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Oceanic Conditions near the Ryukyu Islands-III.

—Oceanic Conditions along 125°E in Spring and Summer of Successive Four Years, 1965-1968*—

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Abstract

Oceanic conditions along 125°E in a region between 20°N and 32°N in spring and summer of successive four years, 1965-1968, based on the CSK data obtained by the Keiten Maru and the Kagoshima Maru, Kagoshima University. Generally speaking, variations of temperature and salinity in this section according to years are rather less remarkable, especially in summer quite few differences are found, with a few exceptions. However, eastward volume transport of the Kuroshio across this section in summer, referred to 1200 d. b. surface, shows large differences according to years with a maximum value of ca 39×10^6 m^3/sec in 1967 and a minimum value of ca 26×10^6 m^3/sec in 1968, while it is nearly same value of ca 30×10^6 m^3/sec in spring every year.

The core of the Kuroshio seems to be situated almost always at the middle point between the border of the East China Shelf and the Ryukyu Submarine Ridge, though the width and the thickness of the current are both variable considerably from time to time.

Another eastward current exists to the far south from the Kuroshio around 20°N-24°N latitude, which may be the Subtropical Countercurrent or may be not. Volume transport of this eastward current varies very much according to seasons or years, with a maximum value of ca 30×10^6 m^3/sec and a minimum value of ca 8×10^6m^3/sec, which may suggest remarkable fluctuations of the current direction, because these values do not contain total transport but only eastward component.

1. Introduction

In successive four years since summer of 1965, the Keiten Maru and the Kagoshima Maru, Kagoshima University, made the meridional oceanographic section in spring and summer along 125°E from 20°N to 32°N for the CSK project. The general feature of oceanic conditions along this section in summer of 1965, and in spring and summer of 1966 are already presented in previous papers (Takahashi and Chaen, 1967, 1969). In the present paper, the oceanic conditions in spring and summer of successive four years, 1965-1968, are discussed on the bases of their results of CSK cruises (The Faculty of Fisheries, Kagoshima University, 1970) and some additional data obtained by some other vessels. During four years, the oceanographic observations are carried out in April and August by the Keiten Maru and the Kagoshima Maru respectively, and the individual observation period in these surveys takes about a week. The stations of serial oceanographic observations and BT observations are fixed at the same latitudes in every time, which are shown in Fig. 1. Some direct current measurements are also added.

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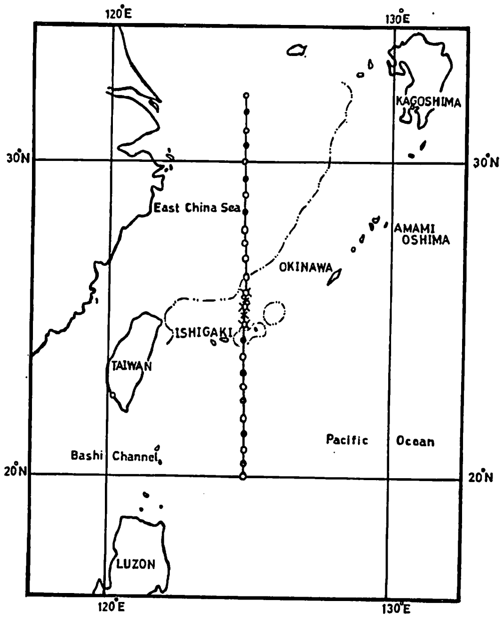


Fig. 1. Map showing the observation stations. Symbols of stations: circles, serial oceanographic observation and BT ; black circles, BT observation ; crosses, direct current observation.

2. Temperature

Among the distribution of temperature obtained by serial observations and BTs in spring and summer of the four years, those in 1967 and 1968 are shown in Fig. 2.

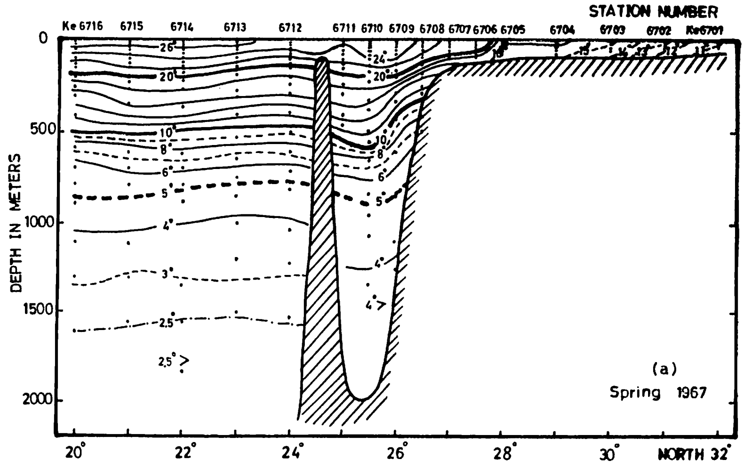


Fig. 2. Temperature distribution (°C) along the meridian of 125°E by serial observation and by BT ; (a), (a′), (b), (b′) spring and summer of 1967, (c), (c′), (d) spring and summer of 1968.

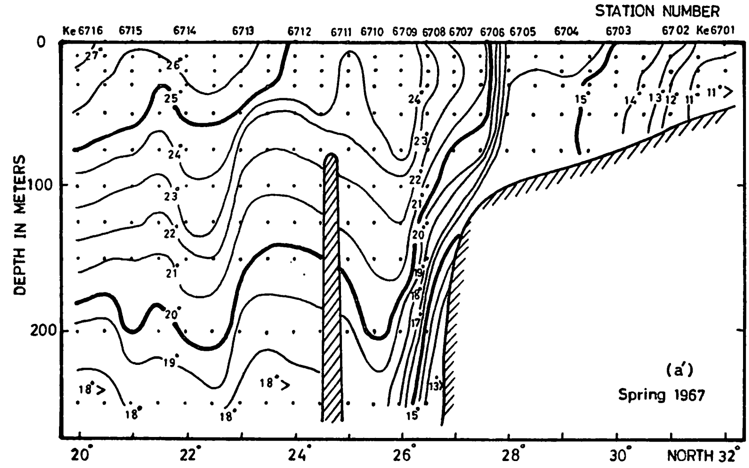


Fig. 2. (a')

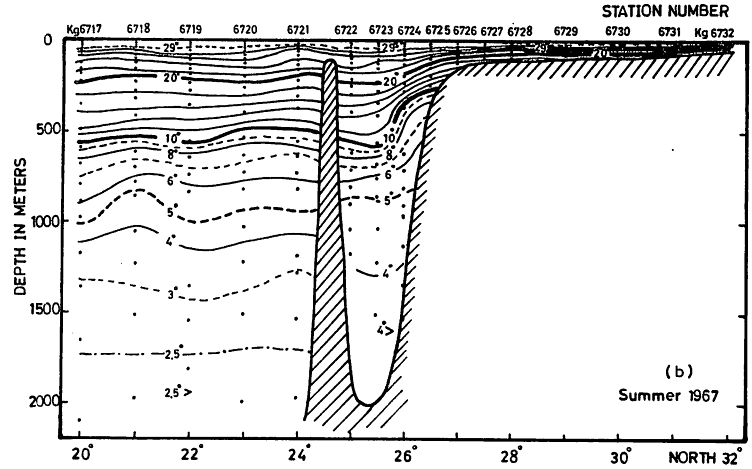


Fig. 2. (b)

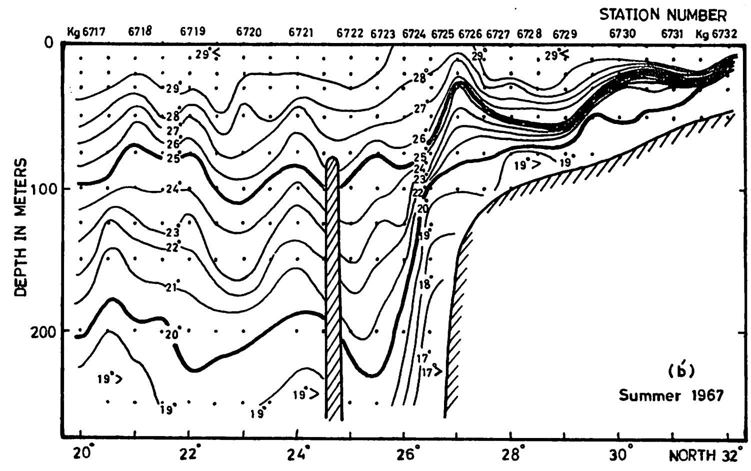


Fig. 2. (b')

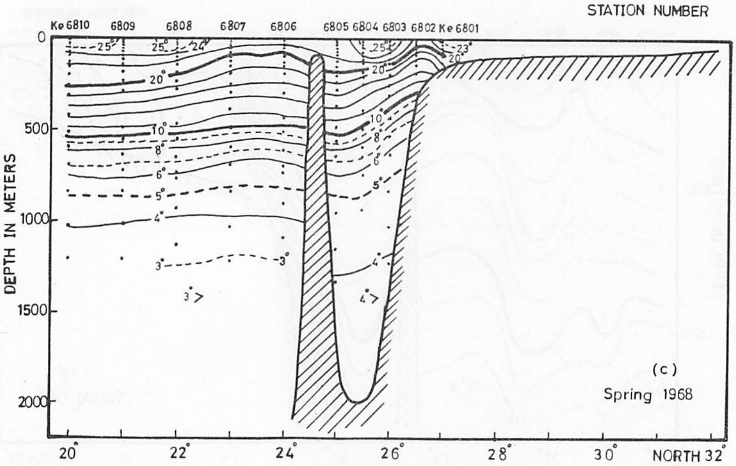


Fig. 2. (c)

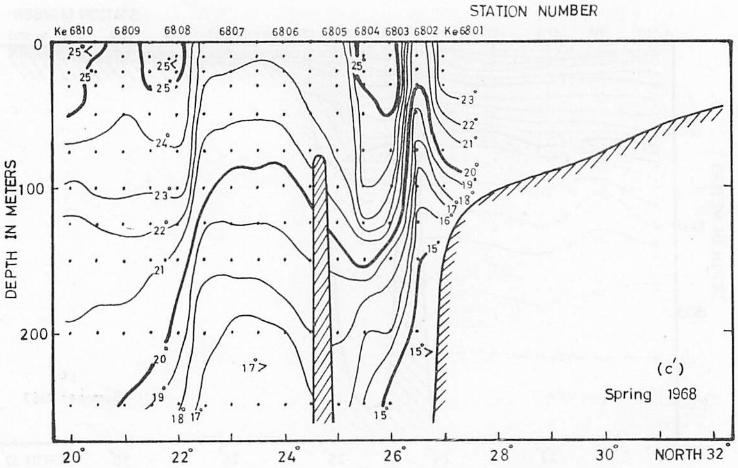


Fig. 2. (c′)

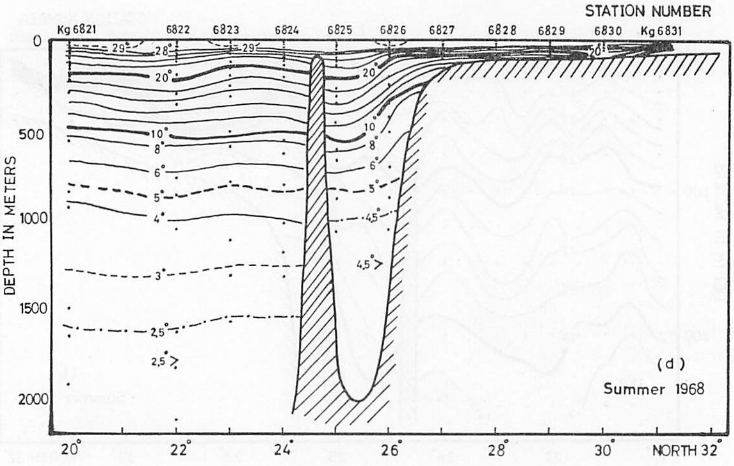


Fig. 2. (d)

On the East China Shelf, temperature in spring is nearly uniform vertically from the surface to the bottom. Approaching the border of the shelf, surface temperature increases abruptly, forming a front. In the region between the border of the continental shelf and the Ryukyu submarine ridge, a warm core is remarkable in the surface layer, on the north of which the maximum slope of isotherms is found. On the south of the submarine ridge, the upwelling towards the surface seems to take place, especially in spring of 1966, 1967, 1968 and in summer of 1965. In summer, warm water of higher temperature than 29°C is found on the very surface along the section excepting near the border of the shelf, where a front exists in spring. The warm core found in spring in the region between the border of the shelf and the submarine ridge is less marked in summer. The upwelling found in spring on the south of the submarine ridge disappears at the surface.

In other two seasons of the year, namely winter and autumn, temperature distribution along the quite same section is obtained by the Nagasaki Maru, Nagasaki University. However, it is difficult unfortunately to discuss the characteristics of the temperature distribution mentioned above, because the intervals of neighboring stations are too wide. Nevertheless, it may be seen that in winter the warm core in the region between the border of the shelf and the submarine ridge and the upwelling on the south of the submarine ridge are less remarkable than in spring, which may be attributed to low temperature at the surface in winter.

The variations of the characteristics of the temperature distribution according to years are rather less remarkable in spring and also in summer. The variation range of the numerical values of temperature according to years is ca 2°C at the bottom on the continental shelf in summer (lower in 1967 and 1968, higher in 1965 and 1966), while at the surface to the south of the border of the shelf is ca 3°C in spring (highest in 1966) and only ca 1°C in summer. However, the slope of isotherms in the region between the border of the shelf and the submarine ridge, on the continental slope, shows rather remarkable differences according to years, with a strong inclination in summer of 1967.

3. Salinity

Salinity distributions along the same meridian in spring and summer of 1967 and 1968 are shown in Fig. 3.

On the East China Shelf, the low salinity from the Yellow Sea origin prevails to the north of 31°N, and another one, near the border of the shelf a thin surface layer characterised by low salinity is also found. These situations and the numerical values of salinity are variable according to seasons and years. For example, the numerical value of salinity at 10m depth at 32°N in 1967 is 32.5‰ in winter, 32.6‰ in spring, 30.2‰ in summer, and 31.5‰ in autumn respectively. To the south of the border of the East China Shelf, surface salinity is a little higher in spring (ca 34.8‰–35.0‰) than in summer (ca 34.5‰–34.6‰).

The subsurface saline water creeps from the oceanic area to the north on the continental shelf, which corresponds to the isanosteric surface of 350 cl/t. The less saline intermediate water which corresponds to the isanosteric surface of 120 cl/t is found in a layer around 600 m depth to the south of the submarine ridge. The aspect of the slope of isohalines in the region between the border of the East China Shelf and the submarine ridge is found to show some differences according to years as well as that of isotherms.

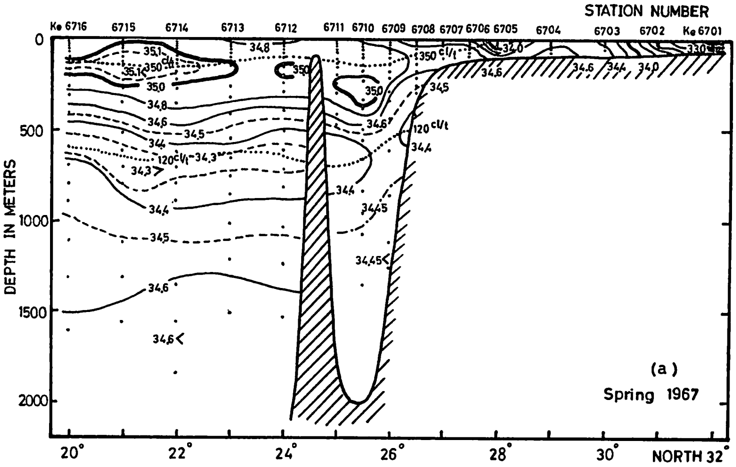


Fig. 3. Salinity distribution (‰) along the meridian of 125°E by serial observation ; (a), (b) spring and summer of 1967, (c), (d) spring and summer of 1968. Doted lines indicate the isanoster of 350 cl/t and 120 cl/t.

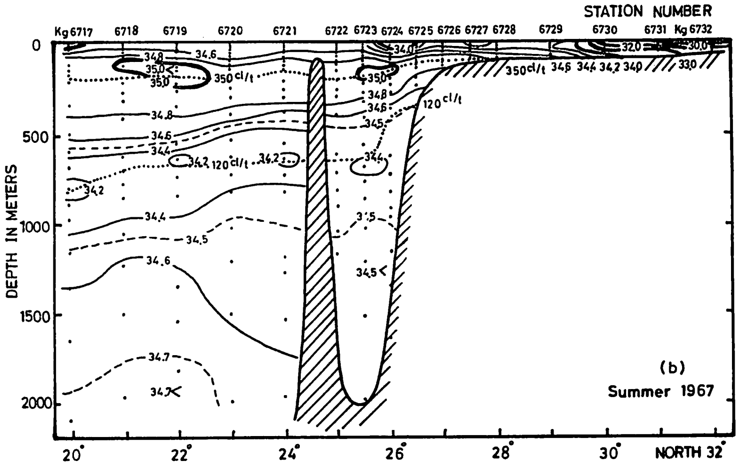
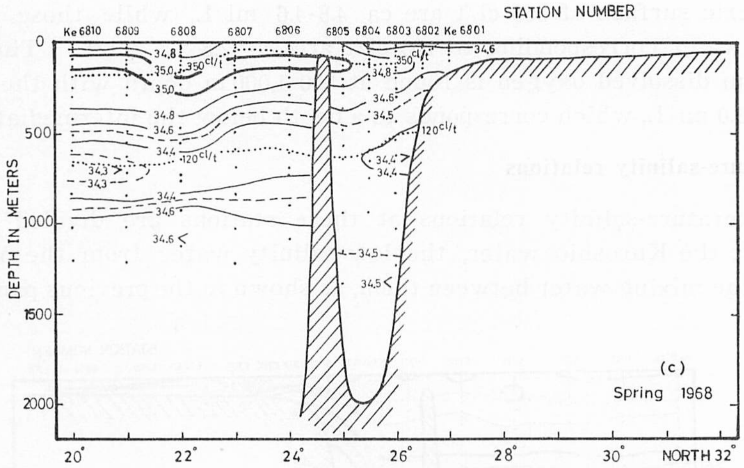


Fig. 3. (b)



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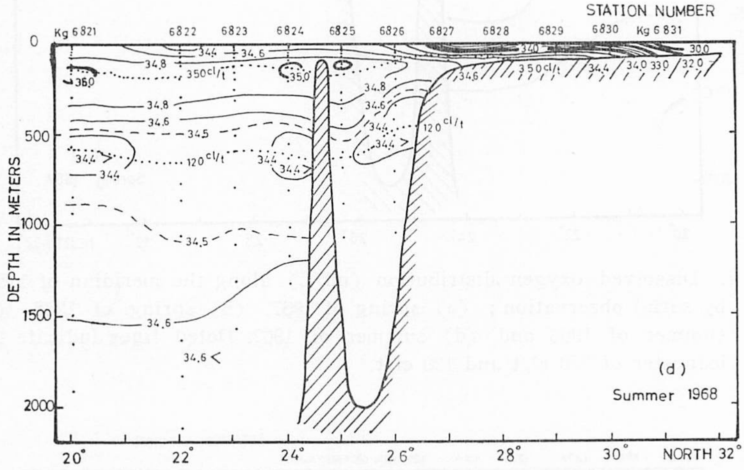


Fig. 3. (d)

4. Dissolved oxygen

Distribution of dissolved oxygen along the same meridian is shown in Fig. 4 (in spring of 1967, 1968 and in summer of 1966, 1967).

On the East China Shelf, the dissolved oxygen is ample in spring, having ca 5.0-6.0 ml/L, while in summer ca 4.8 ml/L and ca 3.5 ml/L at the surface and near the bottom respectively. According to the results of the Nagasaki Maru, in winter of 1967 it is the almost same in spring, while in autumn nearly average value between those in spring and summer. The dissolved oxygen at the surface to the south of the border of the East China Shelf is a little higher in winter and spring than in summer and autumn. Throughout the all seasons, the numerical values of dissolved oxygen for the subsurface saline water corresponding to the isanosteric surface of 350 cl/t are ca 4.8-4.6 ml/L, while those of the intermediate water corresponding to 120 cl/t are ca 2.8-2.5 ml/L. The layer of the minimum dissolved oxygen is found at 800-1,000 m depth with the numerical value of ca 2.0 ml/L, which corresponds to a depth below the intermediate water.

5. Temperature-salinity relations

The temperature-salinity relations at these stations are divided into three groups; i. e., the Kuroshio water, the low salinity water from the Yellow Sea origin, and the mixing water between them, as shown in the previous papers (Taka-

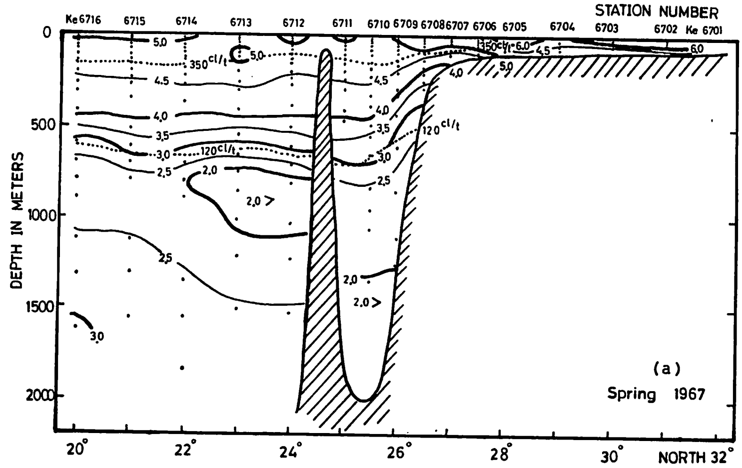


Fig. 4. Dissolved oxygen distribution (ml/L) along the meridian of 125°E by serial observation; (a) spring of 1967, (b) spring of 1968, (c) summer of 1966 and (d) summer of 1967. Doted lines indicate the isanoster of 350 cl/t and 120 cl/t.

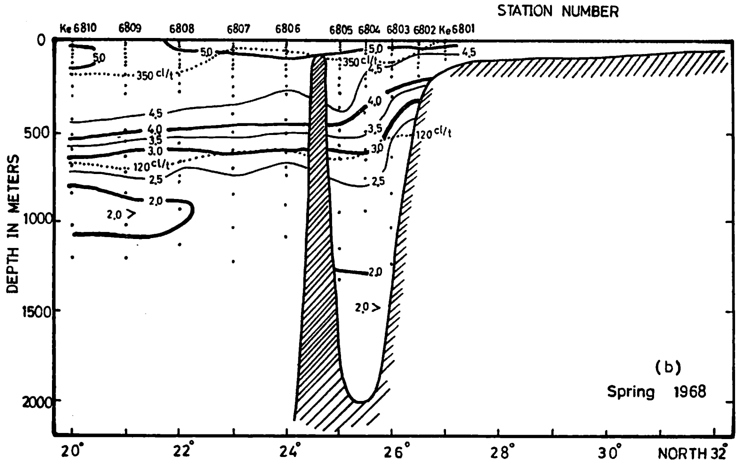


Fig. 4. (b)

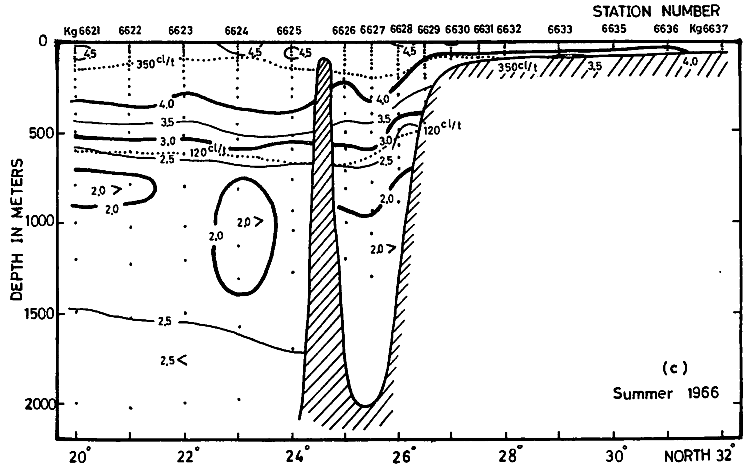


Fig. 4. (c)

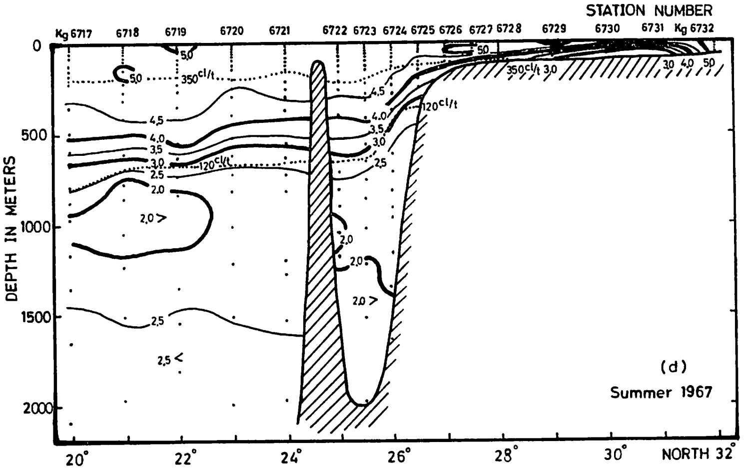


Fig. 4. (d)

hashi and Chaen, loc. cit.).

In order to see the variations in these relations, including mixing stages, according to spring and summer and to years, temperature-salinity relations at all stations are plotted in every spring and summer, as shown in Fig. 5.

T-S relations between 20°N and 26°N represent the Kuroshio water (indicated by dots in Figs) characterized by a clear salinity maximum (the subsurface saline water) and by a clear salinity minimum (the intermediate water). The numerical values of temperature and salinity of those are determined from the curves and shown in Table 1. Those of both temperature and salinity for the subsurface saline water and the intermediate water show only a few differences according to seasons and to years. The numerical values for the subsurface saline water

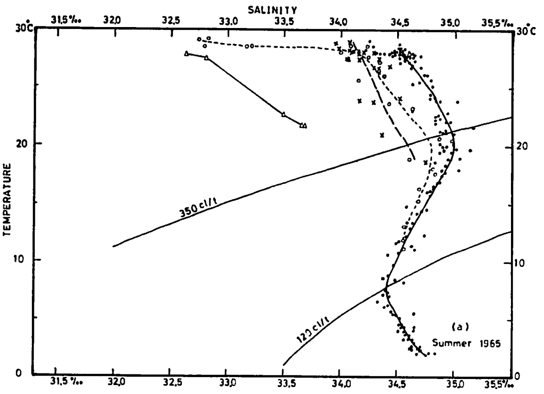
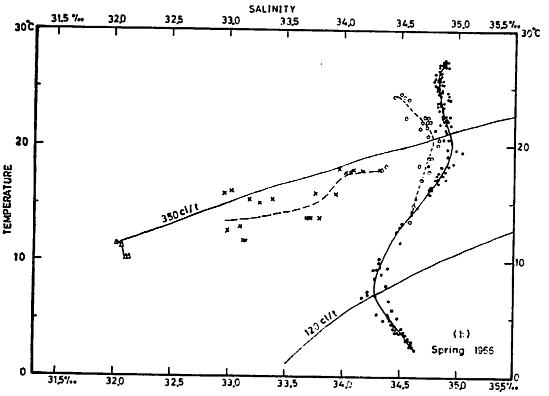


Fig. 5. Temperature-Salinity relations along the meridian of 125°E ; (a) summer of 1965, (b), (c) spring and summer of 1966, (d), (e), (f), (g) winter, spring, summer, and autumn of 1967, and (h), (i) spring and summer of 1968.



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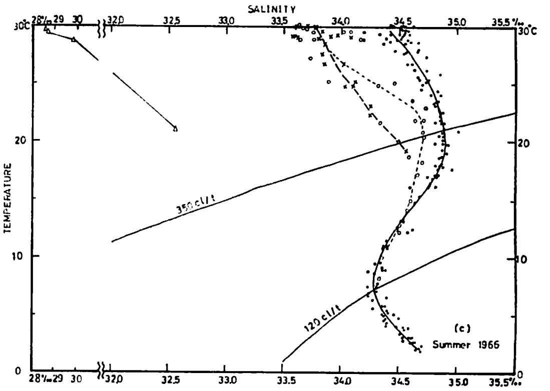

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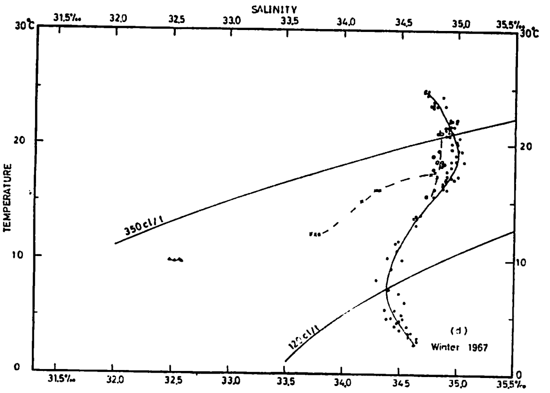
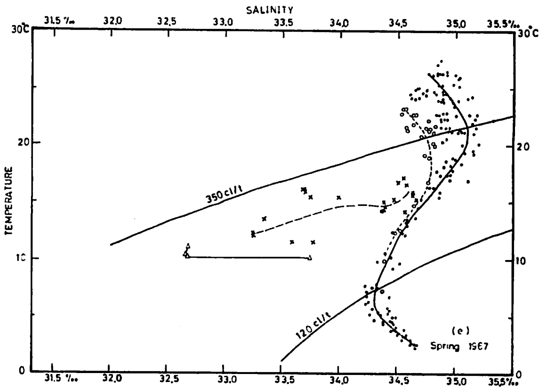


Fig. 5. (d)



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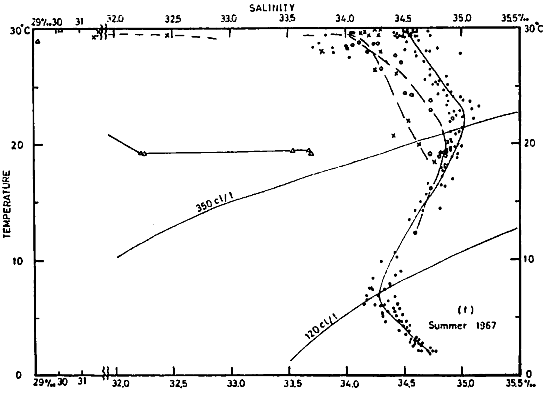

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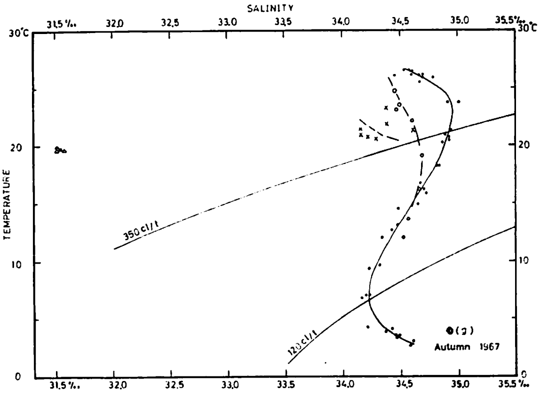

Fig. 5. (g)

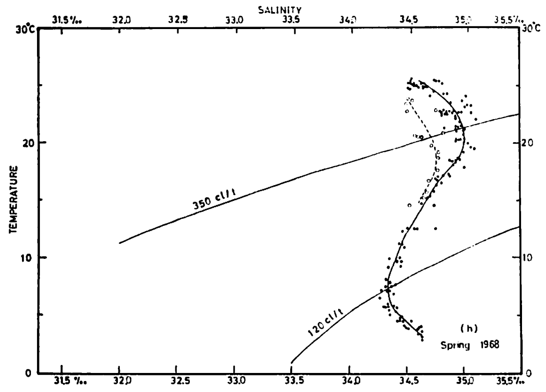

Fig. 5. (h)

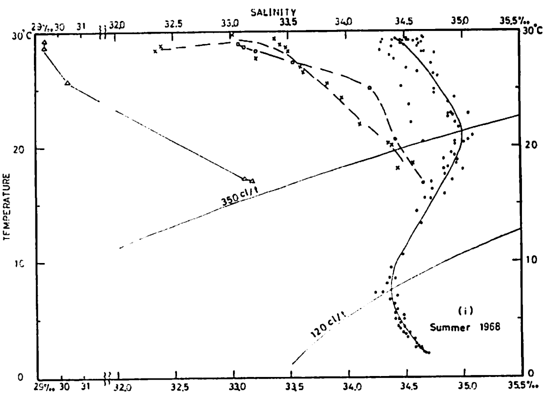

Fig. 5. (i)

are ca 21°C, ca 35.0‰, while the intermediate water ca 7°C, ca 34.3‰.

T-S relations in the region near the border of the East China Shelf (indicated by circles in Figs) still keep the salinity maximum (stations at 26°30′N and 27°N, and occasionally 27°30′N in spring and summer of 1967). To the north of this stations, as far as 30°N in summer of 1967 and 1968 on the East China Shelf (indicated by crosses in Figs) T-S relations show quite differences according to season; i. e., curves in winter and spring are nearly along isanosteric surfaces, while in summer and autumn those cross at nearly right angle to isanosteric surfaces. The Yellow Sea origin water (indicated by triangles in Figs), has the lowest salinity at 31°N or 32°N, as shown in Table 1 with the corresponding temperature. The salinity in summer shows large differences of ca 4.0‰ according to year.

6. Current structure

Distribution of thermosteric anomaly in the same section is shown in Fig. 6,

Table 1. Values of the temperature and salinity for the subsurface saline water (salinity maximum) and the intermediate water (salinity minimum) of the Kuroshio, and of the lowest salinity of the Yellow Sea origin at 31°N or 32°N and the temperature at the same layer. Values in winter and autumn of 1967 are from the data of the Nagasaki Maru.

Water mass Year & Season		Kuroshio				Yellow Sea origin water (lowest salinity at 31° or 32°N and the temperature at the same layer)	
		Subsurface saline water (salinity maximum)		Intermediate water (salinity minimum)			
		Temp. (°C)	Sal. (‰)	Temp. (°C)	Sal. (‰)	Temp. (°C)	Sal. (‰)
1965	Summer	20.0	35.00	7.6	34.42	27.8	32.63
1966	Spring	19.6	34.94	7.5	34.27	11.6	32.01
	Summer	20.0	34.90	7.7	34.28	29.8	28.69
1967	Winter	19.5	35.00	7.0	34.38	9.8	32.48
	Spring	21.0	35.10	6.8	34.30	10.4	32.66
	Summer	22.5	35.02	7.0	34.28	29.0	*29.13
	Autumn	22.5	34.95	6.8	34.22	19.8	31.51
1968	Spring	20.6	35.01	7.0	34.34		
	Summer	21.0	35.00	7.5	34.37	28.6	*29.38

* value at 31°N

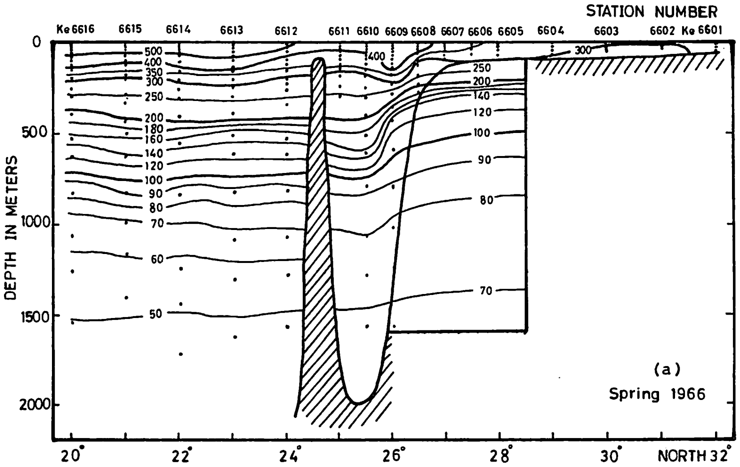

Fig. 6. Thermosteric-anomaly (cl/t) distribution along the meridian of 125°E ; (a), (b) spring and summer of 1966, (c), (d) spring and summer of 1967, and (e), (f) spring and summer of 1968. The block of solid earth surrounded by the continental slope and the straight line indicate the imaginary water mass.

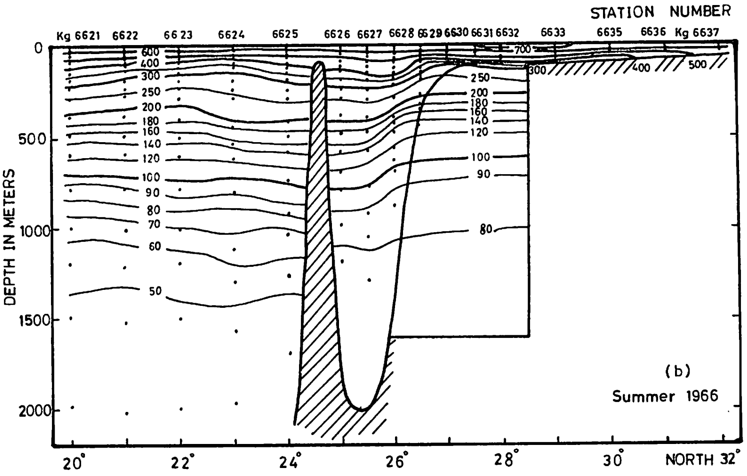

Fig. 6. (b)

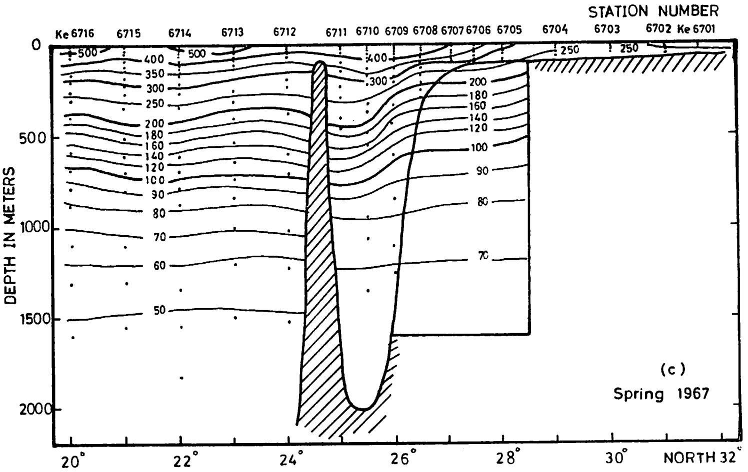

Fig. 6. (c)

except for that of 1965 shown in the previous paper, in order to see the major feature of the current structure by means of the chart of thermosteric anomaly. The sharp slope of isanosters on the continental slope corresponds to the strong current of the Kuroshio, while the convex curve of isanosters on the south of the submarine ridge corresponds to the westward flow on the north side of submarine ridge and the eastward flow on the south. In the figure, the isanosters are extended to the block of the continental slope in order to attempt to carry out the dynamic calculation in the shallow water by B. Groen's method (1948). Adopting a level of 1,200 m as the no motion layer, the east-west component of relative current velocity is calculated, the distribution of which in spring and summer of successive four years, 1965—1968, is shown in Fig. 7. Unfortunately, those in

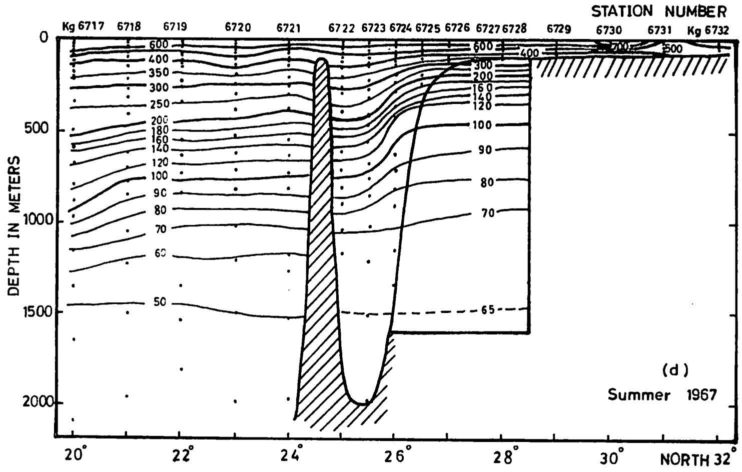

Fig. 6. (d)

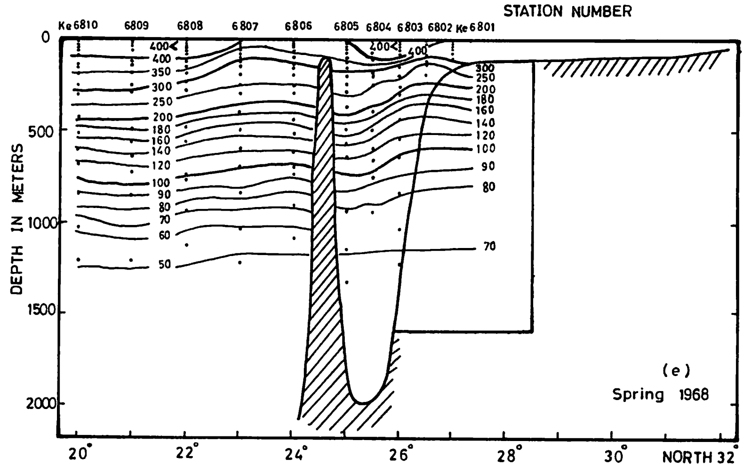

Fig. 6. (e)

winter and autumn of 1967 occupied by the Nagasaki Maru cannot be utilized with similar accuracy due to the insufficiency of the number of observing points.

7. The Kuroshio itself

Numerical values concerning the Kuroshio itself, such as the position of the current axis, the maximum speed of the east component, the current width, the current thikness of higher velocity than 10 cm/sec, and the volume transport of the east component can be easily determined from Fig. 7 showing the current structure, and the results are given in Table 2. The core of the Kuroshio is situated almost always at the middle point between the border of the East China Shelf and the submarine ridge. The maximum speed of the east component varies

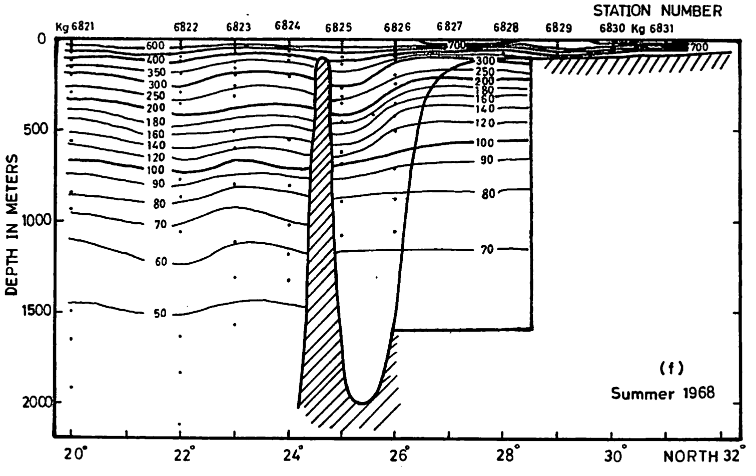

Fig. 6. (f)

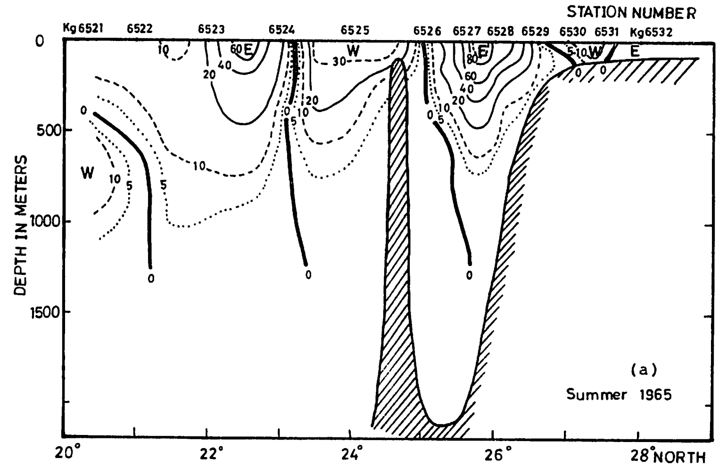

Fig. 7. The east-west component (cm/sec) of calculated relative current velocity across 125°E referred to 1,200 m ; (a) summer of 1965, (b), (c) spring and summer of 1966, (d), (e) spring and summer of 1967, and (f), (g) spring and summer of 1968.

largely according to season and year, showing the highest value of ca 110 cm/sec in summer of 1967 and the lowest of ca 70 cm/sec in summer of 1968. The current width is ca 100 to 160 miles. The current thickness defined here by a depth of the velocity of 10 cm/sec is ca 620 to 690 m, with a excepton of the depth of 490 m in summer of 1968.

The volume transport of the east component in spring is nearly the same value in all of three years, having ca 30×10^6 m^3/sec, while in summer large differences are recognized according to years; i. e., the highest ca 39×10^6 m^3/sec in 1967 and the lowest ca 26×10^6 m^3/sec in 1968.

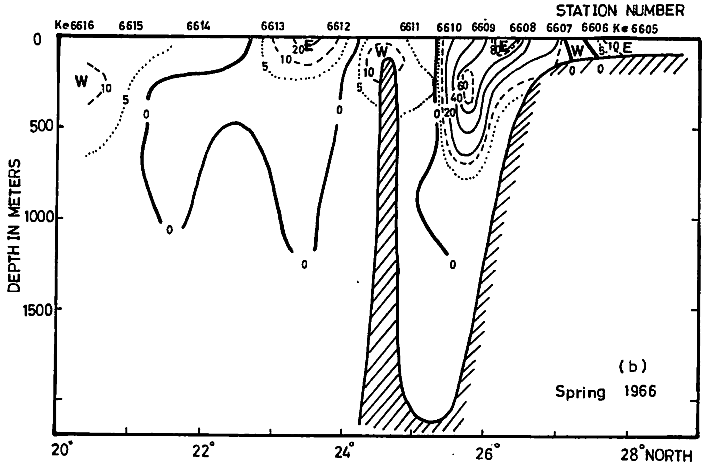

Fig. 7. (b)

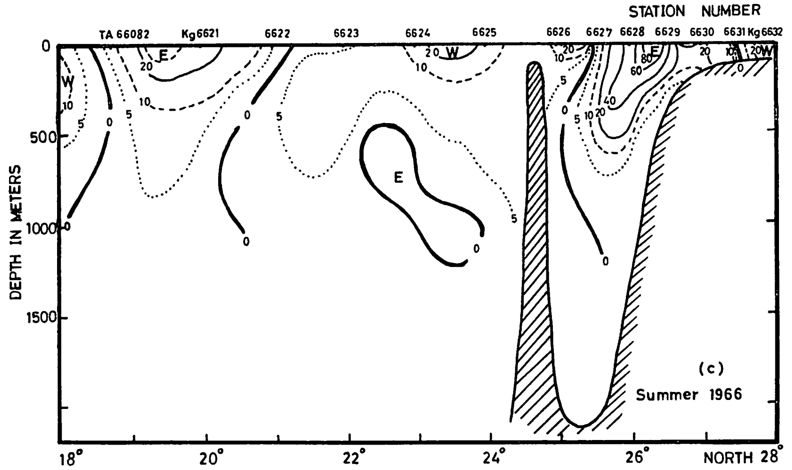

Fig. 7. (c)

In 1965 and 1968 the volume transport is ca 3×10^6 m^3/sec higher in spring than in summer, but in 1967 it is vice versa. However, it is impossible to decide whether the Kuroshio near the Ryukyu Islands is strong in spring or in summer from only these results.

In summer of 1965, 1966, 1967 and in spring of 1968, the relative current referred to a depth of 1,000 m are measured directly by means of two current meters of Ekman-Mertz type at a few stations between the border of the East China Shelf and the submarine ridge. These results are shown in Fig. 8. It can be recognized clearly that the Kuroshio in summer is stronger in 1967 than in 1966. According to the results of Fig. 8, the current flows towards between NNE and ENE and thus the direction of the Kuroshio seems to be stationary. Assuming that the Kuroshio flows to NE direction on an average, it may be determined that

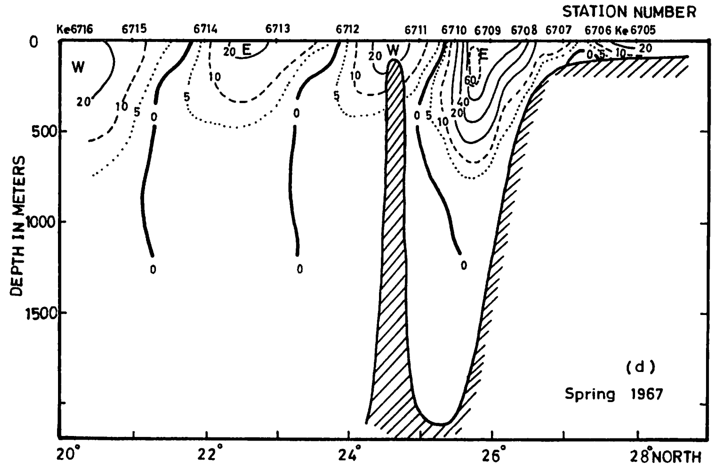

Fig. 7. (d)

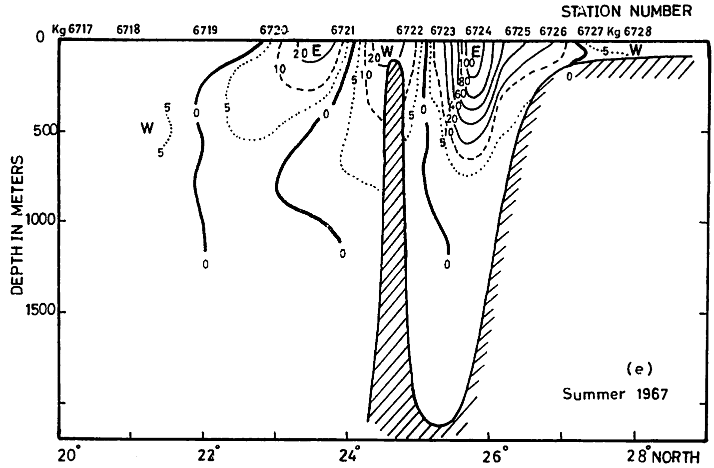

Fig. 7. (e)

the maximum resultant current speed will be excess value by ca thirty per cent of the east component, and the current width will be dificient by ca thirty per cent. The total volume transport, therfore, of the Kuroshio in this region approximately corresponds to that of the calculated east component stated above.

8. Westward and eastward flows to the south of the submarine ridge.

On the south of the Kuroshio, the current flows to the west near the submarine ridge and flows to the east again to the further south of the submarine ridge, as shown in Fg. 7. The westward and the eastward flows may form a vortex found usually at the right hand side of the Kuroshio in the region under consideration (Takahashi and Chaen, loc. cit.). The westward flow seems to be the

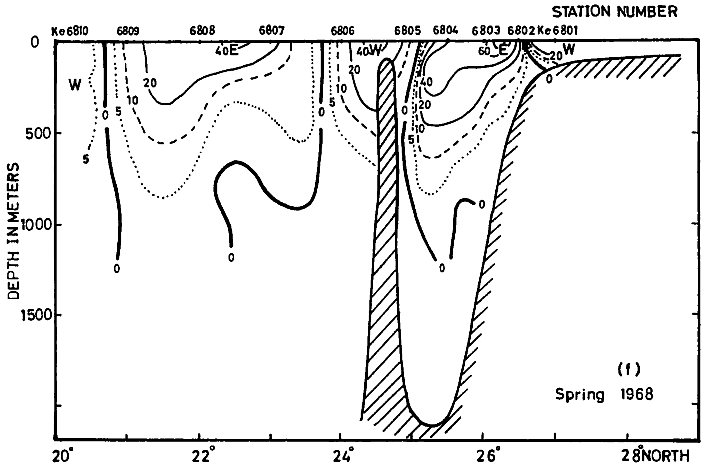

Fig. 7. (f)

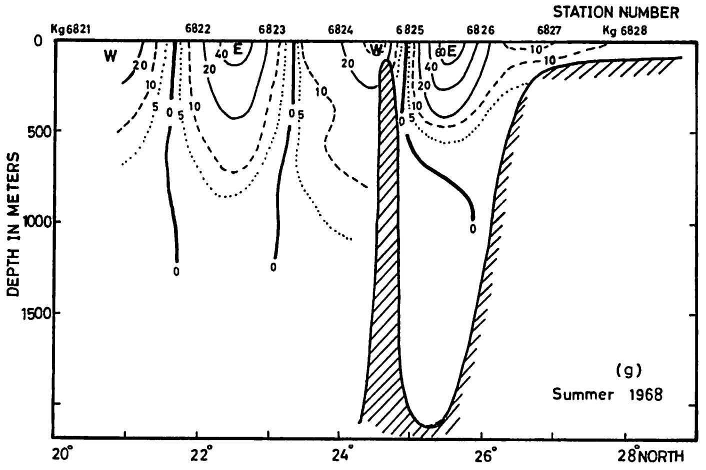

Fig. 7. (g)

counter current of the Kuroshio, but the eastward flow may be the starting portion of the Eastward Subtropical Countercurrent or may be not. With regard to these flows, some current characteristics are also determined and shown in Table 3. The current axis is situated around at 24°N-24°30′N in the westward flow and at 22°30′N-23°30′N in the eastward flow, with a exception in summer of 1966, showing the southward movement. As shown in Table 3, these currents have much variable characters according to season and year, compared with those of the Kuroshio itself. The maximum speed of the eastward current is higher than the westward flow, with a exception in spring of 1967. That of the eastward flow is higher in summer than in spring in general, while in 1966 vice versa. The numerical value of the maximum speed of the eastward flow is ca 70 cm/sec in summer of 1965 as the highest, while ca 22 cm/sec in spring of 1966

Table 2. Values of the current elements of the Kuroshio on 125°E section.

Current elements / Year & Season		Position of current axis (Lat. N)	Max speed of east component (cm/sec)	Current width (mile)	Current thickness (depth of 10 cm/sec velocity) (m)	Volume transport of east component (m³/sec)
1965	Summer	25°45′	100	120	620	30×10⁶
1966	Spring	26°15′	80	115	690	31
	Summer	26°15′	95	112	620	28
1967	Spring	25°45′	77	160 <	690	32
	Summer	25°45′	110	135	690	39
1968	Spring	26°15′	87	103	650	29
	Summer	25°30′	70	150 <	490	26

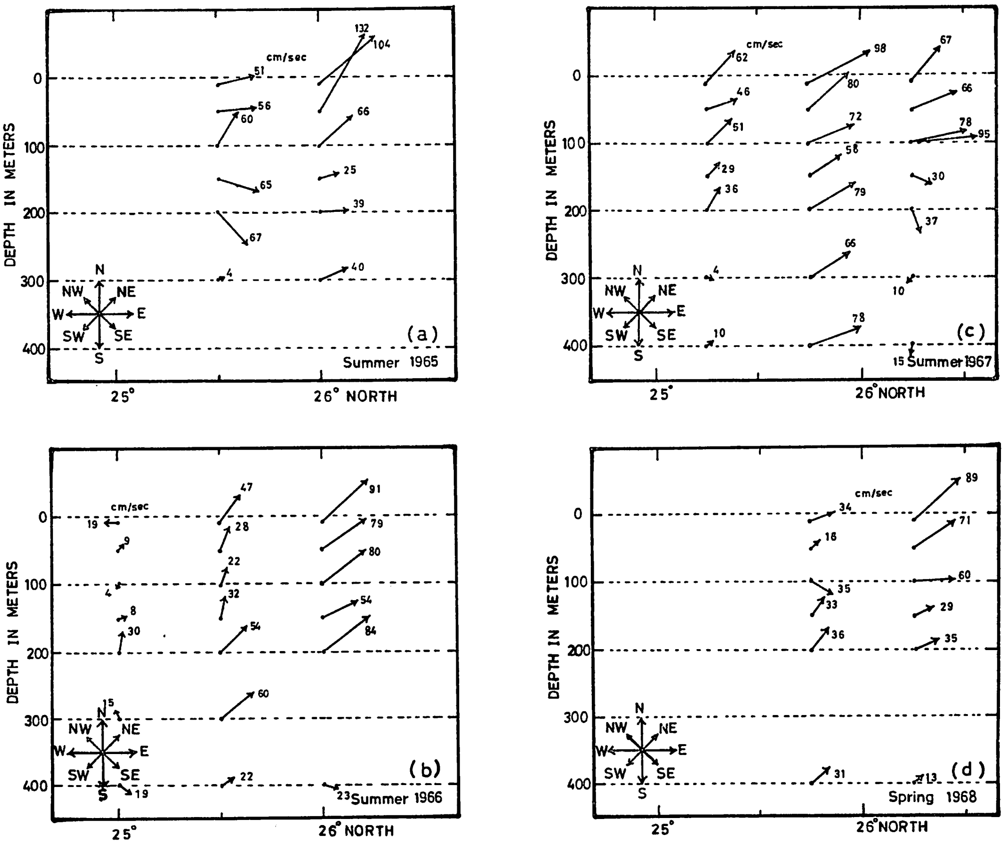

Fig. 8. Vertical distribution of current vectors observed by means of two current meters referred to a depth of 1,000 m ; (a) summer of 1965, (b) summer of 1966, (c) summer of 1967, and (d) spring of 1968.

Table 3. Values of current elements of the westward and eastward flows on 125°E section.

Current elements / Year & Season		Position of current axis (Lat. N)		Max speed of east west component (cm/sec)		Current width (mile)		Current thickness(depth of 10cm/sec velocity) (m)		volume transport of east-west component (m^3/sec)	
flow		West-ward	East-ward	West-ward	Esat-ward	West-ward	East-ward	west-ward	East-ward	West-ward	East-ward
1965	Summer	24°00′	22°30′	36	70	95	165 <	560	750	19×10^6	30×10^6
1966	Spring	24°30′	23°30′	10	22	60	90	100	140	3	8
	Summer	23°30′	19°30′	27	35	250	165	230	370	22	20
1967	Spring	24°30′	22°30′	28	23	90	120	230	320	7	12
	Summer	24°30′	23°30′	28	31	60	75	330	280	6	11
1968	Spring	24°30′	22°30′	42	44	75	180	270	570	10	28
	Summer	24°30′	22°30′	33	59	92	92	600	720	15	23

as the lowest, the latter approximately coincide with that of the Eastward Subtropical Countercurrent reported by Uda and Hasunuma (1969). Similar to the maximum speed, the volume transport of the eastward flow is higher than the westward flow, but with another exception in summer of 1966. The numerical value of the eastward volume transport in summer of 1965 and in spring of 1968 is nearly as high value as those of the Kuroshio in the same season of the year respectively. However, in spring of 1966, in spring and summer of 1967 those are as low values of one-third to one-fourth of those of the Kuroshio itself in the same season of the year. Even these low values are rather higher than that of the Eastward Subtropical Countercurrent suggested by Uda and Hasunuma (loc. cit.), which is ten or twenty per cent of that of the Kuroshio itself.

Such large amount of the volume transport of the eastward flow across 125°E section should be considered to involve a considerable part of a contra solem vortical transport besides the due eastward flow. Therefore, the intensity of the total eastward flow may suggest the existence of the upwelling related to a vortex. It is the most intensive in summer of 1965 during the four years, as shown in the temperature distribution also.

In order to examine these consideraiton mentioned above the charts of the dynamic topography at the sea surface referred to 1,000 m depth in the region between Taiwan and the meridian of 150°E for four seasons are drawn in Fig. 9, on the bases of CSK data for spring (Mar. Apr. and May in 1966 and 1967), summer (June, July, and Aug. in 1965, 1966, and 1967), autumn (Sept., Oct. and Nov. in 1966 and 1967) and winter (Dec., Jan. and Feb. in 1965, 1966 and 1967). In the region under consideration, lower subtropical latitudes, the difference in dynamic depth anomaly between adjacent stations is small, as indicated by Ma-

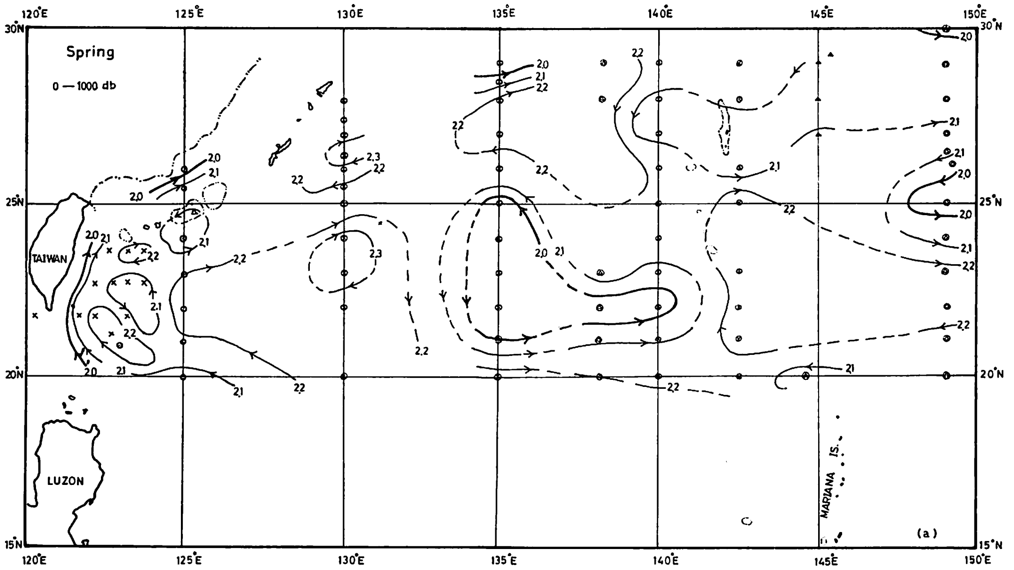

Fig. 9 (a). Dynamic topography of the sea surface referred to 1,000 m depth in spring. Symbols of stations : circles including dots, Keiten Maru, Apr., '66, '67 ; crosses, Yang, Ming, Mar., Apr., '66, Apr., '67 ; circles including crosses, G. Nevelskoy, Mar., Apr., May, '66 ; circles including triangles, Orlick, Mar., Apr., '66, Mar., '67 ; solid triangles, U.M, Schokalsky, May, '67.

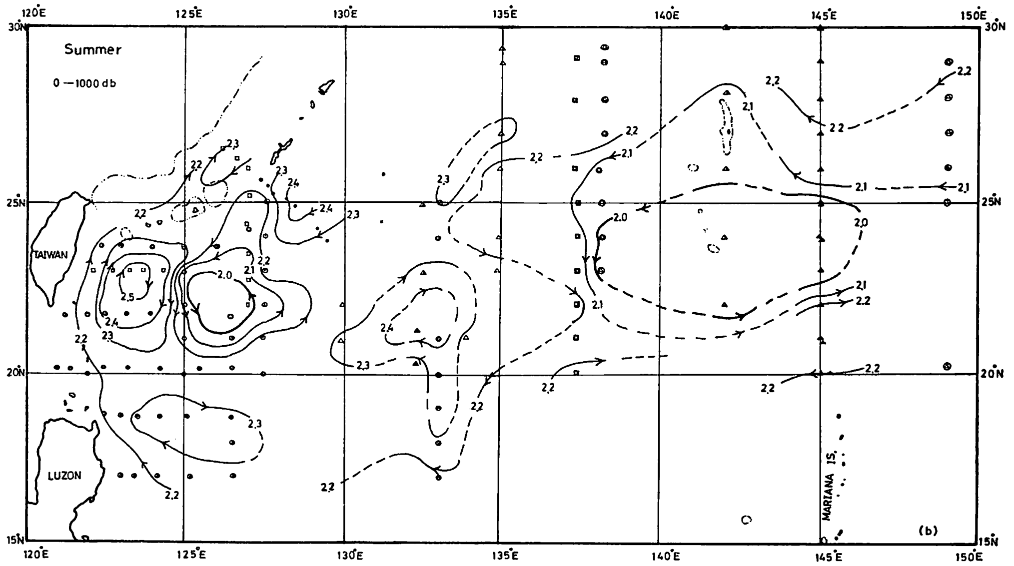

Fig. 9 (b) Dynamic topography of the sea surface referred to 1,000m depth in summer. Symbols of stations : circles, Kagoshima Maru, Aug., '65, '66 ; circles including dots, Keiten Maru, Aug., '65 ; double circles, Takuyo, July, Aug., '66 ; double squares, Shinyo Maru, Aug., '66 ; squares, Chofu Maru, July, ,66 ; solid triangles, U.M. Schokalsky, Aug., '65, June, '67 ; circles including triangles, Orlick, Aug., '67 ; triangles, Uliana Gromova, Aug., '65 ; solid circles, Atlantis II, Aug., '65 ; semi solid circles, Nagasaki Maru, June, '66, '67.

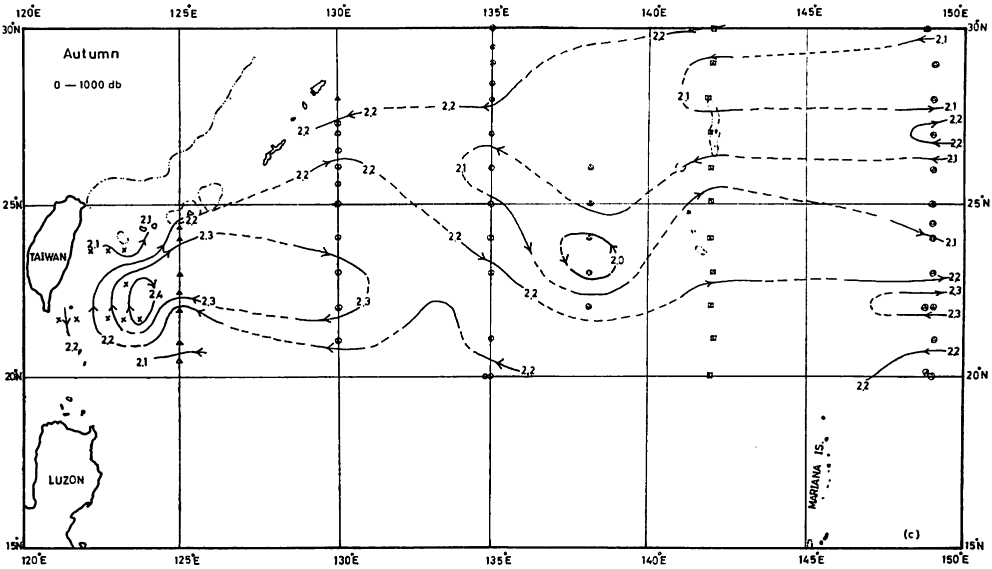

Fig. 9 (c). Dynamic topography of the sea surface referred to 1,000 m depth in autumn. Simbols of stations : crosses, Yang Ming, Sept., Oct., '66 ; circles including crosses, G. Nevelskoy, Sept., Oct., '66 ; circles including triangles, Orlick, Sept., '66, Nov., '67 ; squares including cross, Umitaka Maru, Nov., '67 ; solid triangles, Koyo Maru, Oct, '67; triangles, Nagasaki Maru, Nov., '67.

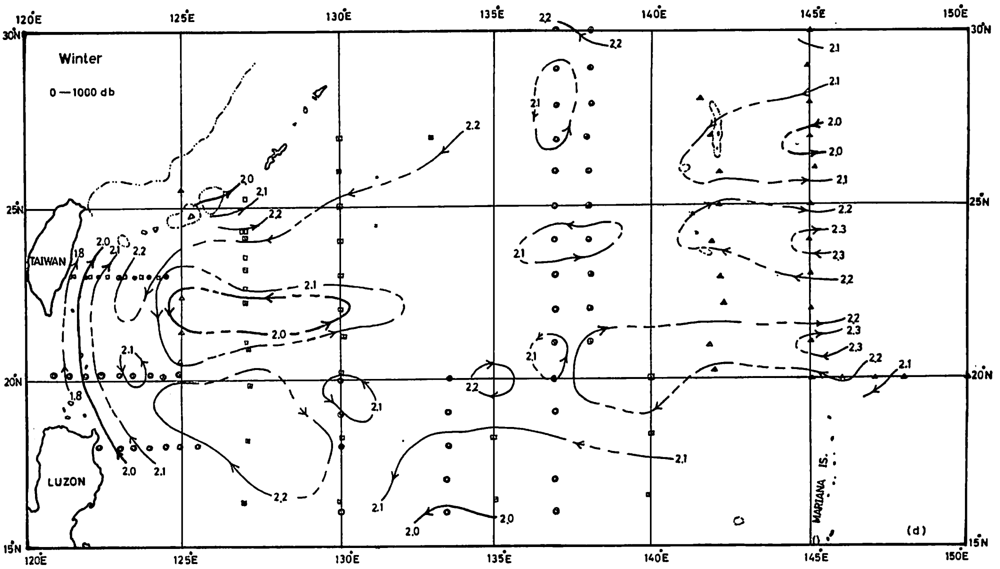

Fig. 9 (d). Dynamic topography of the sea surface referred to 1,000m depth in winter. Simbols of stations : squares including crosses, Vitjaz, Jan., '66 ; squares, Chofu Maru, Jan., '66, '67 ; triangles including solid circles, Oshoro Maru, Jan., '66 ; solid triangles, U.M. Schokalsky, Feb., '66 ; double circles, Ryofu Maru, Jan., Feb., ,67, Feb., '68 ; triangles, Nagasaki Maru, Jan., '67 ; circles including triangles, Orlick, Feb., '67.

suzawa (1967). Moreover, each chart in Fig. 9 is completed by combination of a few year data. In spite of these defects, however, the major characteristic feature of the dynamic topography in the region under consideration can be noticed as follows. Cyclonic and anticyclonic vortices of different sizes are found alternately from west to east. This fact is also found on the CSK Atlas published by JODC (1967, 1968, 1969, 1970). The westward and eastward flows across the 125°E section form part of a large vortex at the western side. Yamanaka, Anraku, and Morita (1965) pointed out that the westward and the eastward flows exist in the lower subtropical latitudes on 130°E, 135°E, and 140°E sections also by means of their charts of the geostrophic current or temperature distribution. Thus the eastward flow extends to the further east in all four seasons along the outer side of the successive vortices with meandering. The Eastward Subtropical Countercurrent is theoretically inidcated, on the bases of the wind stress data, by Yoshida and Kidokoro (1967) as a relatively narrow band with irregular fluctuation in the region between the west wind and trade wind zone. According to the results mentioned so far, the Eastward Subtropical Countercurrent seems to actually exist with irregularity and large meandering. The volume transport of this eastward current varies very much, which may suggest remarkable fluctuation of current direction, because obtained numerical values do not contain total transport but only eastward component.

9. Summary and Conclusion

The oceanographic description along the meridian of 125°E in spring and summer of successive four years, 1965-1968 is presented, based on oceanographic data of the Keiten Maru and the Kagoshima Maru cruises for CSK and some additional data of other vessels participating to CSK.

The variation of the temperature distribution according to years is less remarkable, the range of which is 1-2°C in summer and ca 3°C in spring. However, the slope of isotherms in the region between the border of the shelf and the submarine ridge shows rather remarkable differences according to years.

Two low salinity water are found on the continental shelf in every spring and summer, though these situations and the numerical values are changeable according to seasons and years.

Dissolved oxygen in the surface layer along the sectoin is a little higher in winter and spring than in summer and autumn. Throughout the all seasons, the numerical values of dissolved oxygen for the subsurface saline water and the intermediate water is ca 4.8-4.6 ml/L and 2.8-2.5 ml/L respectively.

Temperature and salinity for the subsurface saline water are ca 21°C and 35.0 ‰, while the intermadiate water ca 7°C, ca 34.3 ‰. T-S relations on the East China Shelf show quite differences according to season; i. e., curves in winter and spirng are nearly along isanosteric surfaces, while in summer and autumn those cross at nearly right angle to isanosteric surfaces.

The core of the Kuroshio is situated almost always at the middle point between the border of the East China Shelf and the submarine ridge, though the width and thickness are both variable. The volume transport of the east component in spring is nearly the same value in all of three years, having ca 30×10^6 m^3/sec, while in summer some differences are recognized according to years, the highest ca $39\times10^6 m^3/sec$ in 1967 and the lowest ca 26×10^6 m^3/sec in 1968. In 1966 and 1968 the volume transport is ca 3×10^6 m^3/sec higher in spring than in summer, but in 1967 it is vice versa.

The westward flow and the eastward flow (20°N-24°N) to the south of the Kuroshio are always found in spring and summer, though the currents have rather variable characters according to season and year compared with those of the Kuroshio itself. The westward flow corresponds to the counter current of the Kuroshio, but the eastward flow may be the starting portion of the Subtropical Countercurrent or may be not. The maximum speed and the volume transport of the eastward flow is higher than the westward flow, in general. The numerical value of the eastward volume transport is nearly same as the Kuroshio itself in high case (30×10^6 m^3/sec), while one-fourth of the Kuroshio in low case (8×10^6 m^3/sec). This fact suggests remarkable fluctuation of the current direction, because these values do not contain total transport but only eastward component. Moreover the large amount of the volume transport of the eastward flow across 125°E section should be considered to involve a considerable part of a vortical transport besides the due eastward flow. Thus the eastward flow extends to the further east along the outer side of the successive vortices with meandering.

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