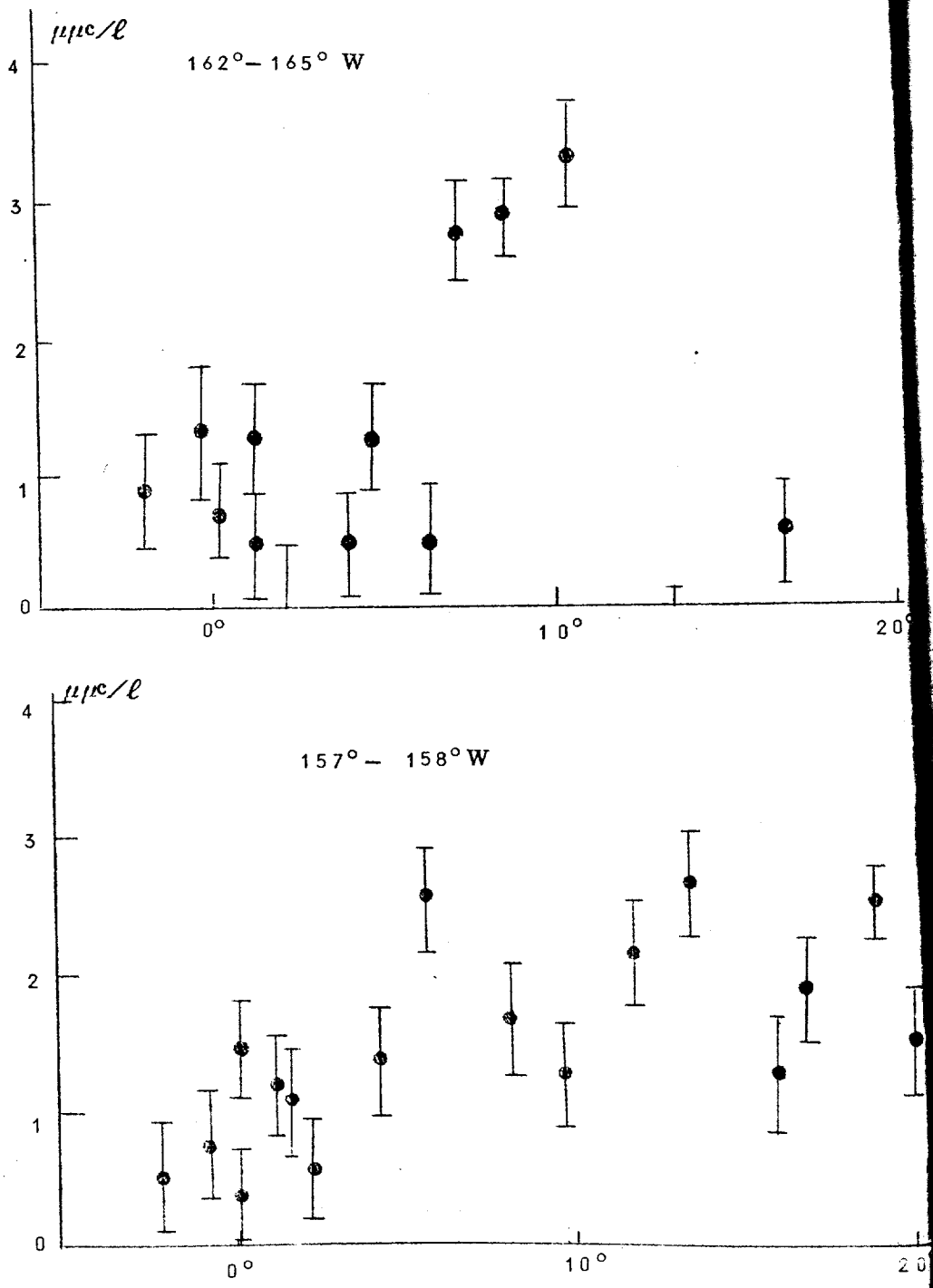
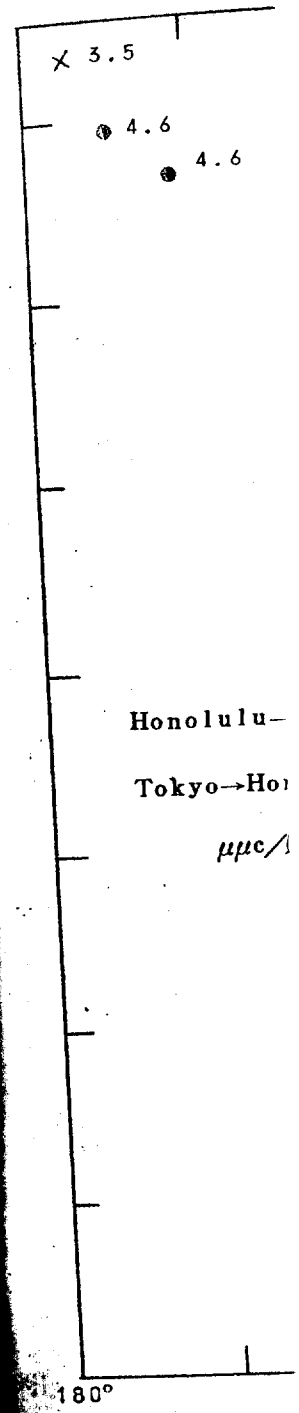
is large in
sts.

Sea Water

Lulu

Activity cpm/ℓ	Activity dpm/ℓ
).3±0.3	0.4±0.4
).2±0.3	-0.3±0.4
2.5±0.3	3.2±0.4
2.0±0.3	2.5±0.3
2.0±0.3	2.6±0.4
).3±0.3	0.4±0.4
1.0±0.3	1.2±0.4
).3±0.3	0.4±0.4
).9±0.3	1.2±0.4
).8±0.3	1.2±0.4
).6±0.3	0.8±0.4
).4±0.3	0.6±0.4
).3±0.3	0.4±0.4
).0±0.3	0.0±0.4
).8±0.3	1.1±0.4
1.0±0.3	1.4±0.4
).5±0.3	0.7±0.4
).4±0.3	0.5±0.4
).2±0.3	0.3±0.4
).7±0.3	1.0±0.4
).4±0.3	0.5±0.4
).9±0.3	1.3±0.4
1.8±0.3	2.5±0.4


μμc/ℓ
162°– 165° W
4
3
2
1
0
0°
10°
20°
μμc/ℓ
157° – 158° W
4
3
2
1
0
0°
10°
20°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4.6
Honolulu–
Tokyo→Ho
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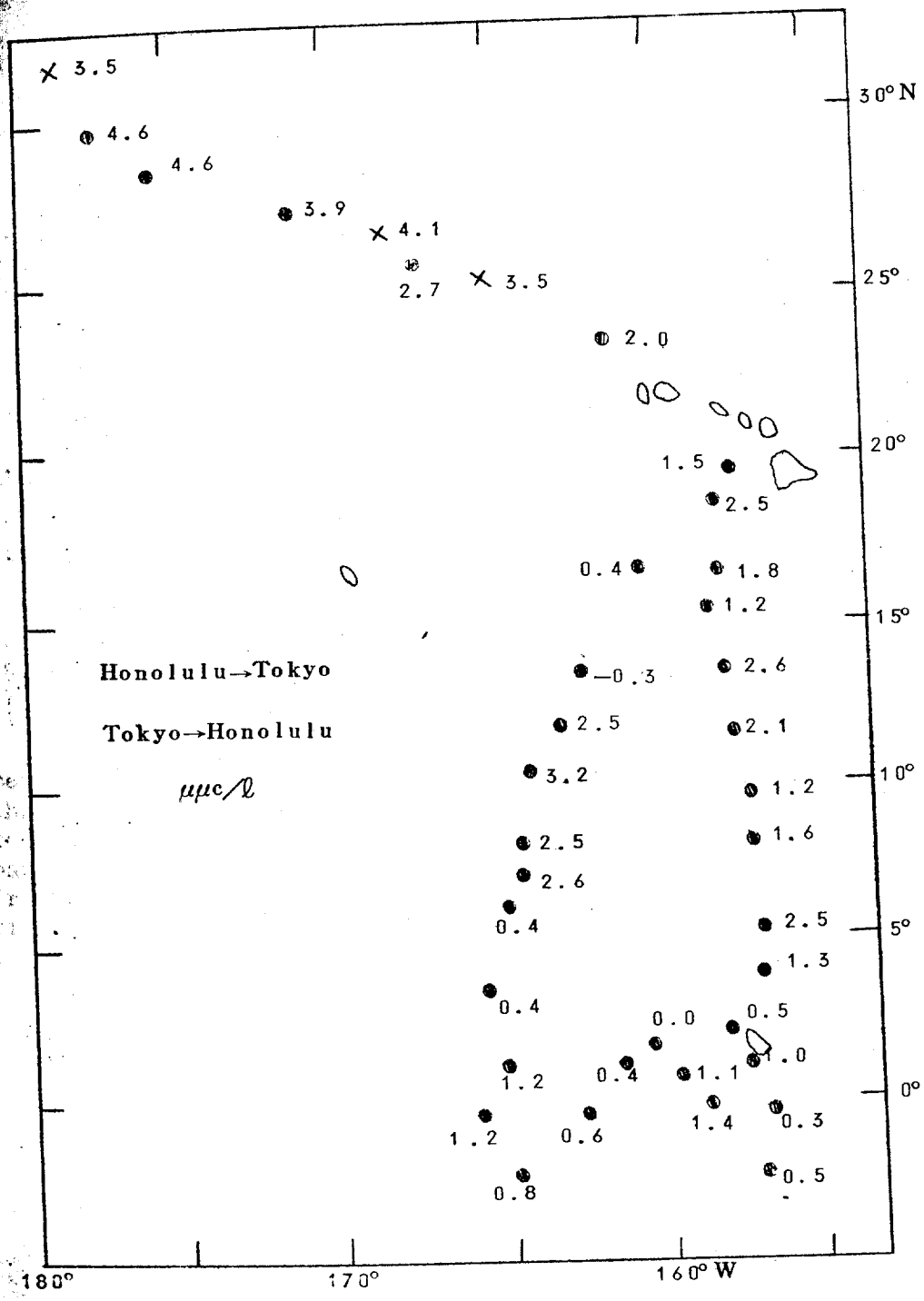
Fig.1


Honolulu→Tokyo
Tokyo→Honolulu
μμc/ℓ
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25°
20°
15°
10°
5°
0°
180°
170°
160° W
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4.6
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1.2
0.6
0.5
0.8

Fig. 1.

Radioactivity of Sea Water - Nuclide Analysis

* Ryoji HIGANO, Masaru SHIOZAKI

and Yoshiro SETO

1. Sample

Twenty liters of sea water were collected from the 0, 150, and 300 m layers, respectively, at each station. As soon as the sample was collected, the hydrogen ion concentration in the water was adjusted to nearly pH 2 by adding concentrated HCl. Analyzed nuclides were ^{90}Sr, ^{137}Cs and ^{144}Ce.

2. Procedure

^{90}Sr - After sea water was neutralized with a 10 M NaOH solution, the alkaline earth elements and rare earth elements were separated from the sea water as carbonate and hydroxide precipitates respectively. The precipitates were dissolved in hydrochloric acid and the rare earth elements were separated from the alkaline earth elements by neutralyzing the hydrochloric acid solution with ammonia water.

Sr was separated from Ca by the fuming nitric acid method and further purified chemically by repeating the fuming nitric acid procedures two times and radiochemically by scavenging with ferric hydroxide and barium chromate. After leaving the purified Sr fraction for two weeks, ^{90}Y was separated by coprecipitation with ferric hydroxide and counted by a 4. gas flow counter.

^{137}Cs - The carrier was added to the sample at the rate of 1mg of Cs per liter of sea water. Cs was precipitated by adsorption of the Cs to the nickel ferrocyanide precipitate. Nickel ferrocyanide was decomposed by heated H_2SO_4. Isolated Cs from the precipitate was purified by the ammonium phosphomolybdate and chloroplatinate methods, and then cesium chloroplatinate was filtered on filter paper and counted by 4π gas flow counter.

*Hydrographic Division, Maritime Safety Board Agency.

^{144}Ce - The Carrier was added to the sample as in the previous procedure. 10 mg of Ce, 5 mg of La, 20 mg of Zr, and 10 mg of Ru were added to 20 liters sea water. The rate earth fraction, separated from alkaline earth elements, was dissolved in hydrochloric acid and precipitated as an oxalate and separated from Zr and Ru. The rare earth oxalate was ignited and dissolved in nitric acid and adjusted to a 9 M HNO_3 solution. Ce was oxidized to quadrivalent by sodium bromate and extracted by MIBK. After the MIBK layer was washed with a 9 M HNO_3 solution containing a few drops of 2 M $NaBrO_3$, Ce was stripped by water containing 3 drops of hydrogen perioxide, precipitated as an oxalate, filtered by filter paper then counted by a 4π gas flow counter.

^{144}Ce was counted after ^{141}Ce completely decayed and its effect on the count of ^{144}Ce became negligible. Counting efficiency for each nuclide was determined by measuring the respective standard at the same geometry and condition as the sample.

3. Results

The results obtained are given in Table 1. The locations of sea water sampling are shown in Fig 1. We can divide the locations to three groups, that is, Stations 23, 25, 27 and 29 belong to the South Equatorial Current, Stations 31 and 35 to the Equatorial Counter Current, and Stations 39, 41 and 43 to the North Equatorial Current.

4. Relation between radioactivity and water temperature.

As is shown in Fig. 6, the temperature range of the thermocline is from 15° to 25°C. These temperature boundaries are indicated by dotted lines in Fig. 6.

a. Above the thermocline, there are differences between the radioactivities of ^{90}Sr, ^{137}Cs and ^{144}Ce in the South Equatorial, Counter and North Equatorial Currents. However, there is no difference between them, below the thermocline.

b. There are con
^{90}Sr radioactivity ab
tends to increase fro

c. The vertical
that of ^{90}Sr and ther
radioactivity above a
South Equatorial Curr
Equatorial Current re
decreases abruptly fr
The value of ^{144}Ce at
abnormally large, but
location are normal.
effect of biological

5. Relation between r

Fig. 7 shows tha
radioactivity and dis
linear function. Thi
supplied to the marin
to a deeper layer by
in the same manner as
coincides with the ch
of ^{90}Sr in sea water
amounts of the stable
there is no linear re
activity and dissolve
is due to the unstabi
sea water.

6. ^{144}Ce to ^{90}Sr

In the South Equ
$^{144}Ce/^{90}Sr$ above the
those of below the th
to indicate that ^{144}C
and suffers the effec
its motion in sea wat
deeper layer faster t

b. There are considerable differences between the ^{90}Sr radioactivity above and below the thermocline which tends to increase from south to north.

c. The vertical distribution of ^{144}Ce differs from that of ^{90}Sr and there is no difference between the radioactivity above and below the thermocline in the South Equatorial Current region. However, in the North Equatorial Current region, radioactivity of ^{144}Ce decreases abruptly from the surface to the thermocline. The value of ^{144}Ce at Station 39, at the 150 m level is abnormally large, but the values of ^{90}Sr and ^{137}Cs at same location are normal. This may be, perhaps, due to the effect of biological concentration.

5. Relation between radioactivity and dissolved oxygen.

Fig. 7 shows that the relation between ^{90}Sr radioactivity and dissolved oxygen is exhibited as linear function. This seems to indicate that ^{90}Sr supplied to the marine surface as fallout is transported to a deeper layer by the mixing action of sea water in the same manner as dissolved oxygen. This result coincides with the chemical and biological stability of ^{90}Sr in sea water due to the existence of large amounts of the stable isotops. On the other hand, there is no linear relationship between ^{144}Ce radioactivity and dissolved oxygen values. We think this is due to the unstability of the ^{144}Ce nuclide in sea water.

6. ^{144}Ce to ^{90}Sr

In the South Equatorial Current, the values of $^{144}Ce/^{90}Sr$ above the thermocline are smaller than those of below the thermocline. These results seem to indicate that ^{144}Ce absorbs to a particular materials and suffers the effect of mixing and gravity during its motion in sea water, allowing ^{144}Ce to reach a deeper layer faster than ^{90}Sr.

Table 1. Radioactivity of Sea Water

Station No.	Location	Depth (m)	Volume (ℓ)	Date	Radioactivity (μμc/ℓ)		
					^{131}Cs	^{90}Sr	^{144}Ce
23	1-55.0'N	0	21.3	22 Aug 62	0.36±0.03	0.09±0.01	0.25±0.02
	160-25.0'W	150	20.3		0.21±0.02	0.10±0.01	0.23±0.02
		300	20.2		0.18±0.02	0.02±0.01	0.48±0.03
25	0-06.5'N	0	21.4	23 Aug 62	0.21±0.10	0.10±0.01	0.30±0.02
	158-57.0'W	150	19.7			0.08±0.01	0.34±0.03
		300	18.5		0.10±0.02	0.04±0.01	0.29±0.03
27	2-00.0'S	0	20.2	24 Aug 62	0.08±0.02	0.10±0.02	0.41±0.03
	157-00.0'W	150	20.0			0.11±0.01	0.45±0.03
		300					
29	1-35.4'N	0	22.0	25 Aug 62	0.09±0.05	0.10±0.01	0.37±0.02
	157-24.0'W	150	20.0			0.09±0.01	0.34±0.03
		300	19.5		0.13±0.02	0.03±0.01	0.43±0.03
31	4-15.5'N	0	20.3	a6 Aug 62	0.04±0.08	0.09±0.01	0.59±0.03
	156-57.0'W	150	20.3		0.26±0.02	0.12±0.01	0.32±0.03
		300	19.0		0.14±0.02	0.05±0.01	0.51±0.03
35	8-16.0'N	0	21.1	27 Aug 62		0.20±0.01	1.15±0.03
	157-03.0'W	150	20.3		0.08±0.02	0.04±0.01	0.52±0.02
		300	18.5		0.06±0.02	0.06±0.01	0.41±0.03

Station No.	Location	Depth (m)	Volume (ℓ)	Date	Radioactivity (μμc/ℓ)		
					^{131}Cs	^{90}Sr	^{144}Ce
39	11-53.0'N	0	21.0	28 Aug 62	0.30±0.02	0.17±0.01	1.29±0.05
	157-28.0'W	150	19.5		0.11±0.02		2.46±0.05
		300	19.8		0.12±0.02	0.05±0.01	0.46±0.03
41	15-43.0'N	0	21.2	29 Aug 62		0.15±0.01	1.38±0.03
	158-04.0'W	150	19.3		0.21±0.02	0.19±0.01	0.60±0.03
		300	20.0		0.10±0.02	0.08±0.01	0.46±0.03
43	18-57.0'N	0	21.4	30 Aug 62	0.41±0.05	0.18±0.01	1.31±0.03
	157-54.0'W	150	19.0		0.38±0.03	0.24±0.02	0.64±0.03
		300	19.8		0.29±0.03	0.12±0.01	0.43±0.03

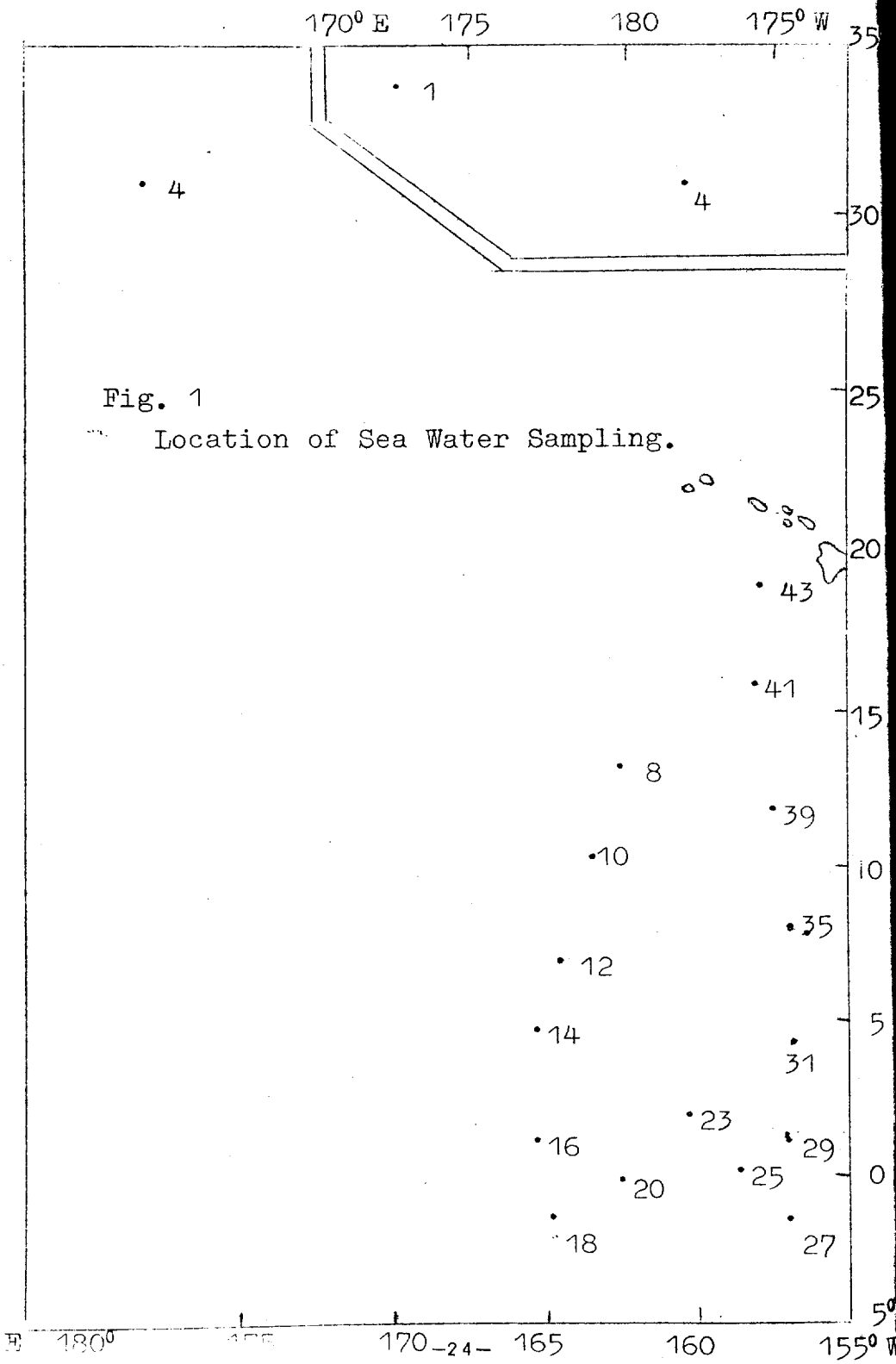
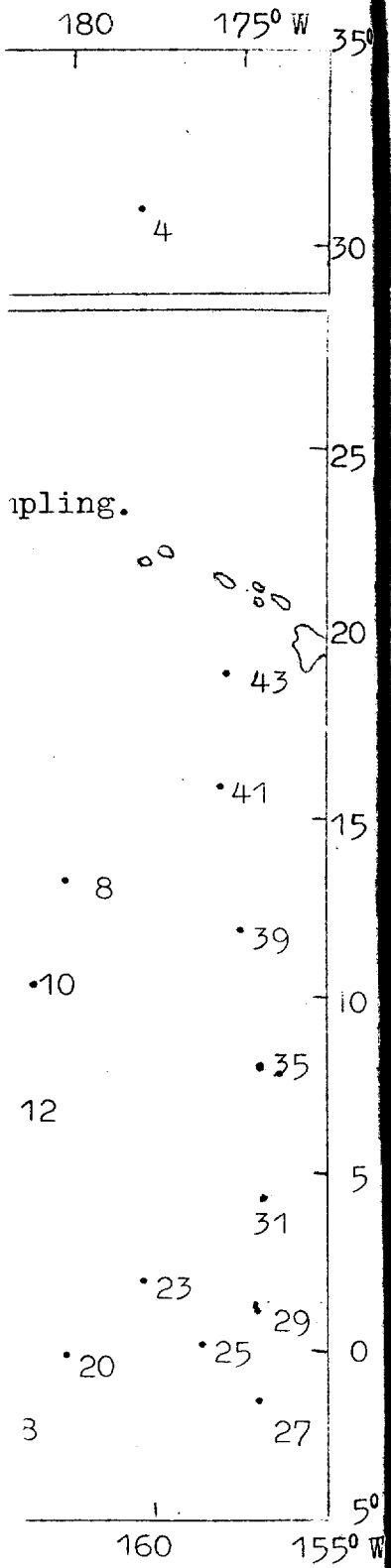


Fig. 1

Location of Sea Water Sampling.



ıpling.

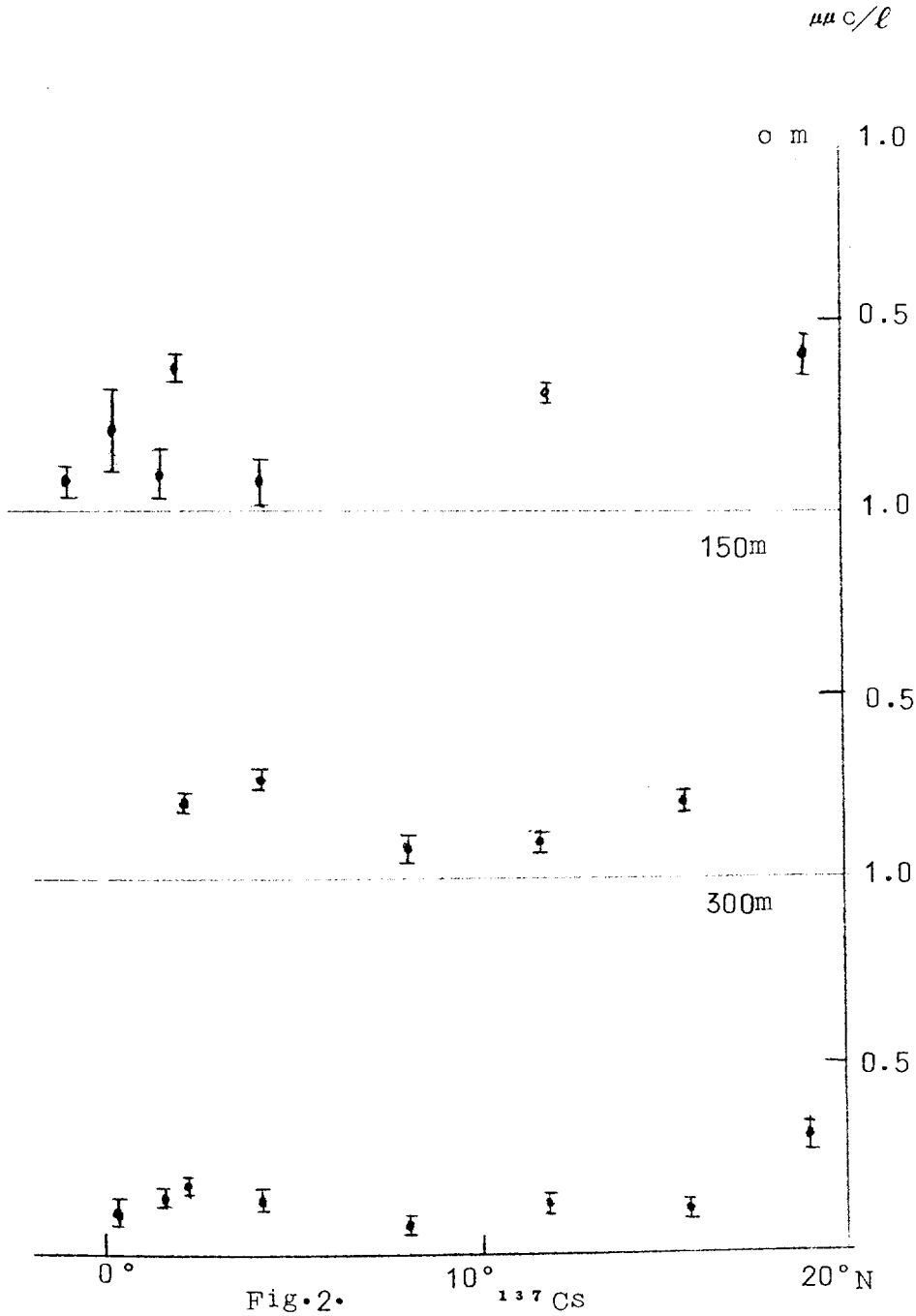


Fig.2. ^{137}Cs

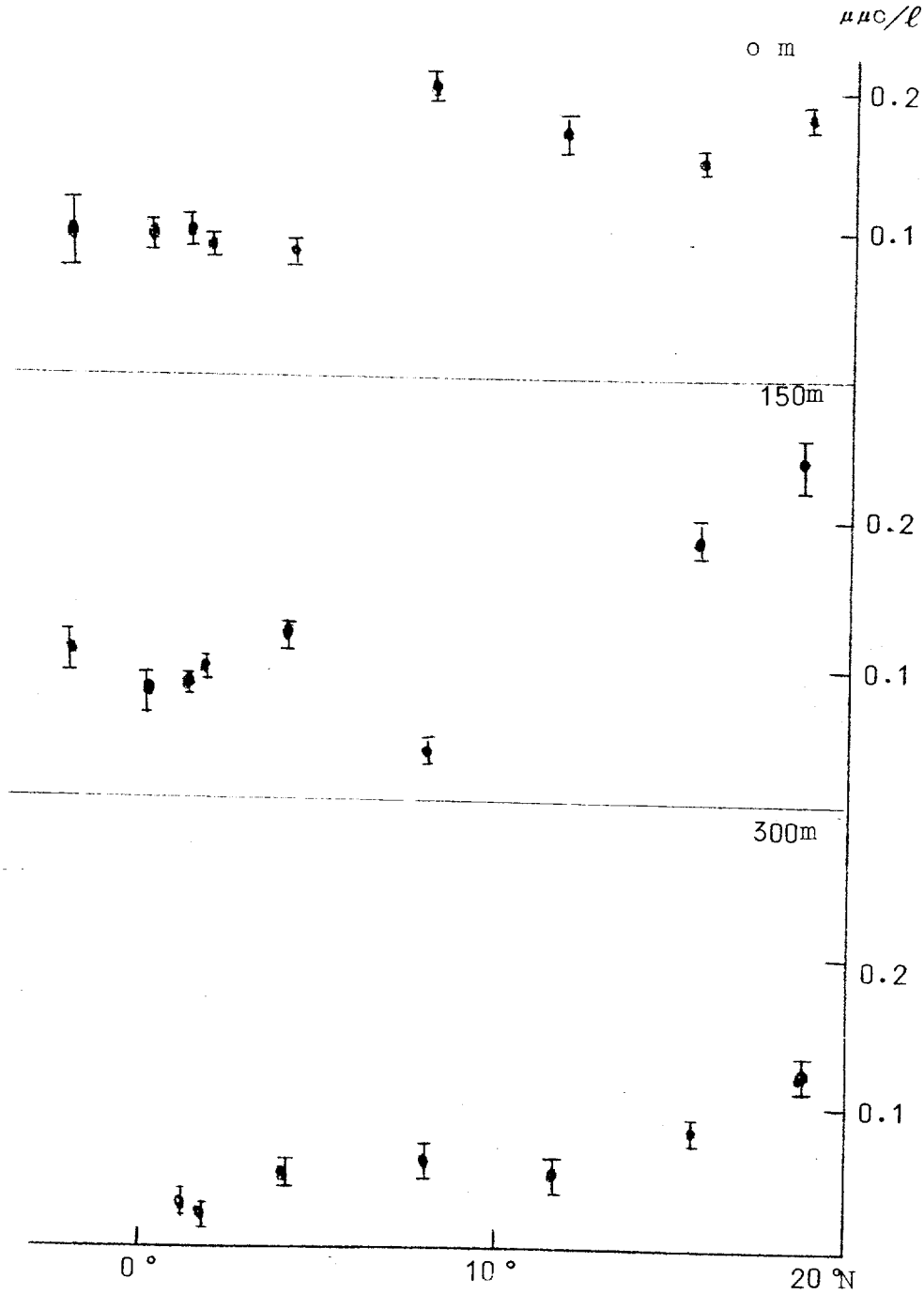


Fig.3 ^{90}Sr

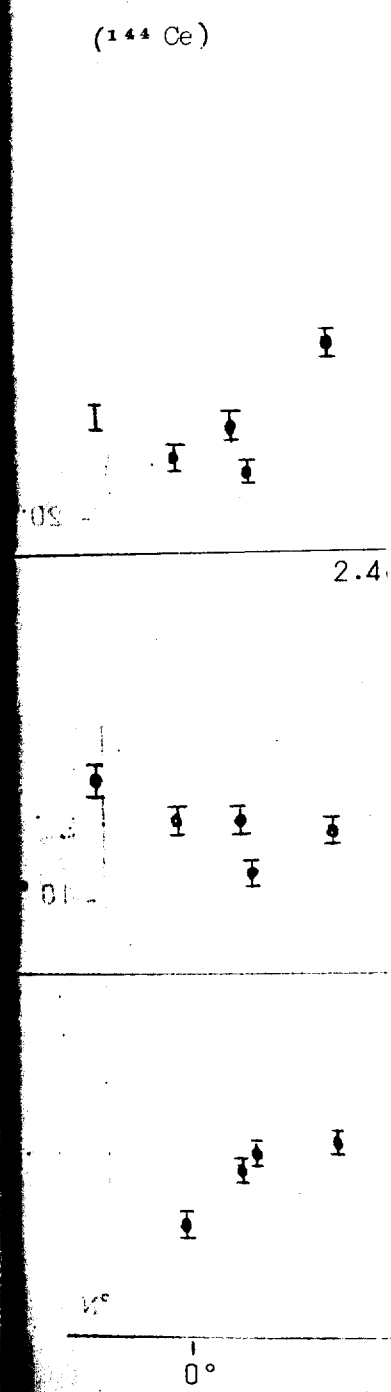
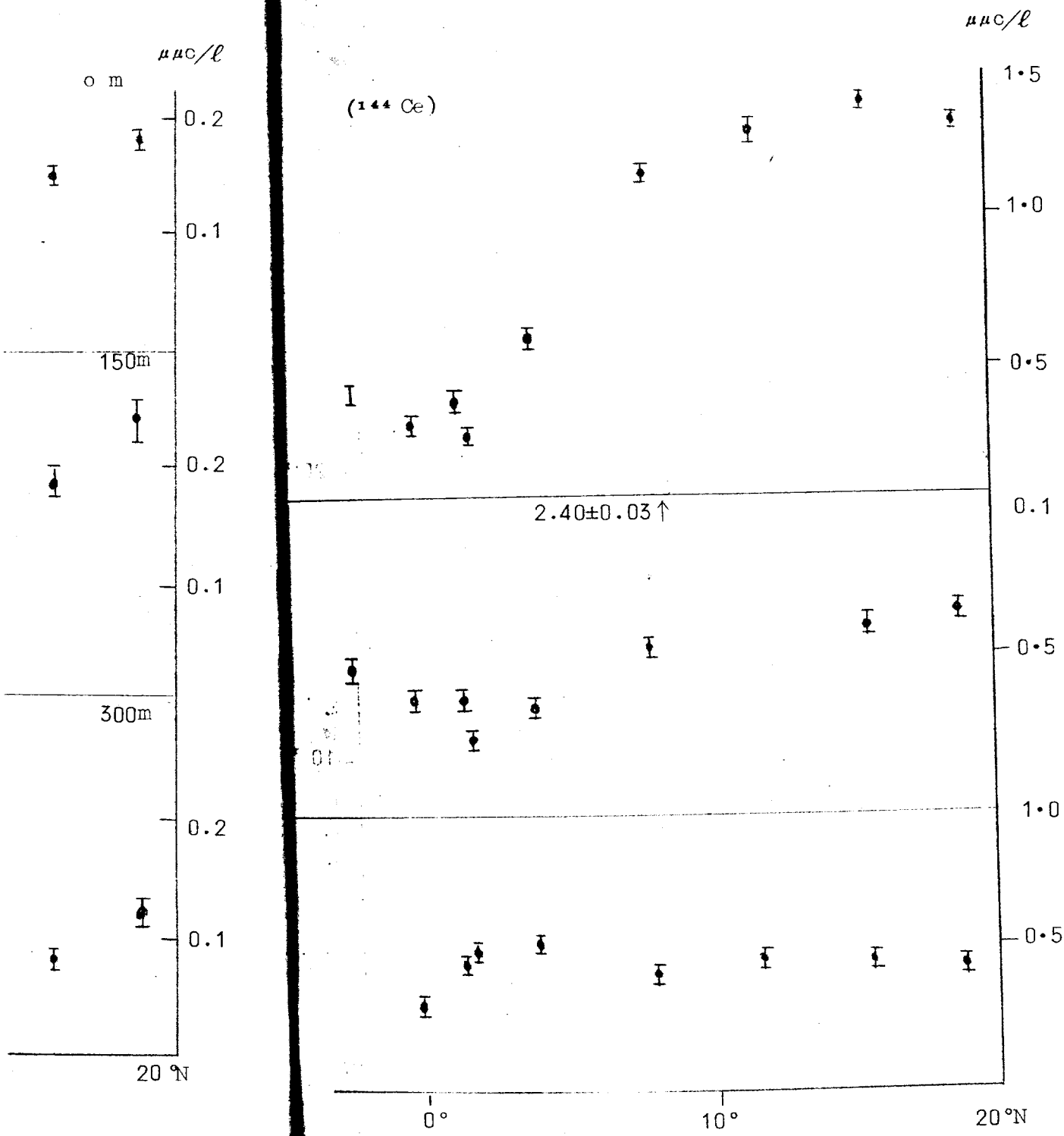


Fig.4.


μμc/ℓ
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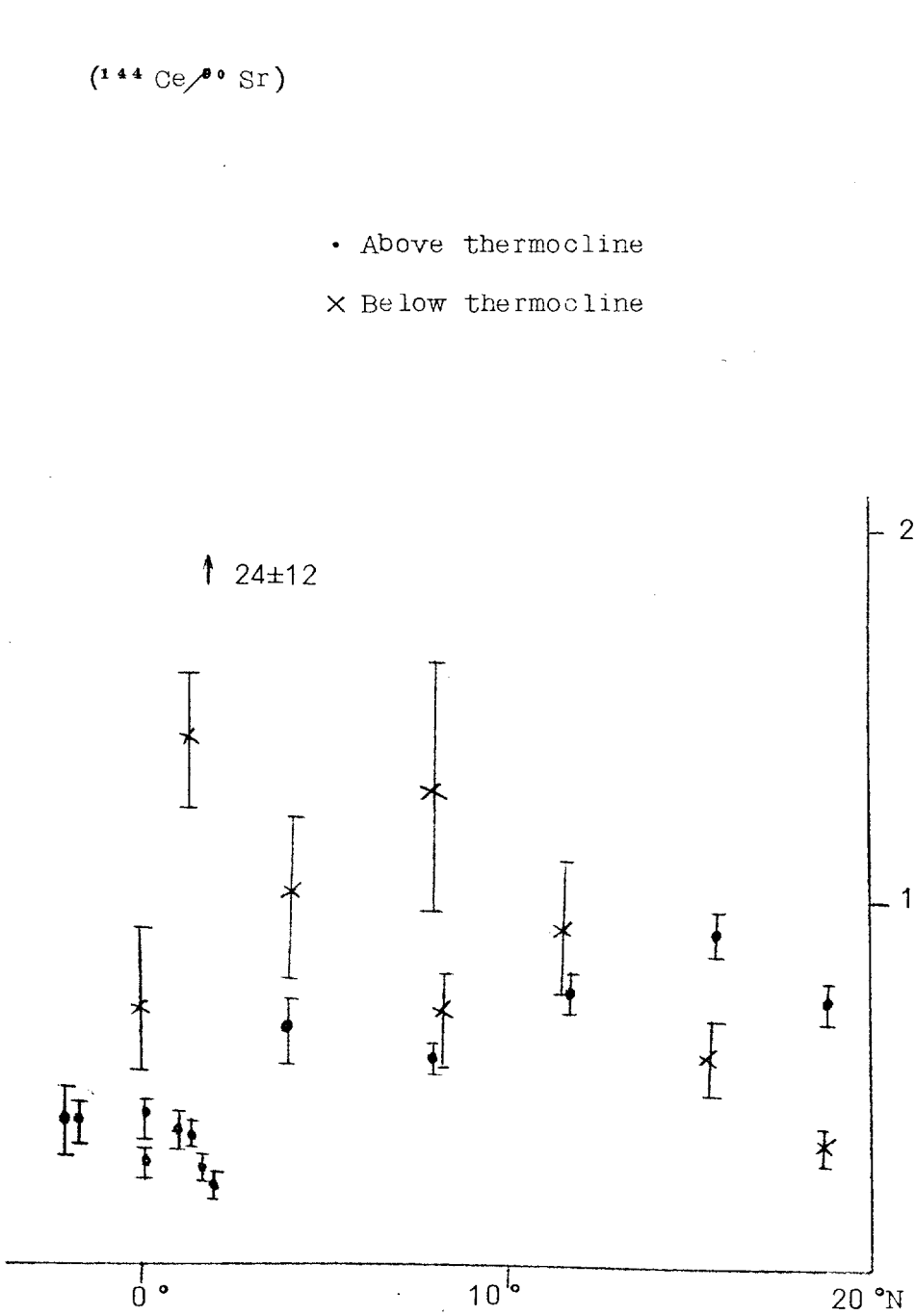
Fig·4.


(^{144}Ce/^{90}Sr)
• Above thermocline
× Below thermocline
24±12
20
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20 °N

Fig.5.

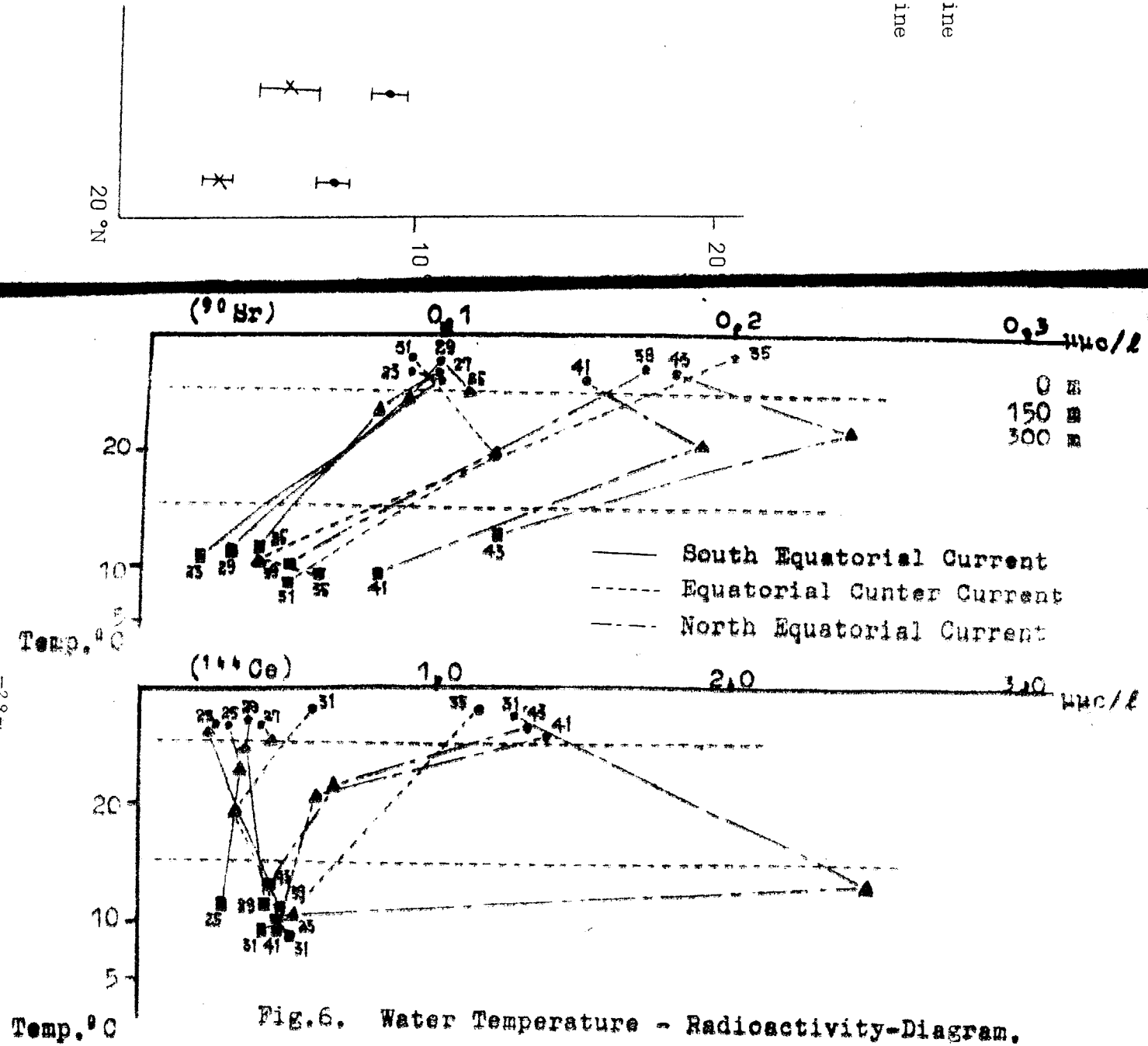

Fig.6. Water Temperature - Radioactivity-Diagram.

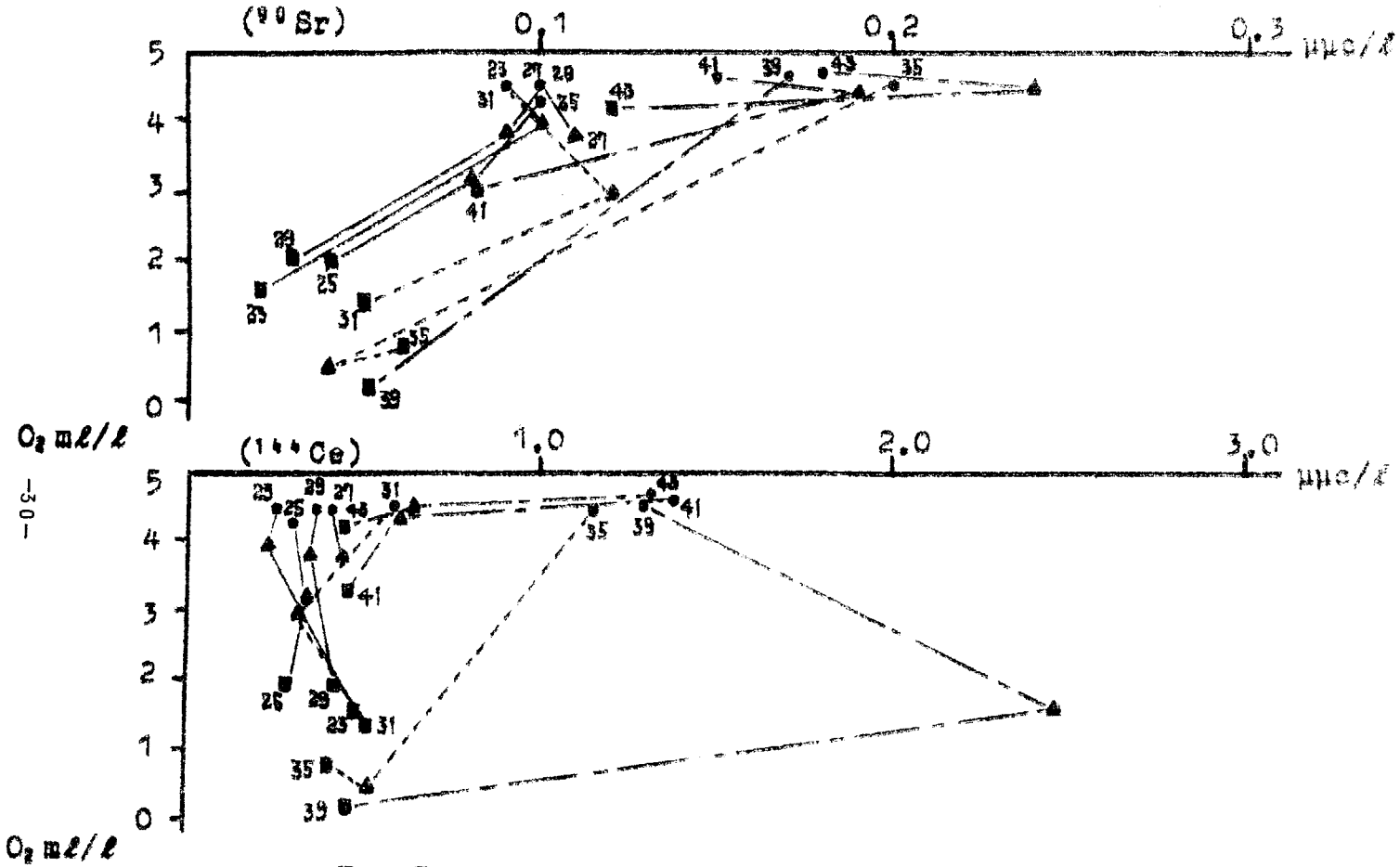

Fig.7. Dissolved Oxygen - Radioactivity-Diagram.

Meteorological

Fig.7. Dissolved Oxygen - Radioactivity-Diagram

Radiochemical Analysis of ^{90}Sr and ^{137}Cs in Seawater

*Katsuko SARUHASHI, Yukio KATSURAGI
and Teruko KANAZAWA

Procedure

Fe, Sr and Cs carriers were added to the water samples which were acidified with hydrochloric acid immediately after the samples were taken.

Sodium carbonate was added to separate the Ca and Sr as carbonates. After the Ca and Sr carbonates were dissolved in diluted HCl, the pH of the solution was adjusted to 8 with an ammonia solution in order to separate iron hydroxide by filtration. After EDTA was added to the filtrate as a masking agent for the majority of the Ca, sodium carbonate was added to separate Sr with the remaining free Ca. Precipitate was dissolved in diluted HNO_3 then the fuming HNO_3 method was used to separate Sr from Ca. ^{90}Sr was counted with a low background, windowless, gas flow counter. Nitric acid was added to the filtrate from the carbonate and ^{137}Cs was separated by the addition of microcrystalline ammonium molybdophosphate. ^{137}Cs was counted with a γ-ray spectrometer.

*Meteorological Reserach Institute

Station No.	Location	Date	Depth (m)	Volume (ℓ)	^{90}Sr (μμc/ℓ)	^{137}Cs (μμc/ℓ)	$^{137}Cs/^{90}Sr$
1	33°09.5'N 172°41.2'E	2 Aug 62	0				
			152				
			300				
4	30°50.6'N 178°06.0'W	4 Aug 62	0				
			147				
			298				
8	13°26.0'N 162°28.0'W	15 Aug 62	0				
			152				
			289				
10	10°22.0'N 163°53.0'W	16 Aug 62	0				
			150				
			290				
12	7°09.7'N 164°08.5'W	17 Aug 62	0				
			148				
			278				
14	4°32.0'N 165°24.0'W	18 Aug 62	0				
			133				
			233				
16	1°08.8'N 165°09.0'W	19 Aug 62	0				
			148				
			294				
18	1°55.0'S 165°00.0'W	20 Aug 62	0				
			146				
			267				
20	0°00.0' 162°35.0'W	21 Aug 62	0				
			117				
			252				

Total γ-radiatio
Scintillation co

A scintillatior
active contaminatior
A block diagram of t
sodium iodide cryst
used as the phosphor
scintillation probe
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during 1956. However
equipment used durir
transistorized.

The length of
300m enabling measu
true depth was made
The counting rates
In these values, th
device was set at a
energy value in the
the γ ray spectrum
probe combined with
analyzer.

* Institute of Phy

Fig. 1. Scintillati

NaI(Tl) Phosphor Element	Photomulti-plier tube (RCA 6199)

16	1°08.8'N	165°09.0'W	19 Aug 62	133	233	0
				148	294	
18	1°55.0'S	165°00.0'W	20 Aug 62	0	146	267
20	0°00.0'	162°35.0'W	21 Aug 62	0	117	252

Total γ-radiation in Sea Water Measured with a Scintillation Counter

* Masaharu OKANO

A scintillation counter was used to monitor radioactive contamination of sea water by γ emitting nuclides. A block diagram of the counter is shown in Fig.1. A sodium iodide crystal, $1\frac{1}{2}$" in diameter and $1\frac{1}{2}$" long, was used as the phosphor element. The construction of the scintillation probe is the same as the type used in the radiological survey performed by the "Shunkotsu Maru" during 1956. However, the circuitry of the electronic equipment used during this survey trip, was completely transistorized.

The length of the scintillation probe cable was 300m enabling measurements at a depth of 200m. The true depth was made by the readings on the bathythermographs. The counting rates at each station are shown in Table 1. In these values, the discrimination level of the measuring device was set at approximately 20 keV of the electron energy value in the phosphor element. At some stations the γ ray spectrum was measured with the scintillation probe combined with an RCL 128 channel pulse height analyzer.

* Institute of Physical and Chemical Research

Fig. 1. Scintillation Counter Block Diagram

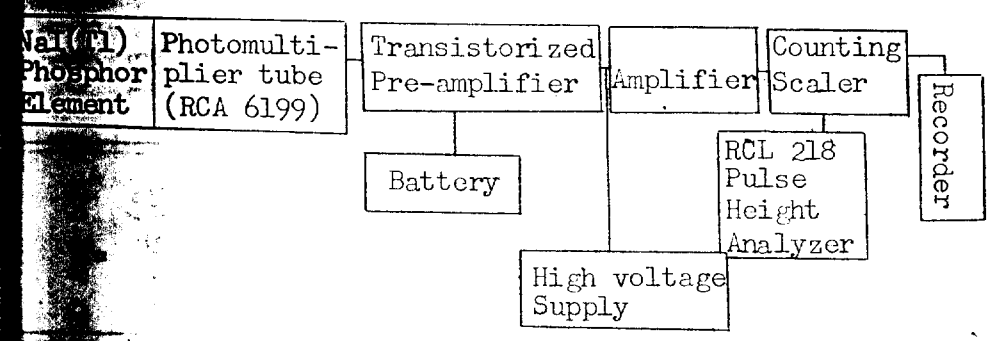


Table 1 γ-radiation in Sea Water

Station No.	Date (JST)	Total γ-Radiation				
		300 m cable		200 m cable		15 m cable
		Depth(m)	CPM	Depth(m)	CPM	CPM
1	2 Aug 62		208		206	242
4	4 Aug 62	267	207	138	197	208
7	6 Aug 62	188				250
8	15 Aug 62	234	214			238
10	16 Aug 62	262	200	109-115	222	
11	"					258
12	17 Aug 62	249	201	153	220	256
13	"					239
14	18 Aug 62	211	201	156	220	229
15	"					241
16	19 Aug 62	168	208			239
17	"					245±4
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	210	221
[illegible]	21 Aug 62	[illegible]	209	[illegible]	233	229
21	"					258
23	22 Aug 62	198	205	162	216	208
24	"					
25	23 Aug 62	160	234	106	218	235
26	"					246
27	24 Aug 62	196	201		217	259
28	"					254
29	25 Aug 62	142	226		214	258
30						277
31	26 Aug 62	257	218	164	219	252
33	"					263
35	27 Aug 62	211	222		234	263
37	"					261

(Continued from the preceding page)

Station No.	Date (JST)	Total γ Radiation				
		300 m cable		200 m cable		15 m cable
		Depth(m)	CPM	Depth(m)	CPM	CPM
39	28 Aug 62	155	200		209	228
40	"					251
41	29 Aug 62	209	227		228	249
42	"					235
43	30 Aug 62	255	222	160	222	241
44	"					
45	6 Sep 62					281
46	8 Sep 62					283
47	10 Sep 62					282
48	12 Sep 62					275
49	14 Sep 62					

46	9 Sep 62		283
47	10 Sep 62		282
48	12 Sep 62		275
49	14 Sep 62		

Oceanographical Properties of Seawater

* Masaru SHIOZAKI

1. Observations

Seawater samples for chemical analysis and water temperature measurements were collected by Nansen bottles equipped with reversable thermometers from the 150 and 300 m levels. Surface water was sampled by polyethylene bucket and the surface temperature was measured with a standard type thermometer. Chemical analysis was performed for dissolved oxygen, chlorine content and hydrogen ion concentration.

2. Measurements

a. Dissolved oxygen - The amount found in the sea water was determined by the Winkler method.

b. Chlorinity - Determined by the Fajans tritation method using Uranin as the indicator and silver nitrate solutions as the titrant.

c. Hydrogen ion concentration - Determined by the visual colorimetric method.

3. Results

Temperature measurements and chemical analysis of the seawater samples are shown in Table 1. Horizontal distribution of seawater temperature at the surface, 50 m level, 100 m level and 200 m level are shown in Figs 1 to 4. Horizontal distribution of chlorinity and dissolved oxygen at the surface and 150 m levels are shown in Figs 5 to 8. Sectional distribution of seawater temperature, chlorinity and dissolved oxygen are shown in Figs 9 to 11.

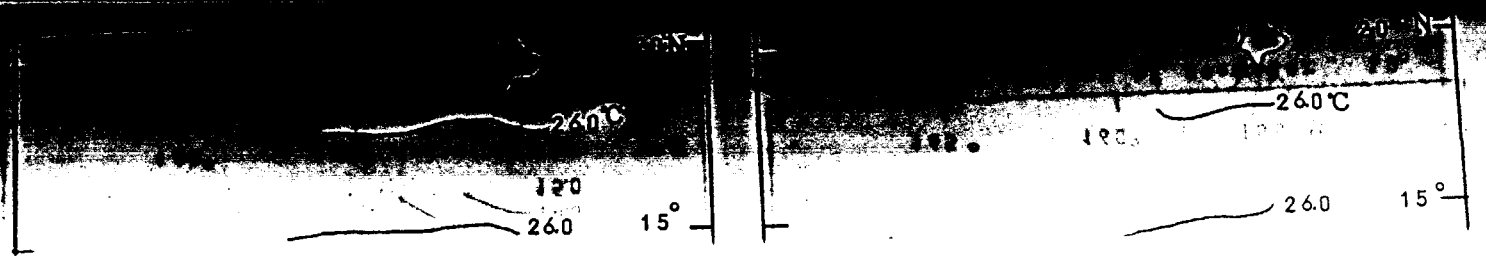
* Hydrographic Division, Maritime Safety Board Agency

Table 1. Temperature Measurements and Chemical Analysis of Seawater

Station No.	Sampling Date	Location	Depth (m)	Temp. (℃)	Cl(‰)	O_2 (ml/l)	O_2 (%)	pH	σ -t
1	2 Aug62	33-09.5'N	0	25.3	19.27	4.79	98.4	8.25	23.22
		172-41.2'E	152	16.47	19.26	4.76	83.7	8.15	25.61
			269	15.21	19.19	4.26	78.2	8.10	25.72
4	4 Aug62	30-50.6'N	0	25.3	19.31	4.82	98.9	8.25	23.28
			147	15.03	19.19	5.01	85.4	8.10	25.73
			298	12.25	19.03	4.97	80.3	8.00	26.11
8	15 Aug 62	13-26.0'N	0	26.1	19.20	4.72	97.2	8.20	22.81
		162-28.0'W	152	19.33	19.35	4.12	76.4	8.05	25.01
			289	9.77	19.00	2.01	31.2	7.75	26.43
10	16 Aug 62	10-22.0'N	0	27.3	19.03	4.58	96.8	8.35	22.25
		163-53.0'W	150	13.42	19.06	1.99	33.1	7.80	25.96
			280	9.64	19.34	0.40	6.2	7.65	26.93
12	17 Aug 62	7-09.7'N	0	28.2	19.13	4.50	95.8	8.20	22.07
		164-08.5'W	148	20.90	19.24	3.51	66.8	8.05	24.33
			278	10.17	19.19	0.11	6.4	7.65	26.71
14	18 Aug 62	4-32.0'N	0	27.7	19.40	4.48	95.2	8.20	22.46
		165-24.0'W	133	27.08	19.41	4.16	87.6	8.15	22.80
			233	10.20	19.16	2.39	37.1	7.80	26.66
16	19 Aug 62	1-08.0'N	0	28.4	19.34	4.49	96.5	8.20	22.38
18	20 Aug 62	165-09.0'W	148	17.82	19.35	3.13	56.6	7.95	25.26
			294	10.61	19.25	1.33	20.8	7.70	26.62
18	20 Aug 62	1-55.0'S	0	27.3	19.21	4.52	95.5	8.20	22.51
		165-00.0'W	146	22.82	19.34	3.53	69.4	8.10	23.91
			267	10.43	19.26	2.20	34.7	7.80	26.81
20	21 Aug62	0-00.0'	0	27.0	19.60	4.33	91.2	8.20	23.08
		162-35.0'W	117	26.12	19.73	3.59	74.3	8.10	23.52
			252	13.75	19.39	3.11	52.0	7.90	26.26
22	22 Aug62	1-55.0'N	0	26.6	19.41	4.47	93.3	8.20	22.80
		160-25.0'W	118	26.14	19.42	3.97	82.2	8.15	23.13
			238	11.16	19.26	1.58	25.1	7.75	26.63
25	23 Aug62	0-06.5'N	0	26.3	19.55	4.30	89.8	8.15	23.32
		158-57.0'W	123	23.31	19.46	3.22	63.8	8.10	24.09
			333	11.51	19.30	2.03	32.7	7.80	26.69
27	24 Aug62	2-00.0'S	0	26.7	19.65	4.51	94.1	8.15	23.08
		157-00.0'W	158	25.20	19.78	3.81	77.8	8.10	23.90
			301	10.54	19.73	1.56	24.6	7.70	27.28
29	25 Aug62	1-35.4'N	0	27.1	19.36	4.54	95.6	8.15	22.73
		157-24.0'W	107	24.68	19.39	3.80	78.2	8.10	23.39
			208	11.48	19.26	1.96	31.6	7.80	26.63

(Continued from the preceding page)

Station No.	Sampling Date	Location	Depth (m)	Temp. (℃)	Cl	O_2 (ml/l)	O_2 (%)	pH	σ -t
29	25 Aug62	1-35.4'N	0	27.1	19.36	4.54	95.6	8.15	22.73
		157-24.0'W	107	24.68	19.39	3.80	78.2	8.10	23.39
			208	11.48	19.26	1.96	31.6	7.80	26.63
31	26 Aug62	4-15.5'N	0	27.9	19.35	4.49	96.5	8.20	22.39
		156-57.0'W	148	19.75	19.26	3.00	55.7	8.00	24.62
			292	9.12	19.20	1.37	20.9	7.70	26.89
35	27 Aug62	8-16.0'N	0	27.8	18.95	4.54	96.8	8.30	21.79
		157-03.0'W	136	11.01	19.23	0.47	7.5	7.65	26.59
			288	9.47	19.21	0.78	12.0	7.65	26.90
39	28 Aug62	11-53.0'N	0	26.8	18.87	4.57	95.7	8.20	22.08
		157-28.0'W	125	13.16	19.04	1.62	26.6	7.75	25.93
			240	10.33	19.19	0.23	3.6	7.65	26.71
41	29 Aug62	15-43.0'N	0	26.0	19.12	4.59	94.6	8.20	22.69
		158-04.0'W	---	20.84	19.41	4.38	83.4	8.15	24.57
			309	9.45	18.91	3.27	50.3	7.80	26.50
43	30 Aug62	18-57.0'N	0	26.6	19.27	4.71	98.3	8.30	22.60
		157-54.0'W	137	21.65	19.43	4.54	87.3	8.15	24.33
			270	13.07	18.99	4.16	68.3	8.00	25.86



39	28 Aug62	11-53.0'N 157-28.0'W	0 125 240	26.8 13.16 10.33	18.87 19.04 19.19	4.57 1.62 0.23	95.7 26.6 3.6	8.20 7.75 7.65	22.08 25.93 26.71
41	29 Aug62	15-43.0'N 158-04.0'W	0 --- 309	26.0 20.84 9.45	19.12 19.41 18.91	4.59 4.38 3.27	94.6 83.4 50.3	8.20 8.15 7.80	22.69 24.57 26.50
43	30 Aug62	18-57.0'N 157-54.0'W	0 137 270	26.6 21.65 13.07	19.27 19.43 18.99	4.71 4.54 4.16	98.3 87.3 68.3	8.30 8.15 8.00	22.60 24.33 25.86

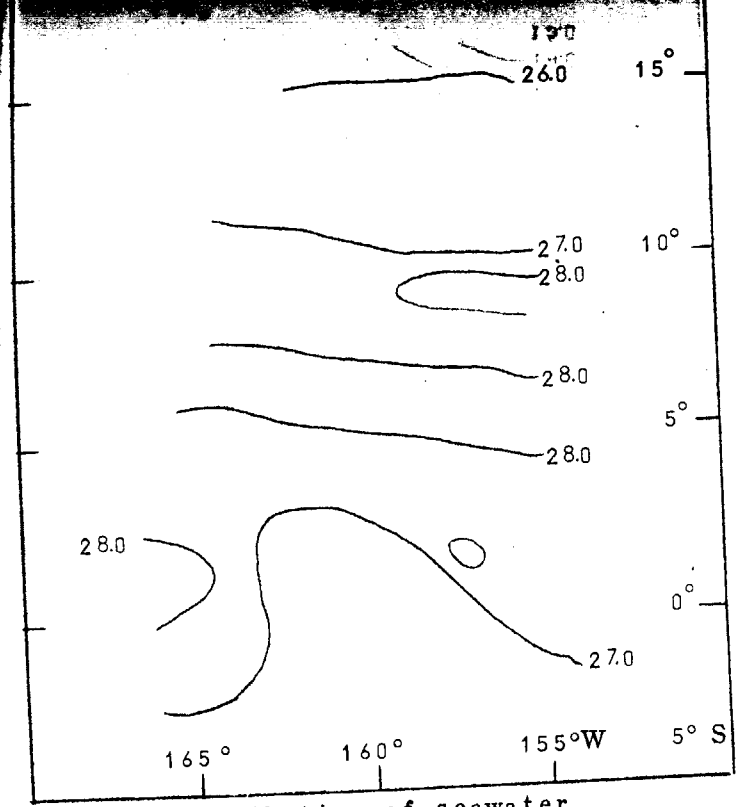


Fig. 1. Distribution of seawater temperatures at surface.

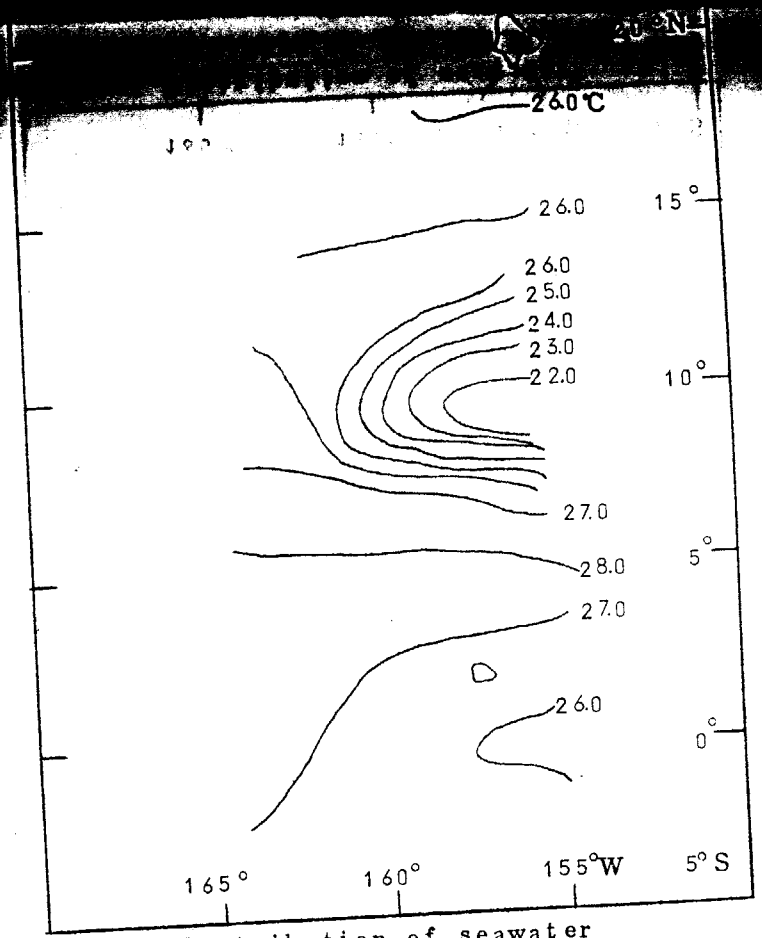


Fig. 2. Distribution of seawater temperatures at the 50 m level.

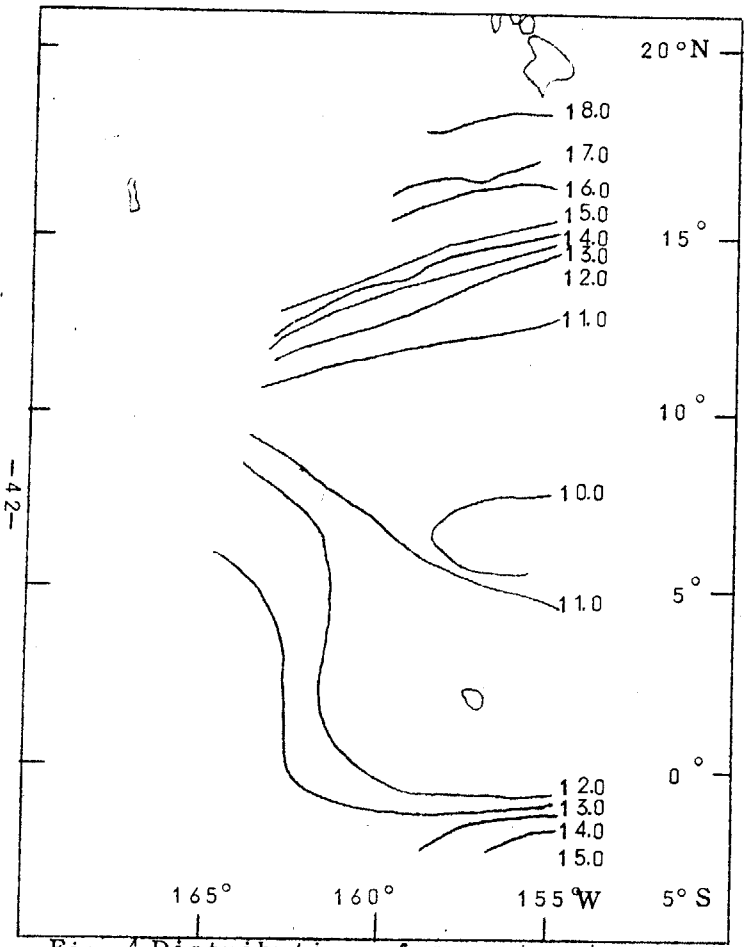


Fig. 4. Distribution of seawater temperatures at the 200 m level.

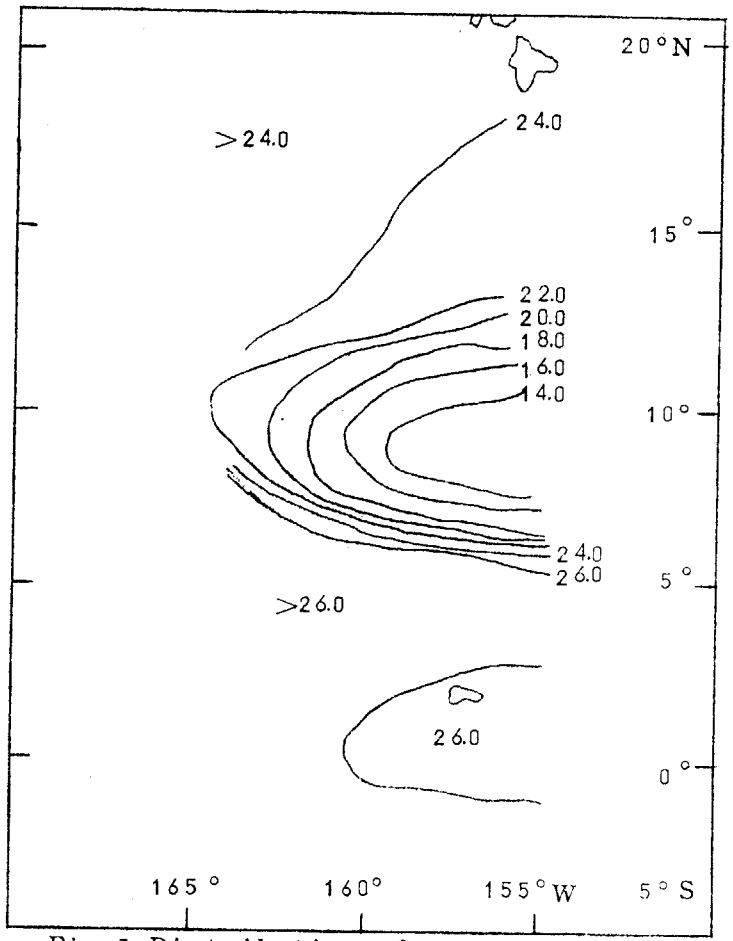
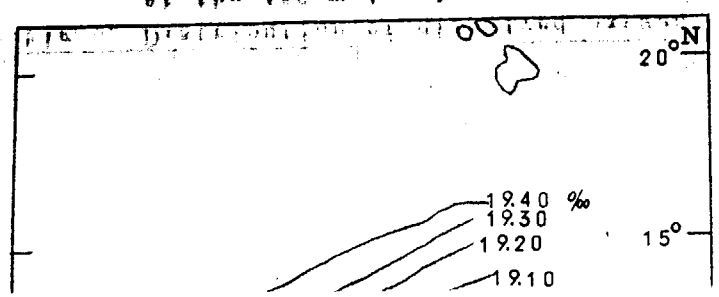
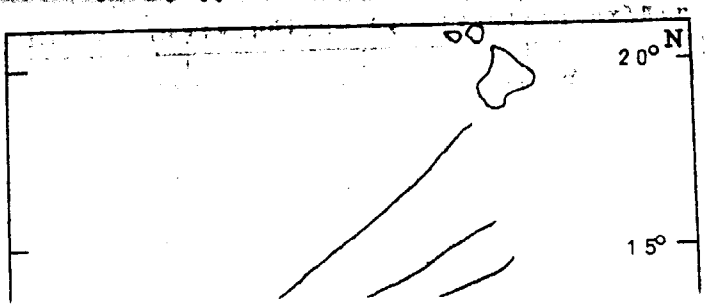


Fig. 3. Distribution of seawater temperatures at the 100 m level.





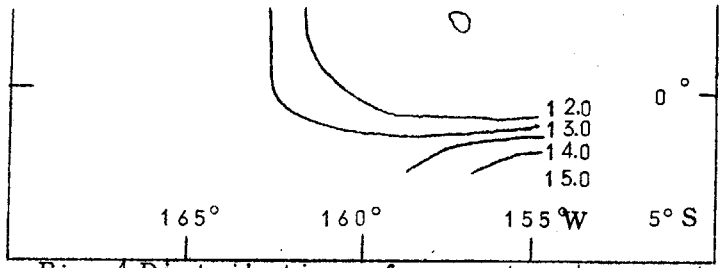


Fig. 4. Distribution of seawater temperatures at the 200 m level.

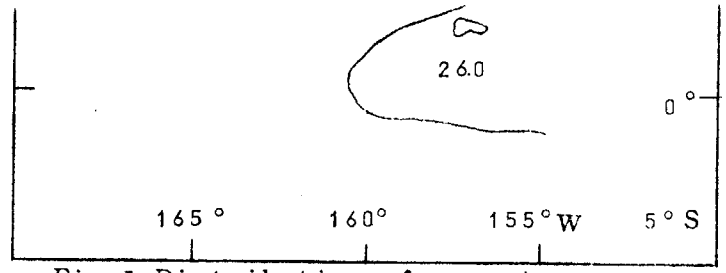


Fig. 3. Distribution of seawater temperatures at the 100 m level.

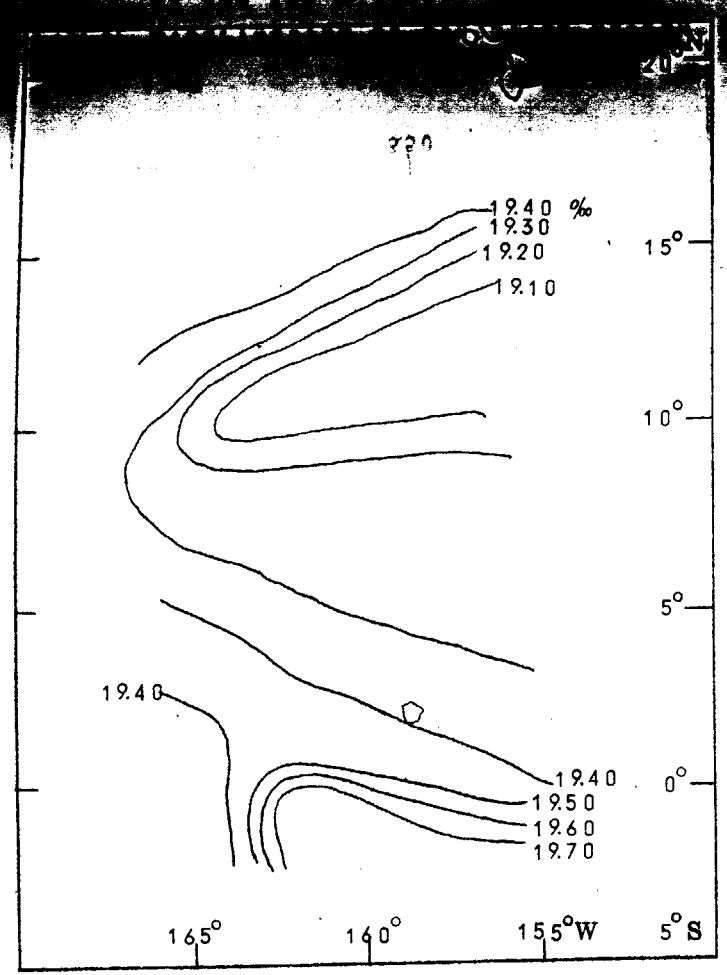


Fig. 6. Distribution of chlorinity at the 50 m level.

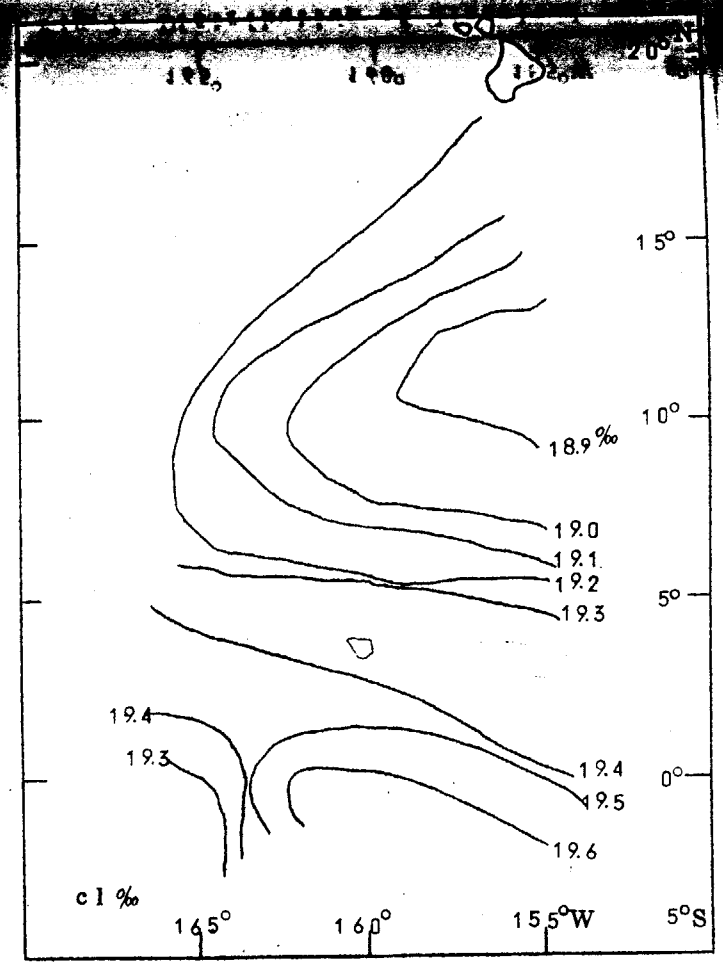


Fig. 5. Distribution of chlorinity at the surface.

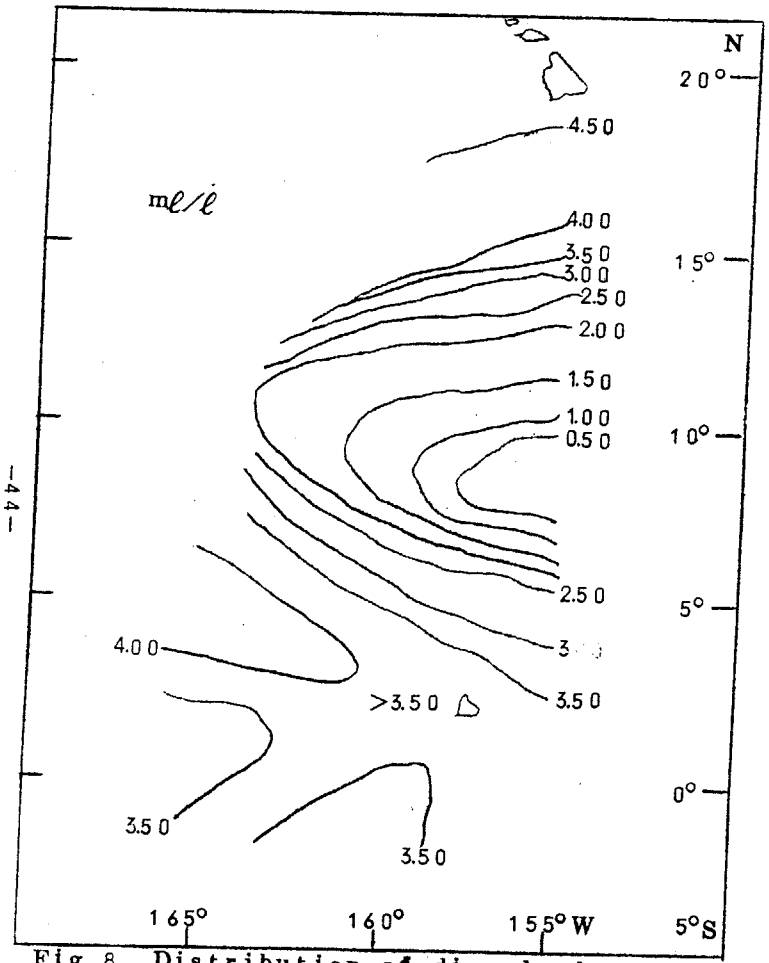


Fig. 8. Distribution of dissolved oxygen at the 150 m level

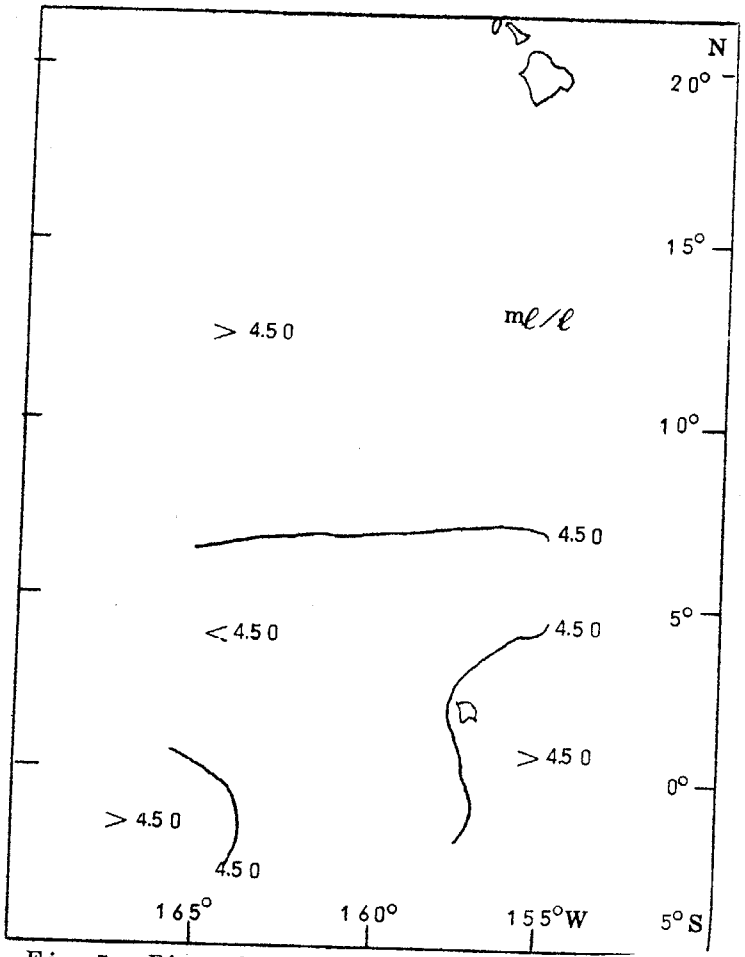


Fig. 7. Distribut

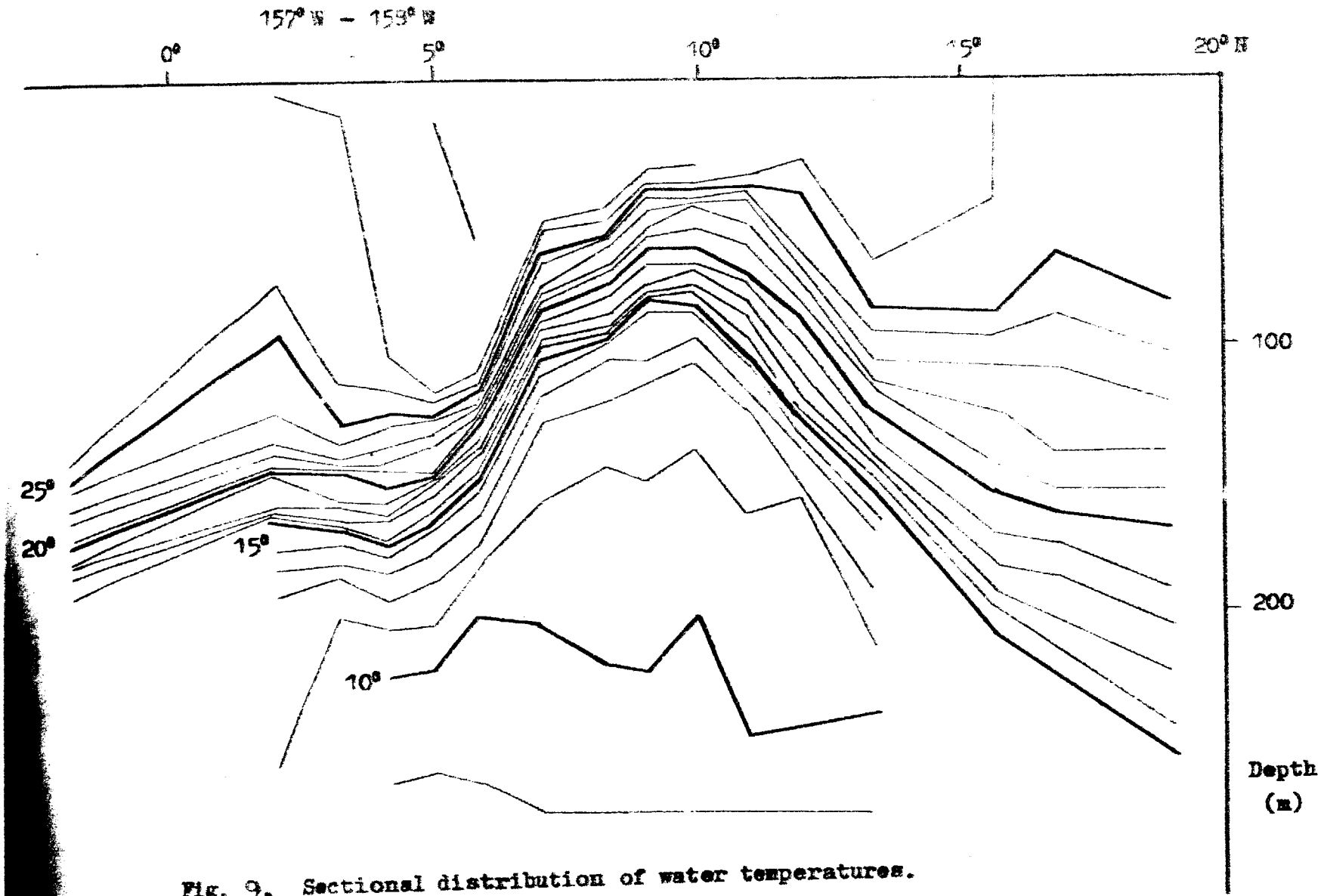


Fig. 9. Sectional distribution of water temperatures.

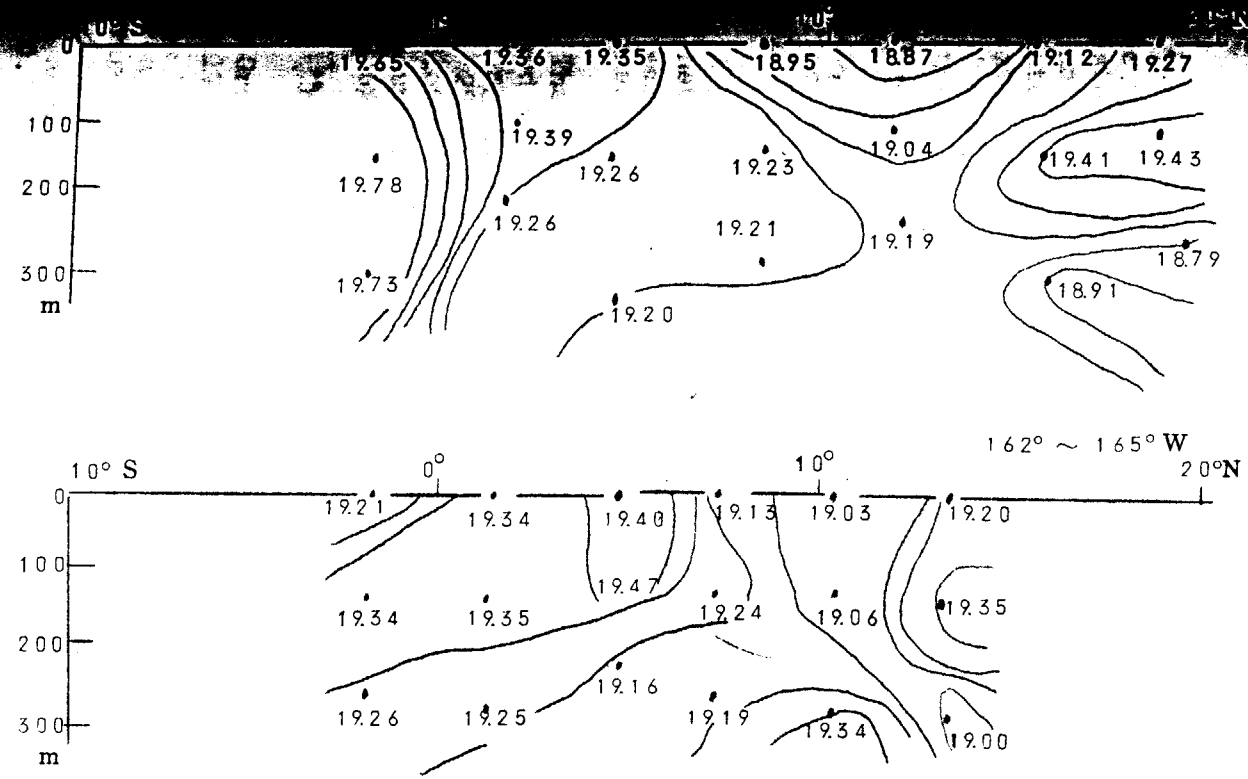


Fig.10. Sectional distribution of chlonity.

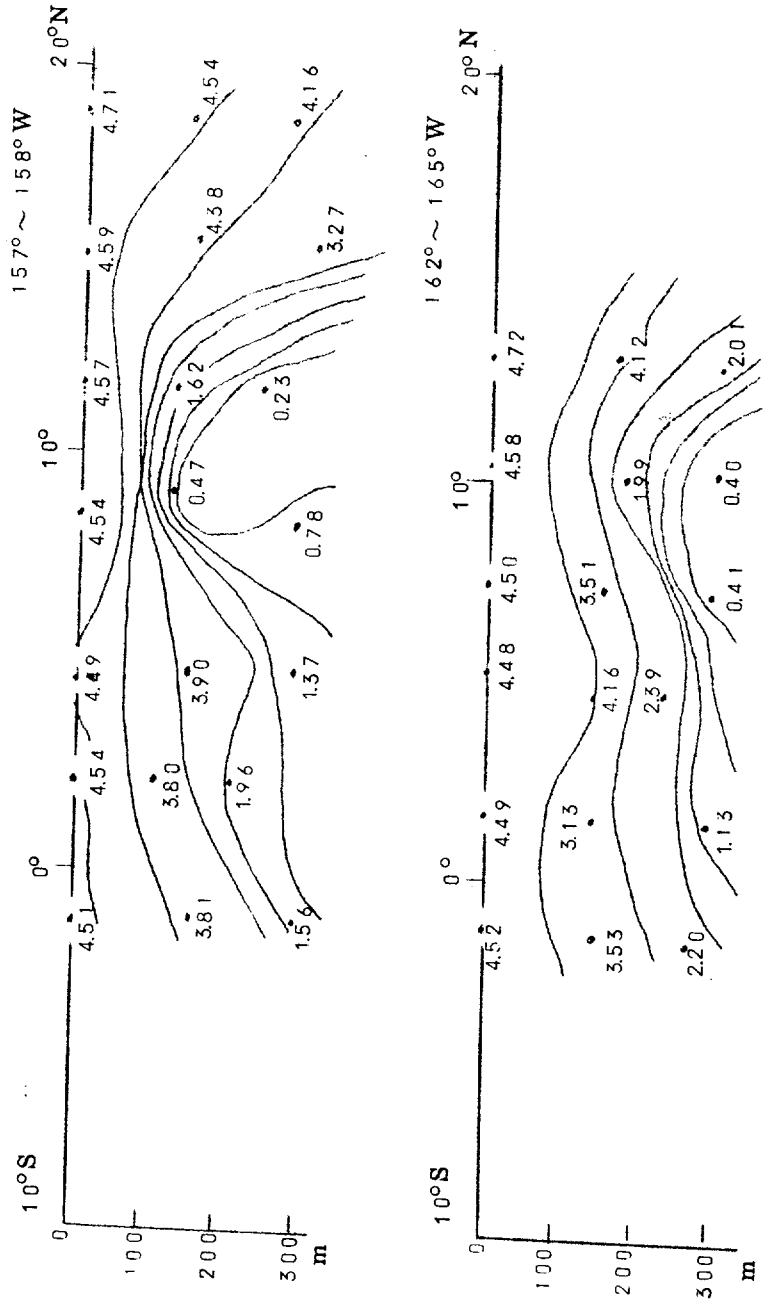


Fig. 11. Sectional distribution of dissolved oxygen.

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Gross β-ra
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average of 632 d
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* Tokai Region

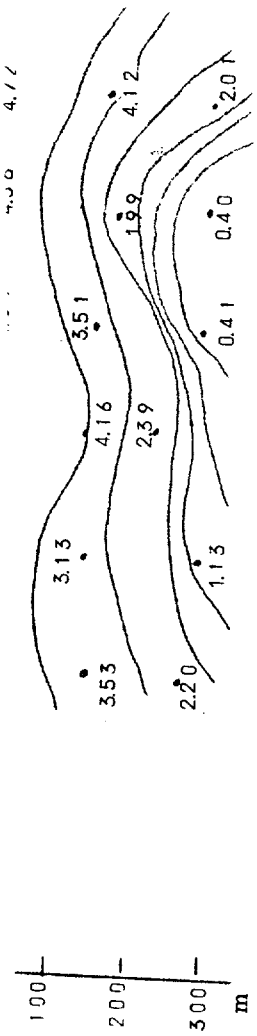

Fig. 11. Sectional distribution of dissolved oxygen.

Plankton Survey

*Hanato TSURUGA and Harumi TOZAWA

The net used for the survey was 130 cm in diameter at the mouth and 450 cm in length. The front portion consisted of a cotton minnow net, 350 cm in length, with an average mesh of 1.6 x 1.9 mm. The back portion consisted of bolting silk, 100 cm in length, with an approximate mesh of 0.3 mm.

During the run in the waters adjacent to Christmas Island, 6 net tows on the surface and 11 tows at a depth of 30-50 m were made for 1 or 2 hours immediately after sunset at a speed of 2-3 knots. Eleven tows on the surface were made during the runs between Tokyo and Honolulu in the same manner mentioned above.

A portion of the plankton samples obtained from each net tow was measured for activity, aboard the ship. The remainder was placed in a 10% formalin solution and preserved for radiochemical analysis.

The plankton sample, 30-50 g in wet weight, was ashed in the muffle furnace after being dried at 110°C. A 0.5 g sample of the ash was placed in a stainless dish, 25 mm in diameter and 8 mm deep, and the gross β-radioactivity measured with a conventional G-M counter. The counting efficiency, based on a ^{95}Zr-^{95}Nb standard was 6.6% for samples 1 to 11, and 6.3% for samples 12 and 13. Corrections were not made for the activity derived from K. Results are shown in Tables 1 and 2.

Gross β-radioactivity of the plankton ranged from 172 dpm/0.5g of ash, and seemed to be approximately equal to that of plankton from Japanese waters. Activity of samples from the Equatorial Countercurrent showed an average of 632 dpm/0.5g of ash in 4 samples. This was slightly higher than the average of 341 dpm/0.5g of ash in 4 samples from the North Equatorial Current or 361 dpm/0.5g of ash in 9 samples from the South Equatorial Current.

*Tokai Regional Fisheries Research Laboratory

Since the activity was measured on the samples which were biologically unclassified, it was difficult to point out the difference in degree of radiation contamination among the different types of organisms. However, if anythings, the activity in samples 1,2,4,9 and 10, in which larval fish, Medusae, Sagitta sp. and Doliolum sp. were predominant, seemed to be generally lower than those found in the samples consisting mainly of Crustacea and Salpa sp.

Gamma spectrometry was made on the ash from the fresh samples or from the samples placed in the preservative. The low level gamma spectrometer used consisted of a heavily shielded scintillation detector with a 256-channel pulse height analyzer (Toshiba Electric Co.). The detector, fitted with a 7.5cmØ x 7.5cm solid NaI(Tl) crystal, was housed inside a special shielding composed of mercury (2.5cm thick) and lead (10cm thick).

Since the predominance of ^{95}Zr-^{95}Nb was observed, attention was paid to these nuclides. Concentrations of ^{95}Zr-^{95}Nb were measured by referring to a standard source of ^{137}Cs (Nuclear Chicago Corp. Model RS 137) with corrections for the difference in the number of photons per disintegration. (i.e. 0.82 for ^{137}Cs and 1.0 for ^{95}Zr-^{95}Nb.) The results are shown in Table 2. In addition to ^{95}Zr-^{95}Nb, the presence of ^{60}Co and ^{144}Ce-^{144}Pr were presumed from the gamma energy spectrum. Some of the data pertaining to concentrations of ^{95}Zr-^{95}Nb in plankton were found to be on the same level as those found in spinach samples measured in Tokyo. It may be of interest to mention that the concentration of nuclides, such as ^{90}Sr, in the marine organisms, amounts to not more than one-hundredth of the concentration found in terrestrial plants.

iological comp

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da, Copepoda
, Siphonophor
sp.

Medusae(20%)
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opepoda, Pter
ta(20%),Siph
0%),Euphausi
hausiacea(10-
%),Siphonoph
es sp.(10-20
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Sagitta sp.(
30%),Copepod
,Sagitta sp.(
edusae
phorae(10%)

,Salpa sp.(
lpa sp.(10%)
rgestes sp.
Sergestes
., Medusae
sp., Pterop
, Megalopa

Table 1. Quantitative and Qualitative Compositions of Plankton Samples

Station	Sample No.	Sampling method	WEIGHT Total, Wet (g.)	Dry/Wet (%)	Ash/Dry (%)
0-1	1	Surface tow	2,860	2.5	53.2
2	2	"	49	8.1	37.8
3	3	"	115	9.3	38.0
5	4	"	92	13.4	24.6
6	5	"	38	7.6	40.2
7	6	"	58	6.8	47.0
9	9	"	28	13.3	39.3
11	10	"		22.3	21.7
"	11	"	350	9.1	50.7
13	12	Underwater tow	180	11.2	35.3
15	14	"	410	6.7	66.1
17	15	"	570	8.2	38.0
19	16	"	850	8.3	46.5
21	17	"	400	10.2	42.5
22	18	"	165	10.5	46.5
24	19	"	450	11.0	44.7
26	20	"	850	9.1	49.2
28	21	"	330	8.6	46.1
30	22	"	1,100	12.0	38.1
33	23	"	580	11.8	44.4
37	24	Surface tow	380	11.4	37.3
40	25	"	600	8.2	48.1
42	26	Surface tow	160	12.1	28.1
44	27	"	390	12.4	32.8
45	28	"	170	10.3	37.5
46	29	"	180	20.3	26.8
47	30	"	210	10.2	33.2
48	31	"	430	13.1	22.5
49	32	"	320	-	-

Biological composition
Doliolum sp.(95%), Sagitta sp., Salpa sp., Copepoda
Sagitta sp., Siphonophorae, Pteropoda, Copepoda
Sergestes sp., Copepoda, Sagitta sp., Siphonophorae, Pteropoda
Sagitta sp.(60%), Copepoda,Sergestes sp.
Sergestes sp.(60%), Sagitta sp.(20%)
Sergestes sp.(50%), Copepoda(20%), Medusae(20%)
Larval fish, Medusae, Pteropoda, Copepoda
Larval fish
Medusae(60%), Copepoda, Appendicularia
Euphausiacea(90%), Copepoda, Appendicularia,Sagitta
Euphausiacea(80%), Salpa sp.(10%), Copepoda, Pteropoda
Copepoda(30%,)Euphausiacea(20%,Sagitta(20%),Siphonophorae(10-20%)
Salpa sp.(30-40%),Siphonophorae(20-30%),Euphausiacea(10-20%),Sagitta sp.(10%),Appendicularia
Copepoda(20%),Siphonophorae(20%),Euphausiacea(10-20%),Pteropoda(10-20%),Salpa sp.
Salpa sp.(30-40%),Euphausiacea(10-20%),Siphonophorae(10-20%),Copepoda(10%)
Copepoda(20%),Salpa sp.(20%),Sergestes sp.(10-20%),Euphausiacea
Salpa sp.(10-20%),Copepoda(10-20%),Euphausiacea(10-20%),Siphonophorae(10%)
Salpa sp.(20%),Euphausiacea(10-20%),Sagitta sp.(10-20%),Copepoda(10%)
Sagitta sp.(30-40%),Euphausiacea(20-30%),Copepoda(10%), Pteropoda(10%)
Salpa sp. (20-30%),Euphausiacea(20%),Sagitta sp.(20%),Siphonophorae(10%)
Euphausiacea, Copepoda, Salpa sp., Medusae
Salpa sp.(70%),Amphipoda(10%),Siphonophorae(10%),Copepoda(5%)
Alima larvae(40-50%),Copepoda(20-30%),Salpa sp.(10%),Sagitta sp.(5%)
Alima larvae(20-30%),Copepoda(20%),Salpa sp.(10%),Sagitta sp.(10%)
Euphausiacea, Copepoda, Salpa sp., Sergestes sp.
Euphausiacea, Alima larvae, Copepoda, Sergestes sp., Salpa sp.
Euphausiacea, Sergestes sp., Salpa sp., Medusae
Copepoda(90%), Siphonophorae, Sagitta sp., Pteropoda, Amphipoda
Copepoda(90%), Amphipoda, Sagitta sp., Megalopa larvae, Mysidaces

Sample No.	Gross β-activity dpm/0.5g of ash	Date measured	$^{95}Zr+^{95}Nb$ μc/1.0g of ash	Date measured
1	118± 6	1 Aug 62	<16	17 Dec 62
2	196±10	4 Aug 62	<47	"
3	421±13	5 Aug 62		
4	386±16	6 Aug 62	112	18 Dec 62
5	341±12	7 Aug 62		
6	337±11	8 Aug 62	<64	"
9	171±12	17 Aug 62	-	-
10	146± 7	18 Aug 62	-	-
11	381±12	"	189	18 Dec 62
12	1172±28	19 Aug 62	93.6	"
14	446±15	20 Aug 62	37.2	8 Dec 62
15	156±13	21 Aug 62	72.6	10 Dec 62
16	355±16	22 Aug 62		
17	451±16	23 Aug 62	<17	11 Dec 62
18	254±15	24 Aug 62		
19	330±14	"	32.3	"
20	300±15	25 Aug 62	<15	"
21	690±17	26 Aug 62	57.2	"
22	268±16	27 Aug 62	-	-
23	392±16	28 Aug 62	110	20 Dec 62

(Continued on the next page)

(Continued from the preceding page)

24	583+16	29 Aug 62	< 48	11 Jan 63
25	900+19	30 Aug 62	224	12 Dec 62
26	181+13	31 Aug 62	83.8	12 Dec 62
27	114+14	1 Sep 62	25.0	"
28	253+16	8 Sep 62	<54	11 Jan 63
29	228+14	10 Sep 62	-	-
30	447+16	12 Sep 62	-	-
31	334+15	14 Sep 62	-	-
32	-	-	-	-

Activity of Fish Samples Surveyed Aboard Ship

*Hanato TSURUGA

Seven longline stations as indicated on the track were used. The longlines, each consisting of a 275 m mainline with 22 m droppers to which 4 hooks were attached, were used at these fishing stations. During the cruise, a total of 34 yellowfins, 10 bigeyes, albacores, 2 skipjacks and 1 marlin were caught.

Radioactivity was measured with a scintillation survey meter. The measurements were made by keeping the detector about 10 cm from both sides of the fish body at the operculum, dorsum, ventrum and tail. Natural count on deck was subtracted from the readings of the survey meter. The mean values found, by fish specimen, are shown in Table 1.

Based on the measurements made with the scintillation survey meter, significant activity on the fish caught by longline was not observed.

National Fisheries Research Laboratory

Table 1. Fish Samples Caught by Longline Fishing.

Station	Sample No.	Species	Body length (cm)	Body weight (kg)	Radioactivity (μr/h)
8	1	Albacore	118	31.2	0.0
"	2	Bigeye	115	26.2	-0.1
"	3	"	162	85.5	0.1
"	4	"	147	69.0	0.3
12	5	"	143	59.5	-0.3
"	6	"	161	79.4	-0.3
"	7	yellow fin	151	63.0	0.8
"	8	Big eye	172	108.4	-0.1
"	9	"	168	101.8	-0.1
"	10	"	134	51.5	-0.2
14	11	Yellow fin	113	25.8	0.0
"	12	"	124	35.6	-0.1
"	13	"	123	29.4	0.1
"	14	"	110	23.6	-0.1
"	15	"	131	40.0	0.1
"	16	"	133	42.0	0.1
"	17	"	124	34.7	0.5
"	18	"	139	49.2	0.1
"	19	"	120	30.5	-0.2
"	20	"	133	43.4	0.0
"	22	Big eye	87	14.6	0.1
"	24	Yellow fin	129	36.5	-0.3
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.2
[illegible]	[illegible]	[illegible]	[illegible]	28.0	-0.3
"	[illegible]	[illegible]	[illegible]	28.5	-0.3
"	29	Yellow fin	134	39.5	-0.3
"	30	"	125	33.9	-0.2
"	31	"	127	38.5	-0.3
"	32	"	130	38.0	-0.3
"	33	"	133	41.0	-0.2
"	34	"	125	37.6	-0.2
"	35	"	138	42.6	-0.2
18	37	"	136	45.3	0.2
"	38	"	128	30.0	-0.3
"	39	Albacore	92	17.3	-0.3
"	40	Yellow fin	145	56.6	-0.2
"	41	"	130	40.0	-0.1
"	42	"	133	44.6	-0.2
"	43	"	136	46.5	-0.3
"	44	Albacore	97	19.0	-0.4
"	45	Yellow fin	121	47.0	-0.3
23	46	"	132	40.0	0.5
25	47	Skipjack	71	7.8	0.4
"	48	Marlin	201	68.4	-0.2
"	49	Skipjack	75	9.5	-0.1
"	50	Yellow fin	141	50.0	-0.1
29	51	"	137	50.4	0.0
"	52	"	147	54.0	0.1
"	53	"	147	53.3	0.0

Radiochemical Analyses of Tuna Fish

*Tamiya ASARI, Morito CHIBA,
Tadashi ARIKI and
Toshiaki YOSHINAGA

ABSTRACT

Radioactive ^{90}Sr, ^{137}Cs, ^{60}Co, ^{65}Zn and total rare earth elements in tuna fish caught by the ship "Shoyo Maru" were analysed. The analytical procedure applied and results of analyses are given in tables. The level of radioactivity of tuna fish examined is low, but the higher activity found in organs suggest their intake of planktons which may contaminated by radioactive substance.

Radioactive nuclides were determined in muscles and organs of 8 tuna fish caught by the ship "Shoyo Maru", which was despatched to survey the radioactivity of the middle Pacific Ocean in 1962.

1. Preparation of samples

(a) The internal organs including the contents of the stomach and intestines were coaked and then ashed in an electric furnace at 400 - 500°C.

(b) The Skins were removed to eliminate the possibilities of the external contamination of the samples, then muscles were coaked and ashed in the same manner as the organs.

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* Japan Analytical Chemistry Research Institute

Tuna Fish

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^{60}Co , ^{65}Zn
tuna fish
were analysed.
and results
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Method of Analysis

The Analytical procedure for radioactive Cs, Sr, Zn and total rare earth elements is described in Diagram 1. With regard to muscles only ^{90}Sr and Cs were dtermined by this procedure.

Diagrame 1.
Determination of Radioactive nuclides in tuna fish

10-15 g of ashed sample

↓ Add 20mg each of Cs^{+}, Ce^{3+}, Co^{2+}, Zn^{2+} and Cu^{2+} as carriers. Leach with aqua regia. Repeat the extraction.

Filtrate

↓ Heat to dryness to expel oxides of nitrogen, dissolve in dil. HCl and saturate with H_2S.

Filt

↓ Boil to drive off H_2S, add Br_2 water, add excessive Na_2CO_3, warm and filter under suction. Dissolve the ppt in HCl and repeat the pptn. procedure.

Filt

↓ Acidify with HNO_3, and add ammonium phosphomolybdate

Ppt → Filt

↓ Dissolve in NaOH soln., add KCl as the carrier then add sodium dipicrylamminate.

Ppt → Filt

↓ Dissolve in methylisobutylketone, extract with dil HCl soln., add H_2PtCl_6 to the HCl layer.

Ppt → Filt

Heat to dryness and weigh as Cs_2PtCl_6.

*

Ppt

Dissolve in dil HCl, add oxalic acid and then neutralize with NH_4OH using bromcresol green as the indicator. Repeat the pptn.

Ppt (Ce, Sr and Ca)

Ash and dissolve in soln. of HNO_3 containing H_2O_2. Add NH_4Cl and NH_4OH.

Ppt

Dissolve in soln. of dil HNO_3 containing H_2O_2. Reduce the acidity to applximately pH_3 by adding NH_4OH, then add exalicacid.

Ppt

Ignite and weigh as total rare earth oxides

Filt

Add oxalic acid to ppt. Ca and Sr, filter and ash the pptn. Dissolve the oxides in HNO_3 evaporate to dryness, dissolve in water, add fuming HNO_3 (final HNO_3 SG 1.45). Dissolve the pptn. in water, add Na_2CrO_4 to remove Ba and Ra, add fuming HNO_3 to the filt.

Ppt

Heat to dryness and weigh as $Sr(NO_3)_2$.

Filt

Filt

Add tartaric acid, render alkaline with NH_4OH, satulate with H_2S.

Ppt (Zn, Co, Fe)

Dissolve in a mixture of H_2SO_4 and HNO_3, add NH_4Cl and NH_4OH. Repeat the pptn.

Ppt

Fe

Filt

Acidify by adding HCOOH and satulate with H_2S. Repeat the pptn.

Ppt

Ignite and weigh as ZnO

Filt

Boil to expel H_2S, oxidize CO by adding Br_2 water, add α-nitroso-β naphtole.

Ppt

Ignite and weigh as Co_3O_4.

Filt

able or natural potassium, strontium, and zinc were so analyzed to determine the relative accumulation of radioactive nuclides. Potassium was determined flamephotometrically using a hydrochloric solution of the ashed sample. Strontium was also analyzed flamephotometrically using a hydrochloric acid solution of the ignited oxalate precipitate obtained by the usual method. For the zinc determination a hydrochloric acid solution of the ashed samples were extracted with carbontetrachloride solution of dithyzone and spectrophotometrically measured.

3. Methods of measuring radioactivity

^{90}Sr, ^{137}Cs and total radioactive rare earth elements were determined by measurement of activities using a low background 2π-gas flow counter. The amount of total radioactive rare earths was calculated taking ^{137}Cs as the standard. ^{60}Co and ^{65}Zn were determined by the RCL-128 channel γ ray spectrometer (crystal, 1 3/4" ϕ x 2") using 1.27 Mev γ ray emmited from ^{22}Na as the standard.

4. Results of analysis

Results of all determinations are shown in Table 1 and 2.

Table 1. Concentrations of Radioactive Nuclids in Organs.

Sample No.	10	15	17	19	2
Station No.	12	14	14	14	1
Sampling date	8.16	8.17	8.17	8.17	8
Quantity (Weight) ashed(kg)	1.000	1.663	1.430	1.725	1
Ash (%)	2.48	1.26	1.50	1.89	1
Ca % (Wet Sample)	0.041	0.017	0.053	0.088	(
Sr ppm (Wet Sample)	2.7	1.3	4.0	7.2	7
^{90}Sr $\mu\mu$c/g of Ca	3.1±0.6	1.8±0.8	2.1±0.4	0.4±0.1	(
^{90}Sr $\mu\mu$c/mg of Sr	0.5±0.10	0.2±0.10	0.3±0.06	0.1±0.02	(
^{90}Sr $\mu\mu$c/kg of Sample	1.3±0.3	0.3±0.1	1.1±0.2	0.8±0.2	(
K % (Wet Sample)	0.359	0.248	0.219	0.181	(
^{137}Cs $\mu\mu$c/g of K	4.6±0.5	3.3±0.4	5.3±0.5	5.0±0.5	
^{137}Cs $\mu\mu$c/kg of Sample	16.7±1.6	8.2±0.9	11.6±1.1	9.0±0.9	
Total rare earth $\mu\mu$c/kg of Sample	1.32±1.2	5.3±0.5	26.7±1.3	11.6±0.7 103	
^{60}Co $\mu\mu$c/kg of Sample	147	60	92	208	
^{65}Zn $\mu\mu$c/kg of Sample	357	173	276		

clids in

organs.

	17	19	20	26	27	46
	14	14	14	14	14	23
	8.17	8.17	8.17	8.17	8.17	8.21
	1.430	1.725	1.900	1.910	1.080	1.450
	1.50	1.89	1.51	1.55	1.80	1.93
	0.053	0.088	0.037	0.092	0.122	0.090
	4.0	7.2	2.6	4.5	6.7	5.4
).8	2.1±0.4	0.4±0.1	0.9±0.4	0.5±0.2	0.4±0.2	0.5±0.2
).10	0.3±0.06	0.1±0.02	0.1±0.05	0.1±0.03	0.1±0.03	0.1±0.04
).1	1.1±0.2	0.8±0.2	0.3±0.1	0.4±0.1	0.5±0.2	0.5±0.3
3	0.219	0.181	0.190	0.276	0.247	0.259
0.4	5.3±0.5	5.0±0.5	2.6±0.3	3.0±0.3	4.7±0.5	3.1±0.3
0.9	11.6±1.1	9.0±0.9	4.9±0.6	8.4±0.7	11.8±1.2	8.2±0.8
		11.6±0.7	18.6±1.0	14.5±0.8	33.0±1.8	16.9±1.2
:0.5	26.7±1.3	103	75	86	98	84
	92	208	120	155	171	146
	276					

Table 2. Concentrations of Radioactive Nuclids in Muscles.

Sample No.	10	15	17	19
Station No.	12	14	14	14
Sampling Date	8.16	8.17	8.17	8.17
Quantity(Weight) ashed(kg)	10.0	10.0	9.5	8.95
Ash (%)	1.32	1.38	1.45	1.13
Ca % (Wet Sample)	0.0059	0.0115	0.0064	0.0066
Sr ppm (Wet Sample)	0.10	0.21	0.13	0.10
^{90}Sr $\mu\mu$c/g of Ca	1.6±0.5	1.6±0.3	2.2±0.6	1.6±0.6
^{90}Sr $\mu\mu$c/mg of Sr	1.0±0.3	0.9±0.2	1.1±0.3	1.1±0.4
^{90}Sr $\mu\mu$c/kg of Sample	0.1±0.03	0.2±0.04	0.1±0.04	0.1±0.04
K % (Wet Sample)	0.385	0.401	0.395	0.340
^{137}Cs $\mu\mu$c/g of K	2.5±0.3	2.9±0.2	4.1±0.3	3.0±0.2
^{137}Cs $\mu\mu$c/kg of Sample	9.6±0.8	11.4±0.9	16.1±1.2	10.3±0.8

Muscles.

	19	20	24	27	46
	14	14	14	14	23
	8.17	8.17	8.17	8.17	8.21
	8.95	10.0	10.0	7.86	10.0
	1.13	1.33	1.12	1.27	0.98
4	0.0066	0.0081	0.0084	0.0106	0.0058
	0.10	0.13	0.12	0.18	0.15
.6	1.6±0.6	1.9±0.4	1.1±0.3	1.4±0.3	1.7±0.3
.3	1.1±0.4	1.2±0.3	0.8±0.2	0.8±0.3	0.7±0.2
.04	0.1±0.04	0.2±0.04	0.1±0.03	0.2±0.05	0.1±0.04
;	0.340	0.365	0.326	0.325	0.283
.3	3.0±0.2	3.4±0.3	3.0±0.2	2.6±0.2	2.1±0.2
1.2	10.3±0.8	12.5±0.9	9.8±0.8	8.4±0.3	6.0±0.5

of the water

5. Conclusions

It was initially intended to measure the β and γ activities of radioactive nuclides after chemical separation of the elements. As the work progressed, it became evident that modifications of usualy procedures were necessary to achive adequate separations of the elements encountered in this analysis. The procedures adopted enable recoveries of greater than 70% of the original samples to be attained. The redioactive decay pattern of the total rare earth fraction indicated the presence of essentially ^{144}Ce - ^{144}Pr, with possibly traces of other rare earth elements. The separation and determination of Ce and Pr is usually accomplished by the solvent extraction technique utilizing methyl-isobutylketone.

Although the determination of ^{95}Zr - ^{95}Nb was not carried out in this analysis, the exsistence of these nuclides in planktons indicates the necessity of establishing methods for the chemical separations and determinations of these elements. An investigation concerning the analysis of these elements is currently being conducted in this laboratory. The exsistence of ^{65}Zn and ^{60}Co in plankton through γ counting was first suggested by Dr. Tsuruga and these determinations were carried out during the process of this analysis.

Although the level of radioactivity of tuna fish examined is rather low, the results suggest their intake of other sealife may contain much higher concentrations of radioactive substances.

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On the Radioactive Substances in Various Organs of Fishes.

*Masamichi SAIKI, Taishi UEDA,
Yuzuru SUZUKI and Zenji MURAKOSHI

1. γ-ray puls hight analysis

γ-ray Spectra were observed on various organa of 19 fishes caught by the Survey Vessel "Shoyo maru".

Two peaks arised by ^{65}Zn(0.51 and 1.12 Me V.) were detected in almost all of organs, with a peak of natural ^{40}K(1.46 Me V.).

In the gill, intestine and stomach contents, a peak of ^{95}Zr-^{95}Nb was also found with peaks of ^{65}Zn and ^{40}K.

* National Institute of Radiological Sciences

2. Radiochemical analysis on ^{90}Sr

Table 1. Concentrations of ^{90}Sr in the Bone and the Scales with Skin.

Species	Sample No.	Bone			Scales with skin		
		μμc/kg (wet)	Ca %	S.U.	μμc/kg (wet)	Ca %	S.U.
Big-eyed tuna Parathunnus mebachi.	2	2.42 ± 0.78	37.0	0.12 ± 0.04	10.56 ± 1.60	35.9	0.33 ± 0.05
"	4	2.41 ± 0.80	37.2	0.12 ± 0.04	11.20 ± 1.60	36.5	0.35 ± 0.05
"	5	1.82 ± 0.42	37.4	0.09 ± 0.02	12.24 ± 2.07	34.4	0.39 ± 0.07
"	6				18.54 ± 1.44	36.0	0.58 ± 0.05
"	22	3.80 ± 0.61	40.3	0.18 ± 0.03	17.60 ± 1.92	32.8	0.55 ± 0.06
"	25	1.62 ± 0.20	35.5	0.08 ± 0.01	19.08 ± 2.16	36.0	0.53 ± 0.06
"	28				9.36 ± 1.17	35.1	0.29 ± 0.04
Yellow-fin tuna Neothunnus macropterus	7	6.27 ± 0.81	38.1	0.32 ± 0.04	11.97 ± 1.77	36.0	0.37 ± 0.04
"	11				16.32 ± 1.92	30.5	0.51 ± 0.06
"	12	1.07 ± 0.41	39.8	0.05 ± 0.02	16.74 ± 1.53	34.5	0.54 ± 0.05
"	37	2.77 ± 0.40	38.7	0.14 ± 0.02	12.16 ± 1.60	35.5	0.38 ± 0.05
"	50	4.04 ± 0.82	38.1	0.20 ± 0.04		36.0	
"	51	2.63 ± 0.80	37.0	0.13 ± 0.04	15.36 ± 2.24	34.8	0.48 ± 0.07
"	52	3.43 ± 0.81	36.0	0.17 ± 0.04	16.00 ± 2.56	35.2	0.50 ± 0.08
Albacor Thunnus alalunga	39	1.95 ± 0.41	38.0	0.10 ± 0.02	13.44 ± 1.92	37.2	0.42 ± 0.06
"	44	5.45 ± 0.20	36.2	0.27 ± 0.01		38.4	
Bonito Katsuwonus peramis	47	4.85 ± 0.83	37.5	0.24 ± 0.04			
Blue marlin Makaira mazara	48	9.54 ± 0.86	38.4	0.43 ± 0.04		34.2	

3. Radiochemical analysis

Table 2. Concentrations of on ^{137}Cs

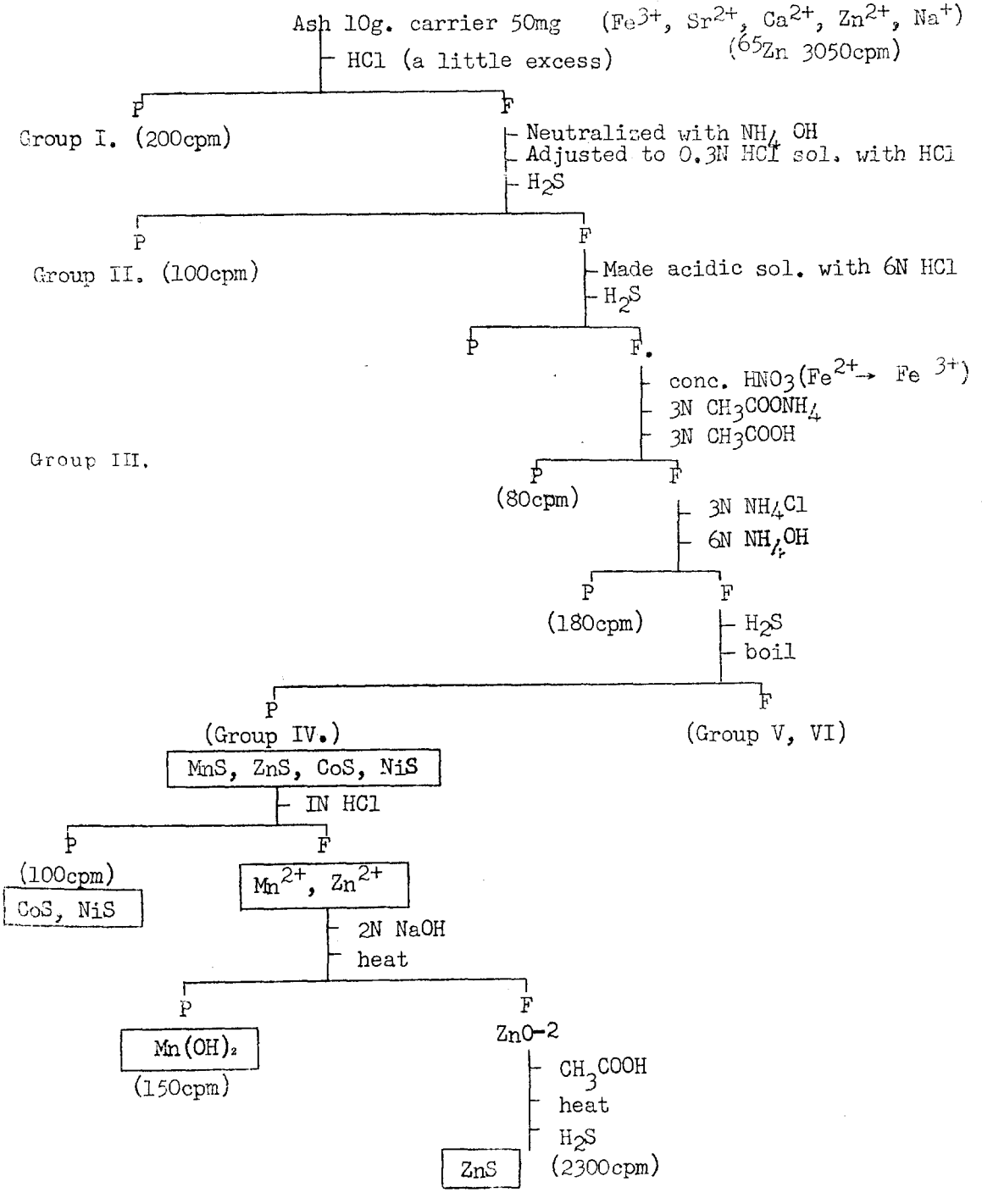
^{137}Cs in the Muscle

Species	Sample No.	Ash %	^{137}Cs $\mu\mu c/kg$ of wet Sample	K % (Wet Sample)	^{137}Cs $\mu\mu c/g$ of K
Big-eyed tuna Parathunnus mebachi	2	1.32	22.5 ± 1.7	0.397	7.1 ± 0.4
"	4	1.07	12.5 ± 1.0	0.337	3.7 ± 0.3
"	5	1.18	6.6 ± 0.9	0.359	2.2 ± 0.3
"	22	1.12	14.3 ± 1.5	0.315	5.1 ± 0.5
Yellow-fin tuna Neothunnus macropterus	7	1.20	11.1 ± 0.9	0.364	3.1 ± 0.3
"	11	1.43	19.4 ± 1.9	0.469	4.2 ± 0.4
"	12	1.22	16.5 ± 1.5	0.382	5.3 ± 0.4
"	37	1.23	8.1 ± 1.1	0.358	2.3 ± 0.3
"	50	1.10	16.2 ± 1.3	0.364	4.9 ± 0.4
"	51	1.21	11.7 ± 1.3	0.377	3.6 ± 0.4
"	52	1.09	8.5 ± 0.7	0.358	2.6 ± 0.2
Albacor Thunnus alalunga	44	1.13	6.1 ± 0.9	0.350	2.0 ± 0.3
Blue marlin Makaira mazara	48	1.17	9.9 ± 1.1	0.343	3.4 ± 0.3

4. Identification of ^{65}Zn

^{65}Zn was isolated in Chemical analysis (Fig. 1.) and identified with the gama-ray analysis.

Fig. 1. Chemical Separation of Zn



ERRATA

Page	Line	"from"	"read"
1	10	30 m^3/min.	30 ℓ/min.
2	5	29, Jul. 23.35	29, Jul. 23.40
2	6	30, 20.00	30, 23.35
13	25	and the background count 12 cpm when	and 12 cpm of background was counted when
13	26	by 5 cm of lead.	with a lead of 5 cm thick.
13	32	latitude are shown	latitude is shown
13	37	no difference	no remarkable difference
13	40	Safety Board Agency	Safety Agency
14	1	is affected	is probable difference
14	2	affected by atmospheric phenomena	related to meteorological condition
14	6	precipitation is large	precipitation was large
14	11	cpm/ℓ dpm/ℓ	cpm/ℓ μμc/ℓ
15	2	cpm/ℓ dpm/ℓ	cpm/ℓ μμc/ℓ
16		Fig. 1.	Fig. 2. Relation between gross β-activity of surface water and location represented by latitude.
17		Fig. 1.	Fig. 1. Horizontal distribution of gross β-activity of surface water.
19	7	in the water	of the water

Page	Line	"from"	"read"
19	9	90Sr, 137Cs and 144Ce.	^{90}Sr, ^{137}Cs and ^{144}Ce.
19	11	After sea	After the sea
19	12	elements and rare	elements and the rare
19	28	1mg	1 mg
19	34	by 4 π	by a 4 π
19	35	Safety Board Agency	Safety Agency
20	3	20 liters	20 liter
20	4	rate	rare
20	13	perioxide,	peroxide,
20	22	givenin	given in
20	30	the temperature range of the thermocline is from 15^0 to 25^0 C.	the thermocline lies between 15^0 C isotherm and 25^0 C.
20	31	temperature boundaries are	tow boundary layers of tem temperature are
21	3	tends to increase from	became clear from
21	10	at Station 39, at the 150 m level is abnormally large,	at Station 39 is abnormally large at the 150 m level,
21	11	^{137}Cs at same	^{137}Cs at the same

ERRATA

Page	Line	"from"	"read"
21	12	This may be, parhaps, due to	This may be, due to
21	15	that the relation	that there is positive correlation
21	16	radioactivity	concentration
21	16	oxygen is exhibited as linear function.	oxygen is exhibited as nearly linear.
21	19	mixing action	mixing processes
21	24	linear relationship	correlation
21	26	unstability	instability
21	28	^{144}Ce to ^{90}Sr	The ratio of ^{144}Ce to ^{90}Sr
21	31	those of below	those below
21	32	^{144}Ce absorbs to a	^{144}Ce is absorbed into
21	33	suffers the effect of mixing	is affected by the mixing
21	34	allowing ^{144}Ce to reach a	consequently, ^{144}Ce reaches
25		Fig. 2.	Fig. 2. Relation between ^{137}Cs concentration of sea water collected from 3 layers and location represented by latitude.
26		Fig. 3.	Fig. 3. Relation between ^{90}Sr concentration of sea water collected from 3 layers and location represented by latitude.

Page	Line	"from"	"read"
27		Fig. 4.	Fig. 4. Relation between ^{144}Ce concentration of sea water collected from 3 layers and location represented by latitude.
29		Fig. 6.	———South Equatorial Current -----Equatorial Counter Current -·-·-North Equatorial Current
33	29	RCL 218	RCL 128
37	2	Sea water samples for chemical analysis and water temperature measurements were collected by	The sampling of the sea water for chemical analysis and the temperature measurements were carried out by using
37	11	The amount found in the sea water was determined by the Winkler method.	Determined by the Winkler method.
37	13	tritation	titration
37	19	Temperature measurements	Results of temerature measurement
37	21	distribution of sea water temperature	distribution of temperature
37	29	Safety Board Agency	Safety Agency
38	5	172-41.2'E 4.76	172-41.2'E 4.74

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Page	Line	"from"	"read"
38	6	4.26	4.62
38	8	4 4Aug62 30-50.6'N	4 4Aug62 30-50.6'N 178-00.0'W
38	18	163-53.0'W 150 280	163-53.0'W 150 290
39	10	22	23
40	8	8.00 24.62	8.00 24.69
40	12	7.65 26.90	7.65 27.90
41		Fig. 1. , Fig. 2. seawater temperatures	Fig. 1. , Fig. 2. sea water temperature
42		Fig. 3. , Fig. 4. seawater temperatures	Fig. 3. , Fig. 4. sea-water temperature
47		Fig. 10. Sectional distribution of chlonity.	Fig. 10. Sectional distribution of chlorinity.
49	15	samples	sample
49	23	-radioactivity measured	β-radioactivity was measured
50	32	nuclides,	nuclide,
52	10	Copepoda,	Copepoda (20%),
57	15	56.6	56.5
59	9	CO^{2+}	Co^{2+}
60	15	applixiately pH_3	approximately pH 3
60	18	exalicacid.	exalic acid.

Page	Line	"from"	"read"
60	20	CO	Co
61	4	hydrochloric solution	hydrochloric acid solution
66	5	usualy	usual
67	5	puls hight	pulse height
67	6	organa	organs
67	8	Me V.	MeV.
67	10	Me V.	MeV.
68	24	Bonito Katsuwonus peramis	Bonito Katsuwonus pelamis
73	3	gama-ray	gamma-ray
73	9	HCl sol.	HCl soln.
73	11	Made acidic sol.	Made acidic soln.
73	26	IN HCl	1 N HCl
11	8	Enginers room	Engineers room