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THE KUROSHIO AND ITS BRANCH CURRENTS IN
THE SEAS ADJACENT TO HACHIJO ISLAND IN
RELATION TO FISHERIES. (REPORT I)

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THE TOKYO UNIVERSITY OF FISHERIES

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The following report illustrates some of the results obtained in the cooperative biological and oceanographic researches in the waters adjacent to Hachijō Is. during the fiscal years 1951 and 1952. A summary of the research programs carried out is given in Table I.

Table I

* All chlorine titration of sea water samples was carried out by the experts in the Tokai Regional Fisheries Expt. St. under the inspection of Mr. R. Fukai.

NO	Time	Research Ship (Organ.)	Locality	Survey
1	May, 18-22, 1951	Shunkotsu-Marū (Tokyo University of Fisheries)	Around Hachijō Is.	Measurement by current-float & oceanographic observations (Dr. Niino)
	" , 18 20, 1951	Takunan-Marū (Hachijō Fish. Expt. St.)	"	
2	July, 17-18, 1951	Shinyo-Marū (Tokyo University of Fisheries)	"	" (Dr. M. Uda)
	" , 11-12, "	Takunan-Marū	"	" (Dr. T. Saito)
	" , 17-18, "	(Tokai Regional Fisheries Experimental Station)*	"	" (Mr. T. Hirano)
3	Feb., Mar., 1952	Tokyo University of Fish.	Sagami-Coast	" (M. Uda)
	Feb. 6,—Mar. 2, "	4 Kaiyo-Marū (Hydr. Dept.)	Kuroshio Area	"
	Feb. 16-22, "	(Hachijō Fish. Expt. St.)	Around Hachijō	" (Mr. Kanno)
4	July, 24-29, "	Shinyo-Marū (Tokyo University of Fisheries)	Sunosaki— Hachijō— Aogashima	" (M. Uda, T. Hirano)
5	Aug., 9-20, "	Tonan-Marū (Tokyo Fish. Expt. St.)	Kuroshio & Hachijō Area	" Current-meter (M. Uda, N. Watanabe)
	Aug., 16-22, "	Umitaka-Marū (Tokyo University of Fisheries)		
6	Sept., 3-8, "	Tateyama Laboratory (Tokyo University of Fisheries)	S-W of Hachijō	Model Expt. (M. Uda, Mr. M. Ishino) Drift Subst.
	Sept. 16- "	Shinyo-Marū, The Patrol ships of the Maritime Safety Agency.		

1. *The Survey of 18-22, May 1951.* Referring to Fig. 1, the currents in May show the comparatively stronger period of warm current and in some degree the after-effect of the winter monsoon. Corresponding to the Kuroshio with its axis displaced to north, a counter current appears strongly in the seas neighbouring Hachijō Is. Accordingly, turning from a SE direction towards S, then to SW and at last to

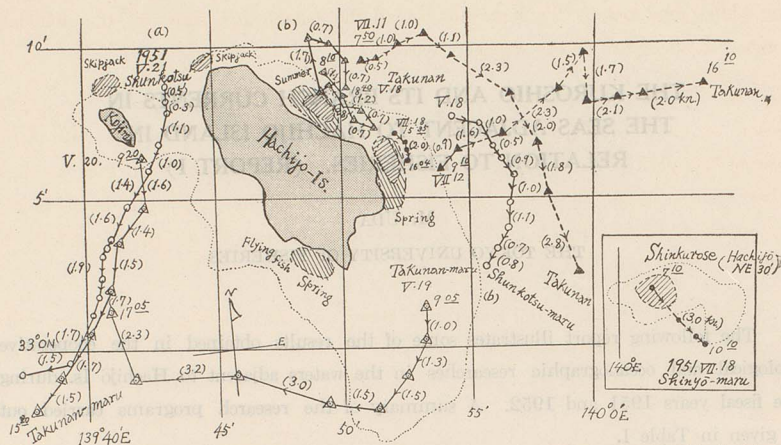


Fig. 1. Currents in May and July, 1951 around Hachijo Is. (Current-float Expt.) & fishing grounds. (●) Skipjack (⊗) Flyingfish (⊖) Sypsilurus agoo (Temminck et Schlegel)

a westerly direction, Kuroshio branches flow around Hachijo. One branch of the stream-lines (a) from the region NW of Hachijo flows in a southerly direction through the channel between Hachijo Main Island and Kojima. Repeated current measurements by means of current-floats on 20 and 21 May show almost the same velocities, 1.5-1.7kn. and 0.6-1.9kn. respectively, and nearly the same trajectories. The other branch of stream-lines (b) shows the current flowing clockwise along the eastern margin of the insular shelf (near the 200 m isobath) with a velocity of 0.7-1.1 kn. and turning to a westerly direction off the southern side of the Is. with the considerably rapid velocity of 1.0-3.4 knots. Then both stream-lines (a) and (b) meet again in the region SW of Hachijo Is. at approximately 33°-00'N, 139°-40'E. There are eddies along the coast of the Island on the southern insular shelf and to the north off Kanminato. Especially in the latter area, the loop-like trajectory of the current-float of May 18th shows clearly the influence of the tidal current (of semi-diurnal nature).

Soon after the finish of the flying-fish season (Feb. 22-May 15 in 1951, poor drift gillnet catch of 1,400,000 kwan against the abundant catch of 2,400,000 kwan in 1950) in the spring our survey was conducted and the surface water temperature of 22.0-23.5° C, its salinity of 34.67-35.00‰ and its transparency of 20-30 m were obtained. It seems that the southern waters off Hachijō Is. possess a higher water temperature, salinity and transparency than do those waters to the north of the Island.

From our survey and the investigations made by the Fisheries Agency in Hachijo Is., we can conclude that the favourable fishing grounds of flying-fish correspond to

the eddies produced by the Kuroshio catches in the year.

2. The Season of Bai-U Current. The season of Bai-U current was carried out in 1951. After the Kuroshio current stream-lines enveloped Hachijo Is. (33°-57' E).

Rather than the Kuroshio which flows along the flying-fish are found offshore southeast of Hachijo ground, however, approaches.

In this season the surface water temperature was 26.0° C, salinity 34.67-35.00‰ and its transparency 100-200 m depth.

In July, 1951, the surface layer of the Kuroshio current season (Bai-U) approached Hachijo Is. with the warm current. The Kuroshio current was an easterly current along the coast of Hachijo Island obtaining a velocity of 1.0-3.4 knots. (See Fig. 1).

The rapid flow of the Kuroshio current along the stream-lines of the Kuroshio current.

3. Abnormal Inflow. The repeated inflow of the Kuroshio current (half day after the passage of the Kuroshio) before the passage of the Kuroshio current. The yellow-tails along the coast of Hachijo Is. on the occasion of the current. The boat Takunan-Maru was at the fishing ground of the Branch Station of Hachijo Is. on the occasion of the abnormal inflow of the Kuroshio current.

the eddies produced by the Kuroshio behind the Island and show in the abundant catches in the years of the stronger Kuroshio.

2. *The Survey of July 1951.* At a date corresponding to the closing season of Bai-U (monsoon rain in the orient), the second survey on the state of the current was carried out with a result which is very different from that above 1. After the Kuroshio approaches from the west or southwest to Hachijo Is. its branch stream-lines envelope the Is. and then meet again behind it at about ($39^{\circ}-07' N$, $139^{\circ}-57' E$). (See Fig. 1)

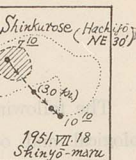
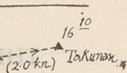
Rather than being in the transparent water with the cobalt-blue tint of the warm Kuroshio which approaches the west coast, the fishing grounds of the summer flying-fish are found in the coastal eddies off the eastern coast produced by the offshore southeast-going current and its coastal counter current. The skipjack fishing ground, however, lies in the region near the capes toward which the warm current approaches.

In this season measurements showed the surface water temperature to be $25.0-26.0^{\circ} C$, salinity above the 50 m depth to be $34.0-34.5\%$ and in the layer of the 100-200 m depth to be $34.7-34.8\%$, and transparency to be 23-32 m.

In July, compared to May, the rise in temperature and the drop in salinity in the surface layer are remarkable owing to the abundant precipitation in the rainy season (Bai-U) and also to the intensified sunshine in early summer. In this season the warm current attains its maximum intensity of the year (1-3 kn) and shows as an easterly current at the north of Hachijo and as a SE current to the east of the Island obtaining a velocity of 3 kn. in the direction $S40^{\circ}E$ over Shin-Kurose Bank. (See Fig. 1).

The rapid fluctuation of the Kuroshio in the season is evident in the contrast of the stream-lines of July 11 and July 12.

3. *Abnormal Fluctuation of the Kuroshio in the Winter of 1952.* The repeated inflow of the storm current from the offing into Sagami Bay on Feb. 8-9 (half day after the passage of the cyclone 1008 mb) and on March 27-28 (one day before the passage of the cyclone 1010 mb) washed out the set-nets arranged to catch yellow-tails along the coast of Sagami Bay and caused severe damage. On the same occasion the currents in the waters adjacent to Hachijo were observed by the fishing boat Takunan-Marun, belonging to the Hachijo Fisheries Experimental Station (the Branch Station of the Tokyo Fish. Expt. St.) and were as shown in Fig. 2a, 2b. An abnormal inflow of the Kuroshio current from the SW direction towards the south



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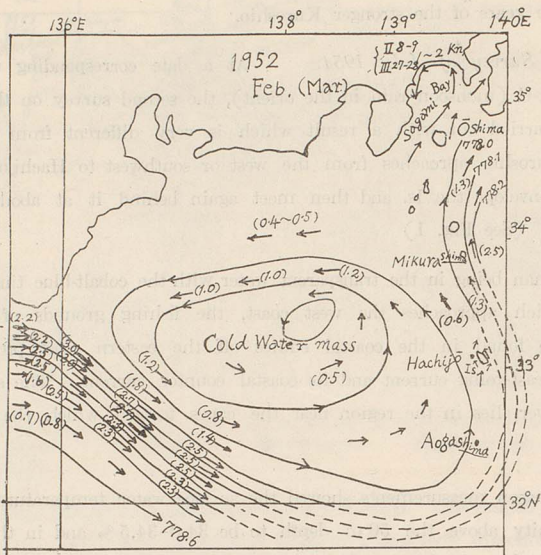


Fig. 2a. Currents in winter of 1952. (Mainly from Kaiyo-Maru, No. 4 Hydr. Dept.) (vel. in knot)

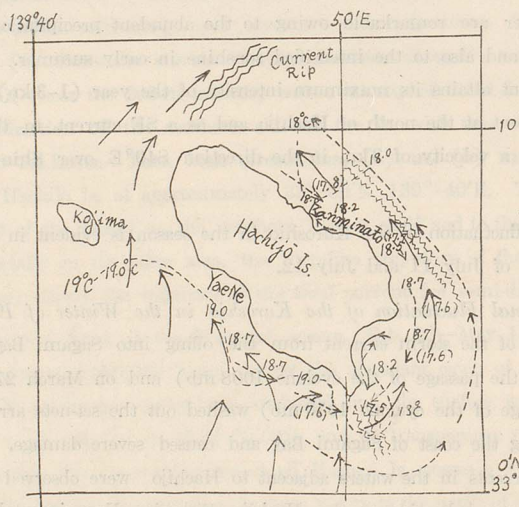


Fig. 2b. Currents around Hachijō Is. in winter of 1952 by Takunan-Maru (→ II. 18, 1952. --- II. 22, 1952. ~~~ Curr. Rips) with surface water temp. (II. 18... no parentheses. II. 22... () figure)

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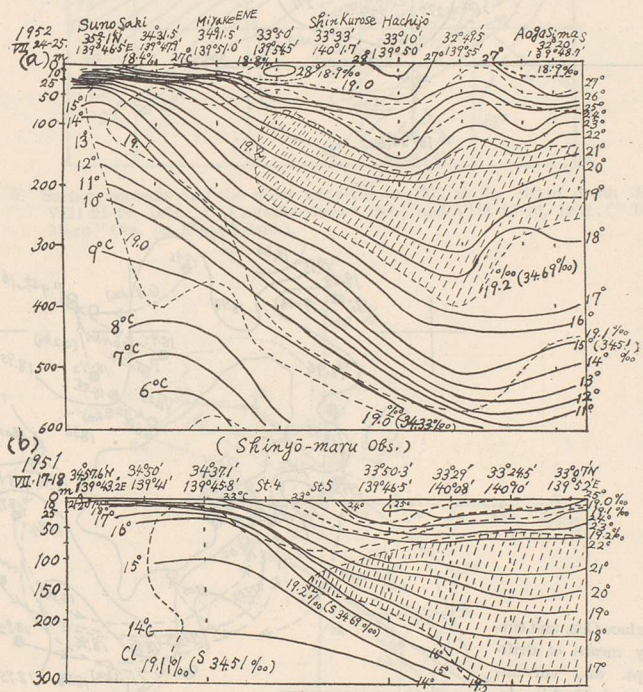
Fig. 3a, b. H

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coast of Hachijo on Feb. 18 and on Feb. 22 is indicated, showing an abrupt change of the current pattern.

According to the survey from Feb. 6 to March 2, 1952 carried out by the Kaiyo-Maru No. 4 belonging to the Japanese Hydrographic Dept*, after the counterclockwise flow around the temporarily developed cold water mass lying south off Enshū-Nada in the winter of 1952, the Kuroshio showed a violent inflow to the north directly from the region south-west of Hachijo Is. into the innermost portions of Sagami Bay. Presumably we may conclude that the above mentioned storm current along the coast of Sagami Bay is due to this abnormal northern inflow of the Kuroshio. However, in the spring (April—May) of 1952 the recovery of the Kuroshio to the normal state was proved by a survey of the same research boat*.

4. The Survey of July 24-29, 1952. The survey made by the Shinyo-



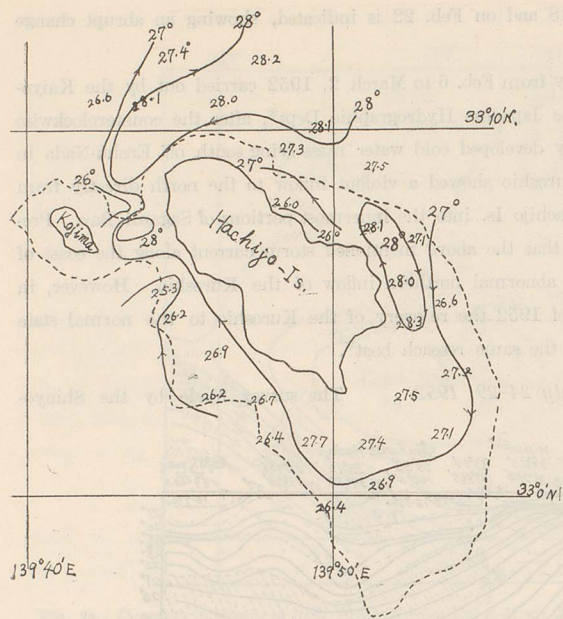


Fig. 4a. Surface water temp. ($^{\circ}\text{C}$) around Hachijo Is. On July 26, 1952. ("Shinyo-Maruo Obs.")

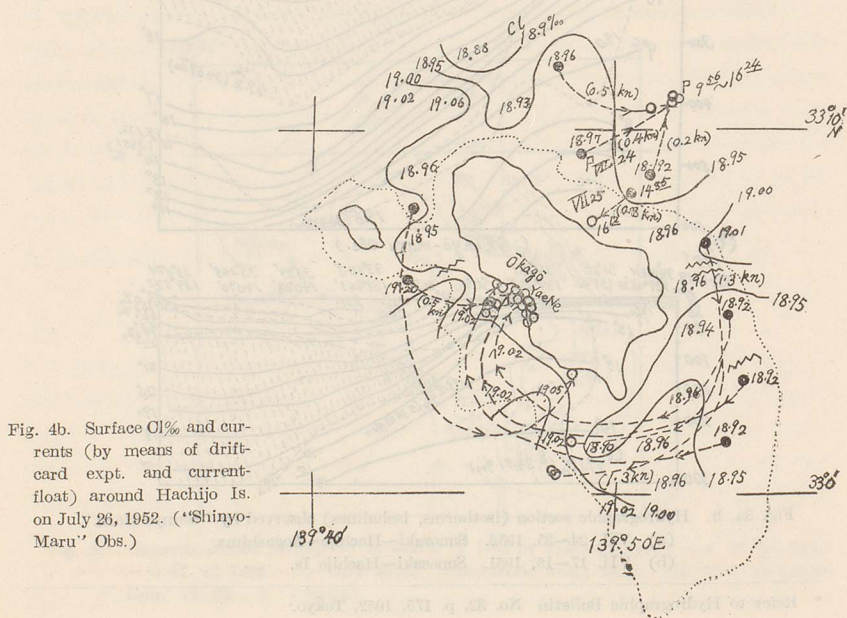


Fig. 4b. Surface Cl% and currents (by means of drift-card expt. and current-float) around Hachijo Is. on July 26, 1952. ("Shinyo-Maruo" Obs.)

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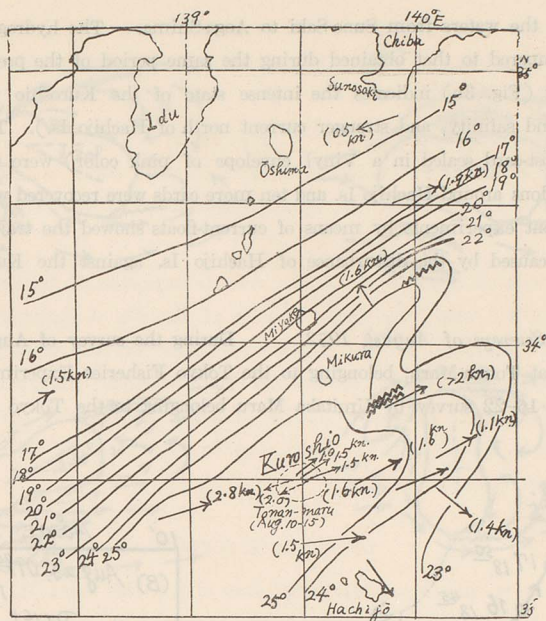


Fig. 5. Surface currents and the water temperature ($^{\circ}\text{C}$) at the 100 m depth during VIII 21-24, 1952. ("Umitaka-Mar" Obs.) and VIII 10-15, 1952. ("Toman-Mar" Obs. on Kurose Bank).

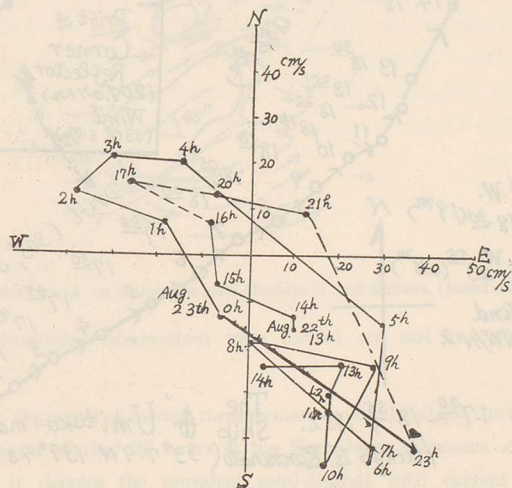
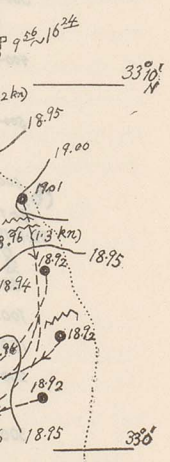


Fig. 6. Currents obtained by means of Ekman Current-meter (No. 4-35) at Kanminato ($33^{\circ}07.9' \text{N}$, $139^{\circ}48.7' \text{E}$) Hachijo Is. on Aug. 22-23, 1952. ("Umitaka-Mar" Obs.)

Maru covered the waters from Suno-Saki to Aoga-Shima. The hydrographic section (Fig. 3a) compared to that obtained during the same period of the previous year by the same boat (Fig. 3b) indicates the intense state of the Kuroshio (higher water temperature and salinity, and stronger current north of Hachijo Is.). Three hundred drift-cards (post-card sealed in a Vinyl envelope of pink color) were thrown in the sea at 15 stations around Hachijo Is. and ten more cards were recovered which with the result of current experiments by means of current-floats showed the trajectories of the wake-streams caused by the disturbance of Hachijo Is. against the Kuroshio (Fig. 4a, b).

5. *The Surveys of August, 1952.* During the survey of August 9-20 by the fishing boat Tonan-Maruru, belonging to the Tokyo Fisheries Experimental Station, and the Aug. 16-22 survey by Umitaka Maru belonging to the Tokyo University of

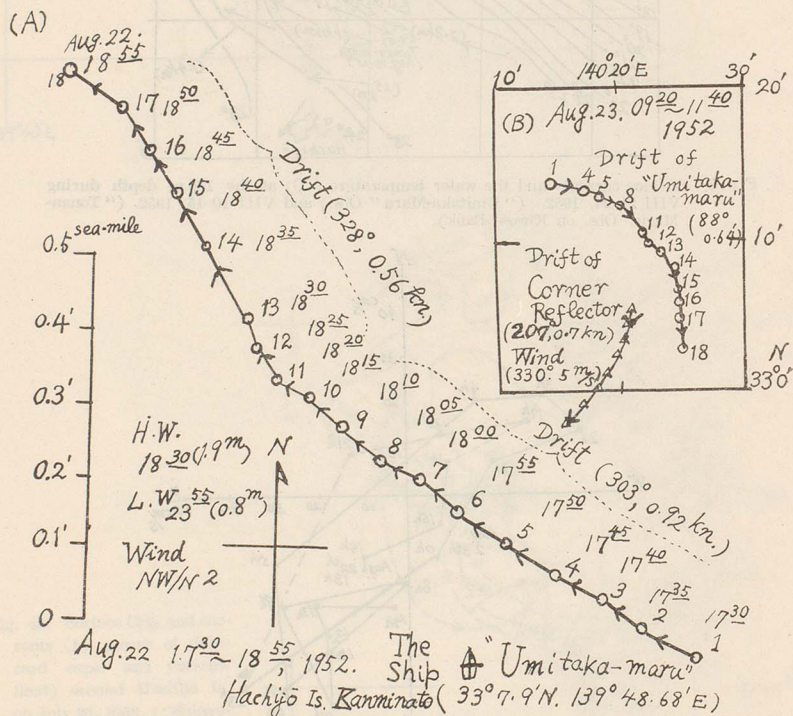


Fig. 7. Drift of the current-floats with corner-reflector observed by means of RADAR on board of "Umitaka-Maruru" (Chief officer K. Ozawa) on Aug. 22-23, 1952 at Hachijo Kanminato.

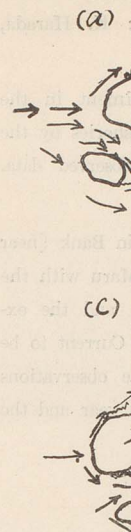
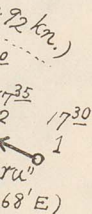
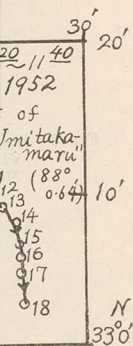


Fig. 8. Fisheries hydrographic section was obtained. Based on Merz current chart constructed, coincides well with preceding year.

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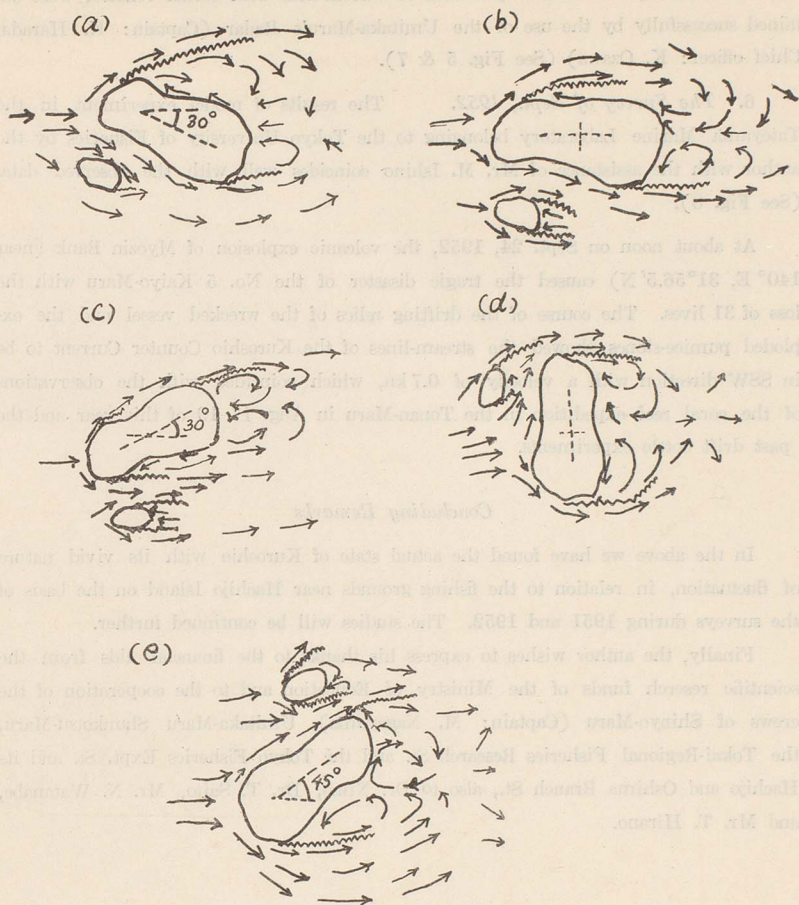


Fig. 8. Model expt. on currents around Hachijo Is. and Kojima. (based on photographs)

Fisheries hydrographic observations were carried out and from their results Fig. 5 was obtained.

Based on the result of current measurement by the Umitake-Maru using an Ekman-Merz currentmeter during 26 hours at the Kanminato anchorage station, Fig. 6 was constructed. It denotes the prevalent semi-diurnal tidal current (NW—SE) and coincides well with the result of observations by current-float off Kanminato in the preceding year. Also, observations on the current trajectories on Shin-Kurose Bank

and near Hachijo Is. made by means of current-float with corner reflector were obtained successfully by the use of the Umitaka-Maru's Radar (Captain: K. Harada, Chief officer: K. Ozawa) (See Fig. 5 & 7).

6. *The Survey of Sept., 1952.* The results of model experiment in the Tateyama Marine Laboratory belonging to the Tokyo University of Fisheries by the author with the assistance of Mr. M. Ishino coincides well with the observed data. (See Fig. 8).

At about noon on Sept. 24, 1952, the volcanic explosion of Myōzin Bank (near 140° E, $31^{\circ}56.5'$ N) caused the tragic disaster of the No. 5 Kaiyo-Maru with the loss of 31 lives. The course of the drifting relics of the wrecked vessel and the exploded pumice-stones showed the stream-lines of the Kuroshio Counter Current to be in SSW direction with a velocity of 0.7 kn, which coincided with the observations of the coral reef expedition in the Tonan-Maru in Aug. 17-19 of this year and the past drift bottle experiments.

Concluding Remarks

In the above we have found the actual state of Kuroshio with its vivid nature of fluctuation, in relation to the fishing grounds near Hachijo Island on the basis of the surveys during 1951 and 1952. The studies will be continued further.

Finally, the author wishes to express his thanks to the financial aids from the scientific reserch funds of the Ministry of Education and to the cooperation of the crews of Shinyo-Maru (Captain: M. Nagayama), Umitaka-Maru Shunkotsu-Maru, the Tokai-Regional Fisheries Research St. and the Tokyo Fisheries Expt. St. and its Hachijo and Oshima Branch St., also to Dr. Niino, Dr. T. Saito, Mr. N. Watanabe, and Mr. T. Hirano.