

# Recoveries from 1964 through 1968 of Drift Bottles Released from a Merchant Vessel, S.S. *Java Mail*, en Route Seattle to Yokohama, October 1964<sup>1</sup>

DONALD M. FISK<sup>2</sup>

**ABSTRACT:** During October 1964, drift bottles were released from a merchant vessel at intervals of about 80 miles during a voyage from Seattle, Washington to Yokohama, Japan. Of 3,840 bottles released, 121 have been recovered. Returns from four release areas are divided among four regions: Coastal, Eastern Subarctic, Central Subarctic, and Western Subarctic. Coastal recoveries reflect the northward drift along the coasts of Washington and British Columbia during winter. Recoveries from releases in the Eastern Subarctic show well-defined zonal flow to the west coast of North America. New information concerning the divergence of the Subarctic Current during winter was obtained from releases in the Central Subarctic.

The long period between release and recovery of the bottles, from all but Coastal and Central Subarctic releases, makes it difficult to derive much new information about circulation in this region where extensive drift-bottle studies have been made. A system of drifting buoys tracked by satellites would provide valuable information to oceanographers, meteorologists, and fisheries research.

RESEARCH VESSELS, alone or together with ocean station systems, do not provide the information required by scientists studying long-term environmental fluctuations in the ocean. Most of our knowledge of oceanwide changes as well as annual changes comes from observations incidental to commercial voyages. Since the days of sailing vessels, mariners have logged conditions at sea. These data have provided much of the material for most of the existing marine atlases. Today it should be possible to take sophisticated scientific observations from commercial vessels. A preliminary study was conducted in October 1964, aboard the S.S. *Java Mail* (American Mail Lines) between Seattle and Yokohama (Aron, 1965). The Bureau of Commercial Fisheries Biological Laboratory, Seattle, provided drift bottles which were released at predetermined locations in the Subarctic Pacific Region. Drift-bottle programs, which are not new aboard merchant vessels, have usually been random or informal. After previous studies of currents in the Subarctic

Pacific Region had been considered, drift-bottle releases were made in sufficient quantity and at locations most likely to add significantly to our knowledge of currents in regions where additional information, particularly during the winter, can be useful for fishery investigations.

## EXPERIMENTAL PROCEDURES

Because of the low percentage of returns observed from previous releases of drift bottles from the R.V. *George B. Kelez* (Favorite, 1964), the bottles were dropped in groups of 96 in an effort to insure a reasonable return. A total of 3,840 unballasted, short-necked bottles, 17 cm long and 4 1/2 cm in diameter at the base, were released; 36 groups of 96 bottles at stations 1 to 36 and two groups of 192 bottles at stations 37 and 38 (Fig. 1 and Table 1). Each drift bottle contained a data card (printed in English, Japanese, and Russian) and a promise of a letter describing the experiment if the card were returned.

## RECOVERY LOCATIONS

A total of 121 recoveries (about 3 percent) have been reported from 20 release locations;

<sup>1</sup> Manuscript received June 1, 1970.

<sup>2</sup> Bureau of Commercial Fisheries, Biological Laboratory, 2725 Montlake Boulevard East, Seattle, Washington 98102.

TABLE 1

RELEASE SITES AND SERIAL NUMBERS OF DRIFT BOTTLES RELEASED BETWEEN SEATTLE, WASHINGTON AND YOKOHAMA, JAPAN, WINTER 1964

STATION NUMBER	DATE	LOCATION		DRIFT BOTTLE SERIAL NUMBER*
		LATITUDE	LONGITUDE	
1	Oct. 20	48°47' N	127°12' W	8
2	Oct. 21	49°05' N	130°08' W	17
3	Oct. 21	49°26' N	134°08' W	29
4	Oct. 21	49°42' N	136°49' W	3
5	Oct. 22	49°50' N	139°37' W	38
6	Oct. 22	49°49' N	144°46' W	14
7	Oct. 23	49°48' N	146°36' W	20
8	Oct. 23	49°49' N	149°31' W	21
9	Oct. 23	49°49' N	153°52' W	23
10	Oct. 24	49°48' N	155°59' W	13
11	Oct. 24	49°49' N	158°43' W	19
12	Oct. 24	49°49' N	161°58' W	6
13	Oct. 25	49°48' N	165°30' W	26
14	Oct. 25	49°49' N	168°47' W	16
15	Oct. 25	49°49' N	172°23' W	30
16	Oct. 26	49°40' N	175°05' W	5
17	Oct. 26	49°18' N	178°14' W	1
18	Oct. 26	48°52' N	179°39' E	9
19	Oct. 27	48°37' N	177°30' E	31
20	Oct. 27	48°19' N	175°04' E	37
21	Oct. 27	48°02' N	172°30' E	35
22	Oct. 28	47°37' N	169°33' E	24
23	Oct. 28	46°59' N	166°26' E	12
24	Oct. 28	46°10' N	163°11' E	11
25	Oct. 29	45°41' N	158°48' E	27
26	Oct. 29	45°21' N	156°28' E	34
27	Oct. 29	45°10' N	153°50' E	28
28	Oct. 30	45°03' N	153°05' E	15
29	Oct. 30	44°42' N	152°34' E	18
30	Oct. 30	44°07' N	151°42' E	10
31	Oct. 30	43°24' N	150°36' E	4
32	Oct. 30	42°05' N	148°37' E	25
33	Oct. 31	41°00' N	146°35' E	33
34	Oct. 31	40°22' N	145°46' E	39
35	Oct. 31	39°47' N	145°00' E	36
36	Oct. 31	38°42' N	143°50' E	22
37	Oct. 31	36°57' N	142°13' E	2 and 7
38	Nov. 1	35°55' N	141°08' E	32 and 40

\* All cards in each group of 96 bottles were given a serial number before the ship left Seattle, but because of storage problems aboard ship the releases were not made in numerical order of the serial number.

no returns have been recovered from Japan or the Soviet Union, perhaps partly because of the cost of foreign mailing and the fact that no reward was offered; also, many people apparently prefer to keep the card as a souvenir.

The recoveries have been divided into the same four geographical regions as were the releases: Coastal, Eastern Subarctic, Central Subarctic, and Western Subarctic.

#### *Coastal*

Bottles released off Washington and Vancouver Island (stations 1 to 4) were recovered in the Queen Charlotte Islands and southeastern Alaska (Fig. 2). Recoveries made in March 1965 from three of the four stations indicate a northward coastal drift during the winter (November to March). Similar flow has been

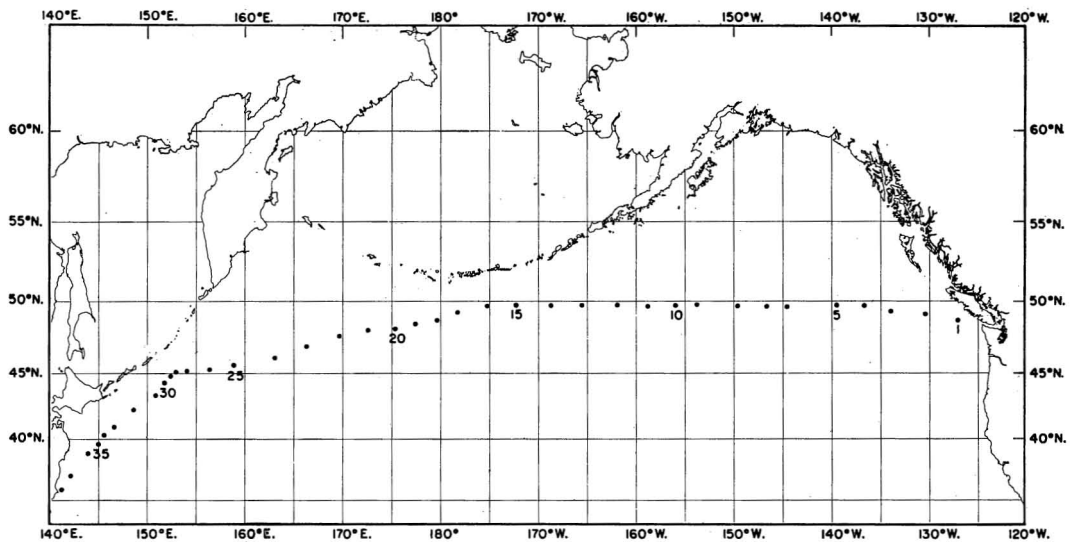


FIG. 1. Cruise track of S.S. *Java Mail* and stations (dots) where drift bottles were released, winter 1964.

reported by Schwartzlose (1963) and Ingraham (1967).

#### *Eastern Subarctic*

Bottles released in the southern Gulf of Alaska (stations 5 to 12) were recovered primarily on the Washington and Oregon coasts (Fig. 3). The number of returns from different stations ranged from 0 to 23. No recoveries have yet been reported from station 10, although a considerable number of releases were made at stations east and west of it.

#### *Central Subarctic*

Bottles released in the Central Subarctic (stations 13 to 22) showed a wide range of recoveries extending from the Oregon Coast to St. Paul Island in the Bering Sea; many were scattered throughout the Aleutian Islands (Fig. 4). Recoveries from stations 13 and 14 were made from the Queen Charlotte Islands to the northern shore of the Gulf of Alaska. Those from station 15 showed a divergent drift; recoveries were reported from the Alaska Peninsula and the northern part of the Gulf of Alaska in February 1966 and from the British Columbia coast in April 1966.

Although these bottles appeared to drift generally eastward after release (during the 7- to

8-month interval before recovery), the presence of a north component of flow in this area is shown clearly by recoveries of bottles from stations 17 and 18 at Amchitka and Attu islands; from stations 18 and 20 at Amchitka Island; and from station 22 at Attu and Amchitka islands (Fig. 4). No recoveries have been reported from station 19. Favorite (1967*a*) showed that the area of these releases contains a shear zone between the westward flowing Alaskan Stream, inshore and south of the Aleutian Islands, and the eastward Subarctic Current south of lat. 50° N.

#### *Western Subarctic*

No recoveries have been reported from the bottles released in the Western Subarctic (stations 23 to 38). Hata (1963) reported that bottles released in this general area in 1963 crossed the Pacific Ocean and were recovered along the coast of the Gulf of Alaska 3 years later. If the North Pacific circulation is the same now, recoveries would have been expected by now. Details about bottles used by Hata were not published; however, the bottles released in the present experiment should have been stable for at least 4 years. A sample bottle that has been immersed in salt water for 5 years shows no deterioration of the cork. The effects of at-

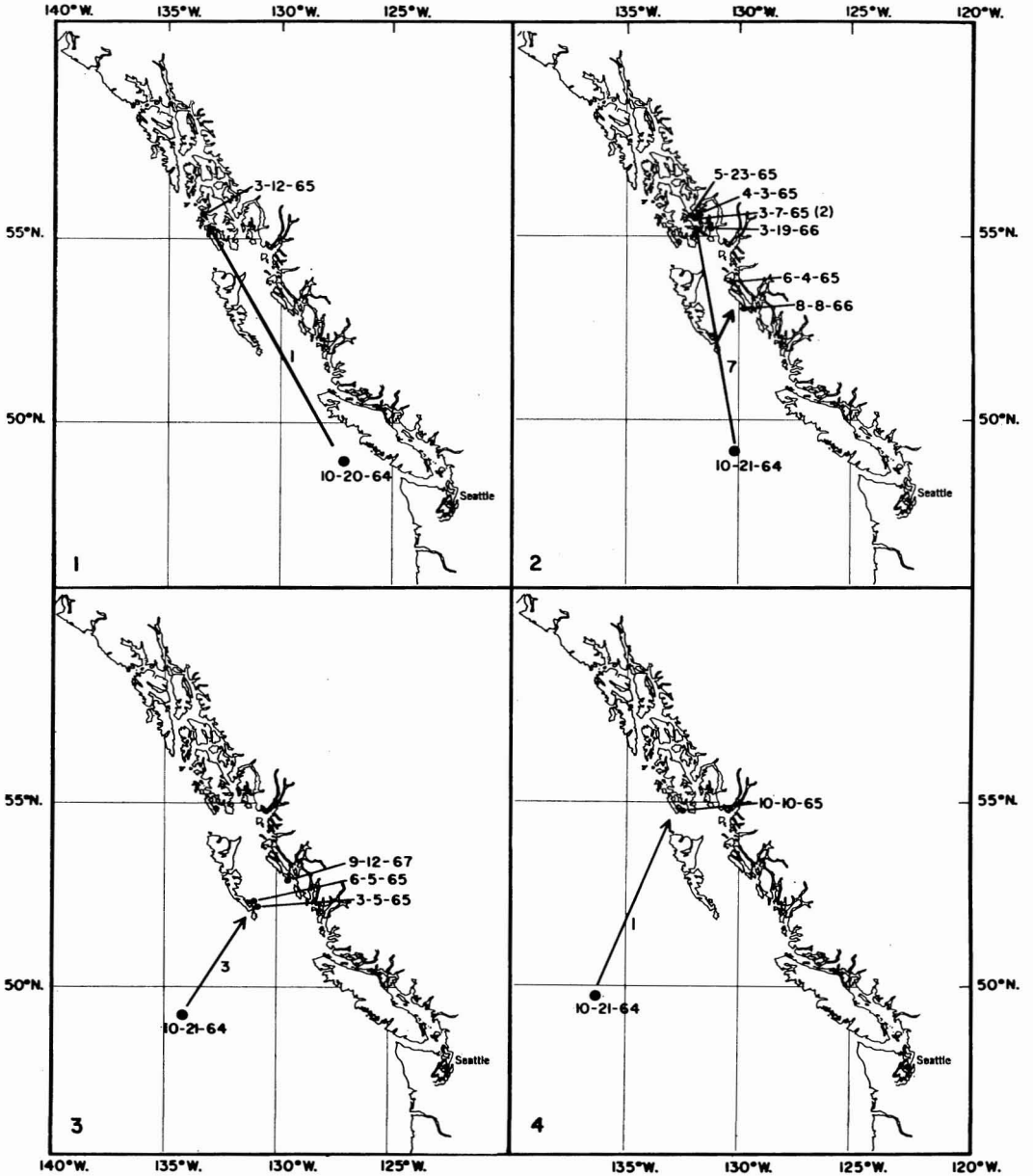


FIG. 2. Locations and dates of recovery of drift bottles released off Washington and British Columbia at stations 1 to 4. (Station numbers are shown in left lower corner of each panel.)

tack or attachment of biological organisms cannot be evaluated, however, in this laboratory experiment.

FUTURE EXPERIMENTS

Drift-bottle experiments are rather easily carried out and are relatively inexpensive, and, if

they were to be continued, the results should provide new and useful information. Favorite (1964) noted that the relatively consistent results from Japanese, Canadian, and U.S. drift-bottle studies in the North Pacific Ocean suggest that any new information likely to be obtained from additional experiments will

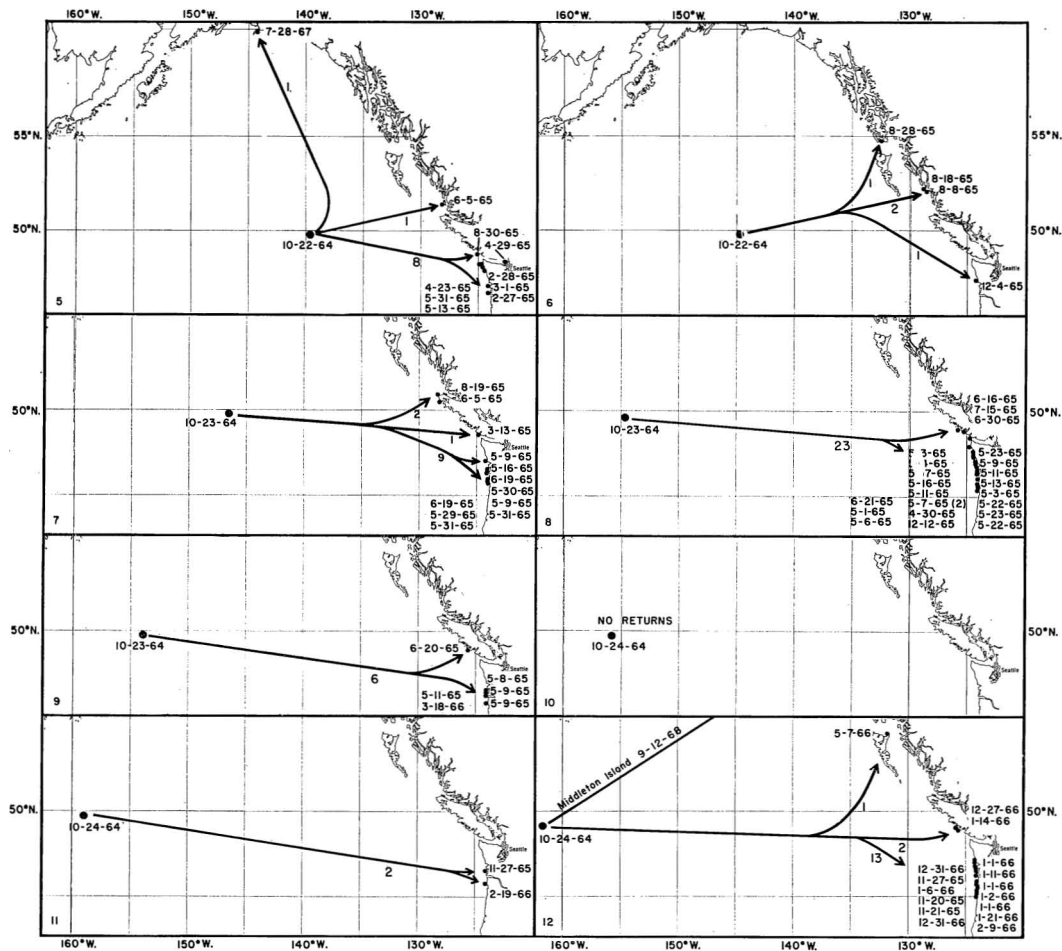


FIG. 3. Locations and dates of recovery of drift bottles released in the Eastern Subarctic Region at stations 5 to 12. (Station numbers are shown in left lower corner of each panel.)

concern only specific features or local areas. Although he was referring to studies from research vessels, the same conclusion is valid for studies from merchant vessels. The general drift from recoveries in the coastal areas could have been anticipated from the study of Burt and Wyatt (1964). The general drift pattern for the Eastern Subarctic area is similar to that described by Dodimead and Hollister (1958).

The releases in the Central Subarctic were made close to the Aleutian Islands and the recoveries there have reconfirmed the circulation suggested for this region. This information is particularly valuable because relatively few data are available on flow patterns in this area during winter. A divergence of the eastward-flow-

ing Subarctic Current occurs in the area during winter, and a northward-flowing extension of the Subarctic Current can be inferred from the Aleutian recoveries. The existence of this northward branch, which joins the westward flow of the Alaskan Stream along the south side of the Aleutian Islands, was later observed in winter 1966 (January to March) from data collected during cruises of R.V. *Argo* and R.V. *George B. Kelez* (Japanese Oceanographic Data Center, 1968, p. 26). Currents in this area are of particular interest from a fishery standpoint. Sockeye salmon (*Oncorhynchus nerka*), which return to Asian and North American streams to spawn after spending 1 to 3 years in the sea, follow migratory paths that bear a close rela-

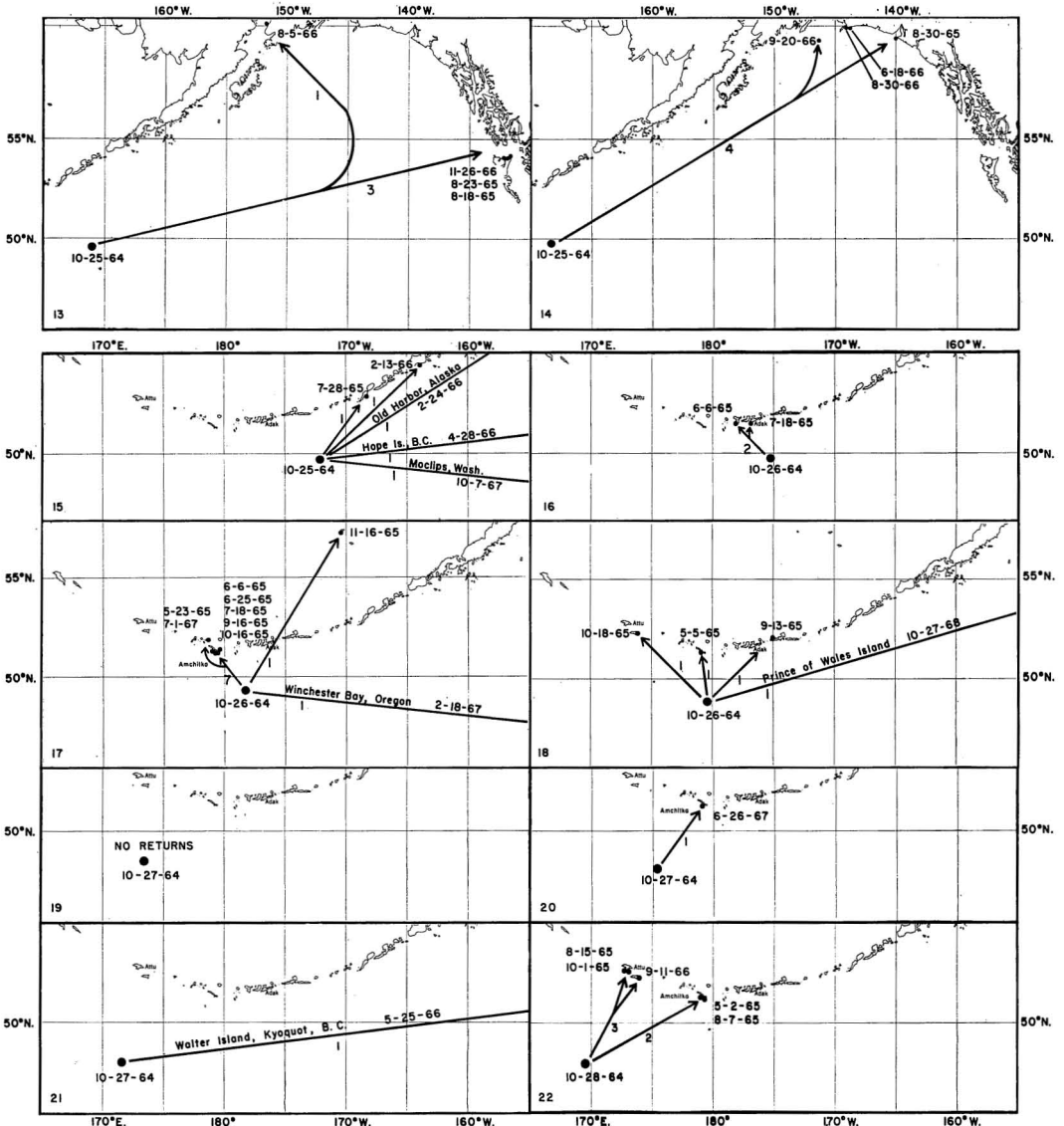


FIG. 4. Locations and dates of recovery of drift bottles released in the Central Subarctic Region at stations 13 to 22. (Station numbers are shown in left lower corner of each panel.)

tion to the ocean circulation patterns (Kondo et al., 1965).

The most useful information from an oceanographic standpoint is obtained from recoveries made within a short time after the release. Release off the Washington, Aleutian, and Japanese coasts from vessels on regularly scheduled runs yield fairly early coastal returns, but drift-bottle recoveries made 1 or more years after release on the high seas are difficult to evaluate

in relation to trajectory and currents. An adequate description of ocean currents and trajectories apparently must wait for the development of a system of drifting buoys tracked by satellites as proposed by Favorite (1967*b*). Such buoys quickly could provide good information on currents and could provide data on additional environmental characteristics such as temperature and salinity.

Dr. William I. Aron of the Smithsonian In-

stitution assisted in planning the experiment and the American Mail Lines arranged for the ship-board release of the bottles.

## LITERATURE CITED

- ARON, W. 1965. Ships of opportunity program: preliminary feasibility study. General Motors Defense Research Laboratories, Sea Operations Department, Santa Barbara, California (U.S. Navy, Office of Naval Research, Contract Nonr-4742 [00], NR 104-784/9-28-64), TR 65-18. 38 pp. (Processed.)
- BURT, W. V., and B. WYATT. 1964. Drift bottle observations of the Davidson Current off Oregon. In: Kozo Yoshida, ed., *Studies on oceanography*, pp. 156-165. University of Tokyo Press, Tokyo.
- DODIMEAD, A. J., and H. J. HOLLISTER. 1958. Progress report of drift bottle releases in the North Pacific Ocean. *Journal of the Fisheries Research Board of Canada*, vol. 15, pp. 851-865.
- FAVORITE, FELIX. 1964. Drift bottle experiment in the northern North Pacific Ocean, 1962-1964. *Journal of the Oceanographical Society of Japan*, vol. 20, no. 4, pp. 6-13.
- . 1967 *a*. The Alaskan Stream. *International North Pacific Fisheries Commission, Bulletin* 21, pp. 1-20.
- . 1967 *b*. *Oceanography*. In: Report on the investigations by the United States for the International North Pacific Fisheries Commission—1965. *International North Pacific Fisheries Commission, Annual Report, 1965*, pp. 94-98.
- HATA, KATSUMI. 1963. Report of drift bottles released in the North Pacific Ocean. *Journal of the Oceanographical Society of Japan*, vol. 19, pp. 6-15.
- INGRAHAM, W. JAMES, JR. 1967. The geostrophic circulation and distribution of water properties of the coasts of Vancouver Island and Washington, spring and fall 1963. U.S. Fish and Wildlife Service, *Fishery Bulletin* 66, pp. 223-250.
- JAPANESE OCEANOGRAPHIC DATA CENTER. 1968. Provisional Cooperative Study of the Kuroshio (CSK) Atlas, vol. 2, winter, 1965-1966. 44 pp.
- KONDO, HEIHACHI, YOSHIMI HIRANO, WABUYUKI NAKAYAMA, and MAKOTO MIYAKE. 1965. Offshore distribution and migration of Pacific salmon (genus *Oncorhynchus*) based on tagging studies (1958-1961). *International North Pacific Fisheries Commission, Bulletin* 17. 213 pp.
- SCHWARTZLOSE, RICHARD. 1963. Nearshore currents of northwestern United States and Baja California as measured by drift bottles. *California Cooperative Fisheries Investigations, Reports* 9, pp. 15-22.