REPORT FROM THE "OSHORO MARU" ON OCEANOGRAPHIC AND BIOLOGICAL INVESTIGATIONS IN THE BERING SEA AND NORTHERN NORTH PACIFIC IN THE SUMMER OF 1955

I. Programme of Investigations and Records of Eye Observations of Sea-Birds and Marine Mammals *

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I. Introduction

Participating in the North Pacific Oceanographic Expedition (Norpac Expedition) coordinated by the oceanographic institutions of Japan, Canada and the United States, the training ship "Oshoro Maru" of the Faculty of Fisheries, Hokkaido University, in Hakodate, Hokkaido, made a research and training cruise from Hakodate to Seattle and return, traversing the Bering Sea on the outward course and the northern North Pacific on the homeward course during the period from June to August, 1955. The sea area assigned to be investigated by the "Oshoro Maru" was the Bering Sea, north of the Aleutian Islands extending from off the east coast of Kamchatka in the west, to Bristol Bay in the east, and north to about latitude 60° N.

In planning the investigations by the "Oshoro Maru", as a part of the Norpac enterprise, a special research committee was organized in the University from staff members who have taken responsibility for the studies in respect to their specialities. The results of the investigations will be published in successive papers under their sponsorship. The committee comprises the following persons:

Professor	Sigeru Motoda, D. Agr.	(Plankton)
Professor	Shin-ichi Satô, M. Sci.	(Ichthyology)
Professor	Naoichi Inoue, D. Sci.	(Turbidity, radio-activity)

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Assistant Professor	Hideto Kotô, M. Sci.	(Physical oceanography)
Assistant Professor	Kenji Katô, M. Sci.	(Chemistry)
Assistant Professor	Tatsurô Kubo, B. Fish.	(Racial investigation of salmons)
Assistant Professor	Takeji Fujii, B. Fish.	Captain of the ship (Navigation and fisheries)

The 1955 cruise was the third one for the "Oshoro Maru" to make to the Bering Sea since the end of World War II. Referring to the results obtained from the two preceding cruises (Mishima & Nishizawa, 1955; Motoda & Kawarada, 1955) and from data provided by other ships (*ref.* Watanabe, 1954) it was desired to lay stress upon research in the most interesting areas; that is, off the east coast of Kamchatka, in which severely cold water is still to be found at around 100 metre depth in summer, and also the vicinity of the Aleutian Ridge over which warm water of low salinity from the east is flowing from the Pacific side into the Bering Sea. The western front of this warm water progressively moves westward with the progress of the season from spring to summer possibly having certain relation to the reduction of the above noted severely cold water in the deep. This front is considered to have certain significance in respect to the location of salmon fishing grounds. However, in making a research cruise roughly covering the whole of the Bering Sea, there was insufficient time and fuel to permit the carrying on of observations in detail in the above interesting areas. The final plan for the cruise was nearly the same as the actual performance.

II. Ship

The "Oshoro Maru" (fig. 1) is owned by the National Government of Japan and placed under the management of the Faculty of Fisheries, Hokkaido University. She was built in 1927 as a training ship of the College of Fisheries, Hokkaido Imperial University, in Sapporo, which was the predecessor school of the Faculty of Fisheries. Her original style was that of a barquentine sailing vessel, 471.76 gross tons, installed with auxiliary Diesel engine, 450 HP, but during World War II the sailing equipment was entirely removed; the mainmast and bowsprit were

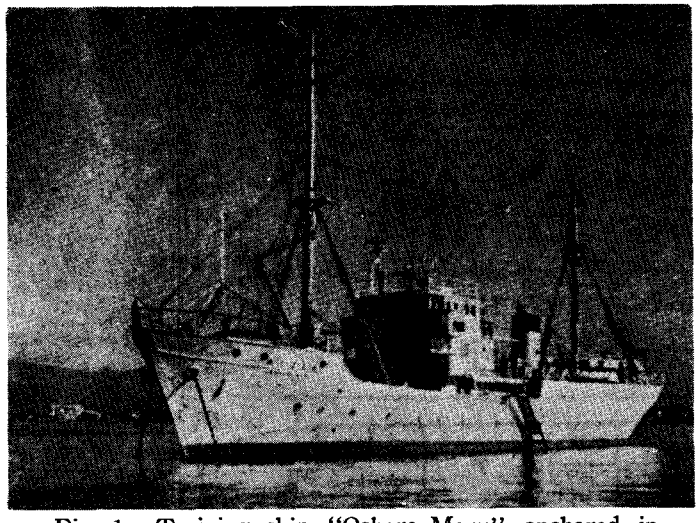

Fig. 1. Training ship "Oshoro Maru" anchored in Hakodate (photographed by Mr. R. Maeda)

also taken away. In 1952 she was enlarged on the occasion of reconstruction; the hull was elongated by five metres in the middle portion, and the engine was renewed. Her particulars at present are listed below:

Gross tonnage:	616.72 tons	Maximum speed:	11.28 knots
Net tonnage:	213.52 tons	Cruising speed:	8.50 knots
Displacement:	969.01 tons	Fuel capacity:	110 tons
Length:	46.79 metres	Fresh-water capacity:	126 tons
Breadth:	9.14 metres	Range of cruise:	7200 miles
Depth:	4.79 metres	Wireless transmitter:	500W, 250W, 50W
Main engine:	Diesel 800 HP	Number of complement:	85 men

The ship was originally built for use entirely in training cadets in navigation and fisheries, having no equipment for oceanographic research, except only sounding winches, and no adequate accommodation for researchers. Such lacks were not corrected on the occasion of reconstruction. In making the present research cruise, the Captain's reception room was temporarily furnished with requisites for chemical analyses, but there was no space left to provide good accommodation for the scientists; they were compelled to use the spare cadet's berths, a berth for patient in the dispensary and a sofa in the Captain's reception room. The general arrangement of the ship is illustrated in fig. 2.

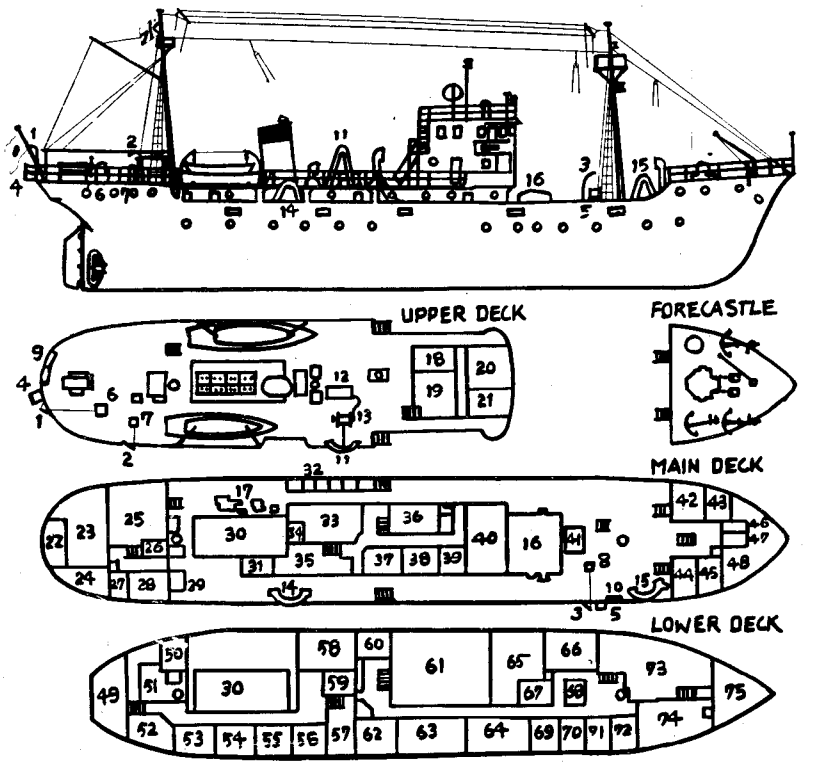

Fig. 2. General arrangement of "Oshoro Maru" (from blue print)

1. Hydrographic davit (upper deck, stern)
2. Hydrographic davit (upper deck, starboard)
3. Hydrographic davit (main deck, starboard)
4. Hydrographic stage (upper deck, stern)
5. Hydrographic stage (main deck, starboard)
6. Electromotive hydrographic winch(upper deck)
7. Spare hand hydrographic winch (upper deck)
8. Hand hydrographic winch (main deck)
9. Nansen bottle carrier (upper deck, stern)
10. Nansen bottle carrier (main deck, starboard)
11. Gallows for turbidity-meter provisionally set
12. Meter part of turbidity-meter
13. Drum for cabtyre cord of turbidity-meter
14. Trawl gallows (after)
15. Trawl gallows (fore)
16. Trawl winch
17. Canning machine
18. Chief wireless operator (1 berth)
19. Wireless room
20. Captain (1 berth)
21. Chemical laboratory
22. Store
23. Steering engine room
24. Store
25. Provision store
26. Photographic dark room
27. W C
28. Scientist's store (2 berths, but not usable during ocean-going)
29. Cold store
30. Engine opening
31. Coal bunker
32. W C
33. Lavatory
34. Bath
35. Galley
36. Chief officer (1 berth)
37. Second officer (1 berth)
38. First officer (1 berth)
39. Pantry
40. Saloon
41. Hatch
42. Cooks and boys (4 berths)
43. Petrol store
44. Bath
45. W C
46. Lamp store
47. Paint store
48. Store
49. Provision store
50. Engine store
51. Rice store
52. Store
53. Second engineer (1 berth)
54. First engineer (1 berth)
55. Chief engineer (1 berth)
56. Junior wireless operator (1 berth)
57. Purser (1 berth)
58. Third officer and third engineer (2 berths)
59. Gyro compass room
60. Dispensary (1 berth for doctor and 1 berth for patient)
61. Cadet's dining room and lacture room
62. Cadets (6 berths)
63. Cadets (8 berths)
64. Cadets (8 berths)
65. Cadets (10 berths)
66. Scientists (8 berths)
67. Refrigerating machine
68. Hatch
69. Boatswain (1 berth)
70. No. 1 oiler (1 berth)
71. Chief steward (1 berth)
72. Store
73. Quarter masters and sailors (12 berths)
74. Oilers and firemen (8 berths)
75. Cordage store

III. Equipment

Fifteen Nansen bottles, twenty protected reversing thermometers and seven unprotected reversing thermometers were provided for the present cruise. One of three hydrographic winches was provided with 3 HP electric motor while the other two, one for spare, were operated by hand. On these winches twisted steel wire of 2.7 mm diameter was wound. Only the above classic instruments were available for regular hydrographic observations, no recently developed instruments, such as Geomagnetic-electrokinetograph (GEK) and Bathy-thermograph (BT), being provided.

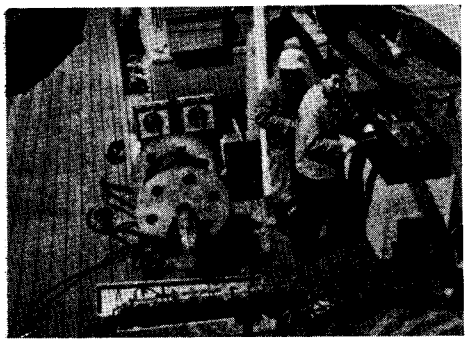

Fig. 3. Trubidity-meter on deck
T: Turbidity-meter
C: Cabtyre cord wound on the drum
M: Meter part

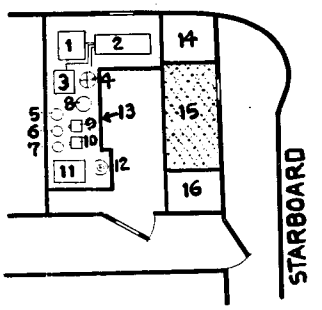

Fig. 4. Arrangement of chemical laboratory (designed by Asst. Prof. K. Katô)
1. Stabilizer for light source
2. Phototube colorimeter
3. Stabilizer for electric tube
4. Gimbals supporting a meter part
5. EDTA for Ca determination
6. N/100 HCl for alkalinity determination
7. N/100 $Na_2S_2O_3$ for oxygen determination
8. Heater
9. Magnetic stirrer
10. Magnetic stirrer
11. Glass electrode pH meter
12. Molecular filter assembly
13. Vacuum pump (beneath the table)
14. Locker
15. Sofa
16. Washstand

For measuring the turbidity of sea water *in situ* a turbidity-meter (fig. 3) constructed according to the design of Prof. N. Inoue of the University was prepared. This turbidity-meter was somewhat different from the original type reported in Fukuda *et al.* (1954).

In the chemical laboratory (figs. 4,5) which was converted from the Captain's reception room such apparatus, as glass electrode pH meter, molecular filter assemblage and phototube colorimeter, were provided in accordance with recent advances in marine chemistry. Two magnetic stirrers were provided for convenience of rapid titration aboard. The arrangement of these pieces of apparatus was made by Asst. Prof. K. Katô.

Six sorts of plankton samplers were prepared. The standard net, so called "Marutoku Net", which was standardized by Mr. *Z.* Nakai of the Tôkai Regional Fisheries Research Laboratory, is conical in shape, 45 cm in mouth diameter, 100 cm in length along the side of cone, and made of coarse bolting silk, GG 54, *i.e.*, 52.5 meshes per linear inch, having

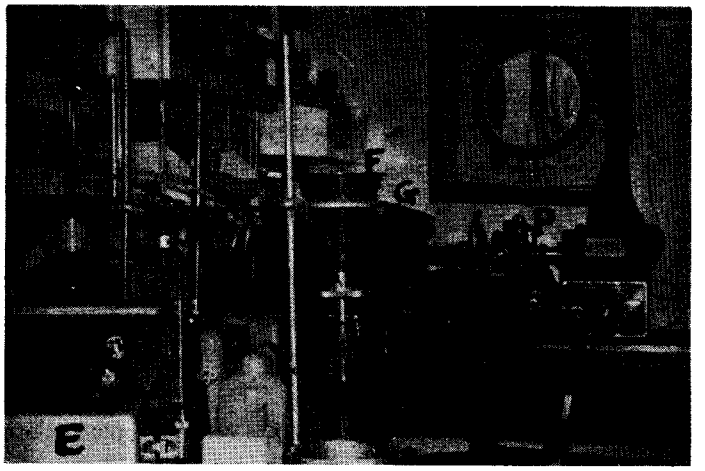

Fig. 5. Inside of chemical laboratory (photographed by Mr. M. Oguro)
P: Phototube colorimeter
G: Gimbals supporting a meter part
B: Burette
M: Magnetic stirrer
F: Molecular filter assembly
E: Glass electrode pH meter

0.33 mm of approximate mesh aperture. In the present cruise use was made of a net having side length of 165 cm and the same mouth diameter as the original type. Two such nets were prepared for the cruise.

A considerably large net, being 63 cm in mouth diameter, 300 cm in total length, and made of coarse bolting silk, GG 40, *i.e.*, 39 meshes per linear inch, in the lower 265 cm of the cone and of shrimp netting in the upper 35 cm, was prepared for deep haul.

A "Twin Net" (fig. 6), more simplified than the original type (Motoda, 1955), was prepared for making frequent deep haul. Each net of the twin has a size of 10 cm along the side of the square mouth and 50 cm in length along the tapering bag of bolting silk, GG 56, *i.e.*, 54.5 meshes per linear inch. A piece of cloth was sewed on inside the net. This is a device for preventing the outflow of materials.

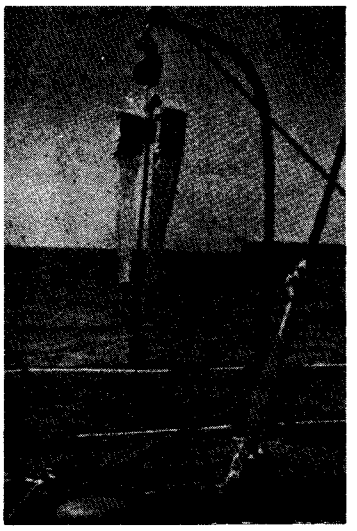

Fig. 6. Twin net for deep haul

For sampling the microplankton in shallow layers two fine mesh nets were provided, 20 cm in mouth diameter and 70 cm in length, made of fine bolting silk, XX 16, *i.e.*, 157 meshes per linear inch.

A "Handy Underway Plankton Catcher, Model II" (fig. 7) (Motoda, 1954) was provided for this cruise. The inserted net was selected to have comparatively fine meshes of bolting silk, XX 13, *i.e.*, 129 meshes per linear inch.

For sampling fish-larvae and large plankton animals at the surface, two fish-larva nets were provided. The net used was a standard size in Japan, that is 130 cm in mouth diameter, 450 cm in length, and made of stramin in the upper 300 cm and of coarse bolting silk,

Fig. 7. Handy underway plankton catcher, model II

GG 54, in the lower 150 cm. One of these nets was lost at the first time of collection.

A diving dredge, the same type as the Scripps Dredge, but smaller in over-all, was provided for sampling comparatively large bottom animals.

All of the samples of water and chemical reagents were kept in polyethylene bottles for convenience of treatment without anxiety about breaking. Plankton specimens were usually preserved in glass vials and the specimens obtained from fish-larva net were stored in larger glass bottles. The sum total of the bottles and vials came to 2647; *viz.*, 4 polyethylene bottles of five litre capacity, 3 of two litre capacity, 340 of one litre capacity, 200 of 250cc capacity, 1500 of 100 cc capacity (for chlorinity determination), 400 glass vials for plankton specimens and 20 larger glass bottles for specimens of larger animals. The specimens of fish were stored in tanks with formalin liquid.

All of the above instruments and bottles were those manufactured in Japan, except the molecular filters made in Germany.

IV. Persons in Charge of Research Work at Sea

The present cruise was carried out under the command of Captain T. Fujii, carrying on board 12 officers, 23 crew members, 32 cadets and 10 scientists; total 78 persons aboard. The Captain and officers took responsibility for training of cadets in navigation, fishing operations and in general duty alloted for seaman.

The scientific party that engaged directly in the research work was composed of the following persons:

Professor	Sigeru Motoda, D. Agr.	(Leader)
Assistant Professor	Kenji Katô, M.Sci.	(Chemistry)
Research Assistant	Kiyû Kobayashi, B. Fish.	(Fish)
Research Assis ant	Miki Oguro, B. Fish.	(Chemistry)
Research Assistant	Masaaki Fukuda, M. Sci.	(Turbidity)
Graduate Student	Reiichi Maeda, B. Fish.	(Plankton)
Graduate Student	Tamitomo Kashiwakura, B. Sci.	(Chemistry)
Graduate Student	Nobuo Yamada, B. Fish.	(Chemistry)
Technical Employee	Kenji Tamukai, B. Fish.	(Turbidity)

In addition, Mr. H. Fukataki, Technical Official of the Japan Sea Regional Fisheries Research Laboratory, Fisheries Agency, in Niigata, joined the scientific members in helping with the research work at sea. The Captain and deck officers also participated in the research work, particularly on the meteorological observations and gill-net

operations. Their names are listed below:

Captain, Assistant Professor	Takeji Fujii, B. Fish.
Chief Officer, Research Assistant	Shigeo Abe, B. Fish.
First Officer, Research Assistant	Shôji Saitô, B. Fish.
Second Officer, Research Assistant	Kiyoshi Masuda, B. Fish.
Third Officer	Satoru Nishiyama, B. Fish.

Mr. Akira Togashi, ship's Purser, has also assisted in the researches by making eye observations on sea-birds. Other crew members and cadets always assisted in the research work at sea while they were on watch duty.

V. Cruise Performed

The "Oshoro Maru" departed from Hakodate on June 21, sailing northward against the Oyashiwo Current (Kurile Current) off the east of the Kurile Islands. Entering into this water of grayish green colour the seamen said that sea began to smell of salmon. It is said that skilful fishermen can distinguish a good water for salmon fishery by the particular smell different from that of other waters. Most of the days the ship was covered with heavy fog, and her wake was shimmering with the luminescence of plankton at night. From hourly measurement of the temperature remarkably low values were obtained, as low as 2.7 °C, at the surface at 47°12'N, 154°19'E, the cold water possibly coming from the Okhotsk Sea passing between the islands of Kurile Chain.

The ship arrived off the south-western coast of Kamchatka on June 26. The hydrographic casts and plankton samplings as well as salmon gill-net operations were begun from this day. The ship turned to the east along about latitude 53°N. From Attu Island she steered for the north-west, but soon had to stop for a day from noonon July 3, because an atmospheric depression (998 milibar) was approaching to the north of the ship. After the depression has passed over, the ship continued her north-westward sailing, and at St. Os 11 off Karaginskii Island an unexpected temperature as high as 6.6°C at the surface was obtained. After sailing to the east for some time the vessel sailed southward to near Attu Island and then eastward to near Kiska Island.

When she was on this course a depression (994 milibar) passing to the north just at this time caused a westerly gale, about 15 m/sec, in the area around the ship. After carrying out the hard work of hydrographic observations at St. Os 18 and Os 19, she traversed Bower's Bank, which is located at about longitude 180°, and occupied St. Os 20. Crossing longitude 180° the date of July 10 was doubled. The bank was then traversed twice, again back westward and again eastward, four further hydrographic casts being made in the vicinity of the bank. The "Oshoro Maru" again steered for the north, going on before St. Os 27 was reached at 0810 on July 12. About this time the sea became rough; the hydrographic work at this station was very hard, angle of suspended wire reaching about 70 degrees. Heavy waves coming from south made impossible

the ship to steer for the east. At 0300 on July 13 she found herself located in a very low depression (985 milibar), and she was forced to continue southward sailing against the wind. When the wind changed to west at 1000 of this day she could steer for Bristol Bay, and was driven by the powerful stern wind, but no hydrographic observations could be carried out before St. Os 28 was reached on July 14. Sailing over to the north of the Pribilof Islands and occupying four shallow hydrographic stations the vessel reached Bristol Bay in the morning of July 16. There she met with the Japanese Crab-Fisheries Mother Ship, "Tôkei Maru," and anchored until the morning of July 19.

The "Oshoro Maru" approached Unimak Island, which lies at the end of the Alaska Peninsula, at dawn on July 20. It was the first sight of land so near since departure from Japan. Everybody on board was impressed by the snow-capped volcances on this island, *viz.*, Shishaldin, Poglomni, etc., shining in the growing morning light in what appeared a desolate neighbourhood. The ship sailed into the Pacific passing through Unimak Pass in the afternoon of this day. Three hydrographic stations were occupied in the Pacific before the ship reached about latitude 52° N. She must have traversed the great current rip in the south of Unimak Pass, as many birds and fur seals were accompanying her and many "bull kelps," *Nereocystis Lütkeana POST. et RUPR.*, were drifting here and there. Small jelly-fish were also abundantly seen in the sea; probably on account of that the samples in the fish-larva net emitted a considerable luminescence.

It was nearly always misty and cold in the Bering Sea, and on only a few days was the sun bright enough to enable men on board the vessel to enjoy basking on the deck, but later, on the course from Unimak Pass to the American coast, the atmosphere became warm and comfortable, though the weather was still often misty or rainy. The "Oshoro Maru" arrived at a point off Vancouver Island at about noon on July 27 and stopped engine until the next morning to adjust the day of arrival at Seattle. She anchored in Seattle for ten days from July 29 to August 8 for refueling and laying in supplies. All of the expedition members aboard the ship greatly enjoyed the stay in this city.

On the return voyage starting August 8 the course of the ship was set to follow a more southern route than the Great Circle course of the ocean liners. The return voyage was made in haste because one of crew suffered a heart attack on August 14 at sea; the hydrographic stations originally plannned in the western part of the northern North Pacific were not occupied. During the first half of the homeward course the ship suffered nearly constantly from heavy pitching because of head winds, but she arrived safely at her home port, Hakodate, on August 29.

The cruise covered 10370 miles in 60 days at sea in total; the approximate location of the track is illustrated in fig. 8.

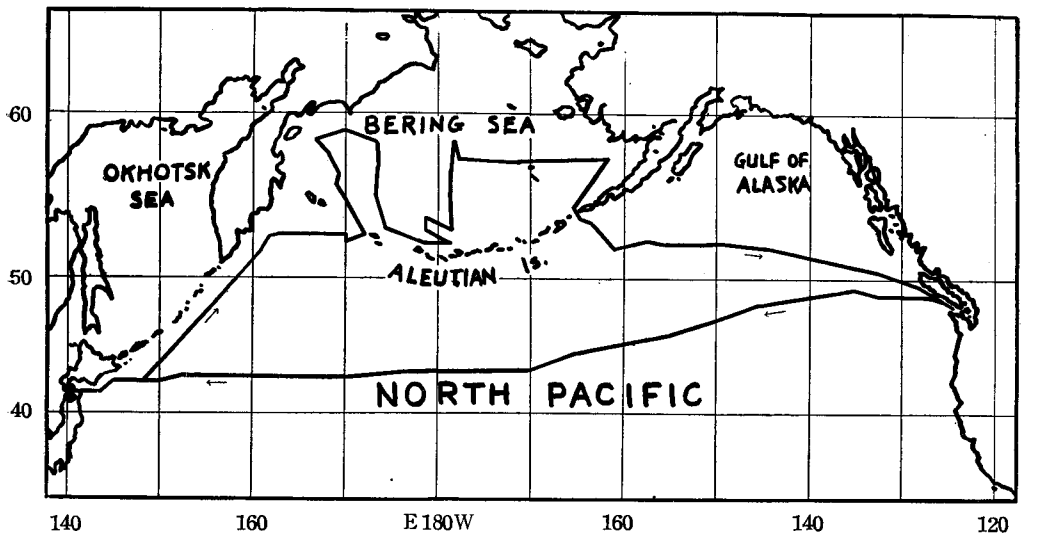

Fig. 8. Course of the "Oshoro Maru" on the present cruise

VI. Works Performed at Sea

Regular meteorological observations at every-three-hour interval were carried out at sea covering the whole course of the outward and homeward cruises under the responsibility of ship's officers. The surface water was dipped at every hour while underway for measurement of the temperature at the sea surface, while the surface water for determination of chlorinity was dipped four times a day.

The hydrographic stations occupied were 37 in total. The stations covered nearly the whole area of the Bering Sea, though they were very widely scattered, a few of them being located out of the Bering Sea.

The position of each hydrographic station was deduced by astronomical sight and made sure by Loran operations if available. Approximate location of the stations together with the track of the ship in the area investigated is illustrated in fig. 9. The exact position by degrees of latitude and longitude with date and time of hydrographic observations including plankton samplings is given in table 1. The hydrographic and biological stations occupied by the "Oshoro Maru" in the present cruise are denoted by adding the symbol "Os" preceding the numeral of the station for distinction from the stations occupied by ships of other institutions which took part in the Norpac Expedition.

The hydrographic casts were made at standard depths in Japan down to 1500 metre depth, once to 2000 metre depth except in the shallow waters in Bristol Bay; the standard depths in Japan are, 0, 10, 25, 50, 75, 100, 150, 200, 300, 400, 500, 600, 800, 1000, 1200, 1500, 2000 metres and deeper. On the "Oshoro Maru" the casts were made by keeping

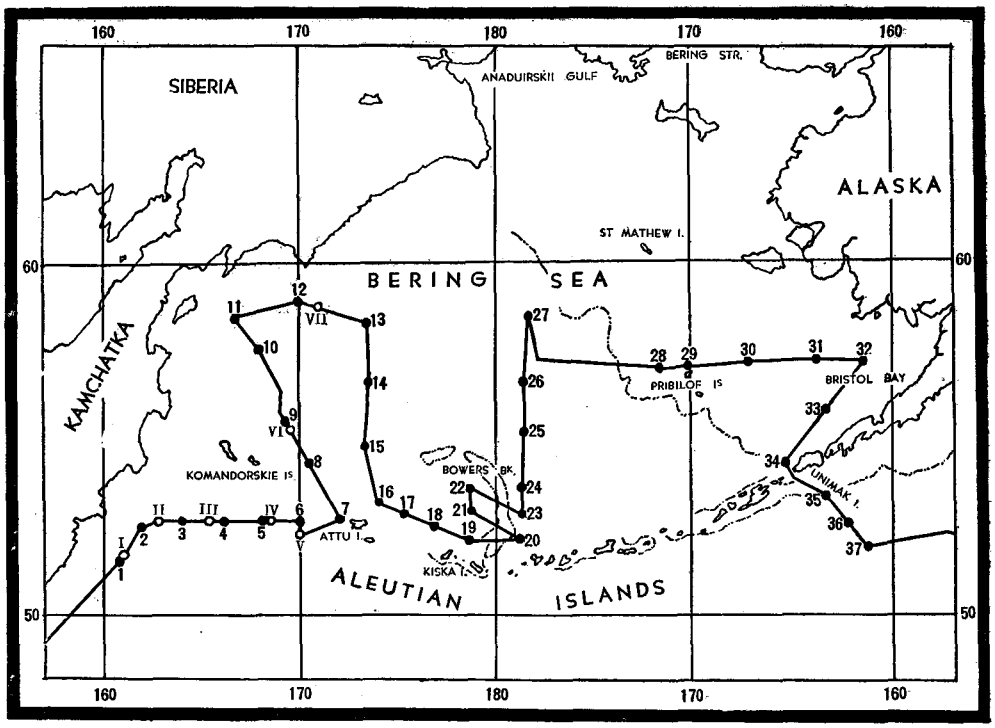

Fig. 9. Approximate location of position of hydrographic stations and gill-net set

● Hydrographic station (1—37)
o Gill-net set (I—VII)

Nansen bottles and thermometers at these depths as represented by wire length run out irrespective of inclination of wire suspended, *i. e.*, not by vertical distance from the surface. The shallow cast was made by hand winch on the main deck in front of the bridge and the deep cast by elctromotive winch on the upper deck at the stern. Ordinary Nansen bottles, which carried two protected reversing thermometers and one unprotected reversing thermometer, were employed for deep cast. In the shallow cast one or two protected thermometers were provided for each Nansen bottle and the unprotected thermometer was attached only on the deepest Nansen bottle at about 200 metre depth.

The water samples taken with Nansen bottles were employed for chemical analyses of the following matters:

Chlorinity of the samples from every depth at every station;
Dissolved oxygen in the samples from every depth at every station (unsuccessful at St. Os 1, 2 and 4);

Hydrogen-ion concentration of the samples from every depth at every station;
Alkalinity of the samples from every depth at 10 stations (St. Os 2, 4, 6, 8, 9, 11, 12, 13, 15, 27);
Phosphate in the samples from every depth at every station;
Silicate in the samples from every depth at 29 stations (St. Os 1-15, 21, 23, 25, 27-37);
Nitrate in the samples from every depth at 17 stations (St. Os 4-6, 8, 9, 11-14, 21, 23, 27, 30, 32, 35-37);
Suspended matters in the samples from every depth at every station;
Calcium in the samples from every depth at 7 stations (St. Os 2, 4, 6, 8, 10, 11, 13);
Particulate iron in the samples from every depth at 6 stations (St. Os 8, 10, 13, 15, 27, 36);
Total iron in the samples from every depth at 14 stations (St. Os 3, 4, 6, 8, 9, 11, 13, 20, 21, 23, 28, 30, 32, 37).

Dissolved oxygen, hydrogen-ion concentration, alkalinity, phosphate, silicate and calcium were analysed aboard ship immediately after the water was sampled, and the scattering intensity against the suspended matters in the water was also soon measured by means of a nepherometer; samples for nitrate were preserved by adding hydrochloric acid for analysis at the laboratory in the University. For determination of iron, the residue on the molecular filters was dried by exposing to infra-red lamp and brought to the University.

After returning from the voyage, at the request of Dr. Roger Revelle of the Scripps Institution of Oceanography, a part of the water samples remaining after chlorinity titration, was sent to the United States through the care of the Hydrographic Office for analysis of deuterium. These are samples from the following depths and stations:

St. Os 3: 0, 500, 1000, 1500 m (actually 0, 490, 977, 1455 m)
St. Os 7: 0, 500, 1000, 1500 m (actually 0, 492, 990, 1485 m)
St. Os 12: 0, 500, 1000 m (actually 0, 485, 984 m)
St. Os 19: 0, 600, 1000, 1500 m (actually 0, 443, 735, 1212 m)
St. Os 27: 0, 800, 1500 m (actually 0, 478, 1053 m)

The water samples from the following stations were put at the disposal of Prof. K. Sugawara of Nagoya University for analyses on the iodine, strontium and calcium.

St. Os 3: every depth
St. Os 13: every depth
St. Os 23: every depth
St. Os 37: every depth

For measuring the radio-activity of the sea water a litre of water was dipped from the sea surface at all stations, except St. Os 13 and 27 where the water was sampled from the surface and also from 50 metre depth.

The measurement of turbidity of sea water as it exists in nature was one of the projects in the present cruise. It was expected to find some indication of the nature of the water correlating to the amount of light obstructing substances suspended in the water. At all hydrographic stations a turbidity-meter was let down into the water to a depth of about 100 metres or more by means of cabtyre cord, and the relative value of the turbidity of sea water at various depths was recorded by the meter on the deck.

Plankton net hauls from 150 metre depth (from shallower in Bristol Bay) with a modified "Marutoku Net" were made at every station for estimating the abundance of zooplankton. As it has been experienced that net hauls made at the same place at nearly the same time often yield a considerable variation in amount of zooplankton (Motoda & Anraku, 1955), the net hauls in the present cruise were performed twice at each station; the first haul was made before beginning the hydrographic cast and the second haul after finishing that cast, about one hour and a half to two hours after the first haul.

For collecting the deep sea plankton for the sake of taxonomic interest a coarse mesh net (63 cm in mouth diameter) was once hauled at St. Os 8 by making separate vertical hauls, *viz.*, 2000–1000 m, 1000–500 m and 500–0 m, by means of a throttling mechanism using Discovery type of single release. These hauls were hardly successful; because of the lightness of weight (10 kg), which could not be increased due to the weak electric power of the winch, there occurred many kinks in the steel wire, so that the collection with such a large net had to be abandoned thereafter.

The "Twin Net" was always used for non-divided deep hauls from 1000 or 1500 metre depths once at each and every station on the occasion of the haul of the Nansen bottles. It was hauled together with the deepest Nansen bottle, so that there was no requirement of special time and labour for the haul. The collection yielded only qualitative samples.

A fine mesh net (20 cm in mouth diameter) was hauled twice vertically from about 50 metre depth at every station principally for the purpose of sampling the phytoplankton in the shallow layer. One of the samples thus collected will be used for studies on the distribution of phytoplankton communities, and another one was put for determining the chlorophyll content of phytoplankton. Colorimetric determination by means of phototube colorimeter was made immediately aboard ship. A small fraction of these samples from all of the stations was sent to Prof. H. Okuno of the Kyoto University of Textile Fibers for study on the electron-microscopic fine structures of diatoms.

In the hauls with the "Marutoku Net" and the fine mesh net, a current meter devised by Mr. Z. Nakai was used for recording the distance actually towed. When the ship is drifted by the wind for a certain distance during the operation of vertical haul of the net, the net would be hauled for a longer distance than the actual length of wire run out, so that the volume of plankton sampled would be increased as compared with the case of a haul in calm sea. For correction of this error the current meter was attached at a distance more than one metre above the mouth of the net (fig. 10). The filtration coefficient of the net was not determined because it is known that the current meter which is held at the center of mouth ring of net does not always rotate in exact correspondence to the amount of water filtered by the net; very different counts of the rotation of the current meter are got according to the absolute size of the net (Nishizawa

Fig. 10. Current meter set above the plankton net
C: Current meter

& Anraku, 1956).

More than 330 cc of the surface water were dipped at every hydrographic station and other fourteen positions while underway, but also from 0, 10, 25, 50, 75, 100, 150 and 200 metre depths at St. Os 8, Os 13, Os 23 and Os 27; these samples of water were preserved by adding formalin liquid. They have been put at the disposal of the planktologists in the Hakodate Marine Observatory for direct count of the microplankton.

During the whole cruise plankton samplings were made with the "Handy Underway Plankton Catcher, Model II" at the surface water while underway. The catcher was put out for towing just after starting from each hydrographic station in the Bering Sea, and twice a day in the morning and evening in the other sea areas. Duration of tow was kept to 20 minutes. Sum total of samples amounted to 102; these samples may be used for studies on the distribution of phytoplankton communities covering the whole area traversed.

A fish-larva net was towed at every station just after finishing the hydrographic cast and plankton net haul,and also at sunset covering the whole course of this cruise. The net was towed at the surface layer at a speed as low as about 2 knots for ten minutes keeping the net exposed to the extent of half of mouth ring above the sea surface. The tow was always supervised by Mr. K. Kobayashi. The total number of the sample vials obtained is 70.

Salmon gill-net operations were performed at seven different places in the western region (fig. 9). Only forty-four "Tan" (approximately 1970 metres in length and 5 metres in depth, made of Amilan having 12.5 cm of mesh length when stretched) of the net were used. The gill-net was usually set adrift in the evening and hauled in the early morning. During the set in the sea the net was disconnected from the ship, but watched on the ship by means of Radar which caught the reflection from the corner reflector placed on the buoy on the net (Ishida & Suzuki, 1954).

The fish caught with gill-net mainly comprised chum salmon, *Oncorhynchus keta*, (Shiro-zake), pink salmon, *O. gorbuscha*,(Karafuto-masu) and sockeye salmon, *O. nerka*, (Beni-zake), but sometimes spring salmon, *O. tschawytscha*, (Masunosuke), dolly vardon trout, *Salvelinus malma*, (Oshorokoma) and Atka-mackerel, *Pleurogrammus monopterygius*, (Kitano-hokke) were also captured. The position, date and hour of gill-net set, and the composition of fish species captured are given in table 2. From these specimens of fish usually 20 individuals per species were put to the measurement

of morphometric characters, observation of maturity, sampling of scales for later examination and sampling of stomachs for analysis of content. From a few specimens blood was sampled for biochemical studies of Asst. Prof. T. Kubo.

The diving dredge was twice employed on the shallow bottom in Bristol Bay and a few specimens of sea-stars, shrimps and molluscan shells were obtained. There was not enough time available to make any sufficient test with this dredge.

In the expectation of recording the offshore distribution of sea-birds, porpoises, fur seals, whales and other animals, eye observations at sea were recommended.

VII. Records of Eye Observations of Sea-Birds, Marine Mammals and Other Objects

The recording of eye observations on sea-birds and marine mammals, especially in areas rarely traversed, may be valuable for information regarding the seasonal distribution and migration routes of such creatures in the open ocean, for example, the reports by Moore (1951) are available on the oceanic birds in the western North Atlantic; otherwise only scanty data on the distribution of oceanic animals would be available. Recently J. D. Mac Donald published a report, "A sight record of Steller's albatross: Ibis." in Vol. 94, No. 3 (1952), Report of the World Voyage 1950-52 of H. M. S. Challenger.

In the present cruise every person on the upper deck or on the bridge, who became aware of sea-birds, porpoises, fur seals, whales or other objects in sight at sea, recorded his findings in the field book. Most of the members of the expedition were unaquainted with the birds and other animals inhabiting the open ocean and felt much difficulty in identifying the species of sea-birds flying at considerable distance and of whales by merely looking at their spout or a part of the body exposed above the sea surface for only a short time before they dived. The observations were of course made only haphazardly, not as systematically as, for instance, the observations at definite times on every day; likewise descriptions were often uncertain as to how many and exactly what species of birds or mammals were caught sight of.

Table 3 gives only fragmentary and rather unreliable records, which would scarcely be acceptable to ornithologists or mammalogists, but may include certain trustworthy records which may be useful when collected with data provided by other ships for this area. Mr. Togashi, ship's Purser, is an amateur ornithologist; he contributed many valuable observations on sea-birds. Sometimes he shot birds at sea, and the ship was steered to enable their bodies to be taken from the water for close examination.

Sea-birds and marine mammals observed at sea probably are:

Shearwaters:

Puffinus leucomelas, Streaked shearwater, Ĉ-mizunagi-dori
Puffinus griseus, Sooty shearwater, Haiiro-mizunagi-dori
Puffinus tenuirostris, Slender-billed shearwater, Hashiboso-mizunagi-dori

Storm petrels:
Oceanodroma leucorrhoa leucorrhoa, Leach's fork-tailed petrel, Koshijiro-umitsubame
Oceanodroma furcata, Grey fork-tailed petrel, Haiiro-umitsubame

Auks:
Aethia cristatella, Crested auk, Etorofu-umisuzume
Phaleris pusilla, Least auk, Ko-umisuzume
Synthliboramphus antiquus, Ancient auk, Umisuzume

Guillemots:
Uria columba columba, Pigeon guillemot, Umibato
Uria aalge inornata, Bering Island guillemot, Umigarasu or Roppen-chô

Puffins:
Lunda cirrhata, Tufted puffin, Etopirika or Ororon-chô
Fratercula corniculata, Horned puffin, Tsunome-dori

Skuas:
Stercorarius parasiticus parasiticus, Arctic skua, Kurotôzoku-kamome

Albatrosses:
Diomedea nigripes, Black-footed albatross, Kuroashi-ahôdori

Gulls:
Larus crassirostris, Japanese gull or Black-tailed gull, Umineko
Larus occidentalis, Western gull
Larus schistisagus, Slaty-backed gull, Ôseguro-kamome
Larus argentatus vegae, Vega herring gull, Seguro-kamome

Plovers:

Snipes:

Wild geese:

Wild ducks:

Migrant land birds:
Phylloscopus puscatus puscatus, Brown bush-warbler, Mujisekka

Whales:
Balaenoptera physalus, Common rorqual or Finback, Nagasu-kujira
Balaenoptera musculus, Sulphur bottom or Blue whale, Shironagasu-kujira
Physeter catodon, Sperm whale or Cachalot, Makkô-kujira

Marine mammals other than whales:
Eumetopias jubatus, Northern sea lion, Todo
Callorhinus ursinus, Northern fur seal, Ottosei
Phocaenoides dallii, Northern porpoise, Kita-iruka

On the basis of experience in two preceding cruises in this area, though it is not apparent from table 3, Mr. Togashi is of the opinion that tufted puffins are more common to the south of the Aleutian Islands than to the north, in summer, while the distribution of Bering Island guillemots seems to be the contrary. Slender-billed shearwaters are common in the Kuriles, while sooty shearwaters are common in the Bering sea in summer.

The appearance of storm petrels round a ship is regarded by superstitious mariners as foreboding a storm, and it is said that this is probably because the passage of a ship commonly leaves an area of calmer water in which it is easier for them to obtain food

(Alexander, 1928, p. 76). In the present cruise the appearance of fork-tailed petrels had no particular connection with stormy weather.

Black-footed albatrosses which are a common species in the North Pacific made their appearance when the "Oshoro Maru" sailed for the American coast along latitude 52° N — 48° N after passing out of the Bering Sea. A flock of them were playing around the ship very near, feeding on galley refuse. It is said that albatrosses are generally silent birds, but one day when the purser shot one of them to obtain its skin, the bird that was shot made grunting noises and other birds soon gathered together to escort it. It is a common belief that albatrosses follow a ship day after day for thousands of miles. After the departure from Seattle several individuals, varying in number day by day, of black-footed albatrosses did follow after the "Oshoro Maru" as far as about longitude 180° on August 19, about 2500 miles from Seattle; thereafter they began to fly at a distance from the ship for a few days and then disappeared. Alexander (1928) stated that the personnel of the albatrosses which follow a ship is constantly changing; steadily increased during the day till evening. Kuroda (1933) stated that the number of black-footed albatrosses following the ship was largest from the seventh to the tenth day after departure from Yokohama and that the number of birds was decreased between Honolulu and San Francisco, with increase in bad weather and decrease in calm sea. Such systematic observations in detail on the number of individuals and composition of personnel of albatrosses in sight were not performed on the present cruise.

Very lovely white gulls (western gull ?) followed the ship from Seattle. They often rested on the hand rail on the deck, without timidness for approaching man, but soon, on the third day after departure, they started back to their home land.

Northern fur seals and sometimes northern sea lions were coming near to the ship when the gill-net was hauled, to devour the salmon entangled in the net. While underway members of the staff were sometimes able to see them, especially often off the Pribilof Islands and in and the southern portion of Unimak Pass.

Acknowledgement

In behalf of all of the members participating in the present research cruise, the writers wish to express sincere gratitude to the staff of the University who have supported them from the beginning of the plan and encouraged them thereafter through the entire course of investigations. They deeply thank Dr. Y. Takenouti, Director of the Hakodate Marine Observatory, Ministry of Transportation, and Asst. Prof. H. Kotô, Asst. Prof. S. Mishima, the former Captain of the "Oshoro Maru", and Instructor S. Nishizawa of the University for their kindness in giving valuable advices as decisions were being made regarding the course of the cruise in the Bering Sea.

Thanks are also due to the Hydrographic Office, Maritime Safety Board, Ministry

Table 1. Position, date and hour of hydrographic observations and plankton samplings and depth of cast

No. of station	Ship's time		Greenwich time		Latitude	Longitude	Depth of sea bottom determined by echo-sounding (m)	Maximum depth of observation (m)
	Date	Hour	Date	Hour				
Os 1	June 26	1920~2130	June 26	0920~1130	51°—43′N	160°—30′ E	——	1440
Os 2	27	1423~1630	27	0423~0630	52°—52′N	161°—50′ E	——	1270
Os 3	28	1045~1300	28	0045~0300	53°—00′N	164°—00′ E	——	1455
Os 4	29	0724~0917	28	2024~2217	53°—01′N	166°—00′ E	——	1447
Os 5	29	1723~1927	29	0623~0827	53°—00′N	168°—00′ E	——	1431
Os 6	30	1352~1530	30	0252~0430	53°—02′N	170°—00′ E	——	1482
Os 7	July 1	1400~1530	July 1	0300~0430	53°—02′N	172°—00′ E	——	1485
Os 8	2	0330~0710	1	1630~2010	54°—30′N	170°—33′ E	——	1989
Os 9	3	0535~0830	2	1835~2130	55°—58′N	169°—11′ E	——	1239
Os 10	4	0930~1106	3~4	2230~0006	57°—41′N	167°—59′ E	——	1456
Os 11	4	1910~2050	4	0810~0950	58°—29′N	166°—32′ E	——	1321
Os 12	5	1405~1525	5	0305~0425	59°—00′N	170°—00′ E	1150	984
Os 13	6	1230~1605	6	0130~0505	58°—30′N	173°—15′ E	——	1460
Os 14	7	0540~0705	6	1840~2005	56°—54′N	173°—17′ E	——	1403
Os 15	7	1937~2102	7	0837~1002	55°—10′N	173°—17′ E	——	1400
Os 16	8	0930~1103	7~8	2230~0003	53°—25′N	173°—38′ E	——	1338
Os 17	8	1720~1848	8	0620~0748	53°—10′N	175°—04′ E	——	1353
Os 18	9	0250~0434	8	1550~1734	52°—50′N	176°—56′ E	——	1331
Os 19	9	1210~1310	9	0110~0210	52°—28′N	178°—40′ E	——	1212
Os 20	9~10	2335~0155	9	1135~1355	52°—30′N	178°—54′ W	——	1205
Os 21	10	1655~1913	10	0455~0713	53°—14′N	178°—40′ E	——	1428
Os 22	10′	0020~0138	10	1220~1338	53°—54′N	178°—40′ E	——	1387
Os 23	10′	1220~1353	11	0020~0153	53°—03′N	178°—52′ W	——	1465
Os 24	10′	1920~2100	11	0720~0900	53°—50′N	178°—52′ W	——	1474
Os 25	11	0830~0952	11	2030~2152	55°—34′N	178°—48′ W	——	1329
Os 26	11	1915~2042	12	0715~0842	57°—00′N	178°—58′ W	——	1466
Os 27	12	0810~1115	12	2010~2315	58°—49′N	178°—43′ W	——	1053
Os 28	14	1005~1030	14	2205~2230	57°—16′N	171°—50′ W	105	95
Os 29	14	1645~1705	15	0445~0505	57°—27′N	170°—11′ W	62	50
Os 30	15	0520~0535	15	1720~1735	57°—26′N	167°—05′ W	65	50
Os 31	15	1750~1815	16	0550~0615	57°—23′N	163°—58′ W	59	50
Os 32	16	0500~0600	16	1600~1700	57°—16′N	161°—40′ W	54	50
Os 33	19	1945~2015	20	0645~0715	56°—04′N	163°—15′ W	82	75
Os 34	20	0940~1015	20	2040~2115	54°—46′N	165°—19′ W	170	147
Os 35	20	2220~2350	21	0920~1050	53°—40′N	163°—31′ W	1630	1482
Os 36	21	0625~0800	21	1725~1900	52°—58′N	162°—19′ W	——	1470
Os 37	21	1430~1620	22	0130~0320	52°—15′N	161°—09′ W	——	1492

Table 2. Position, date and hour of gill-net set and number of fish captured

No. of gill-net set	Position	Date and hour in ship's time		Nuber of individuals of fish captured					
		Net set	Net haul	Chum salmon	Pink salmon	Sockeye salmon	Spring salmon	Dolly vardon trout	Atka-mackerel
F 1	51-43N 160-31E	June 26 1851	June 27 0421	65	14	11	0	4	0
F 2	52-56N 162-28E	27 1951	28 0446	79	85	27	0	1	0
F 3	53-01N 165-14E	28 1921	29 0441	101	43	98	1	0	0
F 4	53-02N 168-00E	29 1954	30 0510	96	37	41	1	0	5
F 5	52-39N 170-00E	30 1921	July 1 0517	71	40	18	0	0	0
F 6	55-51N 169-10E	July 2 1925	3 0507	27	70	41	0	0	0
F 7	58-49N 171-12E	5 2042	6 0434	83	125	2	2	22	0

Table 3. Sight records on sea-birds, marine mammals, etc.

Date	Hour (Ship's time)	Position	Regions	Weather	Air temp. (C)	Sea surface temp. (C)	Objects in sight	Observer
June 22	1900	42-24N, 145-57E	Off Hokkaido	r	8.5	8.3	3 whales	S. Abe
23	0730	42-26N, 148-21E	〃	o	7.9	6.8	5 porpoises	S. Motoda & K. Kobayashi
〃	1245	43-17N, 149-03E	〃	b c	9.0	9.1	1 fur seal	K. Masuda
〃	2200	44-16N, 150-19E	Off Kuriles	b c	7.2	8.4	Wake prominently luminescent, very fine particles	S. Motoda
24	0850	45-28N, 151-56E	〃	c	6.8	6.2	2 sperm whales	S. Abe
〃	0930	45-29N, 151-58E	〃	c	6.8	6.2	6-7 sperm whales	S. Saito
〃	1230	45-54N, 152-30E	〃	d	5.6	3.8	3 porpoises	K. Masuda
〃	1345	45-58N, 152-35E	〃	d	6.1	5.5	1 whale (not sperm whale)	K. Masuda
25	0535	47-45N, 154-56E	〃	o	5.3	5.4	5-6 porpoises	S. Nishiyama
〃	1900	49-20N, 157-57E	〃	c	5.0	6.2	3 whales, more than 10 porpoises	S. Abe
〃	2000	49-26N, 157-19E	〃	c	4.9	5.3	Russian whale catcher boat	T. Fujii
〃	2200	49-46N, 157-39E	〃	o	4.3	6.2	Wake prominently luminescent	S. Motoda
26	0300	50-19N, 158-26E	〃	o	4.0	6.4	1 streaked shearwater, 5-6 Bering Island guillemots	A. Togashi
〃	0530	50-38N, 158-50E	〃	f	3.9	6.1	2 pigeon guillemots, 1 crested auk	A. Togashi
〃	0800	50-48N, 159-06E	〃	f	4.0	5.4	1 brown bush-warbler, migrant	A. Togashi
〃	2030	51-43N, 160-30E	Off Kamchatka	f	4.1	6.2	Flocks of Leach's fork-tailed petrels	A. Togashi
27	0300	51-50N, 160-33E	〃	f	4.0	5.8	2 slender-billed shearwaters, 5-7 sooty shearwaters	A. Togashi
〃	0500	51-55N, 160-43E	〃	f	5.0	5.9	2 slaty-backed gulls, 2 pigeon guillemots	A. Togashi
〃	1310	52-46N, 161-58E	〃	b c	9.9	6.8	3 whales (not sperm whales)	K. Masuda
〃	1700	52-52N, 162-05E	〃	b c	7.0	6.2	Bering Island guillemots, black-tailed gulls, slender-billed shearwaters	S. Motoda
28	0300	52-56N, 162-41E		b c	7.2	6.2	Sooty shearwaters, slender-billed shearwaters, slaty-backed gulls	A. Togashi
〃	0700	52-59N, 162-55E		b c	9.1	7.0	1 pigeon guillemot	A. Togashi
29	1800	53-00N, 168-00E		c	5.9	5.9	1 slaty-backed gulls, Bering Island guillemots	A. Togashi
〃	1930	53-00N, 168-00E		c	6.1	5.3	1 Leach's fork-tailed petrel, 5 Bering Island guillemots	A. Togashi
30	0500	53-00N, 167-55E		f	5.5	5.2	3 shearwaters, 1 streaked shearwater	A. Togashi
〃	1200	53-00N, 169-34E		o	8.9	5.4	3 slaty-backed gulls	A. Togashi
〃	1330	52-55N, 169-40E	Near Attu I.	c	8.2	5.9	1 Bering Island guillemot	A. Togashi
July 1	0600	52-41N, 170-08E	〃	f	4.6	5.2	Tufted puffins	S. Motoda
〃	0800	52-45N, 170-36E	〃	f	5.2	5.1	2 sperm whales	S. Abe
〃	1400	53-04N, 172-00E	〃	o	6.6	5.5	2-3 whales	K. Masuda
July 3	0500	55-38N, 169-10E	Off Komandorskii Is.	o	4.8	5.0	1 fur seal, 1 tufted puffin, 3 vega herring gulls, 1 shearwater, 1 fork-tailed petrel	A. Togashi
〃	0630	55-38N, 169-10E	〃	o	4.8	5.0	3 horned puffins	A. Togashi
5	0500	58-43N, 168-00E	Off Oliutorsk	o	5.0	5.0	No bird	A. Togashi
〃	1900	58-54N, 170-45E	〃	f	5.2	4.3	5-6 shearwaters, 2 gulls	A. Togashi
6	0500	58-46N, 171-30E		o	3.8	4.4	1 fur seal, 1 sea lion, 7 sooty shearwaters, 2 gulls	A. Togashi
7	0500	56-48N, 173-16E		f	4.5	5.0	No bird	A. Togashi
8	0600	53-39N, 173-17E	Near Attu I.	o	5.5	5.4	10 shearwaters	A. Togashi
〃	2200	53-02N, 176-01E	Near Kiska I.	o	5.3	4.9	Luminescence of plankton, indistinct	S. Motoda
9	0430	52-50N, 176-58E	Bower's Bank	o	5.0	5.0	1 sperm whale	S. Nishiyama
〃	2200	52-31N, 178-53W	〃	o	5.8	5.6	Tufted puffins	S. Motoda
11	0900	55-34N, 178-48W	〃	b	9.0	6.1	Flocks of grey fork-tailed petrels, sooty shearwaters and slender-billed shearwaters	S. Motoda
〃	2000	57-30N, 178-58W	〃	b c	7.2	6.4	Bulk of small young squids in fish-larva net	K. Kobayashi
12	0900	58-49N, 178-43W		o	6.3	6.8	Flocks of grey fork-tailed petrels and sooty shearwaters	S. Motoda
14	0900	57-17N, 172-00W		o	6.1	6.3	Many pigeon guillemots and tufted puffins	S. Motoda
〃	1650	57-27N, 170-11W	Near Pribilof Is.	f	5.8	6.2	Fur seals, pigeon guillemots	K. Kobayashi & K. Maeda
〃	1800	57-28N, 170-02W	〃	f	6.0	6.1	12 fur seals and 1 sea lion during 30 minutes	S. Abe
〃	2200	57-27N, 168-42W	〃	o	6.2	5.9	Luminescence of plankton, indistinct	S. Motoda
20	0800	54-17N, 164-49W	Near Unimak I.	b c	9.3	8.9	1 tufted puffin, many pigeon guillemots, many fork-tailed petrels	A. Togashi
〃	1400	54-12N, 164-45W	Unimak Pass	f	8.6	6.4	5-7 plovers, many grey fork-tailed petrels, many shearwaters, many vega herring gulls, many pigeon guillemots, many tufted puffins, 1 wild goose, 1 auk, gulls, many fur seals, ca 30 groups of sea lions ; a group composed of 10-30 individuals	K. Masuda & A. Togashi
〃	1900	54-03N, 164-08W	Off the south of Unimak I.	f	9.5	9.0	Fur seals frequently, many bull kelps, many jelly fish, luminescence of considerable size, but luminescence in wake indistinct	S. Motoda
21	2200	52-18N, 160-21W	North Pacific	f	11.0	10.2	Luminescence of plankton, indistinct	S. Motoda
22	0800	52-24N, 157-42W	〃	f	11.2	10.4	Black-footed albatrosses, tufted puffins	S. Motoda
〃	2200	52-18N, 153-42W	〃	c	10.3	9.5	Luminescence of plankton, indistinct	S. Motoda
23	2200	52-36N, 147-30W	〃	f	10.0	10.1	Luminescence of plankton, indistinct	S. Motoda
24	0800	52-33N, 144-59W	〃	o	9.2	10.0	5-6 black-footed albatrosses	S. Motoda
〃	2200	51-41N, 140-17W	〃	o	11.0	10.5	Luminescence of plankton, indistinct	S. Motoda
25	0800	51-24N, 138-48W	〃	b c	12.3	11.2	5-6 black-footed albatrosses	S. Motoda
July 26	0800	50-36N, 133-27W	North Pacific	o	12.2	12.8	1 Leach's fork-tailed petrel, 1 wild goose, 1 snipe, 4 black-footed albatrosses	A. Togashi
27	0800	49-56N, 128-16W	Off Vancouver I.	c	14.0	13.9	More than 10 black-footed albatrosses	S. Motoda
August 8	1600	47-59N, 123-18W	Juan de Fuca Str.	b	12.8	10.5	5-6 white gulls	S. Motoda
9	0800	48-27N, 126-32W	Off Vancouver I.	b	14.0	13.6	5-6 white gulls, 2 black-footed albatrosses follow the ship	S. Motoda
10	0800	48-39N, 131-56W	North Pacific	o	13.5	14.0	No gull, 2-3 black-footed albatrosses follow the ship	S. Motoda
11	0800	48-45N, 136-44W	〃	o	11.8	12.1	Petrels, black-footed albatrosses follow the ship	S. Motoda
12	0800	48-23N, 141-48W	〃	o	12.0	12.6	12 black-footed albatrosses follow the ship	S. Motoda
13	0800	47-55N, 146-10W	〃	o	12.8	12.1	Black-footed albatrosses follow the ship	S. Motoda
14	0800	47-12N, 150-19W	〃	o	11.2	13.0	Black-footed albatrosses follow the ship	S. Motoda
〃	1700	46-39N, 152-33W	〃	o	12.5	13.7	Sunfish basking at the surface	S. Nishiyama
15	0800	46-10N, 155-00W	〃	f	14.5	14.9	Black-footed albatrosses follow the ship	S. Motoda
16	0800	45-28N, 159-35W	〃	f	17.5	16.8	Black-footed albatrosses follow the ship	S. Motoda
〃	1150	45-22N, 160-18W	〃	o	18.7	16.9	5-6 finback whales	S. Abe
17	0800	44-52N, 164-03W	〃	o	16.0	18.1	6-7 black-footed albatrosses follow the ship	S. Motoda
〃	1540	44-32N, 165-30W	〃	o	15.8	18.3	1 sperm whale	S. Nishiyama
18	0800	43-31N, 169-03W	〃	o	16.6	19.4	Black-footed albatrosses follow the ship	S. Motoda
〃	1600	43-13N, 169-43W	〃	c	18.2	20.4	5-6 sperm whales	S. Nishiyama
〃	1600	43-13N, 169-43W	〃	c	18.2	20.4	Lantern fish flying onto the deck	K. Kobayashi
〃	1730	43-11N, 171-02W	〃	c	17.9	19.9	5-6 porpoises	S. Nishiyama
〃	1743	43-11N, 171-05W	〃	c	17.8	19.6	Swordfish (?)	S. Nishiyama
19	0800	43-07N, 174-10W	〃	b c	19.0	19.1	Black-footed albatrosses follow the ship, Streaked shearwaters	S. Motoda
20	0800	43-08N, 179-08W	〃	c	23.2	21.7	2 black-footed albatrosses at a distance from the ship	S. Motoda
22	0800	43-05N, 175-42E	〃	b c	21.2	21.5	2 black-footed albatrosses at a distance from the ship	S. Motoda
23	0800	42-57N, 171-04E	〃	b c	20.0	20.1	2 black-footed albatrosses at a distance from the ship	S. Motoda
25	0530	42-51N, 162-08E	〃	f	20.0	18.6	1 swordfish, 1 shark	S. Nishiyama
〃	0800	42-50N, 161-38E	〃	f	20.4	18.8	No albatross	S. Motoda
26	1900	42-47N, 154-50E	〃	d	21.5	21.0	Large swarm of *Doliolum* by examining fish-larva net sample	K. Kobayashi
27	0800	42-45N, 152-11E	〃	f	19.0	16.7	No bird	S. Motoda
〃	0950	42-45N, 151-28E	〃	c	19.6	17.4	A group of sperm whales	S. Motoda

Symbols of weather : b. Blue sky c. Cloudy bc. Partly clouded d. Drizzling rain f. Fog o. Overcast

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