



Results of Polish Hydrographical Observations
in the Southern Baltic, May 1967 - May 1968



By
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General character of hydrographical conditions

The summer 1967 was more continental than in the three preceding years and similar to that of 1963. The winter 1968 was rather temperate and water temperatures in the upper layer in February - March did not descend in the open sea below 1.2°.

In the period considered no renewal of bottom waters by an influx of oceanic water into the Bormholm Deep was observed. Thus the bottom salinity and oxygen content in the two most important Deeps of the southern Baltic fell constantly, whereas the phosphate contents increased.

Arkona Deep (Station A₁: 55°02'N, 14°01'E; Fig. 1).

At the beginning of May ¹⁹⁶⁷ the difference between the highest temperature at the surface and the minimum near to the bottom amounted merely to 1.8°C, but with the time advancing the difference grew due to intensive warming up at the surface while at the bottom the warming was much slower. The observations on 19th July revealed, however, a rapid increase in the bottom temperature (11.1°C), below the minimum - at 30 m depth lower than 7°C. This signaled an influx of new waters into the Arkona Deep. In the first decade of August the thermic structure of waters was almost the same, if neglecting a slightly higher surface temperature as well as that at the bottom. The warm bottom waters remained till at least the end of October, when 12.2°C were found.

A month later a decrease in the bottom temperature by nearly 3°C was found. In the period from December 1967 to about the end of March 1968 the temperature was almost uniform in the whole water column amounting to about 8°C in December and decreasing gradually to less than 2°C in February and March. In May 1968 the surface temperature was already higher than 7°C and the thermocline at 10 m to 20 m depth quite distinctly marked. Below 20 m depth the temperature dropped with depth gradually from 3.7°C to 2.2 - 2.4°C near the bottom.

The surface salinity ranged between 7.4‰ and 8.4 ‰. The bottom waters of over 18‰ salinity, which had been found in May 1967, were displaced by less saline waters. In July, however, simultaneously with high temperature, a pronounced increase in salinity occurred, as at 45 m depth nearly 15‰ was observed. During subsequent months the bottom salinity considerably decreased as at the end of November only 9.5‰ was noted. Thus the year's end was characterized by a relatively high (>8‰) surface salinity and a low bottom salinity. In February 1968 considerably high salinity values were obtained. This high salinity, however, did not remain long as a fall to merely 11.1‰ at 44 m depth observed in March, proved that the influx of bottom saline waters in February was a temporary one and of little importance. To the end of April the salinity there increased but slightly.

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Bornholm Deep (Station B₁: 55°20'N, 15°45'E and
Station P-5: 55°18'N, 15°58'E; Fig. 2).

The maximum summer temperature at the surface (in August) was about 18.6°C. The minimum temperature in the top water layer, observed in March 1968, was about 1.7°C.

From April to mid-May 1967 the temperature at the surface rose from 2.4° to 7°C. The winter water with temperatures below 4° was observed at depths about 50 m till July. The low temperatures 4° to 5° endured till August at depths 40 to 70 m. Probably in September the temperatures lower than 5° connected with the winter water remains disappeared. The convection process started in August and embraced a gradually thickening upper water layer so that at the end of 1967 the temperature was almost uniform from the surface to the bottom, because in the bottom water layer also temperatures of about 5.8° were found at that time.

The lowest temperatures at the surface and in the upper water layer, amounting to 1.8°C were observed in March 1968. The surface temperature of 6.9° on 15th May as compared with 8.1° on 18th May 1967 tells us, that the warming process in these two years resulted in almost the same temperature at the same time in spite of a somewhat more prolonged winter cooling of surface waters in 1968 against the previous year. The winter cooling of top waters to temperatures lower than 2° in March, involved waters to 45 m depth, as in the previous year, the lowest temperatures being rather the same as well; the difference was only in the time of occurrence of the minima, the coldest month in 1967 being February.

The bottom temperature of 4.5°C and 5.9°C in May 1967 oscillated afterwards but slightly, between 6.3° and 5.1°, at depths greater than 80 m.

The surface salinity was lower than 7.5‰ during nearly half a year but since December 1967 it has remained slightly higher than 7.5‰. The depth of occurring of the 8‰-isohaline (considered the lower boundary of the isohaline top water layer) oscillated between 45 m and 55 m depth except for the end of April 1968 when it was found at 65 m depth.

At the bottom, the water with salinity higher than 16‰ present in May 1967, disappeared at the end of October. In December the salinity amounted to only 15.66‰. During the subsequent months the bottom salinity continued to fall so that about the end of April 1968 it amounted to 15.1‰.

The most characteristic feature of the salinity conditions in the Bornholm Deep was a gradual decrease in salinity of the bottom waters due to the lack of any marked renewal by an influx from the North Sea. The last influx occurred in spring 1967 and brought in waters very differing in temperature but rather without a difference in salinity.

The western part of the Słupsk Furrow (Station B₂: 55°13'N, 17°02'E;
Fig. 3).

The surface temperatures in this area presented themselves very similarly as compared with those of the Bornholm Deep. The surface water, however, cooled to lowest temperature in March 1968, descended to greater depths than in the Bornholm Deep, due to greater thickness of the isohaline top water layer. Afterwards, the inverse structure settled in and remained till April as in this month the warming process at the surface got sufficiently intense to break the thermally inverse structure of the water masses. Waters warmed up to more than 18°C in August, occupied the depths from the surface to about 20 m. The cold water remains after the winter 1967, with temperature slightly lower than 4°C was observed at 40 to 65 m depth till August (its temperatures lower than 3°C disappeared before May).

The bottom temperature higher than 6°C which was found in May 1967 decreased afterwards and values from 5 to 6°C were observed until the beginning of April 1968, but at the end of this month also the isotherm of 5°C disappeared in turn.

The gradual dropping of the bottom temperature was characteristic for this part of the sea.

During summer and the first part of autumn 1967 the surface salinity remained below 7.5‰, in December 1967 and January-February 1968 it was higher than 7.4‰, but since the end of February the lower values have appeared again.

The lower boundary of the isohaline upper waters (identical with the depth of occurrence of the 8‰ isohaline) ran at 50 to 60 m depth in the period from May to October 1967. Then an unusually lowering of this boundary took place; so in December only 7.85‰ was found at 80 m depth. In February 1968 8.01‰ was noted at 50 m depth again. In subsequent months the thickness of the isohaline top water layer grew by about 15 m.

The changes in the bottom salinity were generally found to be in accordance with those in temperature. In May 1967 the salinity of 14.33‰ was observed at 90 m depth, in August the salinity was about 0.5‰ lower, and continued to decrease until December when at 90 m depth only 11.94‰ was found. From December 1967 to at least February 1968 some increase of salinity to values slightly higher than 12‰ took place.

Generally speaking, the bottom salinity in the western part of the Szupsk Furrow dropped constantly till the end of 1967, and got slightly higher anew in winter 1968.

Southern part of the Gdańsk Deep (Station G₂: 54°50'N, 19°20'E; Fig. 4).

The surface temperature which had amounted to about 6°C in the first days of May 1967, rose to a maximum of 20.8°C in the first half of August. About mid-December temperatures near to 6°C were observed. The minimum winter temperature in 1968 was about 1.8°C and occurred in the period from mid-February to the end of March. About mid-May nearly 7°C was found.

The cold water with temperatures 3 to 4°C, remaining at intermediate depths after the 1967 winter, did not disappear until September. The autumnal convection effected mixing of waters to a depth growing gradually to about 75 m in October and November at temperatures decreasing from the August's maximum to about 5°C in December. In January 1968 the waters from the surface to about 90 m depth indicated temperatures 5° to 3°. About mid-February the temperature fell below 2° and remained so till the end of March in the upper water layer to about 75 m depth. In comparison with the previous year there was a retardation of the warming process in spring this year by about half a month. In April, however, the warming rate was greater than in 1967, the surface temperature on 2nd May being 6.4°C as compared with 6.2° on 7th May 1967. This more intensive warming up of surface waters was reflected in higher temperatures at comparable depths, too.

In the upper part of the bottom water layer (80 to 110 m depth) the temperature oscillated about 5°C, but below 90 m depth it was always somewhat higher than 5° except for the beginning of May 1967 (4.8° at 90 m depth). The maximum bottom temperature 5.84°C was found in the third decade of May 1967 and was nearly as high in August that year. Afterwards a slow decrease in bottom temperature took place. In May 1968 the bottom temperature amounted to nearly 5.3°C.

The surface salinity remained lower than 7.5‰ in the period from May 1967 to the end of December. In May-June it was even lower than 7‰ due to the diluting effect of the Vistula discharge. From January till May 1968 the salinity was higher than 7.5‰, except for a short period in February.

The isohaline top water layer limited from below by the isohaline of 8‰, reached an average depth of 60 to 70 m. The halocline occurred in 1967 between 60 and 85 m depth; it descended, however, afterwards to 90 m and more.

At the bottom, a salinity higher than 12‰ was observed in a layer of at least 15 to 20 m thickness in the period from May 1967 to October. In this month the 12‰ isohaline disappeared. The continuing dilution of bottom waters reached its peak of 11.04‰ at 105 m depth in February this year. Afterwards the salinity rose slightly; and on 2nd May 11.36‰ was found at 108 m depth.

Oxygen conditions

Oxygen contents in the upper water layer in the period from January 1967 to May 1968 allow to make a comparison between the two springs, 1967 and 1968. It was characteristic for the previous year that the highest contents, about 9 ml/l, were observed as early as the beginning of February. Also about mid-May about 9 ml/l was found sporadically. In February 1968 such high values were not observed. However, from the first decade of March until at least 1st May, all over the sea the oxygen contents were relatively very large, being on average as high as 9.7 ml/l, and in one case a value near to 10 ml/l was noticed. If expressed in percentage of saturation, these values amounted to about 115% and 117%, respectively. Most probably the photosynthetic processes in 1968 were more intense than at the same time a year ago.

The lowest contents of the dissolved oxygen were found, as usually, in the warmest month of the year, i.e., in August: on an average 6.2 to 6.3 ml/l (the minimum value, found in the southern part of the Bornholm Deep, was 5.04 ml).

From August the oxygen content in the upper water layer slowly decreased and in December and January 7.6 to 7.7 ml/l was found all over the area investigated. In February an increment by a further millilitre per liter was observed, and in March and subsequent month values exceeding 9 ml/l were frequent, as was already mentioned.

At the bottom the oxygen conditions were particular for each deep. In the Arkona Deep, in May 1967 the oxygen content dropped rapidly from 5 to 2.4 ml/l and remained at this level almost without change until August. In the period between August and October the oxygen conditions improved as at the end of October 5.4 ml/l, and in the last decade of November even 6.9 ml/l was observed due to the temporary replacement of saline bottom waters by less saline waters from above (lowering of the upper layer to unusually great depths, see Fig. 1). Relatively high oxygen contents were also found in mid-March 1968 (8.1 ml/l as well as at the end of April; but at this time the origin of such a considerable oxygen amount was not the same as in autumn. It was apparently due to an influx of saline waters at the bottom, observed in the Arkona Deep in February, the salinity being then by 7‰ higher than in November past year. Unfortunately, the results of the oxygen determinations for February 1968 were not available so far.

The characteristic feature of the bottom oxygen conditions in the Bornholm Deep was the permanent though slow dropping of oxygen amount from 4.75 ml/l in May 1967 through 2.5 ml/l in July and 1.3 ml/l in December to 0.7 ml/l in March and April 1968. These changes can be considered another proof that in the period under consideration there was no renewal of bottom waters in the Bornholm Deep.

In the western part of the Słupsk Furrow the oscillations of the oxygen content in the bottom water layer were but small and the content was close to 3 ml/l. The last observations from March 1968 gave values slightly higher than 3 ml/l.

In the Deep of the Gdańsk the oxygen content in the bottom water layer indicated a gradual dropping from 3.7 ml/l in May 1967 to 0.2 ml/l in December and January 1968. At the end of February some improvement of oxygen conditions seemed to take place as the values found there amounted to about 1.5 to 1.3 ml/l; but already in the first decade of April only 0.8 ml/l and in May 0.5 ml/l were observed again.

Phosphate contents in deep waters

The appended table gives the values of phosphate contents in the water layer below 40-50 m depths at the four stations considered in this contribution. The phosphate contents are expressed in mg of P_2O_5 per cbm. The four stations A_1 , B_1 , B_2 and G_2 represent the four most important areas of the southern Baltic, the Arkona Deep, the Bornholm Deep, the western part of the Słupsk Furrow and the southern part of the Gdańsk Deep, respectively.

Table of Phosphate contents (mg P₂O₅/m³)

Station A₁

Depth (m)	24.V 1967	-	24.VIII 1967	24.XI 1967	-	-	16.III 1968	28.IV 1968
30	-		< 5	-			< 5	-
40	-		-	-			< 5	-
44-47	50		70	5			< 5	25

Station B₁

Depth (m)	18.V 1967		18.VIII 1967		10.XII 1967		20.III 1968	28.IV 1968
40	< 5		< 5		-		-	-
50	30		< 5		-		25	< 5
60	30		30		-		60	< 5
70	45		30		-		70	50
80	80		35		90		100	90
90	-		55		90		-	-
93-98	55		30		90		100	100

Station B₂

Depth (m)	17.V 1967		16.VIII 1967		9.XII 1967		21.III 1968	29.IV 1968
40	-		< 5		-		-	-
50	< 5		< 5		-		< 5	< 5
60	30		15		-		< 5	< 5
70	70		50		-		65	45
80	70		70		-		70	60
90-92	90		100		70		85	-

Station G₂

Depth (m)	25.V 1967	31.V 1967	5.VIII 1967	8.XI 1967	13.XII 1967	27.II 1968	28.III 1968	1.V 1968
50	< 5	< 5	-	-	-	-	< 5	< 5
60	5	-	20	-	-	-	30 ?	< 5
70	25	55	-	-	-	< 5	< 5	< 5
80	25	-	80	-	-	60	30	80
90	40	55	80	-	90	100	70	100
100	65	-	100	120	≥ 100	120	100	-
105-108	100	100	100	140	-	120	160	100

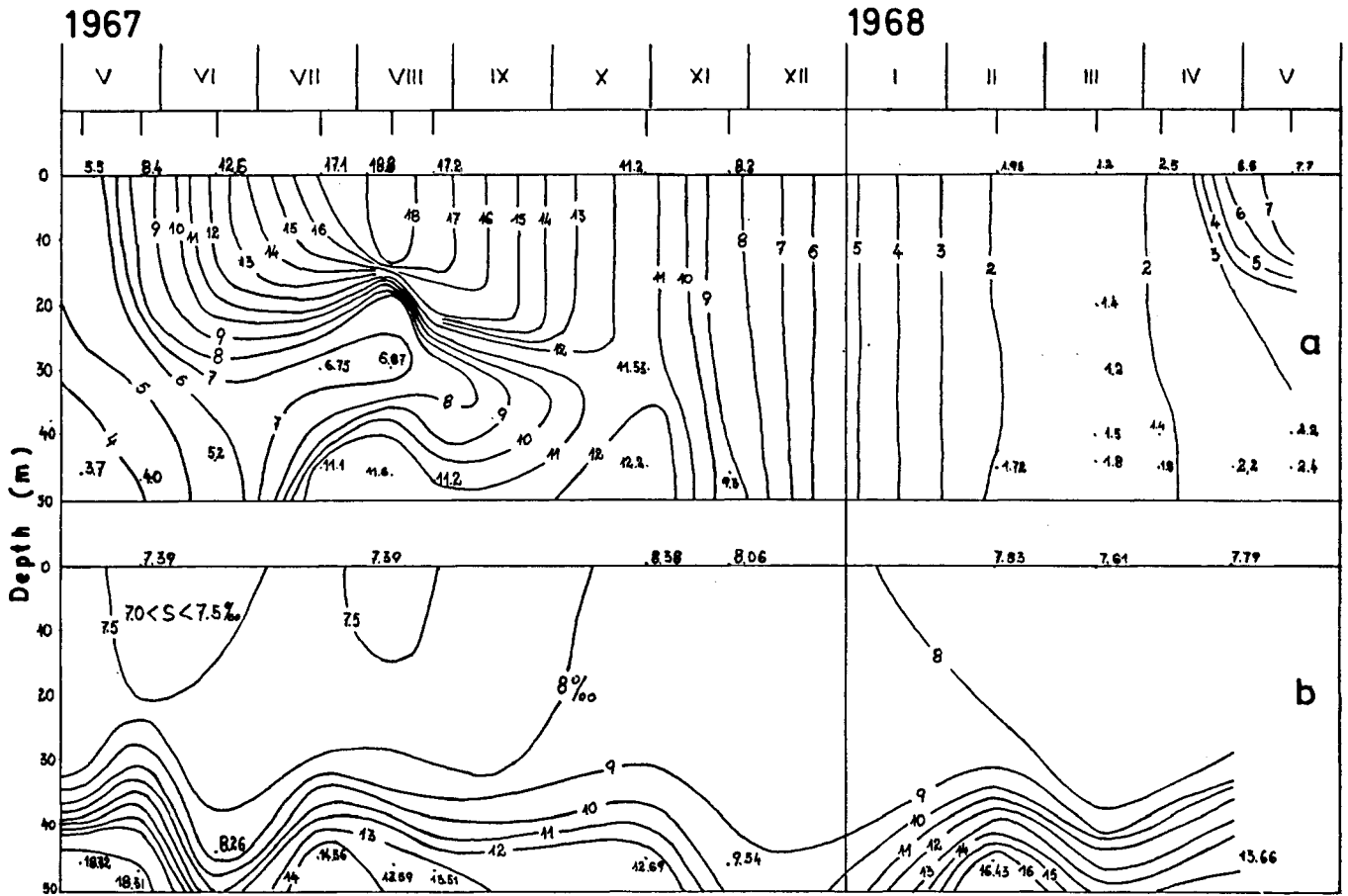


Fig. 1. Temperature (a) and salinity (b) at station A₁

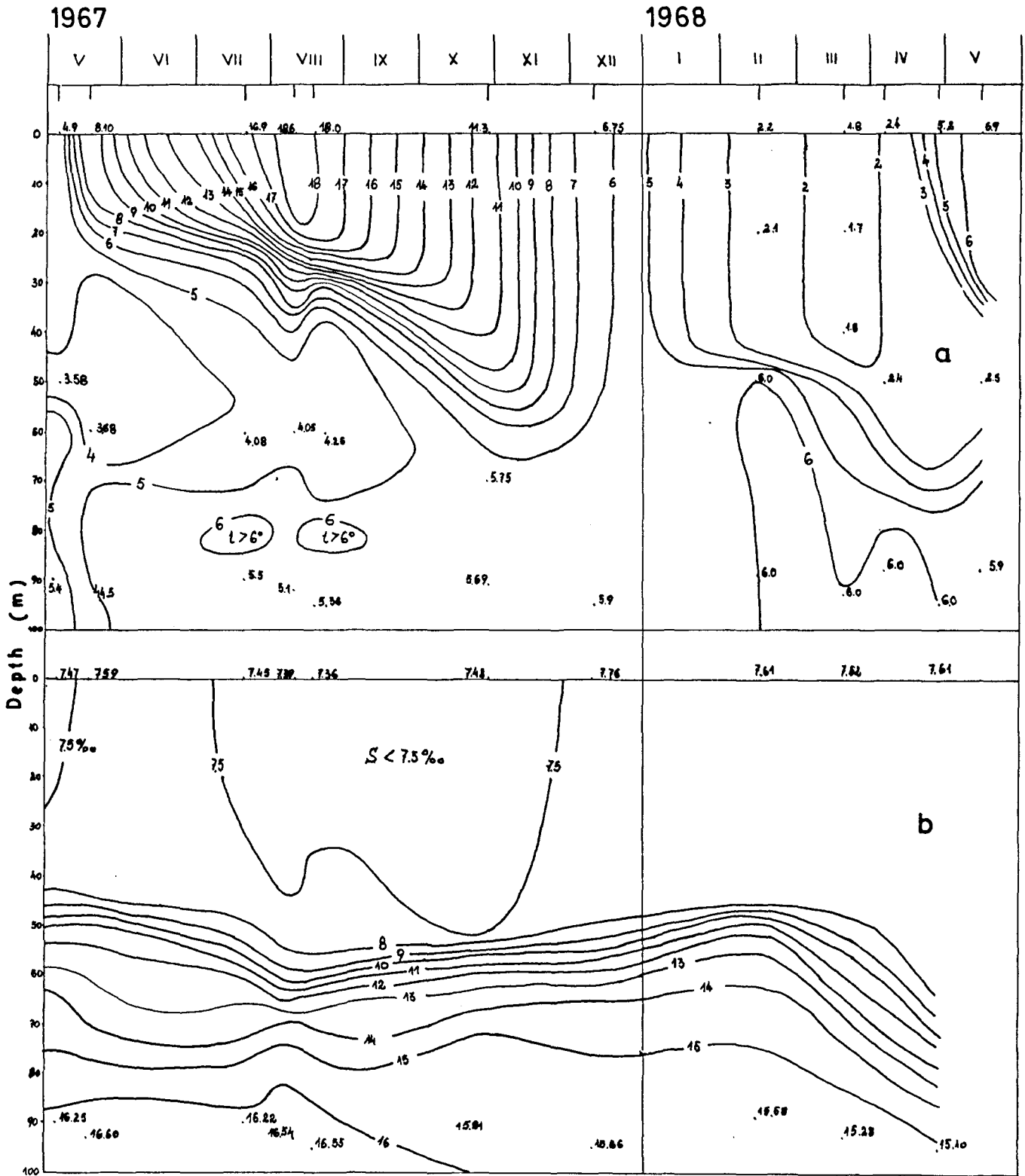


Fig. 2. Temperature (a) and salinity (b) at station B₁

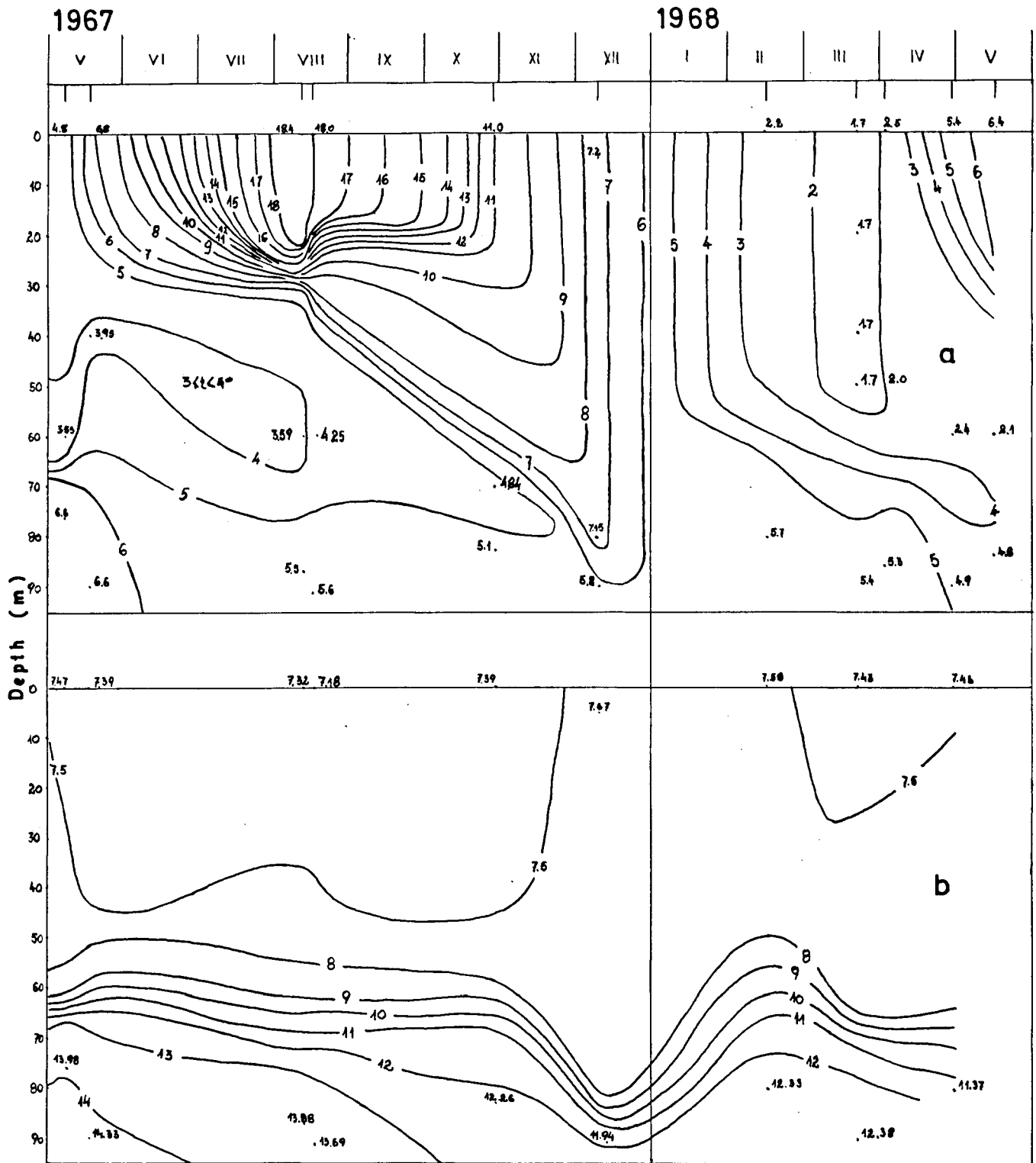


Fig. 3. Temperature (a) and salinity (b) at station B₂

