Characteristics of the Sōya Warm Current in the Okhotsk Sea∗

Takatoshi TAKIZAWA**

Abstract: Characteristics of the Sōya Warm Current from Abashiri Bay to the area off the coast of the southern Kuril Islands are clarified by water mass analysis. The water flowing into the Okhotsk Sea as the Sōya Warm Current is divided into two: the Forerunner of the Sōya Warm Water (March to May) and the Sōya Warm Water (June to November). It is shown that in May the Sōya Warm Current flows in the subsurface layer (about 200-400 m deep) in Abashiri Bay, and flows northeastward just off the coast of the Kuril Islands as a subsurface current reaching a region northwest of Etorofu Island by the end of May. The dissolved oxygen content is fairly effective in identifying the Forerunner of the Sōya Warm Water in the subsurface layer. The Sōya Warm Current shifts upwards to the surface layer in Abashiri Bay by early July, because the Sōya Warm Water with large thermosteric anomaly δσ begins to flow into the Okhotsk Sea in June. It is shown that, in general, the major portion of the Sōya Warm Current flows northeastward just off the coast of the Kuril Islands during the summer season, although a minor branch of the current flows northward in the area off the Shiretoko Peninsula, and another minor branch flows out to the Pacific Ocean through the Nemuro Straits.

1. Introduction

The warm water of the Japan Sea enters the Okhotsk Sea through the Sōya Straits and flows southeastward along the coast of Hokkaidō at a speed of about 1.5 kts on average (MARITIME SAFETY AGENCY, 1977: p. 19). This flow, which occurs in March to November, is named the Sōya Warm Current. The bathymetry of the southwestern Okhotsk Sea is shown in Fig. 1. A broad continental shelf is present offshore from the Cape of Sōya to Monbetsu. The Sōya Warm Current runs southeastward in the coastal area shallower than 150 m, and has a width of about 50 km in summer. In contrast, from Abashiri Bay to the area along the southern Kuril Islands the continental shelf is narrow and a steep bottom slope is present along the coast. The deepest basin, more than 3,000 m, in the Okhotsk Sea is found off Etorofu Island. The Sōya Warm Current follows the coast in Abashiri Bay.

Many investigations have been conducted on the hydrography off Hokkaidō, particularly off the coast from the Sōya Straits to Monbetsu, except in winter when pack ice prevents observations (e.g., SUGIURA, 1958; WAKAO and KOJIMA, 1963; AOTA, 1975). Studies are few, however, on hydrography off the southern Kuril Islands in the Okhotsk Sea; the Sōya Warm Current begins to lose its characteristics and its path becomes obscure beyond the Cape of Shiretoko. The path is considered to branch off into roughly four courses (Fig. 2): the first leading to the Pacific Ocean through the Nemuro Straits; the second turning to the north near the Cape of Shiretoko and diverging offshore; the third heading further northeastward, reaching a region northwest of Etorofu Island (about 46°N, 146-147°E), where the current decays by mixing with surrounding waters; and the fourth branching off from the third near the Kunashiri Channel and also leading to the Pacific Ocean through this channel (NASUKAWA, 1960; IIDA, 1962; FUJI and SATO, 1977; TAKIZAWA and AOTA, 1978; HIRI et al., 1981).

In order to clarify the characteristics of the Sōya Warm Current, particularly variations in its constituent water masses, from Abashiri Bay to the southern Kuril Islands, the present study

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2. A general view of the Sōya Warm Current off the coast of Hokkaidō

The water mass of the Sōya Warm Current which has a high salinity of more than 33.6% is easily identified because no other water with such a high salinity occurs in the upper water in the Okhotsk Sea. FUJI and SATO (1979) distinguished two different waters in the third branch of the Tsushima Warm Current which flows northward along the west coast of Hokkaidō. During June to November a warm water branches off from the third branch west of the Sōya Straits and flows into the Okhotsk Sea. They called it the Sōya Warm Water. On the other hand, during December to May the third branch reaches only as far as off southern Hokkaidō. Therefore, the warm water flowing into the Okhotsk Sea in March to May is not the water of the third branch itself, but the modified water of this branch formed by convective mixing during the period of cooling off the western coast of Hokkaidō. They named this water the Sōyadanryū-Zenku-su (the Forerunner of the Sōya Warm Water). To distinguish it from the Sōya Warm Water they used the total content of three inorganic nitrogen compounds (NO$_3$-N, NO$_2$-N, NH$_3$-N) as well as temperature and salinity (FUJI and SATO, 1977, 1979; SATO, 1981). The present study adopts their definitions; for the sake of convenience, hereafter, this paper refers to the Sōya Warm Current, the Sōya Warm Water and the Forerunner of the Sōya Warm Water as the Current, the Warm Water and the Forerunner Water, respectively.

For water mass analysis the temperature-salinity diagram is one of the most effective tools (SVERDRUP et al., 1942: pp. 141-143). Since the specific volume of the water at atmospheric pressure, which is expressed by thermometric anomaly ($\vartheta_{p}$), depends only on temperature and salinity, isopleths of $\vartheta_{p}$ can be plotted in the diagram. By means of this diagram,
Table 1. Sources of data used

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Organization</th>
<th>Date</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Feb. 2-Mar. 12, 1939</td>
<td></td>
</tr>
<tr>
<td>Sōya</td>
<td>Maritime Safety Agency and ILTS</td>
<td>Mar. 19-20, 1969</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Oct. 4-10, 1973</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mar. 12-14, 1975</td>
<td>RFOO, 1980</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Apr. 11-27, 1977</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>July 19-Aug. 1, 1977</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Nov. 1-13, 1978</td>
<td>RMMOO, 64, 1980</td>
</tr>
<tr>
<td></td>
<td></td>
<td>June 23-July 9, 1977</td>
<td>RMMOO, 62, 1979</td>
</tr>
<tr>
<td></td>
<td></td>
<td>July 2-20, 1978</td>
<td>RMMOO, 64, 1980</td>
</tr>
</tbody>
</table>

therefore, characteristic features of the T-S distribution are well represented and anomalies in the distribution are easily recognized.

The water masses distributed off Hokkaido in the Okhotsk Sea are classified in terms of the characteristics of their T-S relations (Fig. 3 and Table 2). The Warm Water (S in Fig. 3) is characterized by high temperature and high salinity, and the Forerunner Water (S’) by low temperature and high salinity. Note that off Kuril Islands both of the Waters have somewhat lower temperatures and salinities than those off Hokkaido shown in Table 2. The Okhotsk Surface Water (O) with low salinity occurs widely in the surface layer and its temperature in summer increases to as high as that of the Warm Water. This water is formed mainly by the melting of pack ice. The Intermediate Cold Water (IC) is found in the subsurface layer beneath the Okhotsk Surface Water and has the lowest temperature in the Sea. This water is formed by convective mixing under pack ice in winter. The Transient Layer Water (TL) underlies the Intermediate Cold Water and occurs over a wide area at mid-depths of about 300 m to 1,200 m. The temperature

![Graph showing T-S curves of water masses in the southwestern Okhotsk Sea.](image)
Table 2. Characteristic indices of water masses distributed off Hokkaido in the Okhotsk Sea.

<table>
<thead>
<tr>
<th>Water mass</th>
<th>Soya Warm Water*</th>
<th>Forerunner of Soya Warm Water**,***</th>
<th>Intermediate Cold Water</th>
<th>Transient Layer Water</th>
<th>Okhotsk Surface Water</th>
<th>East Sakhalin Current Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period (month)</td>
<td>6-11</td>
<td>3-5</td>
<td>1-12</td>
<td>1-12</td>
<td>4-10</td>
<td>11-3</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>7-20</td>
<td>2-6</td>
<td>-1.8++2</td>
<td>1-2</td>
<td>&lt;18</td>
<td>&lt;7</td>
</tr>
<tr>
<td>Salinity (%)</td>
<td>33.6-34.3</td>
<td>33.8-34.2</td>
<td>32.8-33.4</td>
<td>33.4-34.3</td>
<td>&lt;32.5</td>
<td>&lt;32.0</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>0-150 (0-150</td>
<td>200-400 (in Abashiri Bay) 30-300</td>
<td>300-1,200</td>
<td>0-30</td>
<td>0-50</td>
<td></td>
</tr>
<tr>
<td>Dissolved</td>
<td>150-400</td>
<td>80-130</td>
<td>130-170</td>
<td>70-130</td>
<td>250-400?</td>
<td></td>
</tr>
<tr>
<td>oxygen content</td>
<td>6-8</td>
<td>6-8</td>
<td>6-8</td>
<td>1-5</td>
<td>6-10</td>
<td>6.5-8</td>
</tr>
<tr>
<td>Total content</td>
<td>10</td>
<td>20-70</td>
<td>150-500</td>
<td>10-150</td>
<td>30-100</td>
<td>(in November)</td>
</tr>
<tr>
<td>of three inorganic nitrates (µg/l)</td>
<td>0-70</td>
<td>0-70</td>
<td>30-200</td>
<td>30-200</td>
<td>0-30</td>
<td></td>
</tr>
<tr>
<td>Silicate content (µg-at/l)</td>
<td>0-70</td>
<td>0-70</td>
<td>30-200</td>
<td>30-200</td>
<td>0-30</td>
<td></td>
</tr>
</tbody>
</table>

* Off the southern Kuril Islands the Soya Warm Water and the Forerunner of the Soya Warm Water have somewhat lower temperatures and salinities than those off Hokkaido listed above due to mixing with surrounding waters.

** After an inflow of the Soya Warm Water has begun, the Forerunner of the Soya Warm Water becomes stagnant and its properties then suffer a gradual modification. As the season advances, consequently, the temperature and salinity decrease to the values lower than those listed above, but the oxygen content remains at relatively high value.

and salinity of the Transient Layer Water increase gradually with depth, the temperature showing a maximum value of 2.2-2.4°C at a depth of 1,000 m to 1,200 m and the oxygen content decreasing continuously and tending to attain a minimum value of 1.2-1.4 ml/l at the bottom of this transient layer (IIDA, 1962; YASUOKA, 1967). The East Sakhalin Current Water (E) with a thickness of less than 50 m reaches the coastal area off Hokkaido late in autumn due to reinforcement of the East Sakhalin Current. This water is characterized by low temperature and extremely low salinity. Its origin is thought to be the coastal water off Sakhalin and the water discharged from Siberian rivers, especially from the Amur River.

In the warm season (June to October), the Warm Water occupies the water column from a depth of 10 m to the bottom (150 m) and has a width of about 55 km along the coast off Monbetsu (Fig. 4b). Off Utoro it stretches vertically from the surface to a depth of about 200 m while its width decreases to about 30 km (Fig. 4c).

It was believed formerly that the Current is weakened rapidly in November and disappears during the winter, because with reinforcement of the East Sakhalin Current in autumn a cold and low salinity water spreads southward and covers a wide region in the coastal area off Hokkaido (WATANABE, 1963). However, AOTA (1975) pointed out that even in the middle of December the Current exists in the bottom layer deeper than about 50 m at a distance of about 19 km to 46 km off the coast of Monbetsu.

Scarce as data in winter are, the characteristics of the water masses during this season are illustrated in a T-S diagram (Fig. 5). In February and early in March the coastal area is occupied by water below 0°C in temperature and less than 33% in salinity. In the latter half of March, however, in 1969 (at depths of 65 m to 50 m at Stn. M1 and 125 m at Stn. M2, 28 km and 46 km off Monbetsu, respectively) and in 1975 (throughout the whole water column at Stns. 1, 6 and 13) a relatively warm water was present with a temperature of 1.5-2°C, a salinity of more than 33.8% and a thermosteric anomaly δT ≈ 90 cl/t. This relatively warm water indicates a recovery of the Current and belongs to
Fig. 5. T-S diagram at selected stations in the pack ice season. Thermosteric anomaly $\delta T$ is in °C. The numerals next to plotted points refer to depth in meters.

Fig. 6. Seasonal variation in volume transport of the Sōya Warm Current off Monbetsu (after AOTA, 1975).

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Fig. 4. Surface temperature (solid lines, in °C) and salinity (broken lines, in %) from August to September 1973 (Fig. 4a). Vertical sections of temperature and salinity off Monbetsu and Utoro (Figs. 4b, 4c). Stations 16 and 2 are about 9 and 11 km off the coast, respectively. The locations of the sections are shown in Fig. 4a by lines M and U, respectively.
the Forerunner Water, mentioned earlier.

In May, after pack ice leaves the coastal area, the Current recovers its strength rapidly. According to AOTA (1975), the volume transport of the Current off Monbetsu in May is comparable to that in summer (Fig. 6).

It is considered that the Current is caused by a difference in water level between the Japan Sea and the Okhotsk Sea (IIDA, 1969; AOTA, 1975). Since the former is obviously higher in water level than the latter from April to November, an inflow to the Okhotsk Sea takes place. A sudden decrease in the water level difference occurs for a short while from November to December. This is closely related to the reinforcement of the East Sakhalin Current (WATANABE, 1963). Inflow does not occur during December to March, since the difference is small or occasionally the Okhotsk Sea is higher in water level than the Japan Sea in this period.

In recent years current observations under pack ice have been made using current meters equipped with temperature and conductivity sensors. It has been shown that the Current recovers as a subsurface current late in March, and high salinity water seems to flow from the Japan Sea into the Okhotsk Sea intermittently even in January and February (AOTA and KAWAMURA, 1978; 1979). Lately HANZAWA

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Fig. 7. Surface temperature (solid lines, in °C) and salinity (broken lines, in ¥‰) in May 1955 (Fig. 7a). Vertical sections of temperature and salinity (left), and thermosteric anomaly δT and dissolved oxygen content (right) off Monbetsu, the Cape of Notoro and the Cape of Shiretoko (Figs. 7b–d). Stations V-18, V-9 and V-1 are about 6.5, 7.4 and 16 km off the coast, respectively. The locations of the sections are shown in Fig. 7a by lines M, N and S, respectively.
et al. (1981) revealed that a relation between silicate content and salinity is fairly effective in classifying water masses in the Okhotsk sea. Values of the silicate content of water masses distributed off Hokkaido are listed in Table 2.

3. Characteristics of the current from Abashiri Bay to the area along the southern Kuril Islands

The area of the cross section occupied by the Forerunner Water in the middle of May is comparable to that occupied by the Warm Water in summer (Fig. 7b). As seen from Fig. 7a, the Forerunner Water does not appear at the surface east of the Cape of Notoro. The vertical sections off the Cape of Notoro and Shiretoko (Figs. 7c, d), however, show that the Forerunner Water is present at depths of 50 m to 300 m and 200 m to 400 m, respectively, having almost the same properties as that off Monbetsu. The findings in Figs. 7a-d are confirmed by the T-S and O2-S diagrams given in Fig. 8. The Forerunner Water has a temperature of 4–6°C, a salinity of more than 34.0%, a dissolved oxygen content of 7–8 ml/l and a thermosteric anomaly $\delta_T = 100–120$ cl/t off Esashi (Stn. 23) and Monbetsu (Stn. 17). The surface layer from Abashiri Bay to the Cape of Shiretoko is occupied by low salinity water, but the Forerunner Water is clearly present at a depth of 50 m at Stn. 9, at a depth of 150–200 m at Stn. 10 and at a depth of 200–400 m at Stn. 1. The Transient Layer Water is found at a depth of 300 m to 600 m at Stn. 2. It is difficult at times to distinguish the Forerunner Water from the Transient Layer Water on the basis of physical properties alone (see Table 2 and Fig. 3), and, as a result, a difference in properties between the Forerunner Water and the Transient Layer Water at mid-depths is not so obvious in the T-S diagram. The oxygen content of the former, however, is much higher than that of the latter (see Fig. 8: upper fig.).

Figure 9 presents the T-S and O2-S diagrams from the end of May to the beginning of June in 1977. A warm and homogeneous water with a temperature of about 7°C, a salinity of 33.7–33.8% and a dissolved oxygen content of about 7 ml/l is present at Stn. S (0–30 m) east off the Cape of Soya. It spreads to a depth of 20 m to 30 m at Stn. M off Monbetsu. According

![Fig. 8. T-S and O2-S diagrams at selected stations along the path of the Sōya Warm Current in May 1955. The numerals next to plotted points refer to depth in meters. Thermosteric anomaly $\delta_T$ is in cl/t.](image)

![Fig. 9. T-S and O2-S diagrams at selected stations along the path of the Sōya Warm Current from the end of May to the beginning of June 1977. The numerals next to plotted points refer to depth in meters. Thermosteric anomaly $\delta_T$ is in cl/t.](image)
to its temperature and salinity characteristics, it belongs to the Warm Water. A water with a temperature of about 5°C (at a depth of 75 m to 125 m at Stn. M) belongs to the Forerunner Water judging from its properties. Neither the Warm Water nor the Forerunner Water exists in the surface layer at Stn. D off the Cape of Notoro in Abashiri Bay, but at a depth of 192 m to 308 m, under the Intermediate Cold Water, a relatively warm water (2.9°C at a depth of 308 m) is present. The thermometric anomaly $\delta_T$ of 109–122 cl/l and the high oxygen content of more than 6.6 ml/l indicate that this water belongs to the Forerunner Water, though the salinity shows slightly lower values than that of typical Forerunner Water. There is a noticeable water mass with a high and almost uniform oxygen content $O_2\approx6$ ml/l at a depth of 256 m to 410 m at Stn. A. The temperature of this water ranges from 1 to 2°C and reaches a maximum at a depth of 410 m; its salinity is 33.48–33.64 % while $\delta_T$ is 117–123 cl/l. An isosteric analysis shows that this water is formed by slight lateral mixing of the Forerunner Water with the Transient Layer Water along the isosteric surface with a $\delta_T$ of about 120 cl/l. Only slightly lower values of oxygen content of this water than that of the Forerunner Water at Stn. D indicates that a fairly large proportion of the Forerunner Water remains in the water; that is, the Forerunner Water reaches the region northwest of Etorofu Island by flowing in the subsurface layer specified by a $\delta_T$ of about 120 cl/l without much mixing with the Transient Layer Water. The water with a uniform oxygen content at a depth of 408 m to 510 m at Stn. C off the Cape of Shiretoko is also a mixed water, but the proportion of the Forerunner Water in it is fairly small. On the other hand, at Stn. B north off Kunashiri Island this kind of water does not exist. Consequently, conditions at Stns. B and C suggest that these Stations are far from the flow path; i.e., the Forerunner Water flows northeastward closer to the Kuril Islands. A difference in characteristic properties between the Forerunner Water and the Transient Layer Water is illustrated more clearly in Fig. 9 than in Fig. 8; particularly in the $O_2$-$S$ diagram an obvious difference is revealed. It is established in Figs. 8 and 9 that the oxygen content is a fairly effective indicator of the Forerunner Water in the subsurface layer.

Figure 10 is the $T$-$S$ and $O_2$-$S$ diagrams obtained about one month later than those in Fig. 9. The Warm Water has a temperature of 9.6°C and a salinity of 33.9 % near the Sôya Straits; however, these represent only surface values. The characteristic features of the Forerunner Water at mid-depths at Stns. A–D are clearly seen. As compared with Fig. 9, the Forerunner Water at Stns. A and D is sharply distinguished from the Transient Layer Water in the $T$-$S$ diagram; the oxygen contents still remain at high values of more than 6 ml/l. On the other hand, at this time a trace of the Forerunner Water is recognized at Stn. B more clearly than that at Stn. C. Oxygen content at Stn. O which is located on the Okhotsk Sea side of the North Uruppu Channel decreases monotonously with depth, and a layer high and uniform in oxygen content is not found. According to YASUOKA (1967; 1968), an inflow of
the Pacific Water through this Channel occurs below a depth of 1,500 m and the oxygen content of inflow water is about 2 ml/l. Other channels of the southern Kuril Islands are less important for water exchange, and they are marked by a predominant outflow from the Okhotsk Sea (Kurashina et al., 1967). These facts strongly suggest that the water with high and uniform oxygen content in the subsurface layer does not come from the Pacific Ocean. Therefore, it can be reasonably concluded as mentioned above that the origin of this water is the Forerunner Water.

Early in July 1978, the characteristic features of the Forerunner Water were also recognized along the southern Kuril Islands, although the stratification is a little complicated (Fig. 11). The Warm Water is seen at a depth of 30 m off the Cape of Notoro (Stn. D). At Stn. Ko-2791 northeast of Stn. A a layer high and uniform in oxygen content at mid-depths, which displays the existence of the Forerunner Water, is not found.

The T–S and O₂–S diagrams obtained in the middle of October 1977 and in the beginning of November 1978 are shown in Fig. 12. The Warm Water exists at a depth of 56 m at Stn. A (Ry–5116) and at a depth of 33 m at Stn. Ry–5115 in 1977. The Forerunner Water is still found at depths of 194 m and 241 m at Stn. A (Ry–5116), although it is less obvious than that in June–July (Fig. 10). In 1978 the Warm Water exists at a depth of 74 m at Stn. Ry–5313; the Forerunner Water is also present at a depth of 518 m at Stn. A (Ry–5314). It should be noted that the salinities of both Waters mentioned above are somewhat decreased to values lower (33.3–33.5% in the Warm Water, and 33.4–33.7% in the Forerunner Water) than those listed in Table 2 (33.6–34.3% in the former, and 33.8–34.2% in the latter). This may be attributed to mixing with surrounding waters. In particular, the properties of the Forerunner Water have suffered a considerable change.

![Fig. 11. T–S and O₂–S diagrams at selected stations along the path of the Sōya Warm Current in July 1978. The numerals next to plotted points refer to depth in meters. Thermosteric anomaly δτ is in cl/t. The surface T–S relation alone is available at Stn. 78–232 because it was a BT station.](image1)

![Fig. 12. T–S and O₂–S diagrams at selected stations in October 1977 and November 1978. The numerals next to plotted points refer to depth in meters. Thermosteric anomaly δτ is in cl/t.](image2)
The following is concluded from Figs. 8–12 concerning the characteristic features of the Current from Abashiri Bay to the area along the southern Kuril Islands: in May the Current flows in the subsurface layer (about 200–400 m deep) in Abashiri Bay, and then flows north-eastward as a subsurface current along the Kuril Islands and finally reaches the area northwest of Etorofu Island at the end of May. The Warm Water seen at a depth of 30 m at Stn. D in Fig. 11 shows that the transition from a subsurface current to a surface current occurs by early July; the Current can exceptionally go northeast beyond Etorofu Island, but normally it diffuses north-west of this island. After July the properties of the Forerunner Water lying in the subsurface layer are gradually changed, and it is considered most likely that these properties are ultimately lost by convective mixing with surrounding waters in winter. Furthermore, the Warm Water also will certainly decay by mixing in winter.

A marked difference in flow characteristics between the region from the Cape of Sōya to the Cape of Notoro and the region from Abashiri Bay to the area along the Kuril Islands is as follows: in the former region the depth with flow is physically restricted by the shallow bottom; in contrast, in the latter region, as the bottom becomes abruptly deeper, bottom topography has no effect on the Current except near the coast. Therefore, the Water flows at the depth corresponding to its specific volume (density); that is, the Forerunner Water with small $\delta r$ flows in the subsurface layer and conversely the Warm Water with large $\delta r$ flows in the surface layer.

The Warm Water is present only at a depth of 20 m to 50 m at Stn. 28 in the southern end of the section in August–September (Fig. 13a). It can be seen in Fig. 13b that the core of the Warm Water lies immediately to the east of the Cape. Flow of the Warm Water can be considered to be as follows: the Current goes round the Cape following the isobaths and then near the mouth of the Nemuro Straits it branches into two. One branch flows to the northeast and the axis of this current lies close to the Kuril Islands; this would explain why the characteristics of the Current at Stns. B and C are much less clear than those at Stns. A and D is the

Fig. 13. Vertical north-south sections of temperature (solid lines, in °C) and salinity (broken lines, in %) off the Cape of Shiretoko from the end of August to the beginning of September (section S, Fig. 13a) and in October (section S', Fig. 13b) 1973. The locations of the sections are shown in Fig. 4a by lines S and S', respectively.

T–S and O$_2$–S diagrams in Figs. 9, 10 and 11. The other branch enters the Pacific Ocean through the Nemuro Straits.

The northward branch from the Cape of Shiretoko, as shown in Fig. 2, certainly exists, but it is rather minor and is liable to frequent
variation. Further, this branch is not always observed; in fact, it is not seen in Figs. 4a, 13a,b.

Since the depth of the Notsuke Channel Sill, which occurs in the narrowest part of the Nemuro Straits, is shallower than 10 m and as the current in the Channel is weak, it is reasonable to expect that the outflow through the Nemuro Straits is fairly small, and it may be concluded that the major portion of the Current flows northeastward just off the coast of the Kuril Islands. As for outflows of the Current through other straits, NASUKAWA (1960) has pointed out that the Warm Water flows out to the Pacific Ocean through the strait to the west of Etorofu Island, the Kunashiri Channel. Owing to the scantiness of data, it is impossible to estimate the ratio of the outflow through the Kunashiri Channel to the flow leading to the area northwest of Etorofu Island.

The description of water characteristics presented above is based on observational data for only several specified years as representative examples. Undoubtedly water characteristics may vary to some extent from those described in the present analysis, because of year-to-year variations in the Current. It is fairly reasonable, however, to consider that the general features of the Current have been observed and described in this study.

4. Summary

Some features of hydrography from Abashiri Bay to the southern Kuril Islands have been analyzed for clarification of the characteristics of the Sōya Warm Current on the basis of T-S and O₂-S diagrams. The warm water flowing into the Okhotsk Sea through the Sōya Straits is divided into two: the Sōya Warm Water (June to November) and the Forerunner of the Sōya Warm Water (March to May).

Some noteworthy findings are as follows:

1) The oxygen content is very effective in distinguishing the Forerunner of the Sōya Warm Water in the subsurface layer.

2) At the end of May the Sōya Warm Current flows in the subsurface layer (about 200-400 m deep) in Abashiri Bay, and furthermore it flows northeastward as a subsurface current just off the coast of the Kuril Islands and reaches the region northwest of Etorofu Island.

3) As the Sōya Warm Water with large δr begins to flow into the Okhotsk Sea in June, the Sōya Warm Current shifts to the surface layer and this is also the case from Abashiri Bay to the Kuril Islands. Consequently, the Sōya Warm Water and the Forerunner of the Sōya Warm Water are seen in the surface and the subsurface layers, respectively.

4) After going round the Cape of Shiretoko following the isobaths, the Sōya Warm Current branches off into two courses near the mouth of the Nemuro Straits. One branch turns to the northeast and flows close to the Kuril Islands reaching the region northwest of Etorofu Island, although it has previously been thought to head straight northeastward from the Cape of Shiretoko. The other branch, which is thought to be minor, flows out to the Pacific Ocean through the Nemuro Straits.

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宗 谷 暖 流 の 特 性

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要旨: オホーツク海の宗谷暖流(特に網走湾から千島列島沖の海域)の海況をT-S図、O₂-S図及び温度・塩分の鉛直断面図を用いて解析した。暖流を構成する水塊は二種類あり、3月に卓越する低温でやや高塩分の水塊は宗谷暖流前流体、6-11月に見られる高温水は宗谷暖流主体である。3月後半に観測した暖流は、5月末には数値計算で表面に現れているが網走湾からは中層(約200から400m深)を流れ釧路島北西沖にまで達していることが明らかになった。この際、溶存酸素量が中層前流態を認め得るのに有効であった。6月には密度の小さい宗谷暖流水が流入するので網走湾で暖流は表層を流れるようになる。この暖流は表層流への推移の影響も7月初めまでは起こる。一般に宗谷暖流は夏期にはその一部が知床沖で反転流となり、また他の一部が根室海峡を通じて太平洋に流出するものので、暖流の大部分は千島列島に近いところを北東流することが明らかになった。