

RDC-2

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 cm ϕ), every 24 hours. Suction volume of the sampler was approximately 30 l^m/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/cm² thick) and the samples was approximately 1 cm. The counting efficiency, calibrated with ⁹⁵Zr-⁹⁵Nb, 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 cm² 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.

* National Institute of Radiological Sciences

Table. 1

Gross β -activity in Air

| Date | Suction | | Activity cpm/m ³ | $\mu\text{c}/\text{m}^3$ | Weather |
|----------|------------------|-----------------------------|--------------------------------|--------------------------|---------------------|
| | Time Hrs.Mins | Volume (M ³) | | | |
| 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 | Latitude | Longitude | Rainfall (mm) | Activity (cpm/ml) | Activity ($\mu\text{Ci/ml}$) |
|---------------|------------|-------------|-----------|---------------|-------------------|--------------------------------|
| 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 |
| 9, | 33°-17.0 N | 165°-40.0 E | | 1.2 | 0.20±0.01 | 1.42±0.09 |
| 11, | 34°+33.0 N | 156°-00.0 E | | 0.5 | 0.28±0.01 | 1.99±0.07 |
| 13, | 34°-42.0 N | 151°-42.8 E | | 0.5 | 0.67±0.02 | 4.80±0.15 |
| 14, | 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) |
|------------|---------------------|--------------|------------------------------|
| 1 | 29°37'N 174°55'W | 4 Aug. '62 | 3.0 |
| 2 | 14°12'N | 14 Aug. '62 | 3.3 |
| | 161°57.5'W | 16 Aug. '62 | 50 |
| | 08°03.7'N | " | " |
| | 164°50.5'W | " | " |
| 3 | 07°09.7'N | 17 Aug. '62 | 17.5 |
| | 164°08.5'W | " | " |
| | 08°00'N | 26 Aug. '62 | 7.7 |
| | 157°00'W | " | " |
| 3 | " | 30 Aug. '62 | 2.3 |
| | " | 3 Sept. '62 | |
| 4 | 31°06'N 176°53'E | 10 Sept. '62 | 100 |

| Sample volume (ml) | ^{90}Sr $\mu\text{uc}/\text{m}^2$ | ^{89}Sr $\mu\text{uc}/\ell$ | ^{137}Cs | $^{89}\text{Sr}/^{90}\text{Sr}$ | $^{137}\text{Cs}/\%$ |
|--------------------|--|--------------------------------------|-------------------|---------------------------------|----------------------|
| 350 | 30 | 10 | - | - | |
| 360 | 106 | 1.5 | 30.6 | 20 | |
| 880 | | | | | |
| 200 | | | | | |
| 570 | | | | | |
| 460 | 232 | 23.2 | - | - | |
| 240 | | | | | |
| 330 | | | | | |
| 410 | 240 | 2.4 | 50.5 | 21 | |
| 1780 | | | | | |

Measurement of Environmental Radiation and Exposure Dose

*Masaharu OKANO

The main objectives of measuring environmental radiation was to keep the ships personnel from undue 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 μ r/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 μ r/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.

* Institute of Physical and Chemical Research

Table 1. γ -radiation on the survey vessel

| Measurement sites | Counting rate (cpm)(1.5"x1.5" Nal(Tl)) | Survey meter reading(μ r/hr) | Exposure dose (μ r/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 investigation

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

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 |

| meter g(μ r/hr) | Exposure dose (μ r/hr) |
|-------------------------|-----------------------------------|
| 5 | |
| 5 | |
| | 0.8 |
| | |
| | 1.1 |
| | 0.0 |
| | |
| | |
| | 1.4 |
| | |
| | 1.3 |

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 12 liter portion of the acidified sea water was transferred to a 3 liter glass beaker, then 10 mg of Fe³⁺ and 10 mg of Ba²⁺ 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/cm² 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 | 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 |

material in the
 ic phenomena.
 Counter Current
 he Equatorial
 e climatic
 is large in
 sts.

| Sampling Date | Station No. | Location | Activity | |
|---------------|-------------|----------------------|----------|---------|
| | | | cpm/l | 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 |

Sea Water
 lulu

| Activity | |
|----------|---------|
| cpm/l | dpm/l |
| 0.3±0.3 | 0.4±0.4 |
| 0.2±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 |
| 0.3±0.3 | 0.4±0.4 |
| 1.0±0.3 | 1.2±0.4 |
| 0.3±0.3 | 0.4±0.4 |
| 0.9±0.3 | 1.2±0.4 |
| 0.8±0.3 | 1.2±0.4 |
| 0.6±0.3 | 0.8±0.4 |
| 0.4±0.3 | 0.6±0.4 |
| 0.3±0.3 | 0.4±0.4 |
| 0.0±0.3 | 0.0±0.4 |
| 0.8±0.3 | 1.1±0.4 |
| 1.0±0.3 | 1.4±0.4 |
| 0.5±0.3 | 0.7±0.4 |
| 0.4±0.3 | 0.5±0.4 |
| 0.2±0.3 | 0.3±0.4 |
| 0.7±0.3 | 1.0±0.4 |
| 0.4±0.3 | 0.5±0.4 |
| 0.9±0.3 | 1.3±0.4 |
| 1.8±0.3 | 2.5±0.4 |

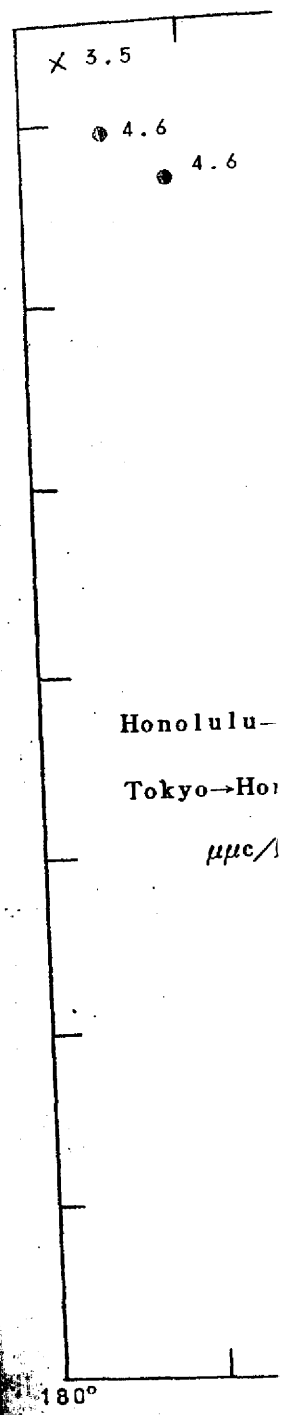
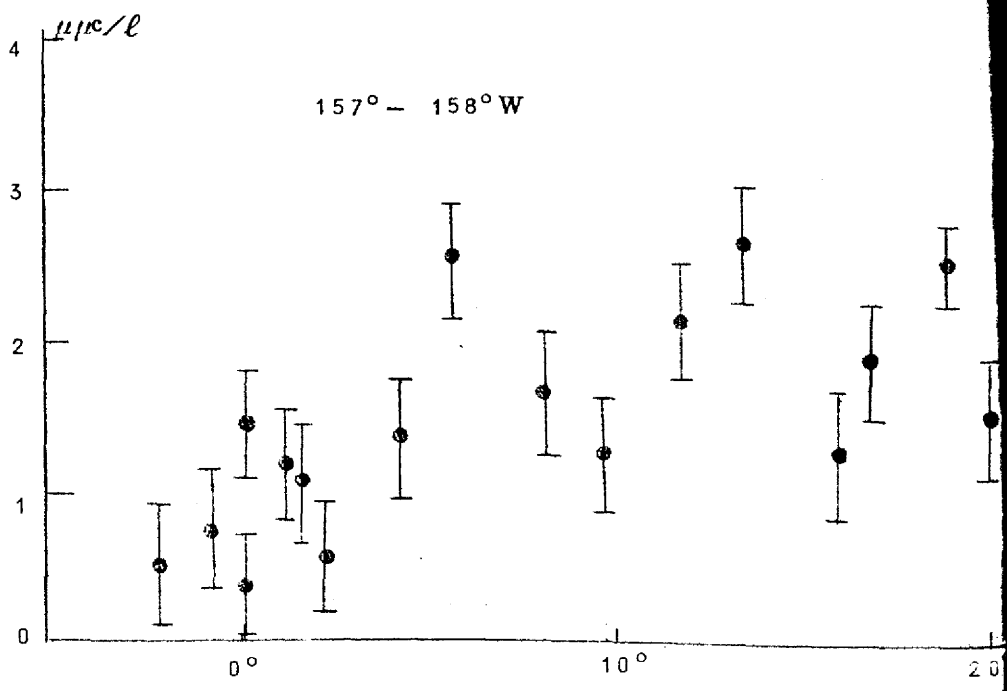
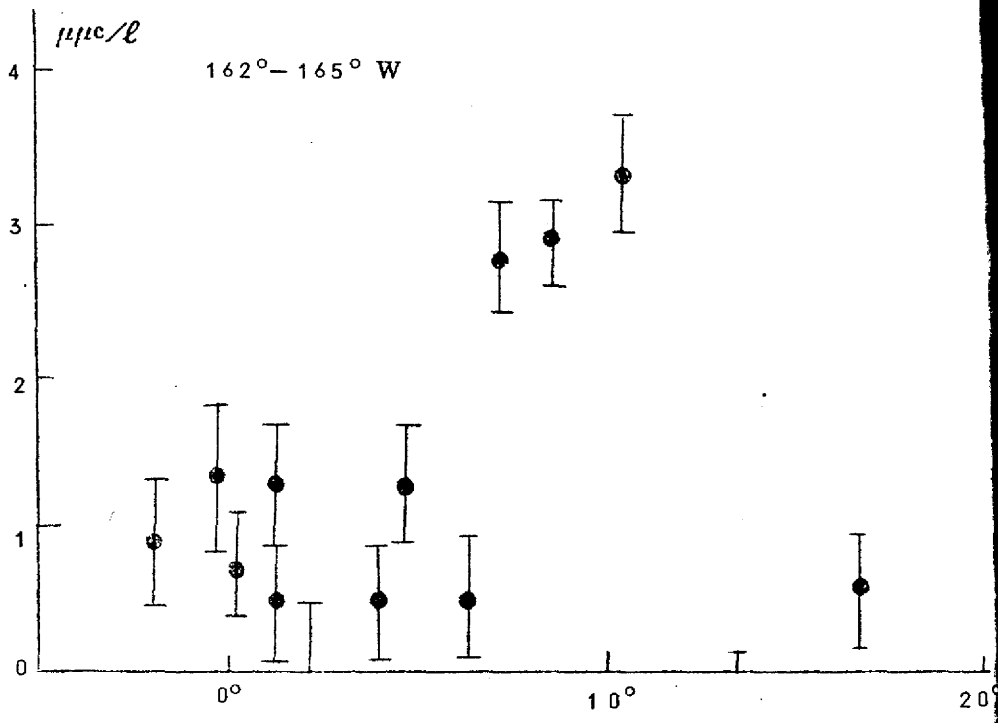


Fig. 1

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 neutralizing 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 4π 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 rare 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 peroxide, 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
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effect of biological

5. Relation between r

Fig. 7 shows the
radioactivity and dis
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of ^{90}Sr in sea water
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there is no linear re
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is due to the unstab
sea water.

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

In the South Equ
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Table 1.
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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 isotopes. 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 $^{144}\text{Ce}/^{90}\text{Sr}$ 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 ($\mu\text{c}/\ell$) | | |
|-------------|------------|-----------|------------|-----------|--------------------------------------|------------------|-------------------|
| | | | | | ^{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 | 26 Aug 62 | 0.04±0.08 | 0.09±0.01 | 0.59±0.03 |
| | 156-57.0'W | 150 | 20.3 | | | 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 ($\mu\text{c}/\ell$) | | |
|-------------|------------|-----------|------------|-----------|--------------------------------------|------------------|-------------------|
| | | | | | ^{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 |

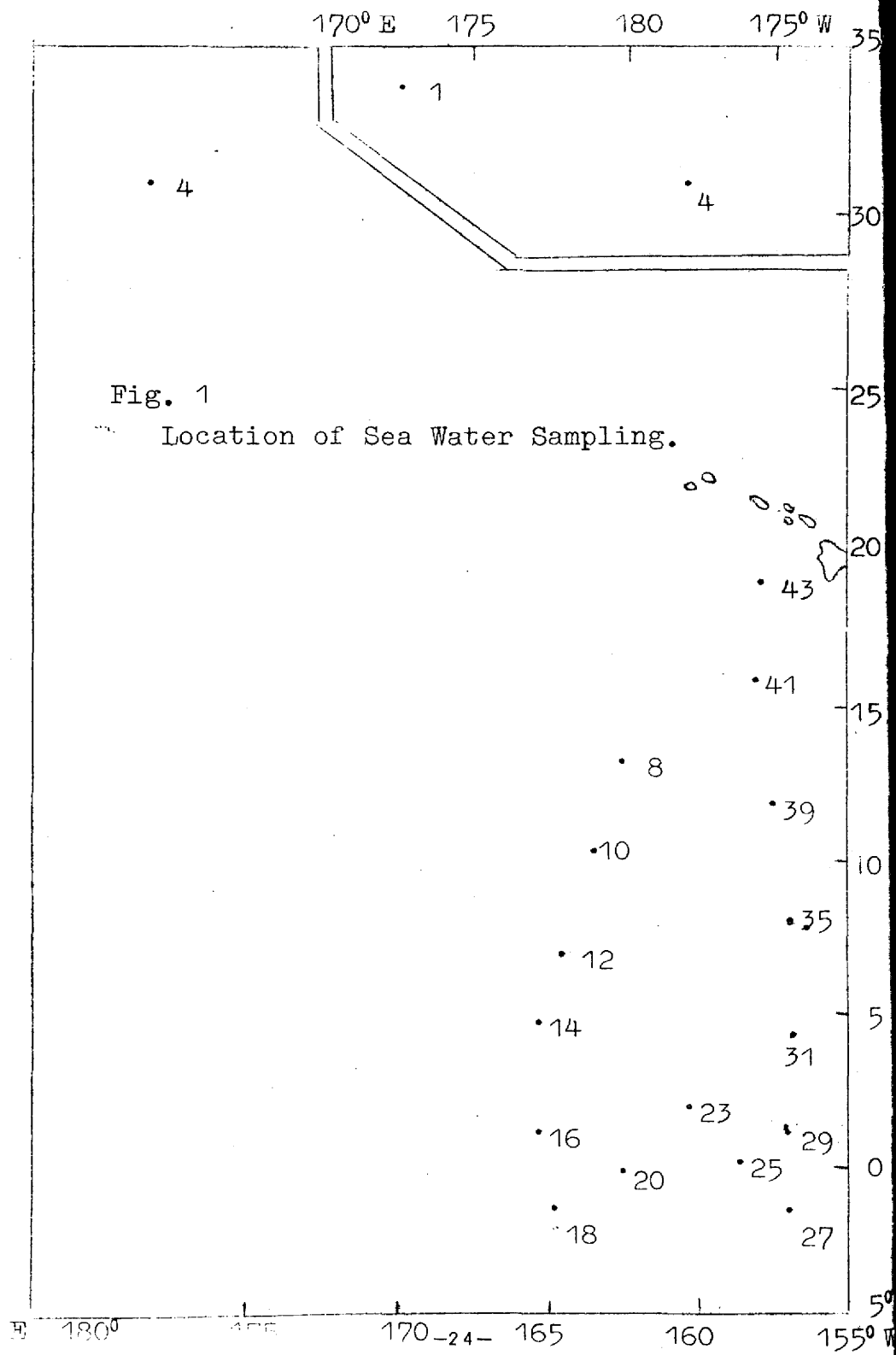
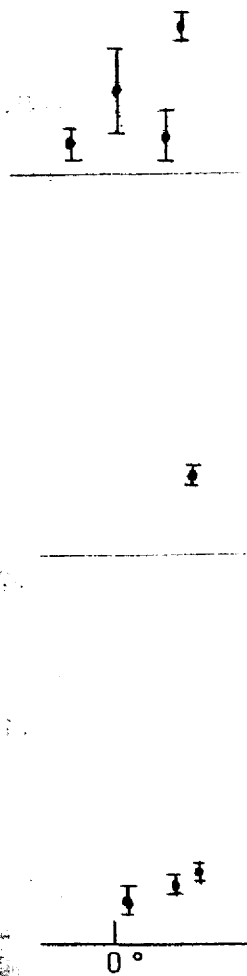


Fig. 1
Location of Sea Water Sampling.



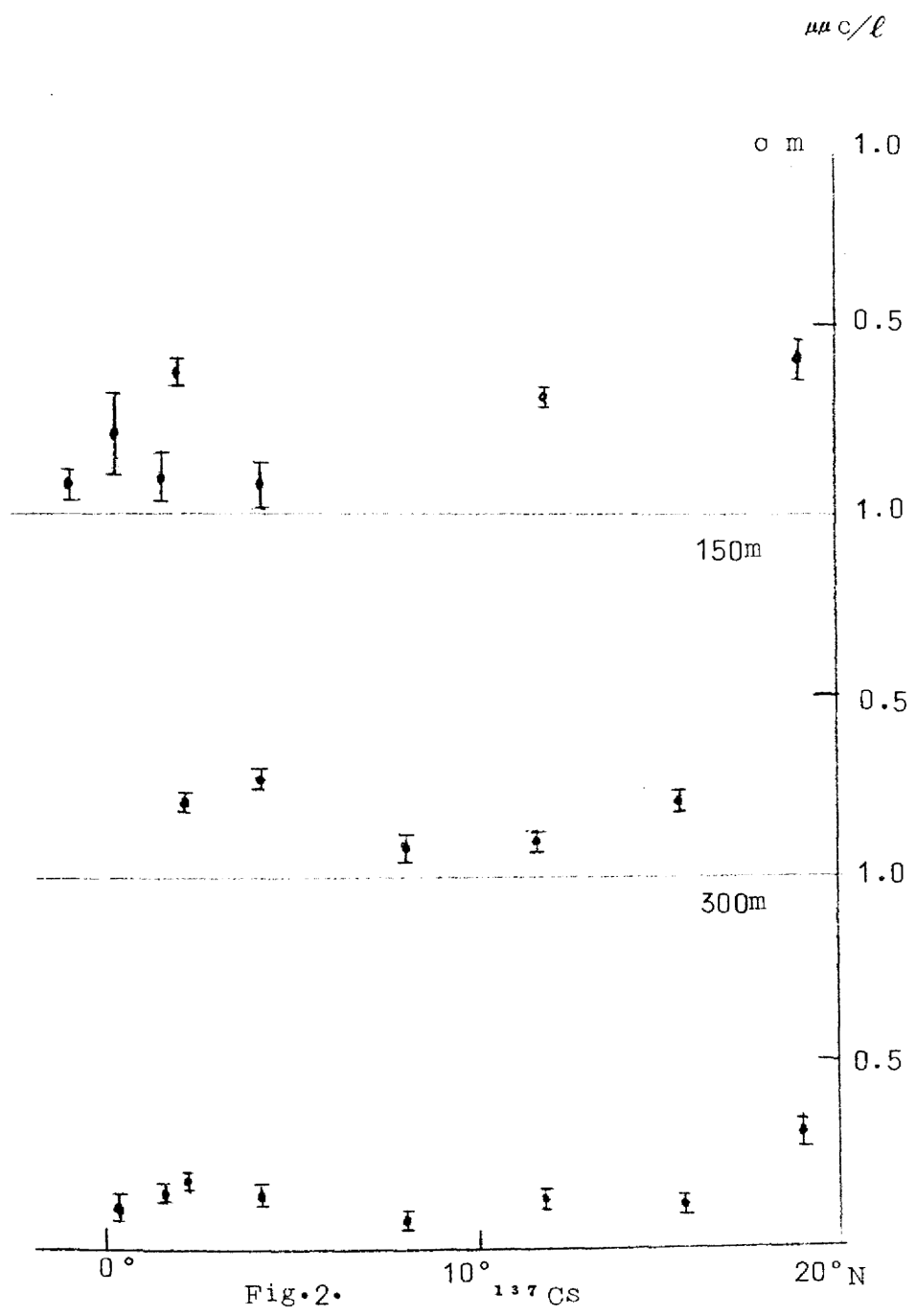
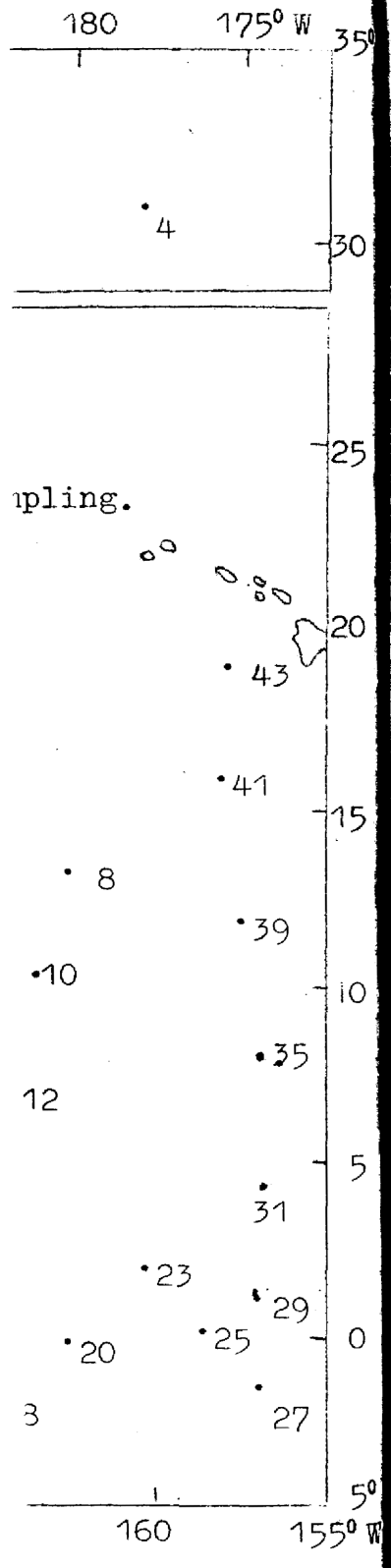


Fig. 2.

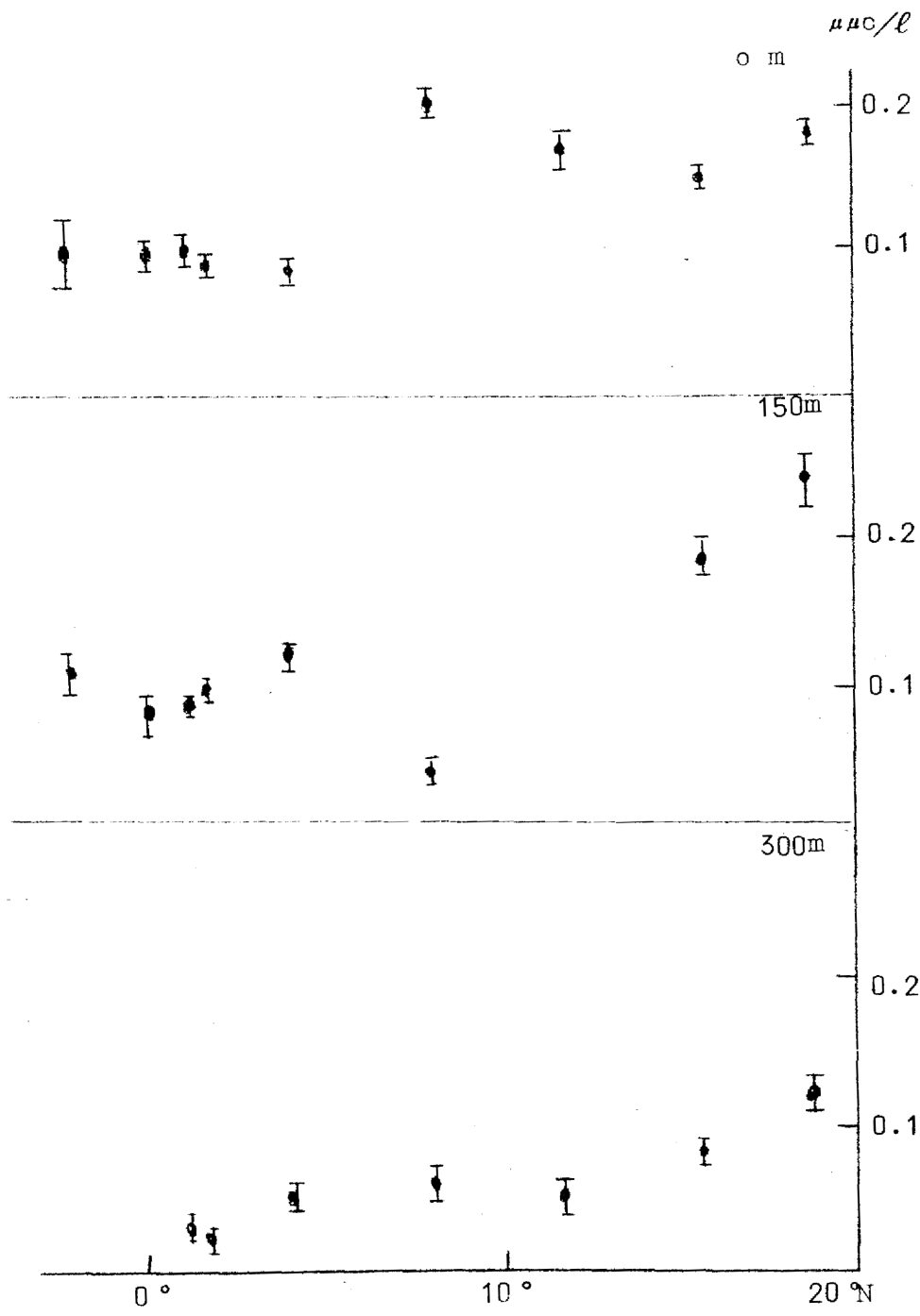


Fig.3 ^{90}Sr

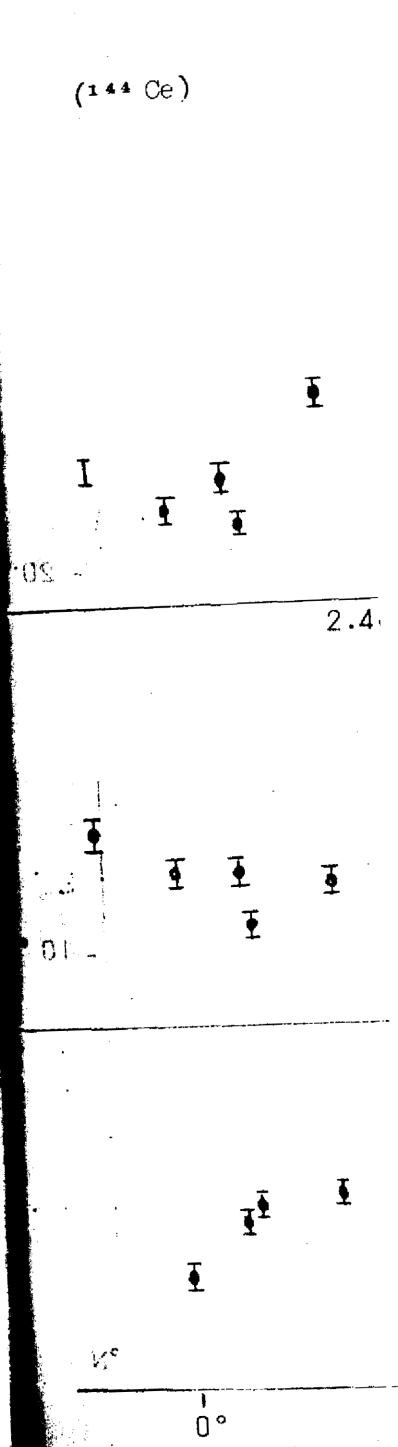


Fig.4.

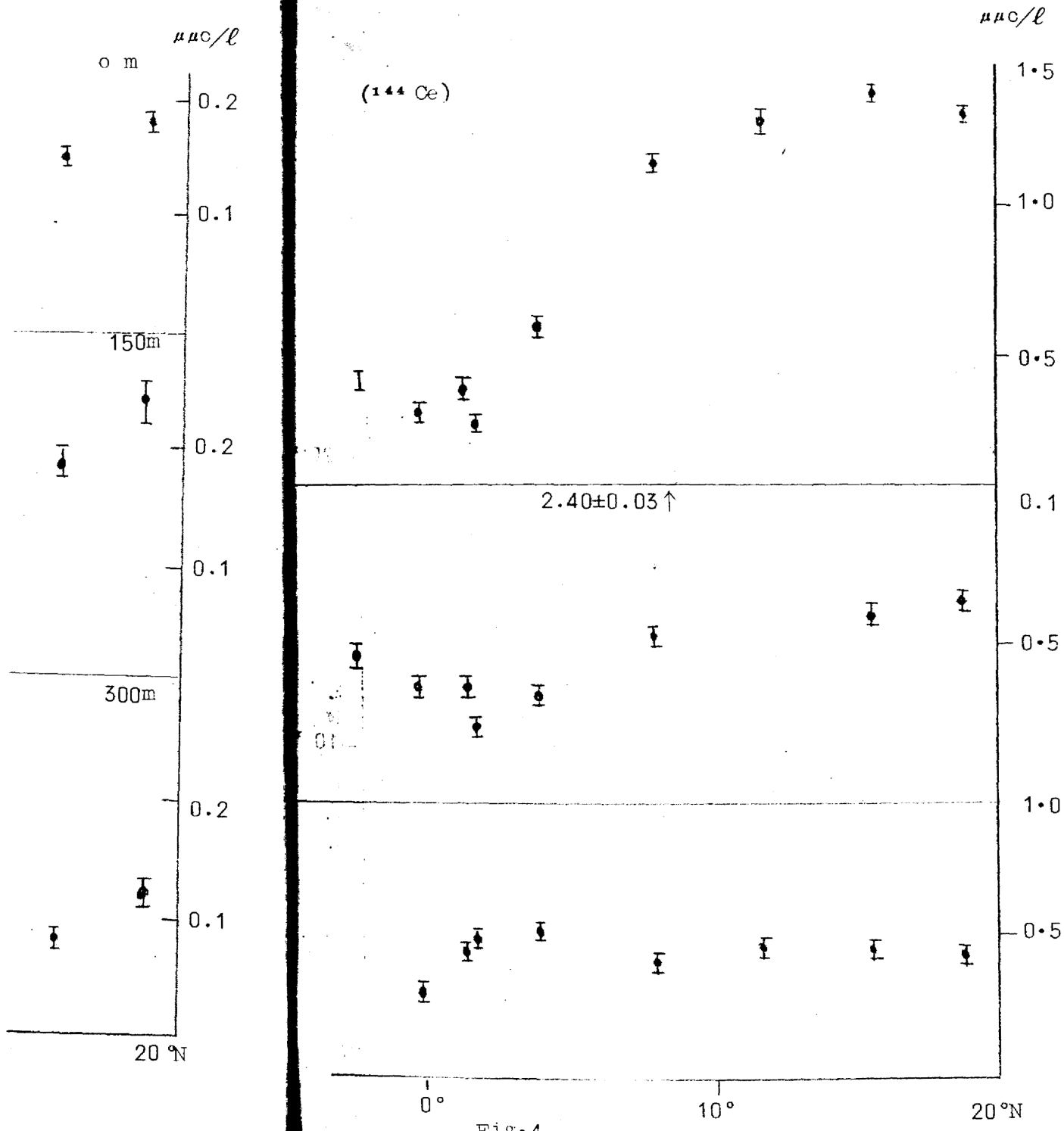


Fig.4.

$(^{144}\text{Ce}/^{88}\text{Sr})$

• Above thermocline

× Below thermocline

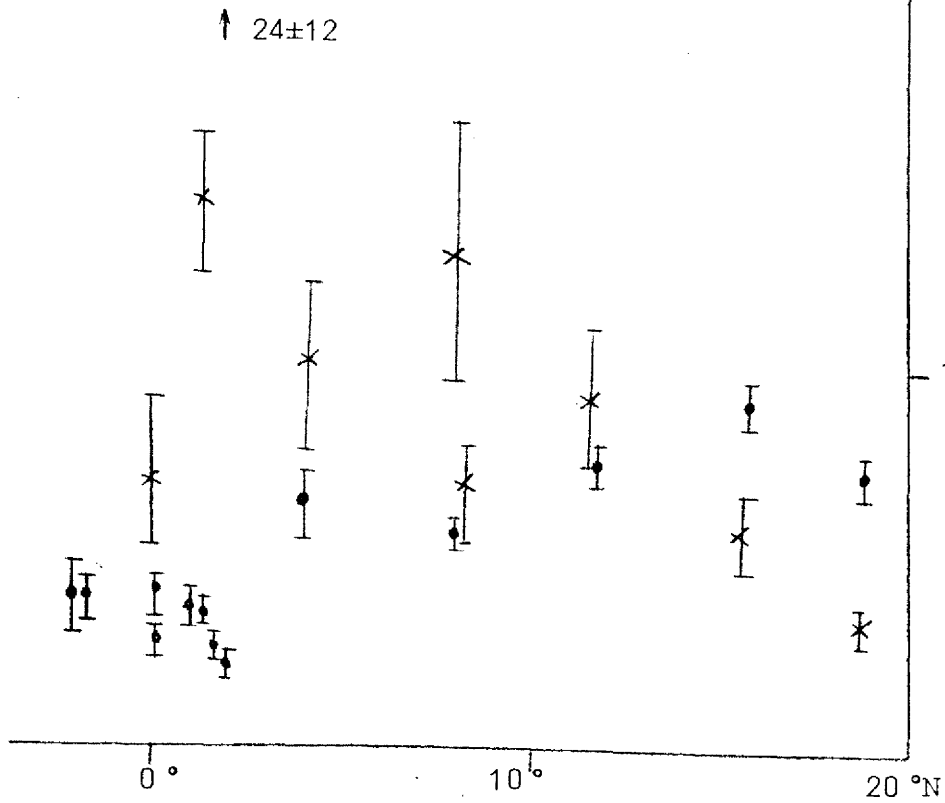
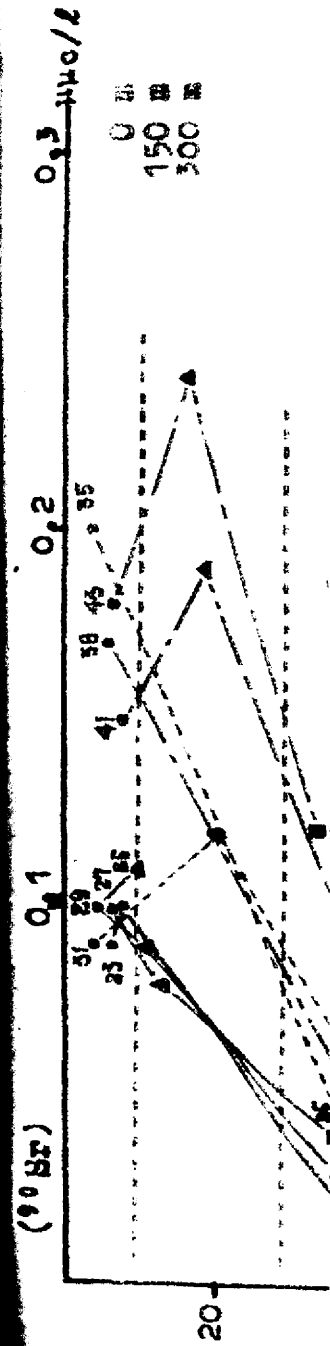


Fig. 5.



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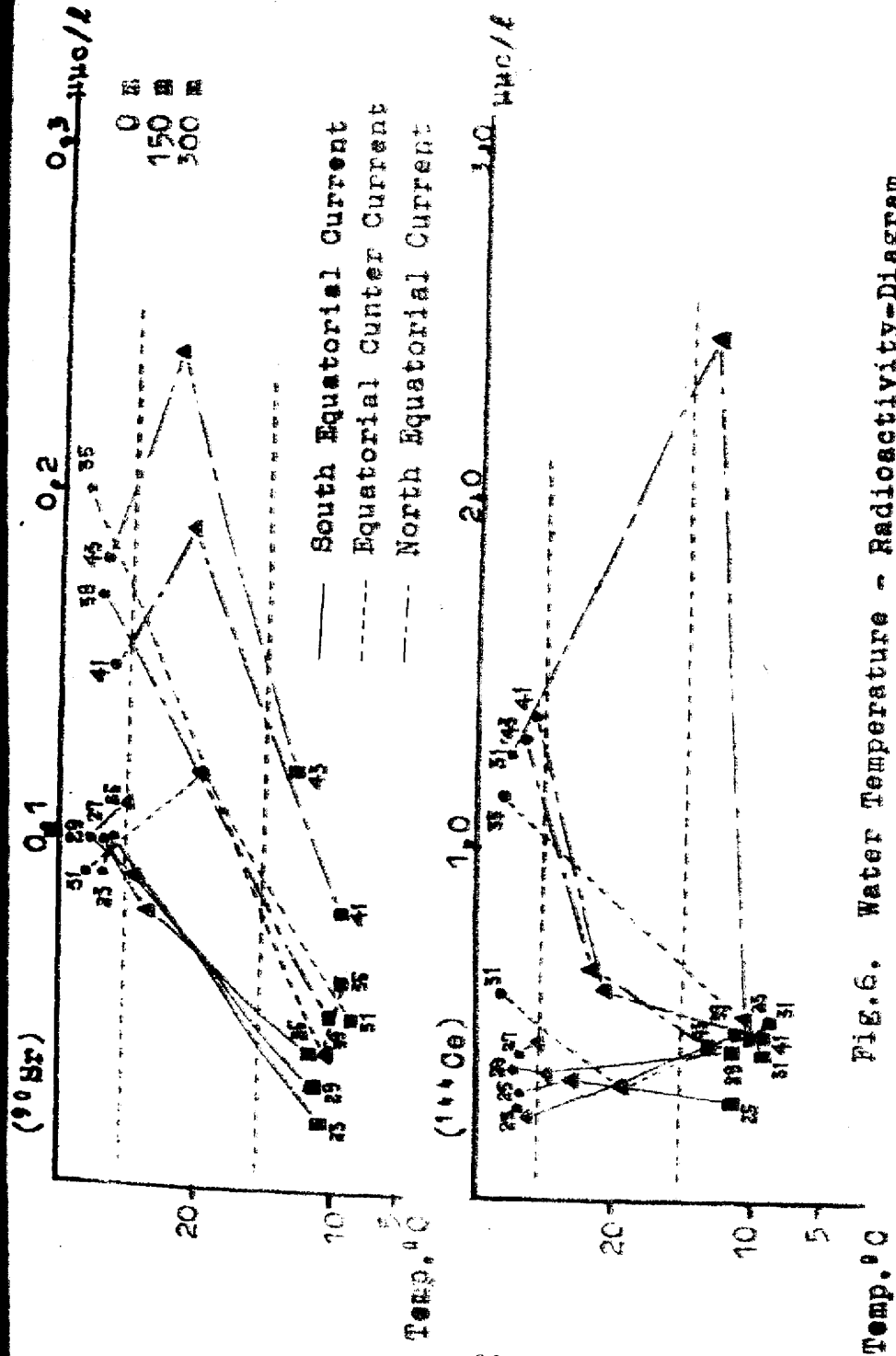
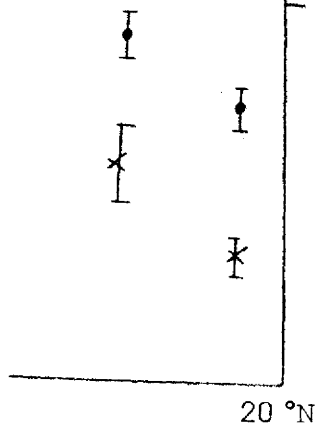


Fig. 6. Water Temperature - Radioactivity-Diagram.

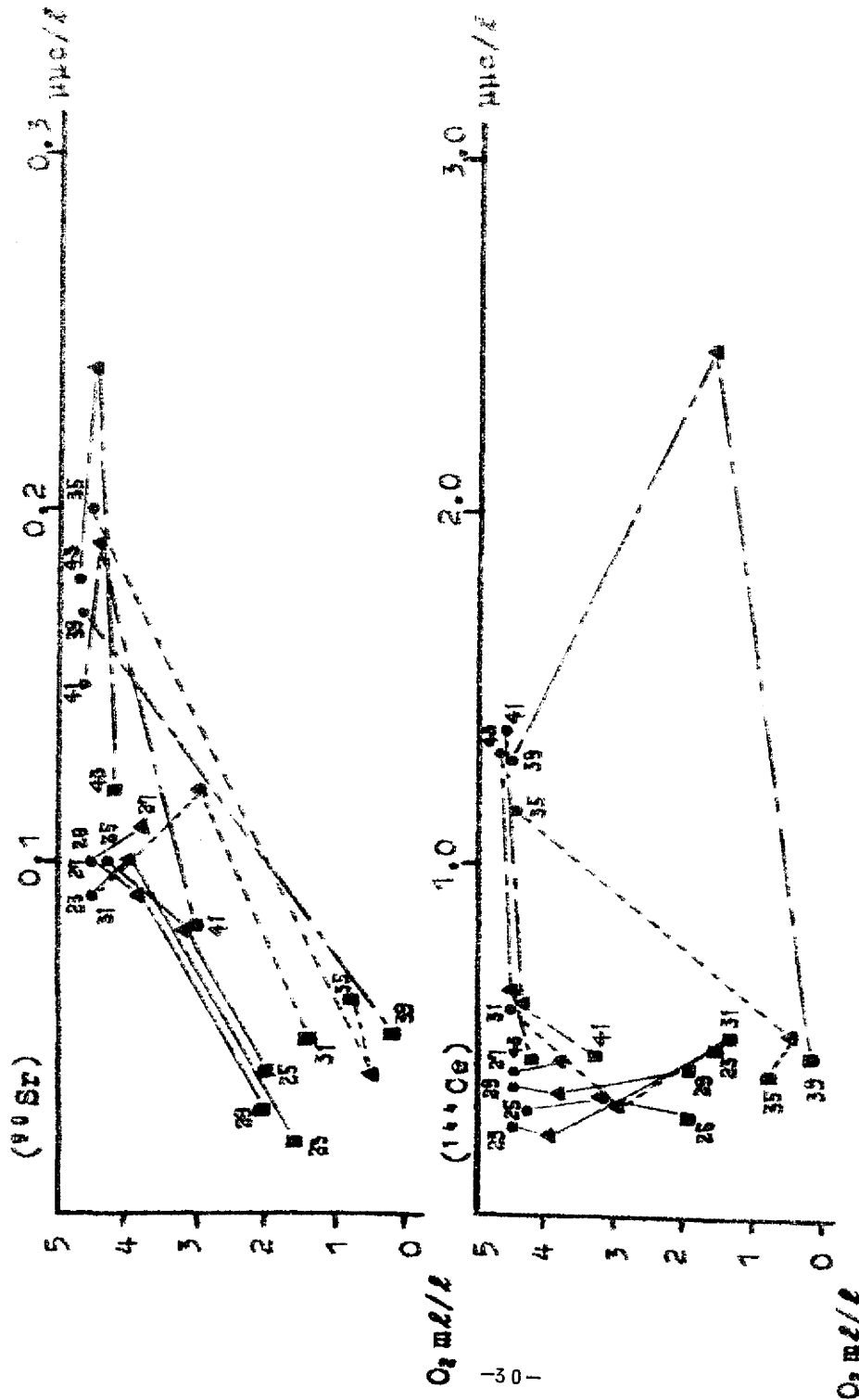


Fig. 7. Dissolved Oxygen - Radioactivity-Diagram.

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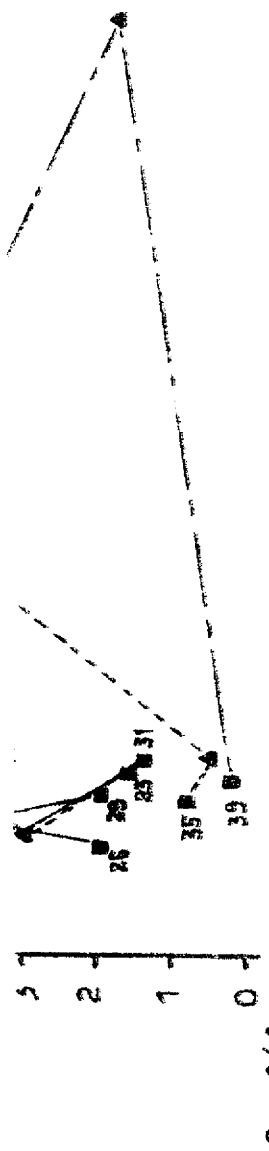


Fig. 7. Dissolved Oxygen - Radioactivity-Diagram.

Radiochemical Analysis of ⁹⁰Sr and ¹³⁷Cs 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 HNO₃ then the fuming HNO₃ method was used to separate Sr from Ca. ⁹⁰Sr was counted with a low background, windowless, gas flow counter. Nitric acid was added to the filtrate from the carbonate and ¹³⁷Cs was separated by the addition of microcrystalline ammonium molybdophosphate. ¹³⁷Cs was counted with a γ-ray spectrometer.

Meteorological Research Institute

| Station No. | Location | Date | Depth (m) | Volume (ℓ) | ^{90}Sr ($\mu\text{mc}/\ell$) | ^{137}Cs ($\mu\text{mc}/\ell$) | $^{137}\text{Cs}/^{90}\text{Sr}$ |
|-------------|----------------------|-----------|-----------|------------|--|---|----------------------------------|
| 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 -radiation
Scintillation counter

A scintillation active contamination sodium iodide crystal used as the phosphor scintillation probe radiological survey during 1956. However, equipment used during transistorized.

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

* Institute of Physics

Fig. 1. Scintillation

| | |
|--------------------------|---------------------------------|
| NaI(Tl) Phosphor Element | Photomultiplier tube (RCA 6199) |
|--------------------------|---------------------------------|

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.

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

Institute of Physical and Chemical Research

Fig. 1. Scintillation Counter Block Diagram

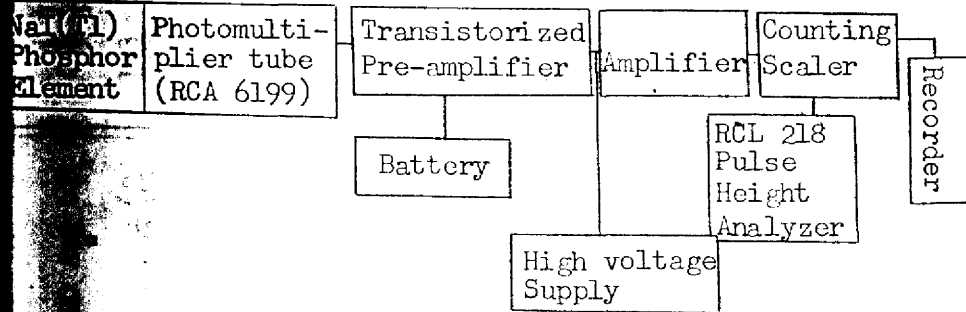


Table 1 γ -radiation in Sea Water

| Station No. | Date (JST) | Total γ -Radiation | | | | |
|-------------|------------|---------------------------|-----|-------------|-----|----------------|
| | | 300 m cable | | 200 m cable | | 15 m cable CPM |
| | | Depth(m) | CPM | Depth(m) | 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 |
| 18 | | | 208 | | 210 | 221 |
| 19 | 21 Aug 62 | 165 | 209 | | 233 | 229 |
| 20 | " | | | | | 258 |
| 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 |

-34-

(Continued from the preceding page)

| Station No. | Date (JST) | Total γ Radiation | | | | |
|-------------|------------|--------------------------|-----|-------------|-----|----------------|
| | | 300 m cable | | 200 m cable | | 15 m cable CPM |
| | | Depth(m) | CPM | Depth(m) | 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 | | | | | |

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| | | | |
| 40 | 02 Sep 62 | | |
| 47 | 10 Sep 62 | | |
| 48 | 12 Sep 62 | | |
| 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 reversible 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 titration 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. (°C) | Cl(‰) | O ₂ | | pH | σ-t |
|-------------|---------------|-------------------------|-----------|------------|-------|----------------|------|------|-------|
| | | | | | | (ml/l) | (%) | | |
| 1 | 2 Aug 62 | 33-09.5'N 172-41.2'E | 0 | 25.3 | 19.27 | 4.79 | 98.4 | 8.25 | 23.22 |
| | | | 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 Aug 62 | 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 162-28.0'W | 0 | 26.1 | 19.20 | 4.72 | 97.2 | 8.20 | 22.81 |
| | | | 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 163-53.0'W | 0 | 27.3 | 19.03 | 4.58 | 96.8 | 8.35 | 22.25 |
| | | | 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 164-08.5'W | 0 | 28.2 | 19.13 | 4.50 | 95.8 | 8.20 | 22.07 |
| | | | 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 165-24.0'W | 0 | 27.7 | 19.40 | 4.48 | 95.2 | 8.20 | 22.46 |
| | | | 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 165-09.0'W | 0 | 27.4 | 19.34 | 4.49 | 96.5 | 8.20 | 22.38 |
| | | | 118 | 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 165-00.0'W | 0 | 27.3 | 19.21 | 4.52 | 95.5 | 8.20 | 22.51 |
| | | | 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 Aug 62 | 0-00.0' 162-35.0'W | 0 | 27.0 | 19.60 | 4.33 | 91.2 | 8.20 | 23.08 |
| | | | 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 Aug 62 | 1-55.0'N 160-25.0'W | 0 | 26.6 | 19.41 | 4.47 | 93.3 | 8.20 | 22.80 |
| | | | 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 Aug 62 | 0-06.5'N 158-57.0'W | 0 | 26.3 | 19.55 | 4.30 | 89.8 | 8.15 | 23.32 |
| | | | 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 Aug 62 | 2-00.0'S 157-00.0'W | 0 | 26.7 | 19.65 | 4.51 | 94.1 | 8.15 | 23.08 |
| | | | 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 Aug 62 | 1-35.4'N 157-24.0'W | 0 | 27.1 | 19.36 | 4.54 | 95.6 | 8.15 | 22.73 |
| | | | 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 |

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(Continued from the preceding page)

| Station No. | Sampling Date | Location | Depth (m) | Temp. (°C) | Cl | O ₂ | | pH | σ-t |
|-------------|---------------|-------------------------|-----------|------------|-------|----------------|------|------|-------|
| | | | | | | (ml/l) | (%) | | |
| 29 | 25 Aug 62 | 1-35.4'N 157-24.0'W | 0 | 27.1 | 19.36 | 4.54 | 95.6 | 8.15 | 22.73 |
| | | | 107 | 24.68 | 19.39 | 3.80 | 78.2 | 8.10 | 23.39 |
| | | | 20S | 11.48 | 19.26 | 1.96 | 31.6 | 7.80 | 26.63 |
| 31 | 26 Aug 62 | 4-15.5'N 156-57.0'W | 0 | 27.9 | 19.35 | 4.49 | 96.5 | 8.20 | 22.39 |
| | | | 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 Aug 62 | 8-16.0'N 157-03.0'W | 0 | 27.8 | 18.95 | 4.54 | 96.8 | 8.30 | 21.79 |
| | | | 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 Aug 62 | 11-53.0'N 157-28.0'W | 0 | 26.8 | 18.87 | 4.57 | 95.7 | 8.20 | 22.08 |
| | | | 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 Aug 62 | 15-43.0'N 158-04.0'W | 0 | 26.0 | 19.12 | 4.59 | 94.6 | 8.20 | 22.69 |
| | | | --- | 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 Aug 62 | 18-57.0'N 157-54.0'W | 0 | 26.6 | 19.27 | 4.71 | 98.3 | 8.30 | 22.60 |
| | | | 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 |

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| | | | | | | | | | |
|----|-----------|------------|-----|-------|-------|------|------|------|-------|
| 39 | 28 Aug 62 | 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 Aug 62 | 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 Aug 62 | 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 |

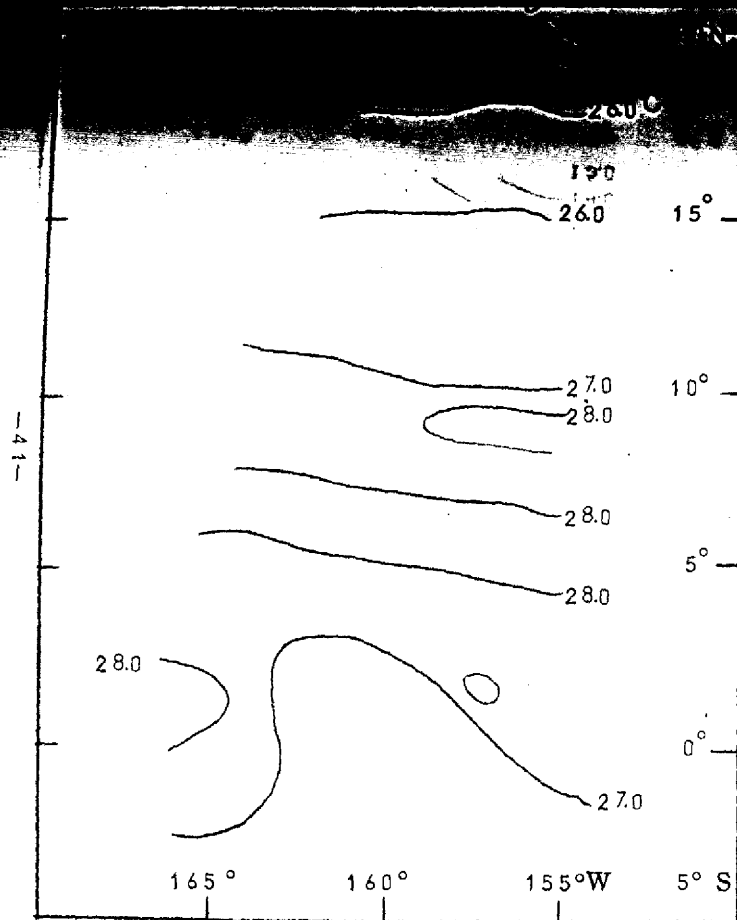


Fig. 1 Distribution of seawater temperatures at surface.

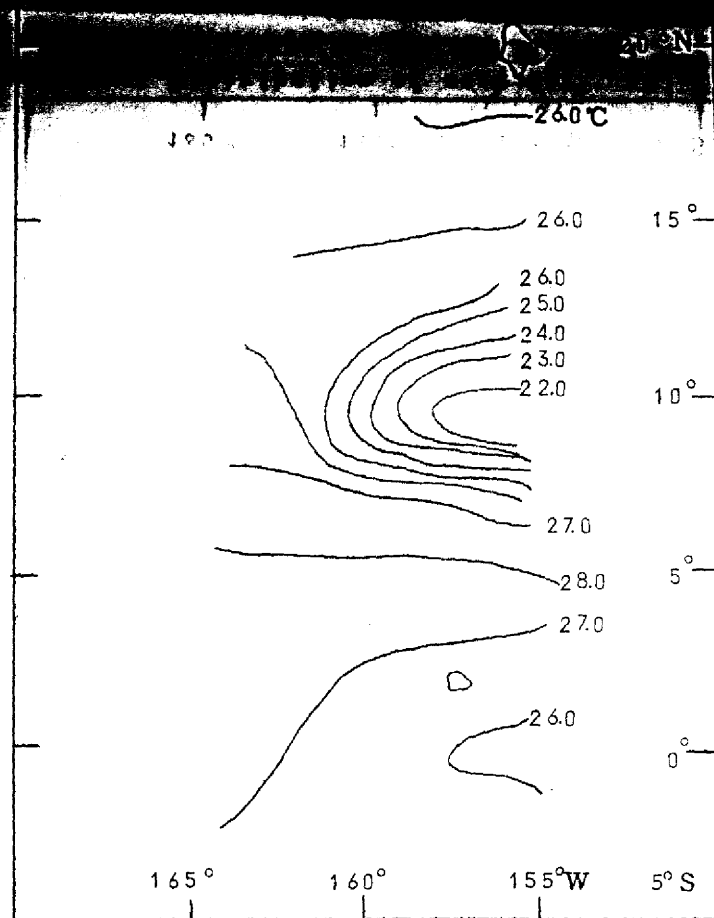


Fig. 2 Distribution of seawater temperatures at the 50 m level.

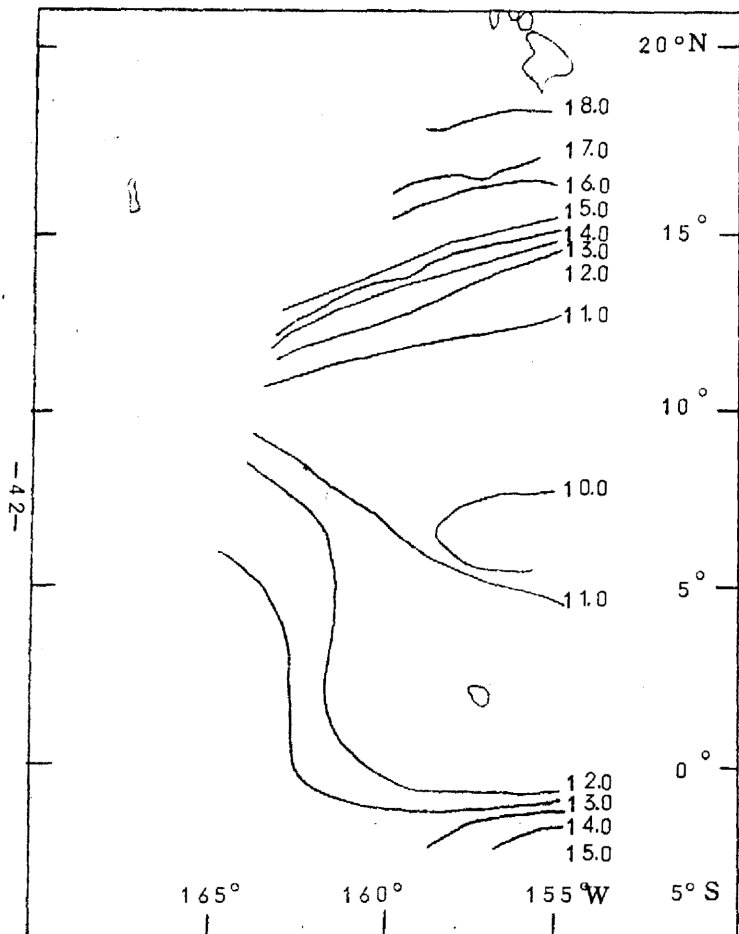


Fig. 4. Distribution of seawater temperatures at the 200 m level.

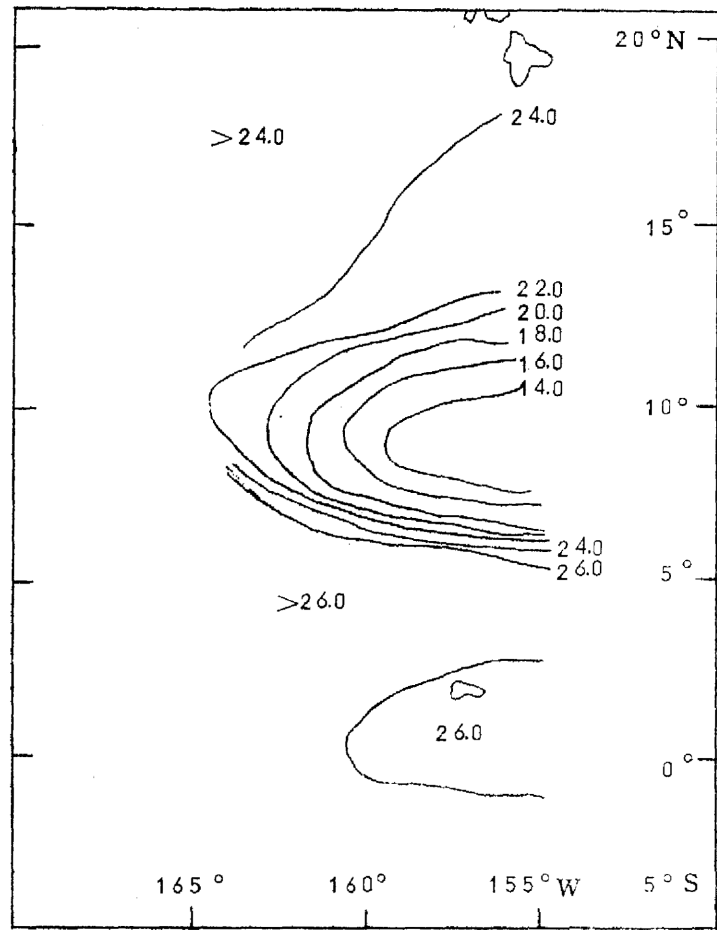
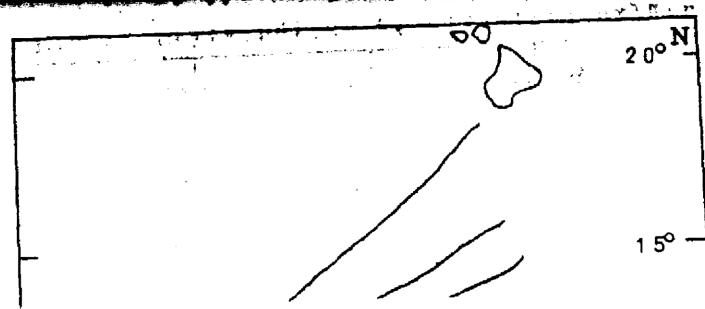
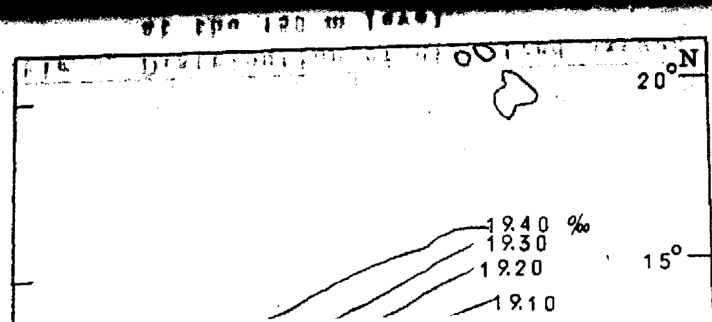


Fig. 3. Distribution of seawater temperatures at the 100 m level.



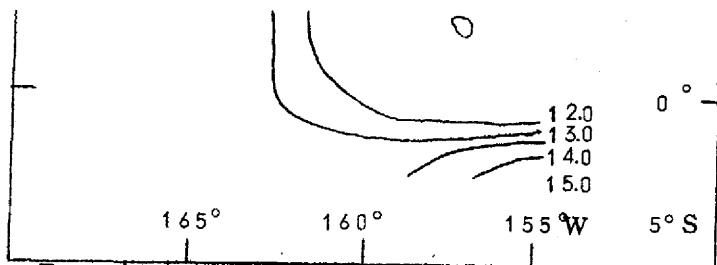


Fig. 4. Distribution of seawater temperatures at the 200 m level.

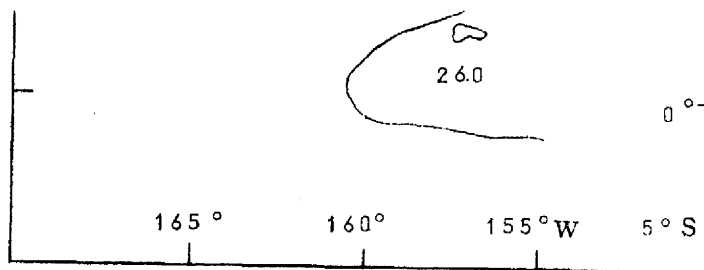


Fig. 3. Distribution of seawater temperatures at the 100 m level.

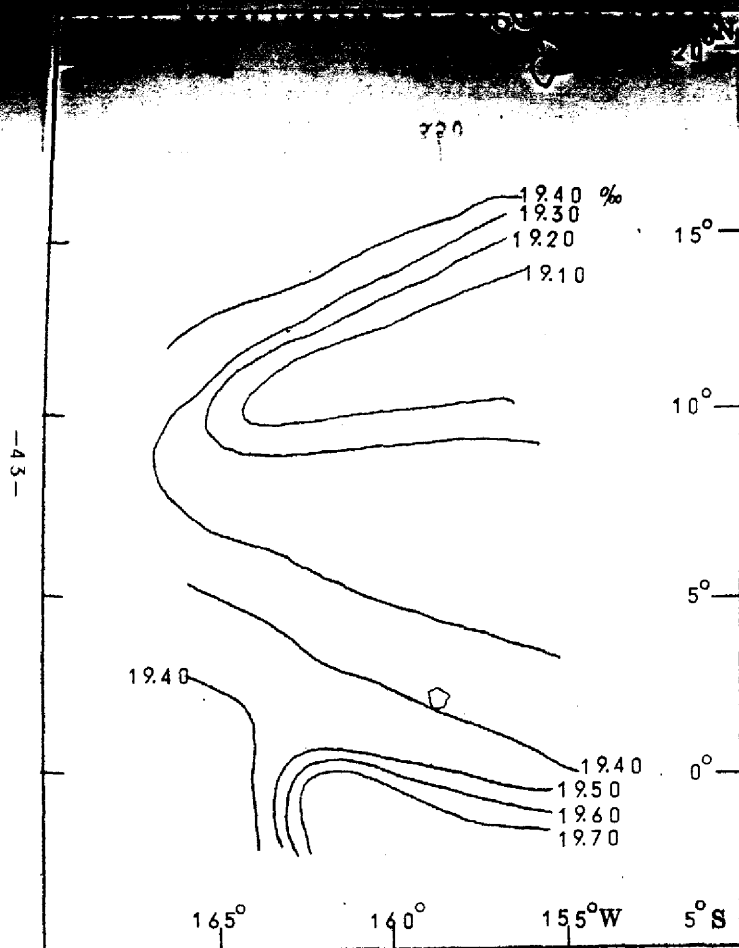


Fig. 6. Distribution of chlorinity at the 50 m level.

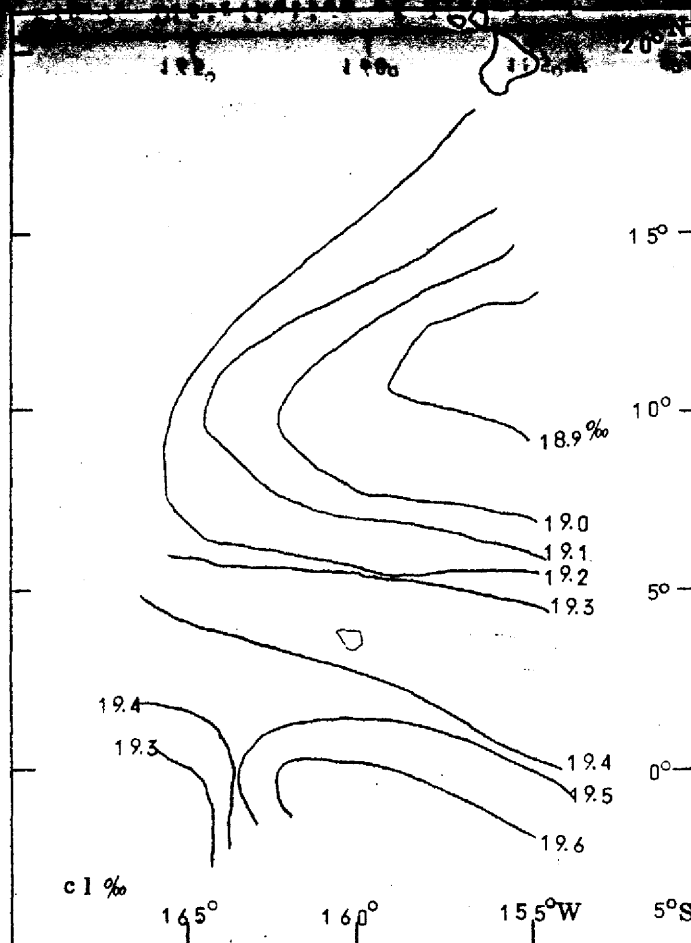


Fig. 5. Distribution of chlorinity at the surface.

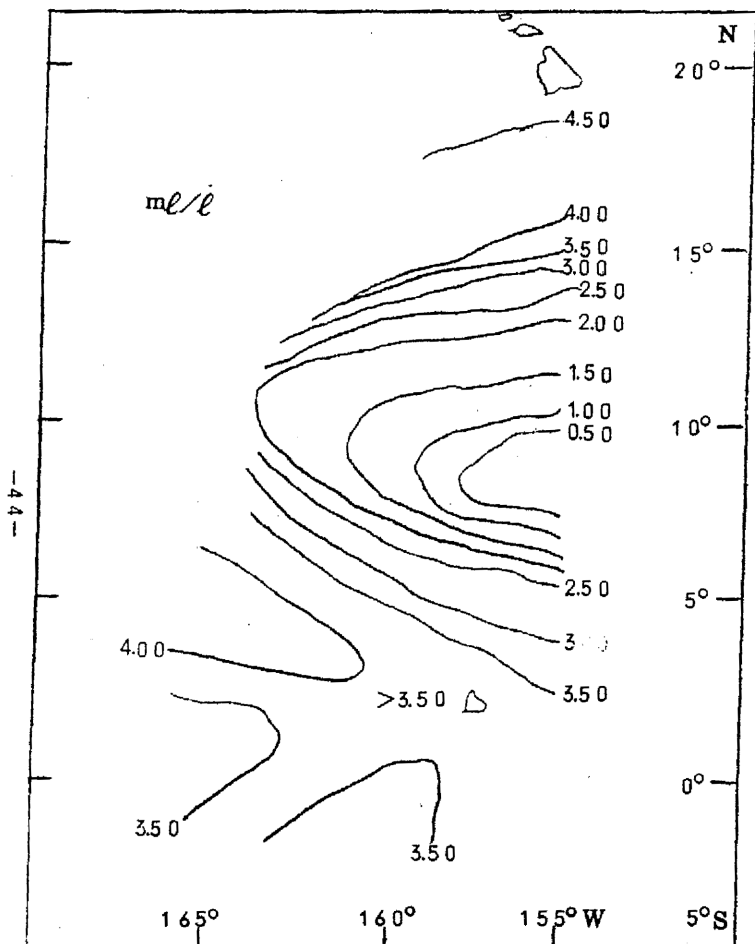


Fig. 8. Distribution of dissolved oxygen at the 150 m level

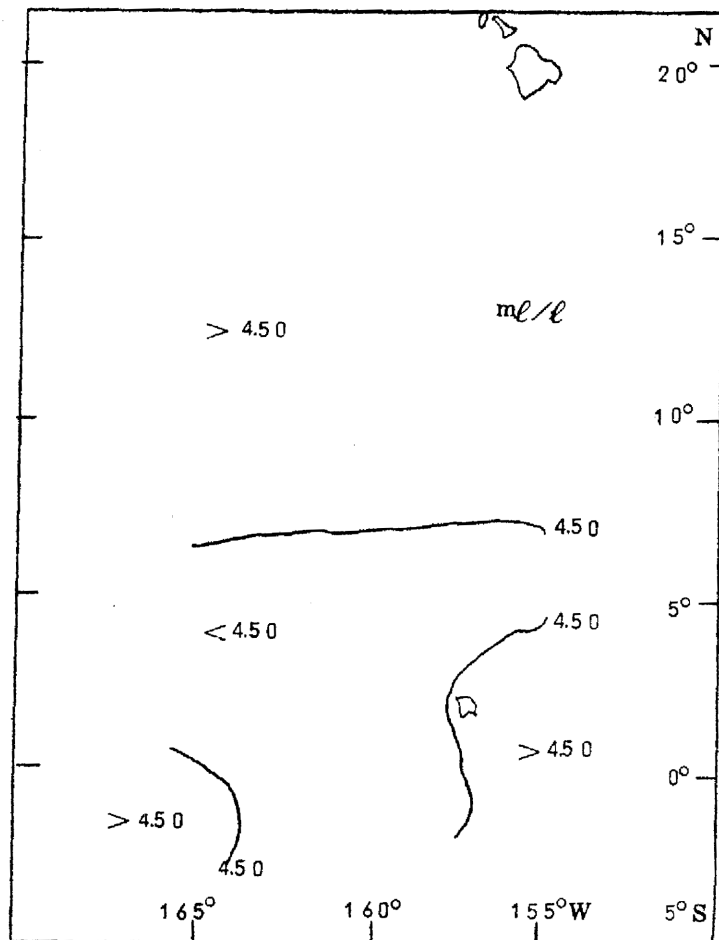


Fig. 7. Distribution

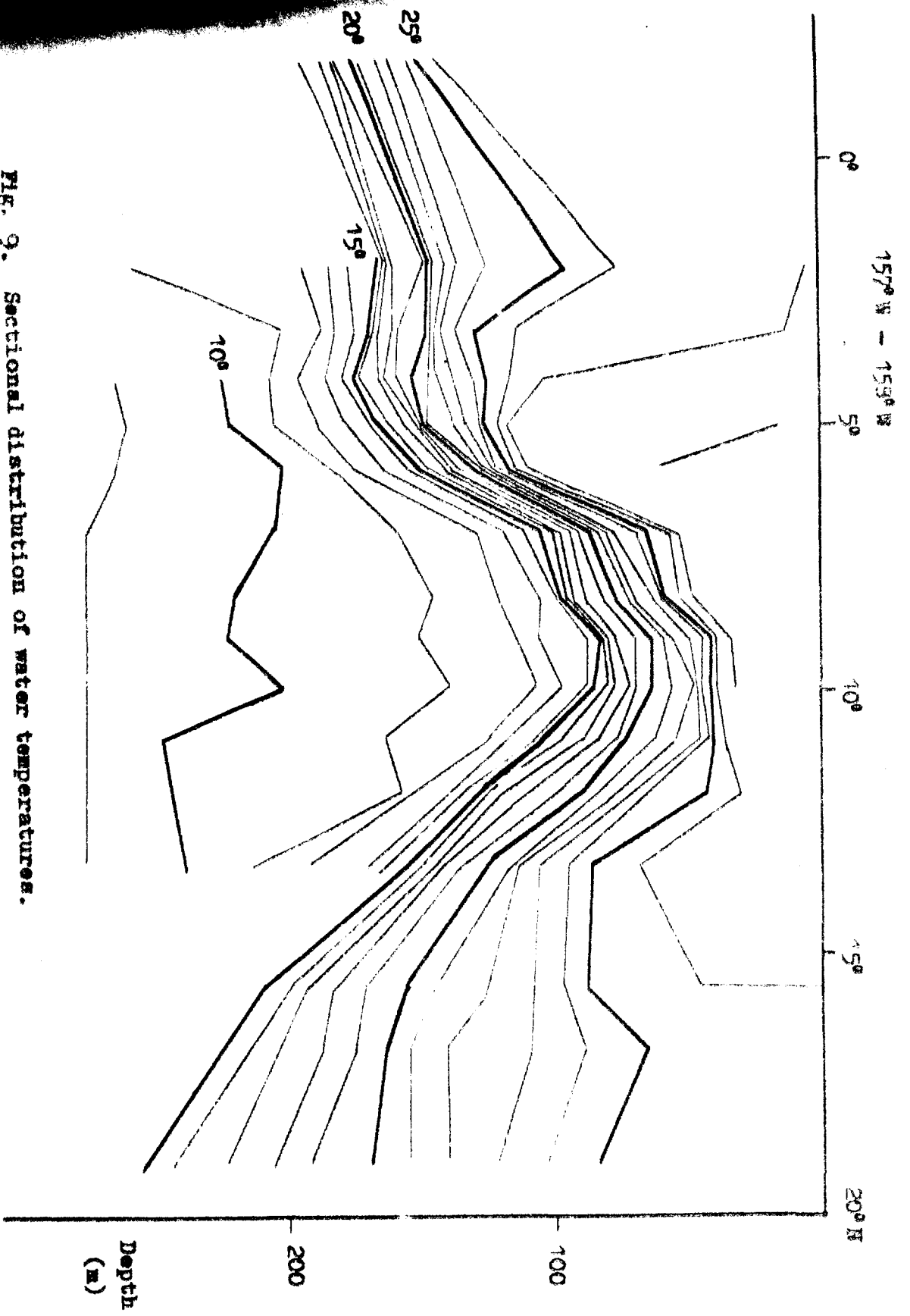


FIG. 9. Sectional distribution of water temperatures.

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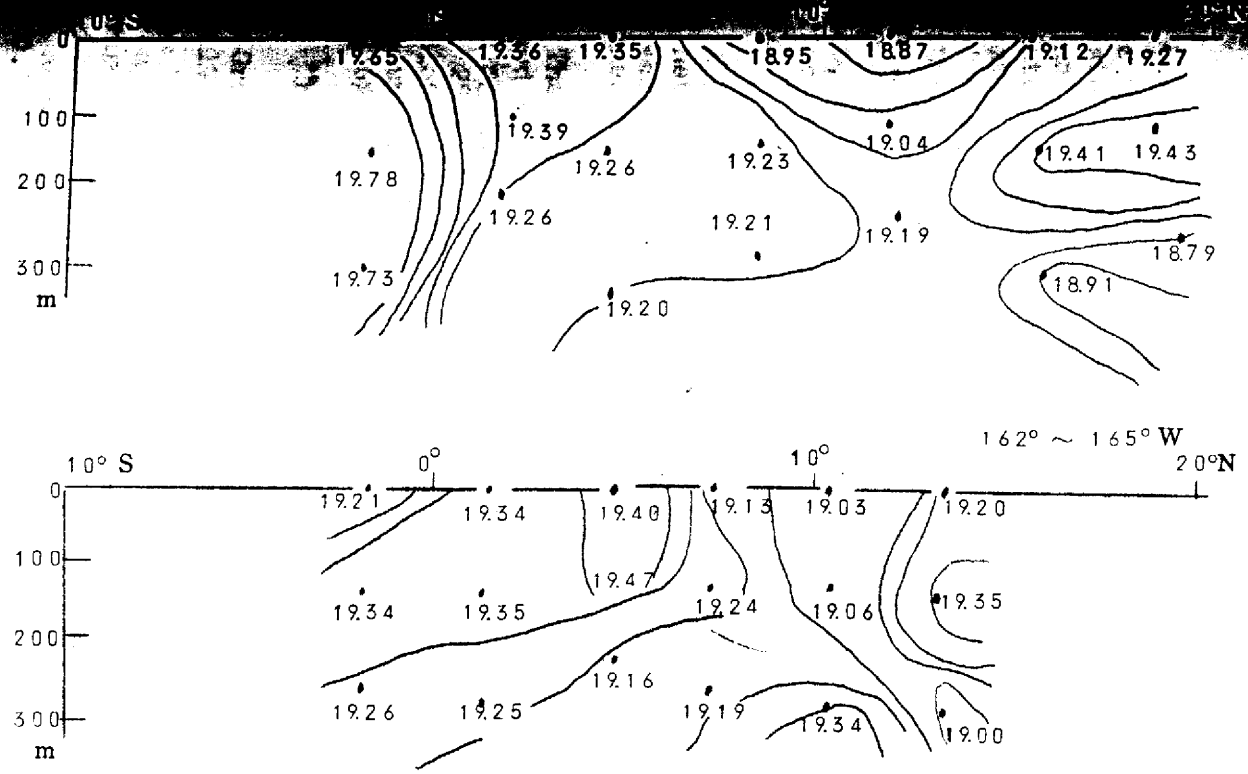


Fig.10. Sectional distribution of chlorinity.

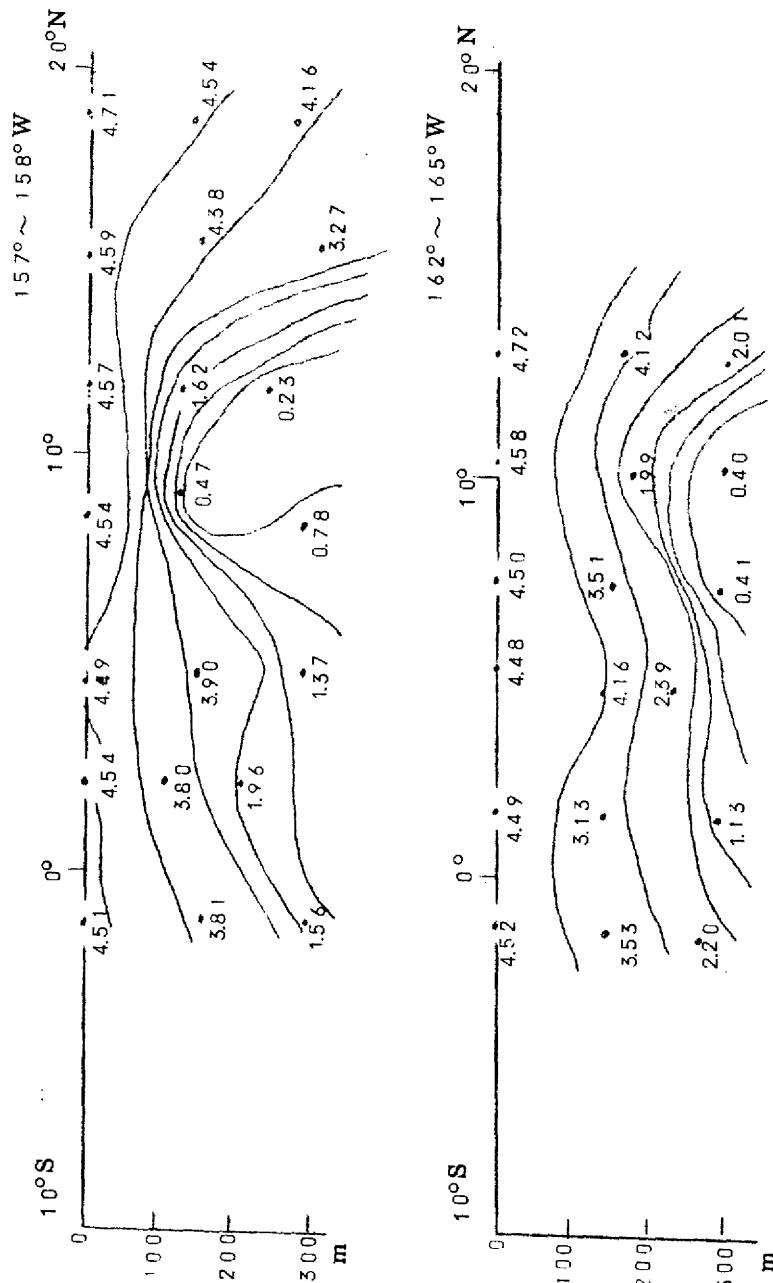


Fig. 11. Sectional distribution of dissolved oxygen.

The net used at the mouth and consisted of a cone with an average diameter consisted of bolts with an approximate mesh

During the cruise at Midway Island, 6 net tows of 30-50 m were made at sunset, at a speed of 2 knots. Surface water samples were made at Honolulu in the

A portion of each net tow was retained for radiocarbon analysis. The remainder was retained for radiocarbon analysis.

The plankton were ignited in the microwave oven. A 500 mg sample of ash was placed in a dish, 25 mm in diameter. The radioactivity was measured. The counting efficiency was 9.6% for samples to 31. Corrections were made from ^{40}K . Results

Gross β -radioactivity was 114-1172 dpm/0.5g of ash, equal to that of the ash. Of samples from the cruise, the average of 632 dpm/0.5g was slightly higher than in 4 samples from the cruise, 400-500 dpm/0.5g of ash in current.

* Tokai Region

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 sunrise 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 dried in the muffle furnace after being dried at 110°C. A 0.5 g sample of the ash was placed in a stainless steel crucible 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 1.6% for samples 1 to 11, and 6.3% for samples 12 to 14.

Corrections were not made for the activity derived from the decay of ^{95}Zr . Results are shown in Tables 1 and 2.

The 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 4 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

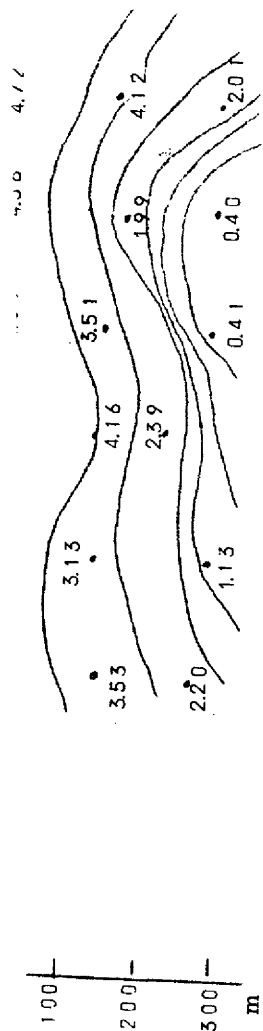


Fig. 11. Sectional distribution of dissolved oxygen.

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 anything, 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.

biological comp

Coa sp., Copepo
da, Copepoda
, Siphonophor
s sp.

Medusae(20%)
Copepoda

ia
cularia, Sagit

Copepoda, Pter
ta(20%), Siphc

0%), Euphausia
hausiacea(10-

%), Siphonoph
es sp.(10-20%

Euphausiacea(1
Sagitta sp.(1

30%), Copepod
, Sagitta sp.(

Medusae
Siphonophorae(10%).

, Salpa sp.(1
Salpa sp.(10%)

Sergestes sp.
Sergestes s

, Medusae
sp., Pterop

, Megalopa l

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 $^{95}\text{Zr} + ^{95}\text{Nb}$ activity | | $^{95}\text{Zr} + ^{95}\text{Nb}$ | |
|------------|--|---------------|-----------------------------------|---------------|
| | dpm/0.5g of ash | Date measured | $\mu\text{c}/1.0\text{g}$ 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 |

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| | | | | |
|----|--------|-----------|------|-----------|
| 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 | - | - | - | - |

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Seven lo
chart were us
275 m mainlin
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on surve
samples ca

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 75 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, 2 bacores, 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. Background count on deck was subtracted from the readings of the survey meter. The mean values found, by fish species, 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.

Regional Fisheries Research Laboratory

Table 1. Fish Samples Caught by Longline Fishing.

| Station | Sample No. | Species | Body length (cm) | Body weight (kg) | Radioactivity (μ r/h) |
|---------|------------|------------|------------------|------------------|----------------------------|
| 8 | 1 | Albacore | 118 | | |
| " | 2 | Bigeye | 115 | 31.2 | 0.0 |
| " | 3 | " | 162 | 26.2 | -0.1 |
| " | 4 | " | 147 | 85.5 | 0.1 |
| 12 | 5 | " | 143 | 69.0 | 0.3 |
| " | 6 | " | 161 | 59.5 | -0.3 |
| " | 7 | yellow fin | 151 | 79.4 | -0.3 |
| " | 8 | Big eye | 172 | 63.0 | 0.8 |
| " | 9 | " | 168 | 108.4 | -0.1 |
| " | 10 | " | 134 | 101.8 | -0.1 |
| 14 | 11 | Yellow fin | 113 | 51.5 | -0.2 |
| " | 12 | " | 124 | 25.8 | 0.0 |
| " | 13 | " | 123 | 35.6 | -0.1 |
| " | 14 | " | 110 | 29.4 | 0.1 |
| " | 15 | " | 131 | 23.6 | -0.1 |
| " | 16 | " | 133 | 40.0 | 0.1 |
| " | 17 | " | 124 | 42.0 | 0.1 |
| " | 18 | " | 139 | 34.7 | 0.5 |
| " | 19 | " | 120 | 49.2 | 0.1 |
| " | 20 | " | 133 | 30.5 | -0.2 |
| " | 22 | Big eye | 87 | 43.4 | 0.0 |
| " | 24 | Yellow fin | 129 | 14.6 | 0.1 |
| | | | | 36.5 | -0.3 |

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| | | | | | |
|----|----|------------|-----|------|------|
| " | 28 | " | 116 | 37.5 | 0.2 |
| " | 29 | Yellow fin | 131 | 28.0 | -0.3 |
| " | 30 | " | 125 | 28.5 | -0.3 |
| " | 31 | " | 127 | 39.5 | -0.3 |
| " | 32 | " | 130 | 33.9 | -0.2 |
| " | 33 | " | 133 | 38.5 | -0.3 |
| " | 34 | " | 125 | 38.0 | -0.3 |
| " | 35 | " | 138 | 41.0 | -0.2 |
| 18 | 37 | " | 136 | 37.6 | -0.2 |
| " | 38 | " | 128 | 42.6 | -0.2 |
| " | 39 | Albacore | 92 | 45.3 | 0.2 |
| " | 40 | Yellow fin | 145 | 30.0 | -0.3 |
| " | 41 | " | 130 | 17.3 | -0.3 |
| " | 42 | " | 133 | 56.6 | -0.2 |
| " | 43 | " | 136 | 40.0 | -0.1 |
| " | 44 | Albacore | 97 | 44.6 | -0.2 |
| " | 45 | Yellow fin | 121 | 46.5 | -0.3 |
| 23 | 46 | " | 132 | 19.0 | -0.4 |
| 25 | 47 | Skipjack | 71 | 47.0 | -0.3 |
| " | 48 | Marlin | 201 | 40.0 | 0.5 |
| " | 49 | Skipjack | 75 | 40.0 | 0.5 |
| " | 50 | Yellow fin | 141 | 7.8 | 0.4 |
| 29 | 51 | " | 137 | 68.4 | -0.2 |
| " | 52 | " | 147 | 9.5 | -0.1 |
| " | 53 | " | 147 | 50.0 | -0.1 |
| | | | | 50.4 | 0.0 |
| | | | | 54.0 | 0.1 |
| | | | | 53.3 | 0.0 |

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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.

* Japan Analytical Chemistry Research Institute

2. Method

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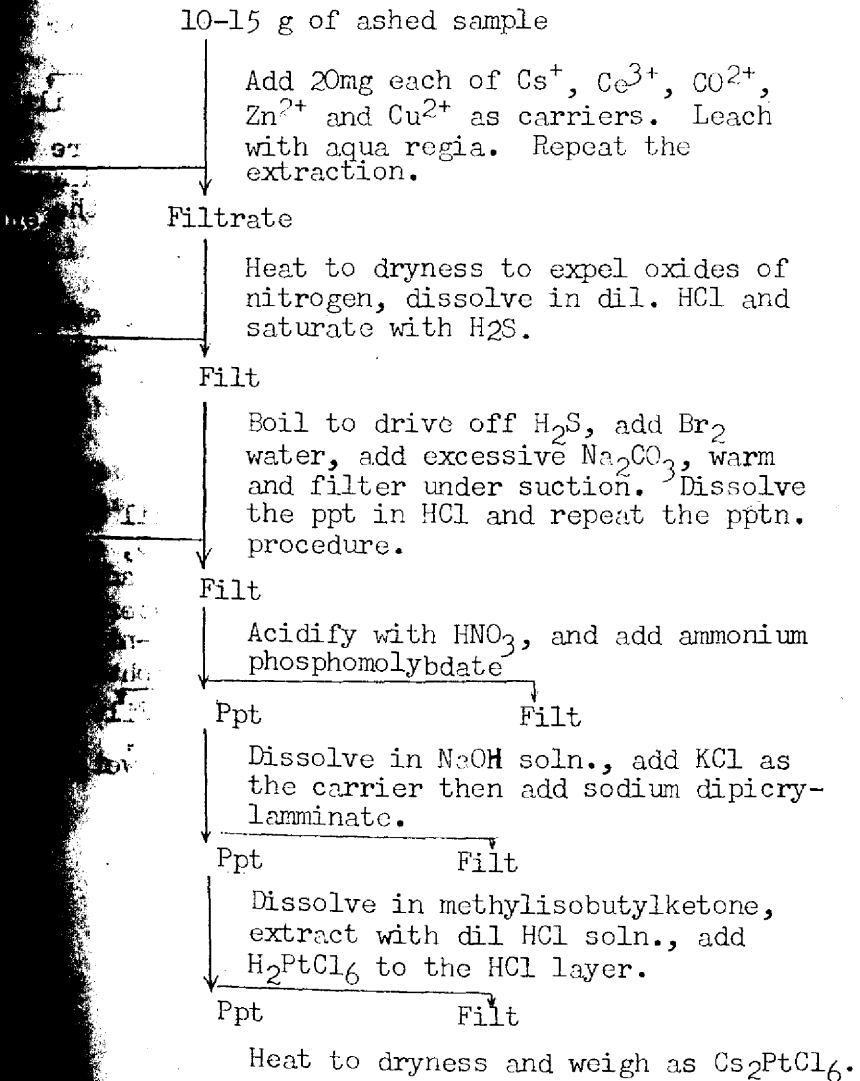
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Method of Analysis

The Analytical procedure for radioactive Cs, Sr, and total rare earth elements is described in Diagram 1. With regard to muscles only ⁹⁰Sr and ¹³⁷Cs were determined by this procedure.

Determination of Radioactive nuclides in tuna fish

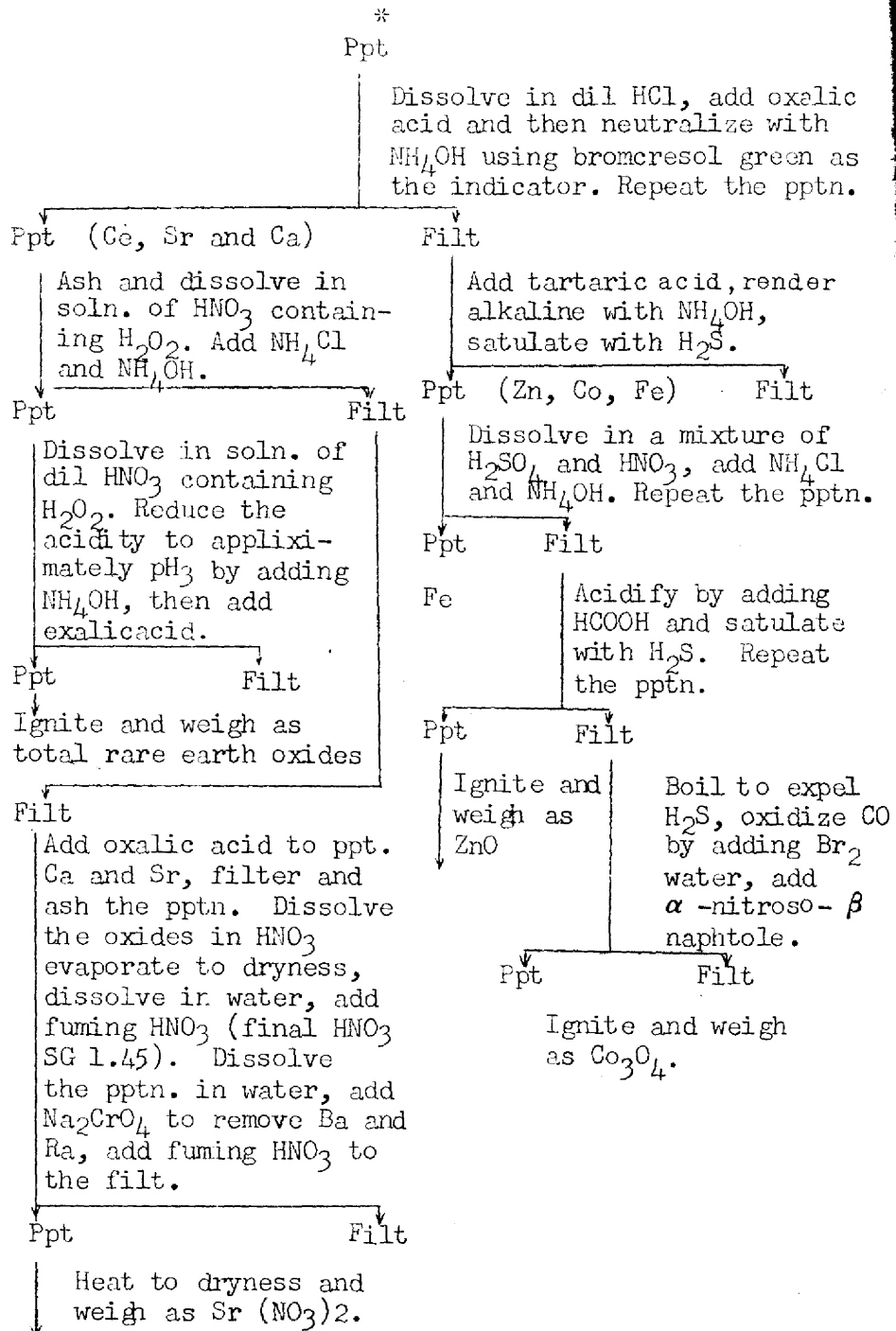


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able or natural potassium, strontium, and zinc were also analyzed to determine the relative accumulation of radioactive nuclides. Potassium was determined flame-photometrically using a hydrochloric solution of the ashed sample. Strontium was also analyzed flamephotometrically using a hydrochloric acid solution of the ignited sulfate 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

⁹⁰Sr, ¹³⁷Cs 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 ⁶⁰Co as the standard. ⁶⁰Co and ⁶⁵Zn were determined by the RCL-128 channel γ ray spectrometer (crystal, 4" Ø x 2") using 1.27 Mev γ ray emitted from ⁶⁰Co as the standard.

4. Results of analysis

Results of all determinations are shown in Table 1

Fig. 7. Horizontal distribution of gross β-activity of surface water of the water

7 in the water

Table 1. Concentrations of Radioactive Nuclids in

| | | | Organs. | 19 | 2 |
|--|----------|----------|----------|----------|---|
| Sample No. | 10 | 15 | 17 | 14 | 1 |
| Station No. | 12 | 14 | 14 | 8.17 | 8 |
| Sampling date | 8.16 | 8.17 | 8.17 | 1.725 | 1 |
| Quantity (Weight) ashed(kg) | 1.000 | 1.663 | 1.430 | 1.89 | 1 |
| Ash (%) | 2.48 | 1.26 | 1.50 | 0.088 | 0 |
| Ca % (Wet Sample) | 0.041 | 0.017 | 0.053 | 7.2 | 2 |
| Sr ppm (Wet Sample) | 2.7 | 1.3 | 4.0 | 0.4±0.1 | 0 |
| ⁹⁰ Sr $\mu\text{c/g}$ of Ca | 3.1±0.6 | 1.8±0.8 | 2.1±0.4 | 0.1±0.02 | 0 |
| ⁹⁰ Sr $\mu\text{c/mg}$ of Sr | 0.5±0.10 | 0.2±0.10 | 0.3±0.06 | 0.8±0.2 | 0 |
| ⁹⁰ Sr $\mu\text{c/kg}$ of Sample | 1.3±0.3 | 0.3±0.1 | 1.1±0.2 | 0.181 | 0 |
| K % (Wet Sample) | 0.359 | 0.248 | 0.219 | 5.0±0.5 | |
| ¹³⁷ Cs $\mu\text{c/g}$ of K | 4.6±0.5 | 3.3±0.4 | 5.3±0.5 | 9.0±0.9 | |
| ¹³⁷ Cs $\mu\text{c/kg}$ of Sample | 16.7±1.6 | 8.2±0.9 | 11.6±1.1 | 11.6±0.7 | |
| Total rare earth $\mu\text{c/kg}$ of Sample | 1.32±1.2 | 5.3±0.5 | 26.7±1.3 | 103 | |
| ⁶⁰ Co $\mu\text{c/kg}$ of Sample | 147 | 60 | 92 | 208 | |
| ⁶⁵ Zn $\mu\text{c/kg}$ of Sample | 357 | 173 | 276 | | |

clids in
organs.

| | | | | | |
|-------|----------|----------|----------|----------|----------|
| | 19 | 20 | 25 | 27 | 46 |
| 17 | 14 | 14 | 14 | 14 | 23 |
| 14 | 8.17 | 8.17 | 8.17 | 8.17 | 8.21 |
| 8.17 | 1.725 | 1.900 | 1.910 | 1.080 | 1.450 |
| 1.430 | 1.89 | 1.51 | 1.55 | 1.80 | 1.93 |
| 1.50 | 0.088 | 0.037 | 0.092 | 0.122 | 0.090 |
| 0.053 | 7.2 | 2.6 | 4.5 | 6.7 | 5.4 |
| 4.0 | 0.4±0.1 | 0.9±0.4 | 0.5±0.2 | 0.4±0.2 | 0.5±0.2 |
| 0.8 | 0.1±0.02 | 0.1±0.05 | 0.1±0.03 | 0.1±0.03 | 0.1±0.04 |
| 0.10 | 0.8±0.2 | 0.3±0.1 | 0.4±0.1 | 0.5±0.2 | 0.5±0.3 |
| 0.1 | 0.181 | 0.190 | 0.276 | 0.247 | 0.259 |
| 3 | 5.0±0.5 | 2.6±0.3 | 3.0±0.3 | 4.7±0.5 | 3.1±0.3 |
| 0.4 | 9.0±0.9 | 4.9±0.6 | 8.4±0.7 | 11.8±1.2 | 8.2±0.8 |
| 0.9 | 11.6±1.1 | 11.6±0.7 | 14.5±0.8 | 33.0±1.8 | 16.9±1.2 |
| 0.5 | 26.7±1.3 | 103 | 75 | 86 | 98 |
| | 92 | 208 | 120 | 155 | 171 |
| | 276 | | | | 146 |

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 $\mu\mu\text{c/g}$ of Ca | 1.6 \pm 0.5 | 1.6 \pm 0.3 | 2.2 \pm 0.6 | 1.6 \pm 0.6 |
| ⁹⁰ Sr $\mu\mu\text{c/mg}$ of Sr | 1.0 \pm 0.3 | 0.9 \pm 0.2 | 1.1 \pm 0.3 | 1.1 \pm 0.4 |
| ⁹⁰ Sr $\mu\mu\text{c/kg}$ of Sample | 0.1 \pm 0.03 | 0.2 \pm 0.04 | 0.1 \pm 0.04 | 0.1 \pm 0.04 |
| K % (Wet Sample) | 0.385 | 0.401 | 0.395 | 0.340 |
| ¹³⁷ Cs $\mu\mu\text{c/g}$ of K | 2.5 \pm 0.3 | 2.9 \pm 0.2 | 4.1 \pm 0.3 | 3.0 \pm 0.2 |
| ¹³⁷ Cs $\mu\mu\text{c/kg}$ of Sample | 9.6 \pm 0.8 | 11.4 \pm 0.9 | 16.1 \pm 1.2 | 10.3 \pm 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 |
| 1.6 | 1.6±0.6 | 1.9±0.4 | 1.1±0.3 | 1.4±0.3 | 1.7±0.3 |
| 1.3 | 1.1±0.4 | 1.2±0.3 | 0.8±0.2 | 0.8±0.3 | 0.7±0.2 |
| 1.04 | 0.1±0.04 | 0.2±0.04 | 0.1±0.03 | 0.2±0.05 | 0.1±0.04 |
| 5 | 0.340 | 0.365 | 0.326 | 0.325 | 0.283 |
| 1.3 | 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 usual procedures were necessary to achieve 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 radioactive decay pattern of the total rare earth fraction indicated the presence of essentially $^{144}\text{Ce} - ^{144}\text{Pr}$, 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 $^{95}\text{Zr} - ^{95}\text{Nb}$ was not carried out in this analysis, the existence 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 existence 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

Table 1. Concentrations of ^{90}Sr in the

| Species | Sample No. | Bone |
|---|------------|-------------------------------|
| | | $\mu\text{c}/\text{kg}$ (wet) |
| Big-eyed tuna Parathunnus mebachi. | 2 | 2.42 ± 0.78 |
| " | 4 | 2.41 ± 0.80 |
| " | 5 | 1.82 ± 0.42 |
| " | 6 | |
| " | 22 | 3.80 ± 0.61 |
| " | 25 | 1.62 ± 0.20 |
| " | 28 | |
| Yellow-fin tuna Neothunnus macropterus | 7 | 6.27 ± 0.81 |
| " | 11 | |
| " | 12 | 1.07 ± 0.41 |
| " | 37 | 2.77 ± 0.40 |
| " | 50 | 4.04 ± 0.82 |
| " | 51 | 2.63 ± 0.80 |
| " | 52 | 3.43 ± 0.81 |
| Albacor Thunnus alalunga | 39 | 1.95 ± 0.41 |
| " | 44 | 5.45 ± 0.20 |
| Bonito Katsuwonus peramis | 47 | 4.85 ± 0.83 |
| Blue marlin Makaira mazara | 48 | 9.54 ± 0.86 |

analysis on ^{90}Sr

Bone and the Scales with Skin.

| Ca % | S.U. | Scales with skin | | |
|------|-----------------|-------------------------------|------|-----------------|
| | | $\mu\text{c}/\text{kg}$ (wet) | Ca % | S.U. |
| 37.0 | 0.12 ± 0.04 | 10.56 ± 1.60 | 35.9 | 0.33 ± 0.05 |
| 37.2 | 0.12 ± 0.04 | 11.20 ± 1.60 | 36.5 | 0.35 ± 0.05 |
| 37.4 | 0.09 ± 0.02 | 12.24 ± 2.07 | 34.4 | 0.39 ± 0.07 |
| | | 18.54 ± 1.44 | 36.0 | 0.58 ± 0.05 |
| 40.3 | 0.18 ± 0.03 | 17.60 ± 1.92 | 32.8 | 0.55 ± 0.06 |
| 35.5 | 0.08 ± 0.01 | 19.08 ± 2.16 | 36.0 | 0.53 ± 0.06 |
| | | 9.36 ± 1.17 | 35.1 | 0.29 ± 0.04 |
| 38.1 | 0.32 ± 0.04 | 11.97 ± 1.17 | 36.0 | 0.37 ± 0.04 |
| | | 16.32 ± 1.92 | 30.5 | 0.51 ± 0.06 |
| 39.8 | 0.05 ± 0.02 | 16.74 ± 1.53 | 34.5 | 0.54 ± 0.05 |
| 38.7 | 0.14 ± 0.02 | 12.16 ± 1.60 | 35.5 | 0.38 ± 0.05 |
| 38.1 | 0.20 ± 0.04 | | 36.0 | |
| 37.0 | 0.13 ± 0.04 | 15.36 ± 2.24 | 34.8 | 0.48 ± 0.07 |
| 36.0 | 0.17 ± 0.04 | 16.00 ± 2.56 | 35.2 | 0.50 ± 0.08 |
| 38.0 | 0.10 ± 0.02 | 13.44 ± 1.92 | 37.2 | 0.42 ± 0.06 |
| 36.2 | 0.27 ± 0.01 | | 38.4 | |
| 37.5 | 0.24 ± 0.04 | | | |
| 38.4 | 0.43 ± 0.04 | | 34.2 | |

3. Radiochemical analysis

Table 2. Concentrations of

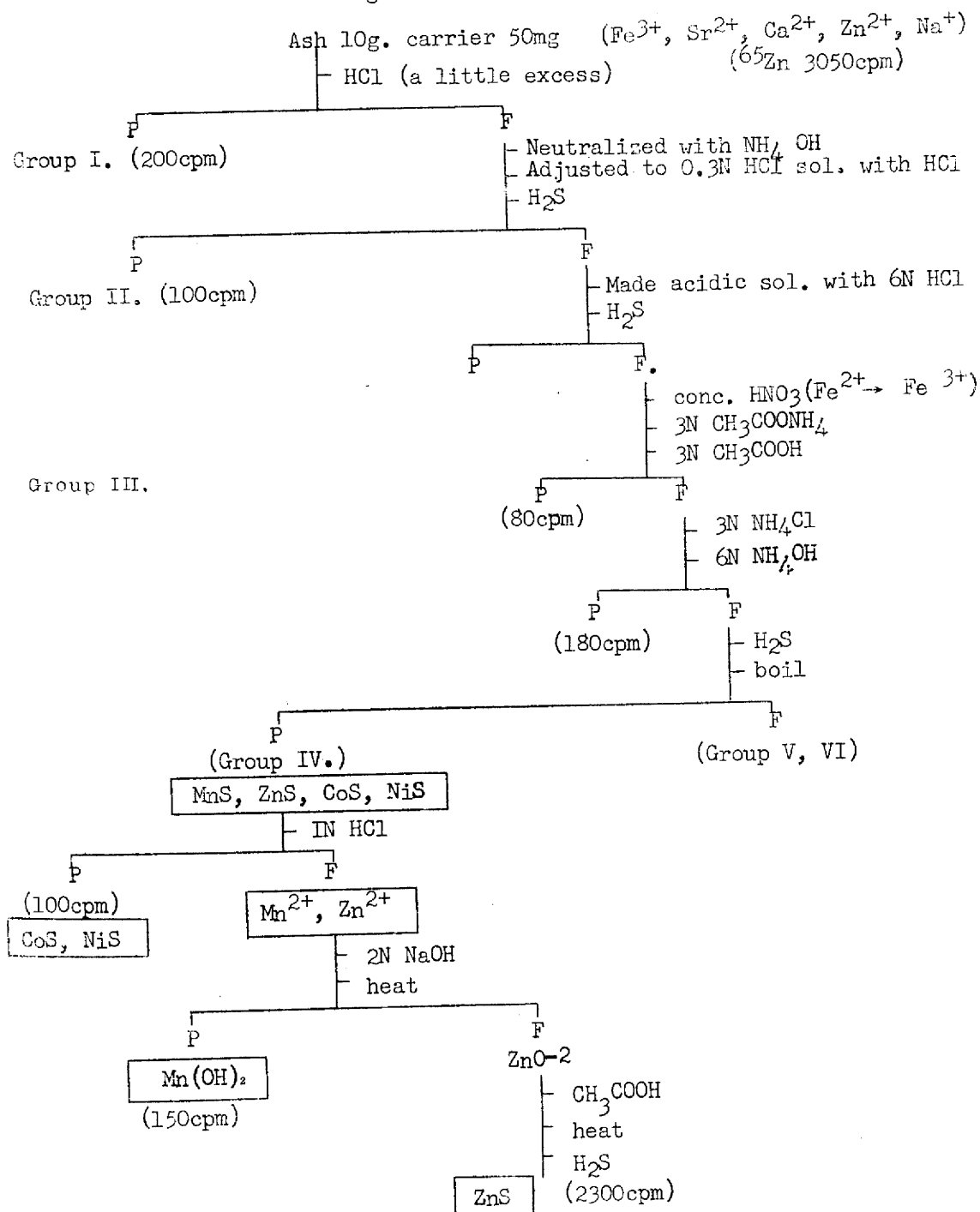
| Species | Sample No. | Ash % |
|---|------------|-------|
| Big-eyed tuna Parathunnus mebachi | 2 | 1.32 |
| " | 4 | 1.07 |
| " | 5 | 1.18 |
| " | 22 | 1.12 |
| Yellow-fin tuna Neothunnus macropterus | 7 | 1.20 |
| " | 11 | 1.43 |
| " | 12 | 1.22 |
| " | 37 | 1.23 |
| " | 50 | 1.10 |
| " | 51 | 1.21 |
| " | 52 | 1.09 |
| Black Thunnus alalunga | 44 | 1.13 |
| Blue marlin Makaira mazara | 48 | 1.17 |

on ^{137}Cs ^{137}Cs in the Muscle

| ^{137}Cs $\mu\text{C}/\text{kg}$ of wet Sample | K % (Wet Sample) | ^{137}Cs $\mu\text{C}/\text{g}$ of K |
|--|---------------------|---|
| 22.5 ± 1.7 | 0.397 | 7.1 ± 0.4 |
| 12.5 ± 1.0 | 0.337 | 3.7 ± 0.3 |
| 6.6 ± 0.9 | 0.359 | 2.2 ± 0.3 |
| 14.3 ± 1.5 | 0.315 | 5.1 ± 0.5 |
| 11.1 ± 0.9 | 0.364 | 3.1 ± 0.3 |
| 19.4 ± 1.9 | 0.469 | 4.2 ± 0.4 |
| 16.5 ± 1.5 | 0.382 | 5.3 ± 0.4 |
| 8.1 ± 1.1 | 0.358 | 2.3 ± 0.3 |
| 16.2 ± 1.3 | 0.364 | 4.9 ± 0.4 |
| 11.7 ± 1.3 | 0.377 | 3.6 ± 0.4 |
| 8.5 ± 0.7 | 0.358 | 2.6 ± 0.2 |
| 6.1 ± 0.9 | 0.350 | 2.0 ± 0.3 |
| 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 gamma-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 μuc/l |
| 15 | 2 | cpm/l dpm/l | cpm/l μuc/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 ^o to 25 ^o C. | the thermocline lies between 15 ^o C isotherm and 25 ^o C. |
| 20 | 31 | temperature boundaries are | tow boundary layers of tem perature 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, perhaps, 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. | <p>———South Equatorial Current</p> <p>-----Equatorial Counter Current</p> <p>-----North Equatorial Current</p> |
| 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 | titration | titration |
| 37 | 19 | Temperature measurements | Results of temperature 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 chlorinity. | 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 | appliximately 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 | 1N HCl | 1 N HCl |
| 11 | 8 | Enginers room | Engineers room |