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An inflow of unusually warm water into the Baltic deep basins

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Abstract

During the autumn 1976 an inflow of Kattegat water into the Baltic occured. The temperature of the water was unusually high. In January 1977 the bottom water of the Gotland Deep had a temperature above 7°C. This is the highest bottom temperature ever recorded in the Gotland Deep. The inflow is described by help of diagrammes and figures. The oxygen conditions in the Baltic deep water are discussed and a new stagnation period is predicted.

A study of the oxygen variations in the Gotland Deep shows that the deep water was renewed during the winter 1976-77 (Fig. 1). Since 1970 the salinity in the Gotland Deep has been almost continously decresing. Small inflows of new water have only occasionally increased the salinity, but the trend has been showing a steady decreasing. In the beginning of 1976 the salinity at 240 m was down at 12.46 ‰. The water renewal during the winter raised the salinity to 13.28 ‰ in January 1977 at this depth. Such a high salinity has not been observed in the Gotland Deep since 1962 (Fig. 2).

Still more surprising is the temperature of this high saline water. At 240 m the water temperature was in January 1977 7.43°C, in March 7.31° and in June 7.23°. These are the highest temperatures ever recorded in the Gotland Deep (Fig. 3), (Fonselius 1962). In the figure the unusually low temperature in 1972 also may be noted.

A closer study of the inflow shows that it begun in November 1976 or maybe a little earlier in the autumn. The "Argos" made in November a routine cruise in the Baltic. The "Argos" left Karlskrona at the

Swedish south east coast the 22nd of November and begun the hydrographic work at station BY 4, moving then along the BY section against the Gotland Deep, continuing to the Gulf of Bothnia and home west of Gotland to Göteborg. Therefore the stations BY 3, 2 and 1 were taken at the end of the cruise in January. Because of the time lag between the sampling at BY 4 and the stations BY 1, 2 and 3, the temperatures at the latter stations cannot be compared to the temperatures at the stations taken at the beginning of the cruise. In Fig. 4, which shows the temperature distribution in the section BY 1 - BY 27, the three first stations have been excluded. Instead the temperature recorded by the "Argos" during a biological cruise the 16th of November, has been used in the figure. At that occasion the temperature through the whole water column was a little above 9°C at BY 2, the only station sampled. In Fig. 4 we can see how a parcel of warm water with a core above 10°C has entered into the Baltic. It is moving at intermediate depths through the Bornholm basin and is passing through the Stolpe channel. At station BY 8 water with a temperature above 9° is found at 80 and 90 m depths.

No complete hydrographic cruise was carried out in January-February 1977, but one hydrographer participated in a fisheries programme on the "Argos", covering the western and northern parts of the Baltic proper. The stations BY 2 and BY 15-27 from the BY section 1-27 were sampled. Fig. 5 shows the temperature distribution between the Gotland Deep (BY 15) and BY 27 at the beginning of February 1977. The station BY 2 is also included but we can only guess the conditions between BY 2 and BY 15. From the figure we can see that the bottom temperature in the Gotland basin is now above 7°C. Obviously the inflowing water has just arrived to the Gotland Deep. As was shown in Fig. 1, the oxygen concentration at 240 m at this occasion had raised to above 2 ml/l. The next hydrographic cruise with the "Argos" was carried out in March. Fig. 6 shows the temperature distribution in the same section during this cruise. The Gotland Deep contains 7° water in the botton layer and is filled to the brim with 6° water. In June the 6° water has also entered into the Fårö Deep, BY 20, (Fig. 7). The botton layer in the Gotland Deep still contains 7° water.

If look at the conditions in the section BY 39 - BY 22, which goes west of Gotland to the Landsort Deep (BY 31) and from there into the Gulf of Finland, nothing remarcable can be seen in the temperature distribution during the March cruise (Fig. 8). In June a weak increasing of

the temperature may be detected in the deep water at station BY 29, where the water from the eastern Gotland basin is entering the northern central basin, (Fig. 9).

A study of the oxygen conditions in the two sections in June 1977 shows that the oxygen concentration was relatively high in the southern Baltic, especially in the deep water of the Stolpe channel and the fishing grounds east of the channel. In the Gotland basin the oxygen concentration is again decreasing close to the bottom (Fig. 10). In the Landsort Deep the oxygen concentration is above 1 ml/l from the bottom up to close to 200 m. Hydrogen sulfide is only found in the bottom water of station BY 38. The inflow has obviously not penetrated that far into the Baltic (Fig. 11).

In figure 12 the development of the oxygen conditions in the Landsort Deep can be followed. New water is in June still flowing into the basin slowly filling it up. It can also be seen that the renewal of the water in the Landsort Deep begun allready during the autumn 1976. The water flowing at intermediate depths below the halocline, seems to move very fast through the Baltic.

The first impression of the above described inflow is that a real improvment of the oxygen conditions in the deep water of the Baltic has occured. This is of course true for the moment. Unfortunately the warm water probably will increase the oxydation speed of organic matter in the deep water, using up the oxygen very fast. This can be seen in Fig. 1. where the oxygen concentration in the bottom water of the Gotland Deep in 5 months has decreased from around 2 ml/l to around 0.5 ml/l. Therefore we may soon expect a new stagnation period in the Baltic deep basins. This stagnation period will, judging from the figure, last for several years.

Acknoledgements

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References

Fonselius, Stig H., 1962: Hydrography of the Baltic Deep Basins. Fishery Board of Sweden, Series Hydrography, Report No. 13.

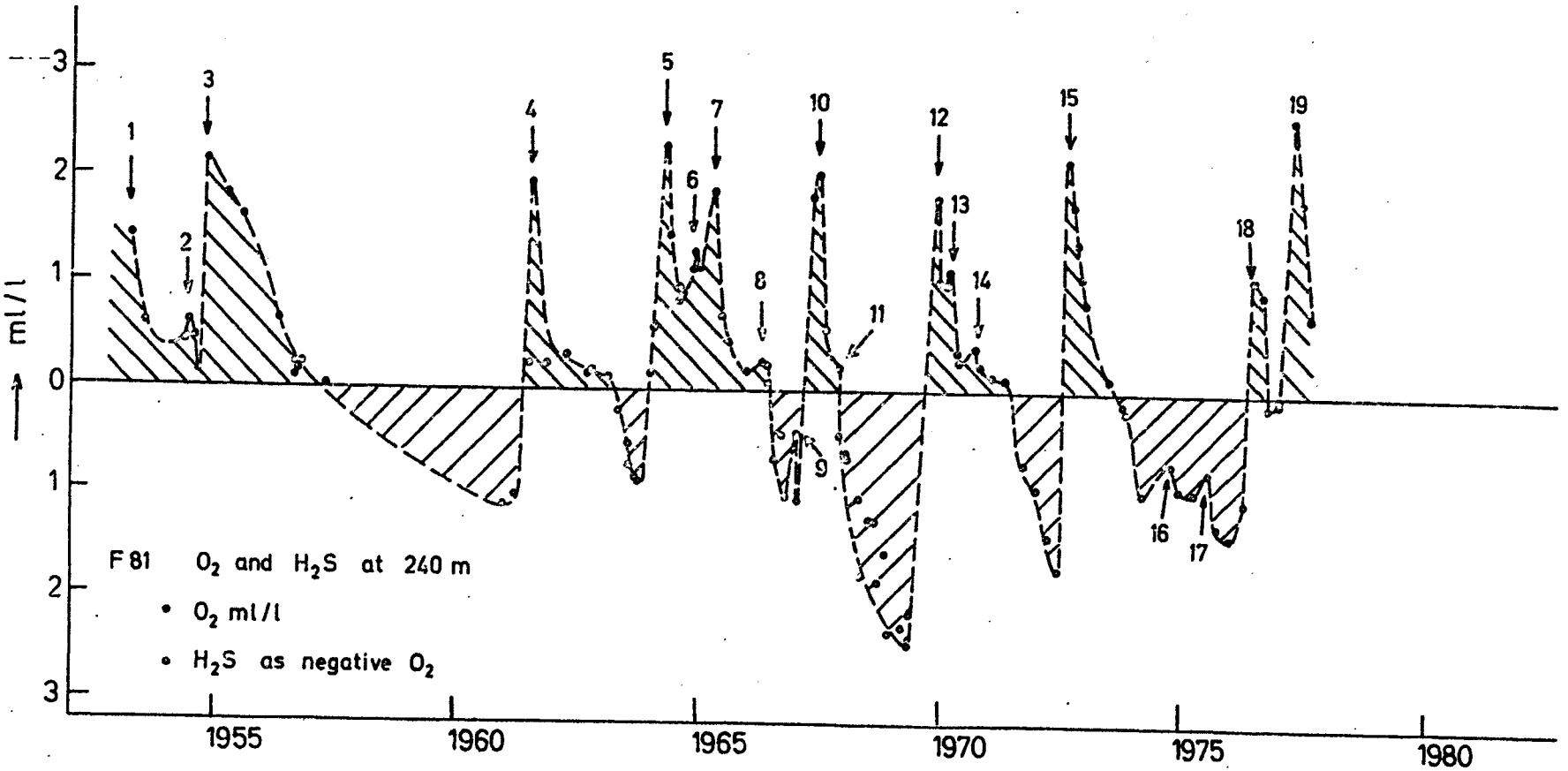
ml/l
3
2
1
0
1
2
3
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
F 81 O_2 and H_2S at 240 m
• O_2 ml/l
• H_2S as negative O_2
1955
1960
1965
1970
1975
1980

FIG. 1

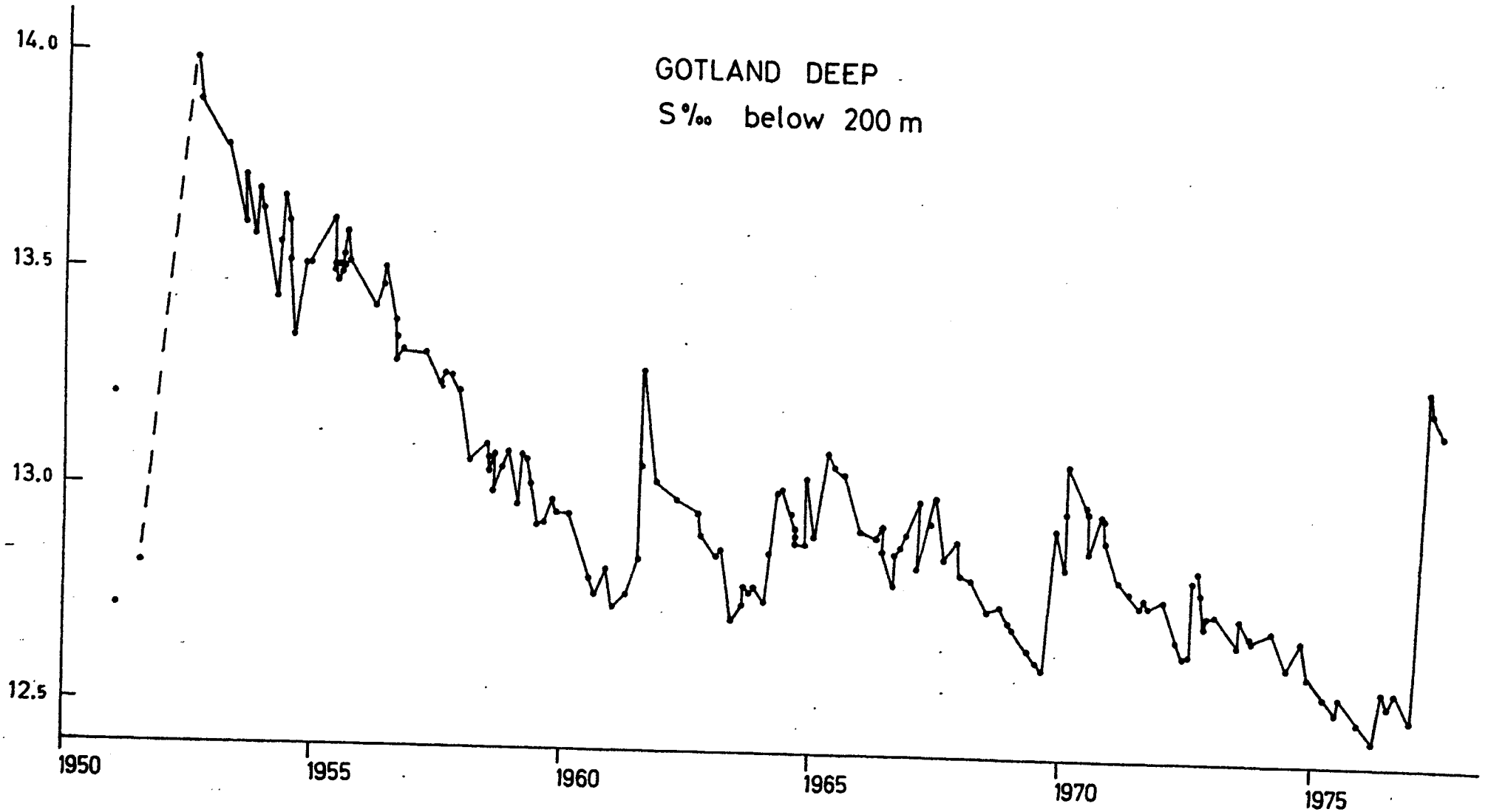
GOTLAND DEEP
S‰ below 200 m
14.0
13.5
13.0
12.5
1950
1955
1960
1965
1970
1975

FIG. 2

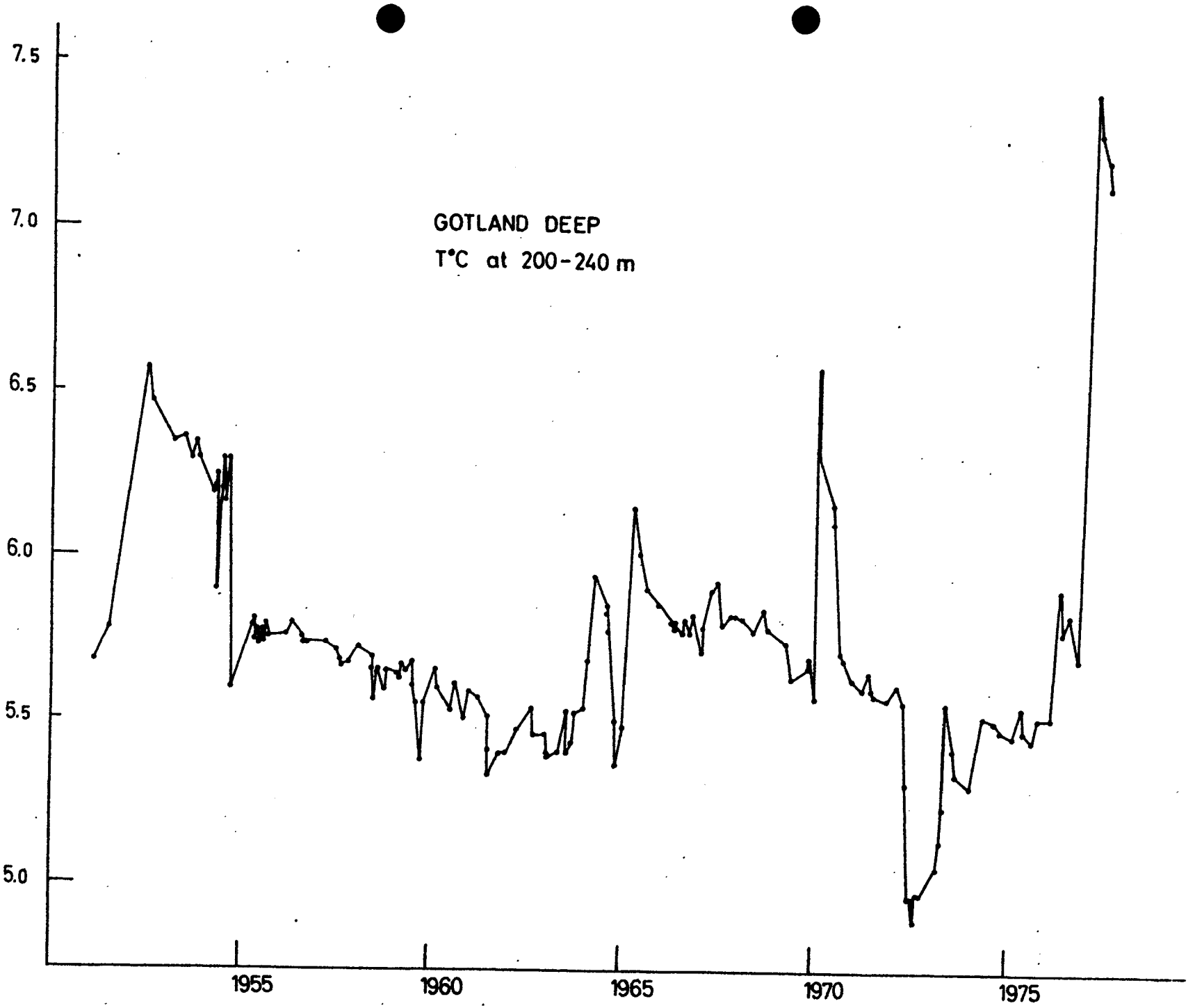
GOTLAND DEEP
T°C at 200-240 m
7.5
7.0
6.5
6.0
5.5
5.0
1955
1960
1965
1970
1975

FIG. 3

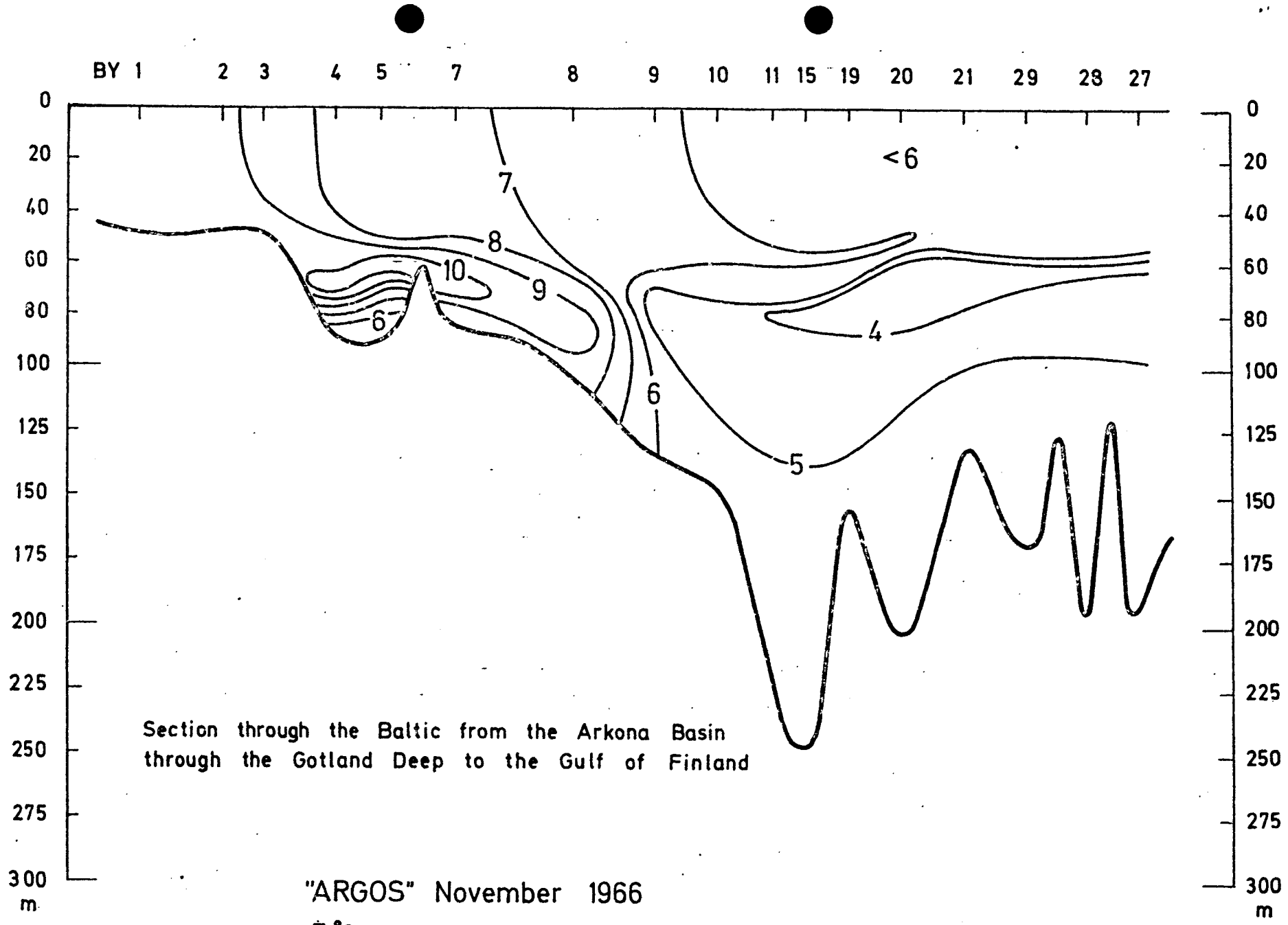
BY 1 2 3 4 5 7 8 9 10 11 15 19 20 21 29 28 27
0 20 40 60 80 100 125 150 175 200 225 250 275 300 m
<6
7
8
10
9
6
4
6
5
Section through the Baltic from the Arkona Basin through the Gotland Deep to the Gulf of Finland
"ARGOS" November 1966
T °C

FIG. 4

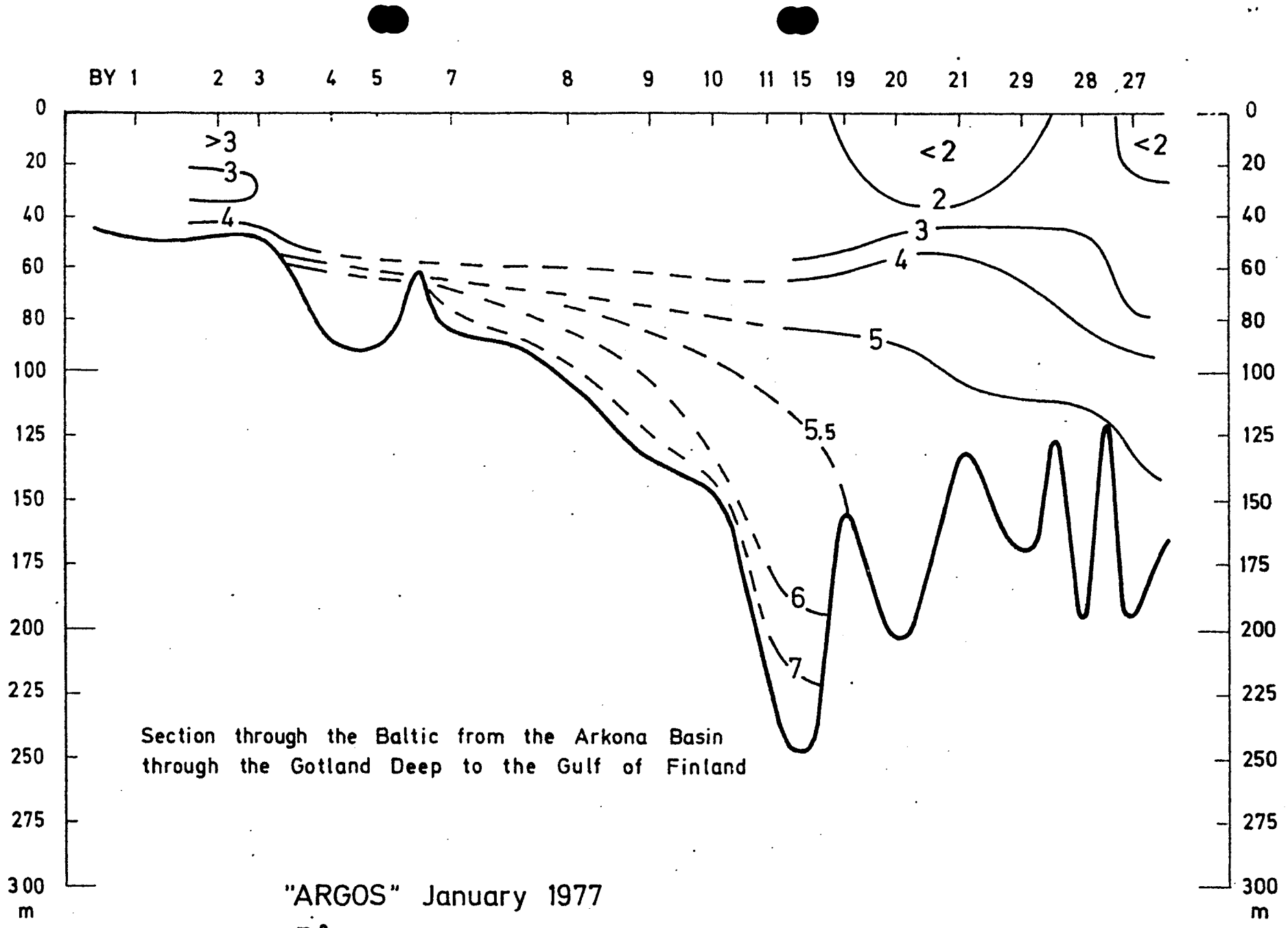
BY 1
2
3
4
5
7
8
9
10
11
15
19
20
21
29
28
27
0
20
40
60
80
100
125
150
175
200
225
250
275
300
m
>3
3
4
<2
2
3
4
5
5.5
6
7
Section through the Baltic from the Arkona Basin
through the Gotland Deep to the Gulf of Finland
"ARGOS" January 1977
T °C

FIG. 5

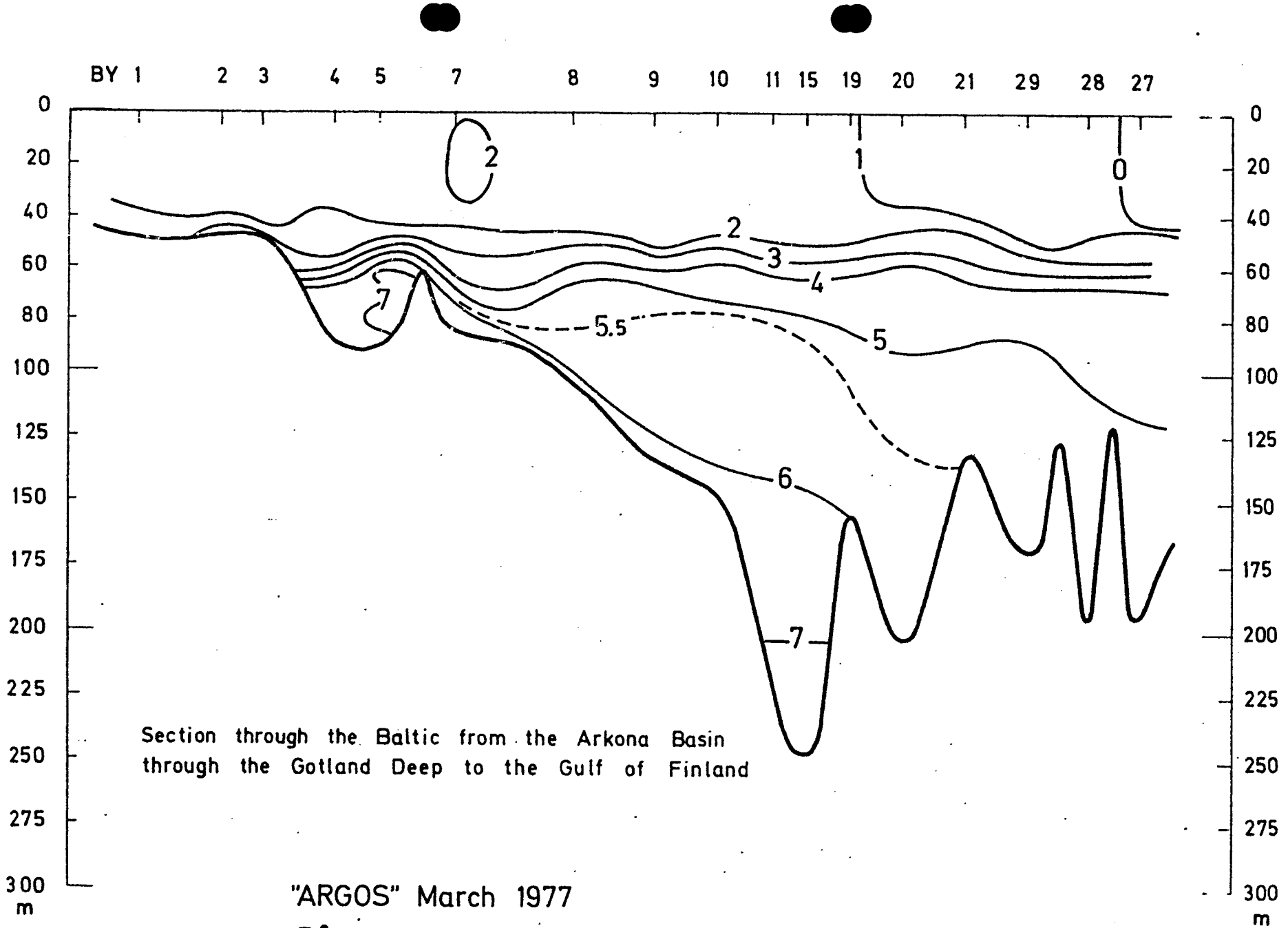
BY 1 2 3 4 5 7 8 9 10 11 15 19 20 21 29 28 27
0 20 40 60 80 100 125 150 175 200 225 250 275 300 m
2
1
0
2
3
4
7
5.5
5
6
7
Section through the Baltic from the Arkona Basin through the Gotland Deep to the Gulf of Finland
"ARGOS" March 1977
T °C

FIG. 6

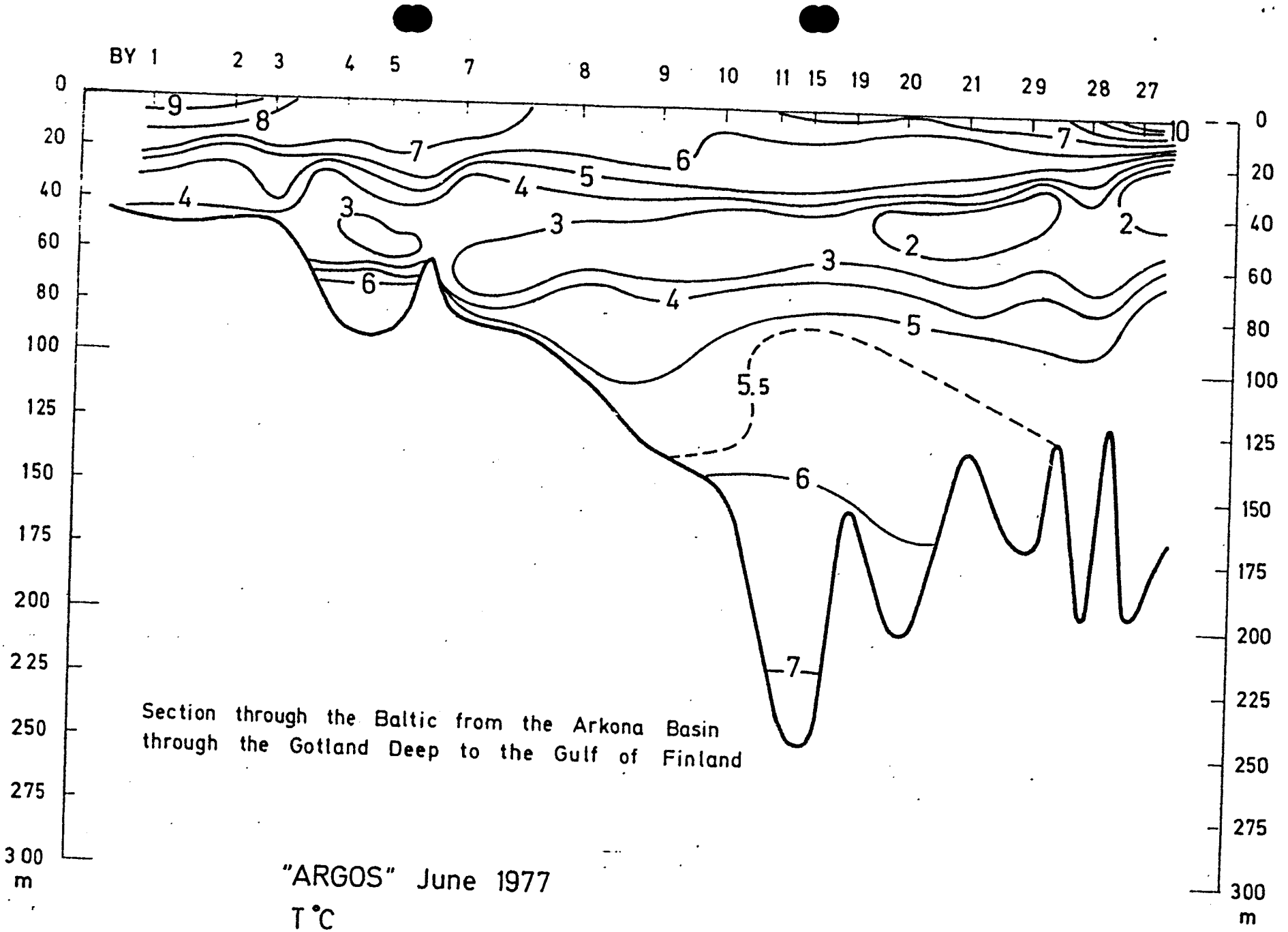
BY 1 2 3 4 5 7 8 9 10 11 15 19 20 21 29 28 27
0 20 40 60 80 100 125 150 175 200 225 250 275 300 m
9 8 7 6 5 4 3 2 10 5.5
Section through the Baltic from the Arkona Basin through the Gotland Deep to the Gulf of Finland
"ARGOS" June 1977
T °C

FIG. 7

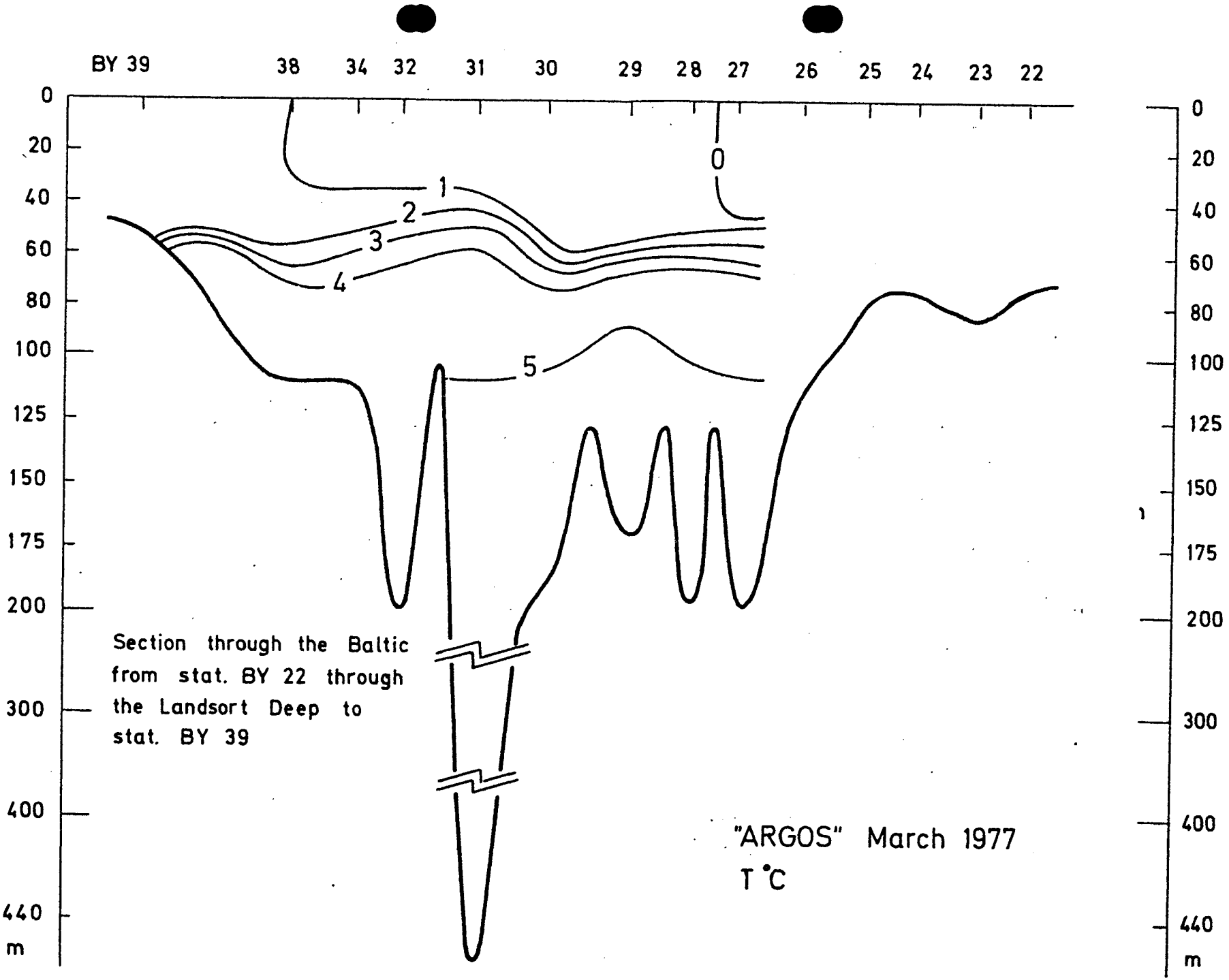
BY 39
38
34
32
31
30
29
28
27
26
25
24
23
22
0
20
40
60
80
100
125
150
175
200
300
400
440
m
0
1
2
3
4
5
Section through the Baltic from stat. BY 22 through the Landsort Deep to stat. BY 39
"ARGOS" March 1977
T °C

FIG. 8

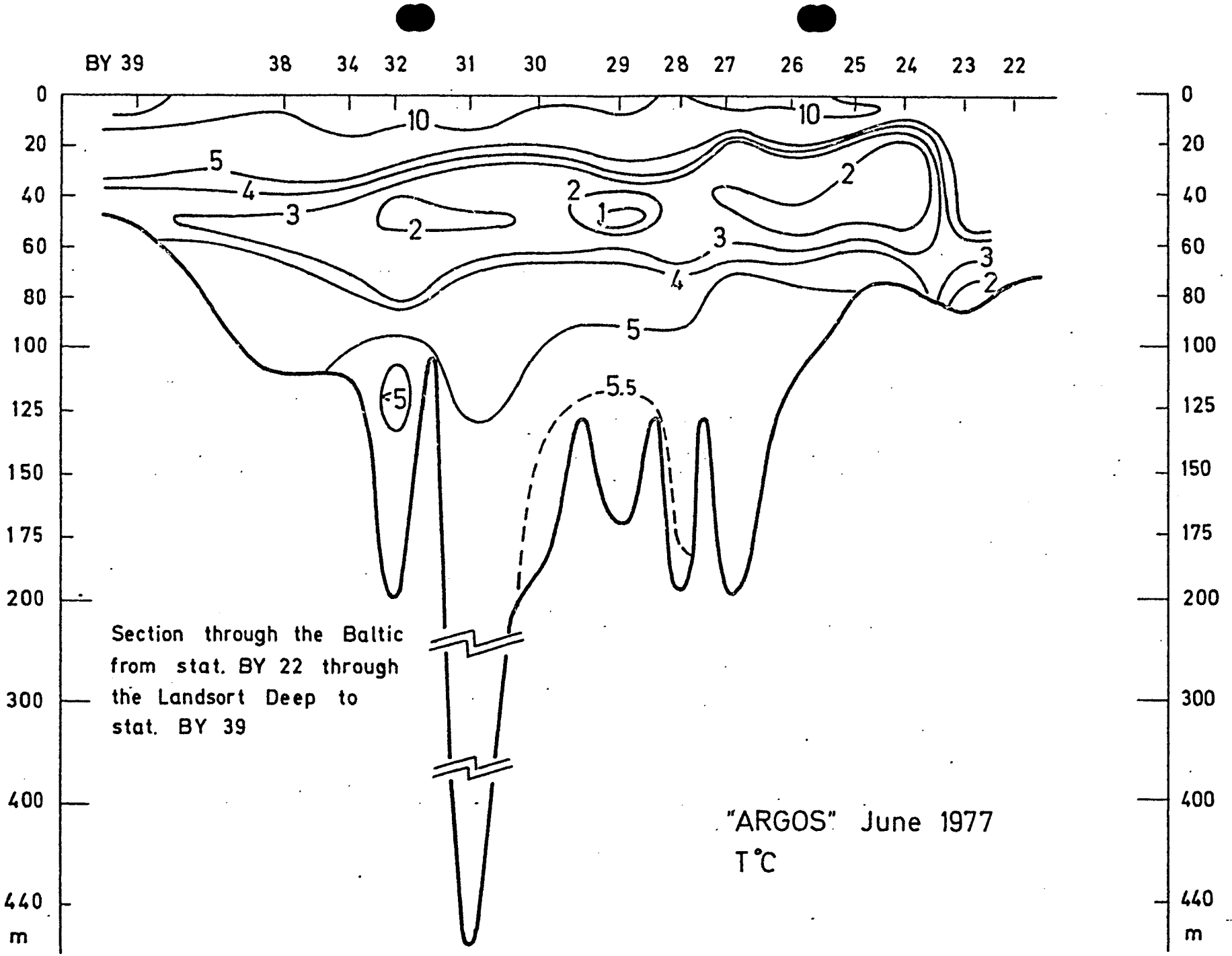
BY 39
38
34
32
31
30
29
28
27
26
25
24
23
22
0
20
40
60
80
100
125
150
175
200
300
400
440
m
10
5
4
3
2
1
5
5.5
Section through the Baltic from stat. BY 22 through the Landsort Deep to stat. BY 39
"ARGOS" June 1977
T°C

FIG. 9

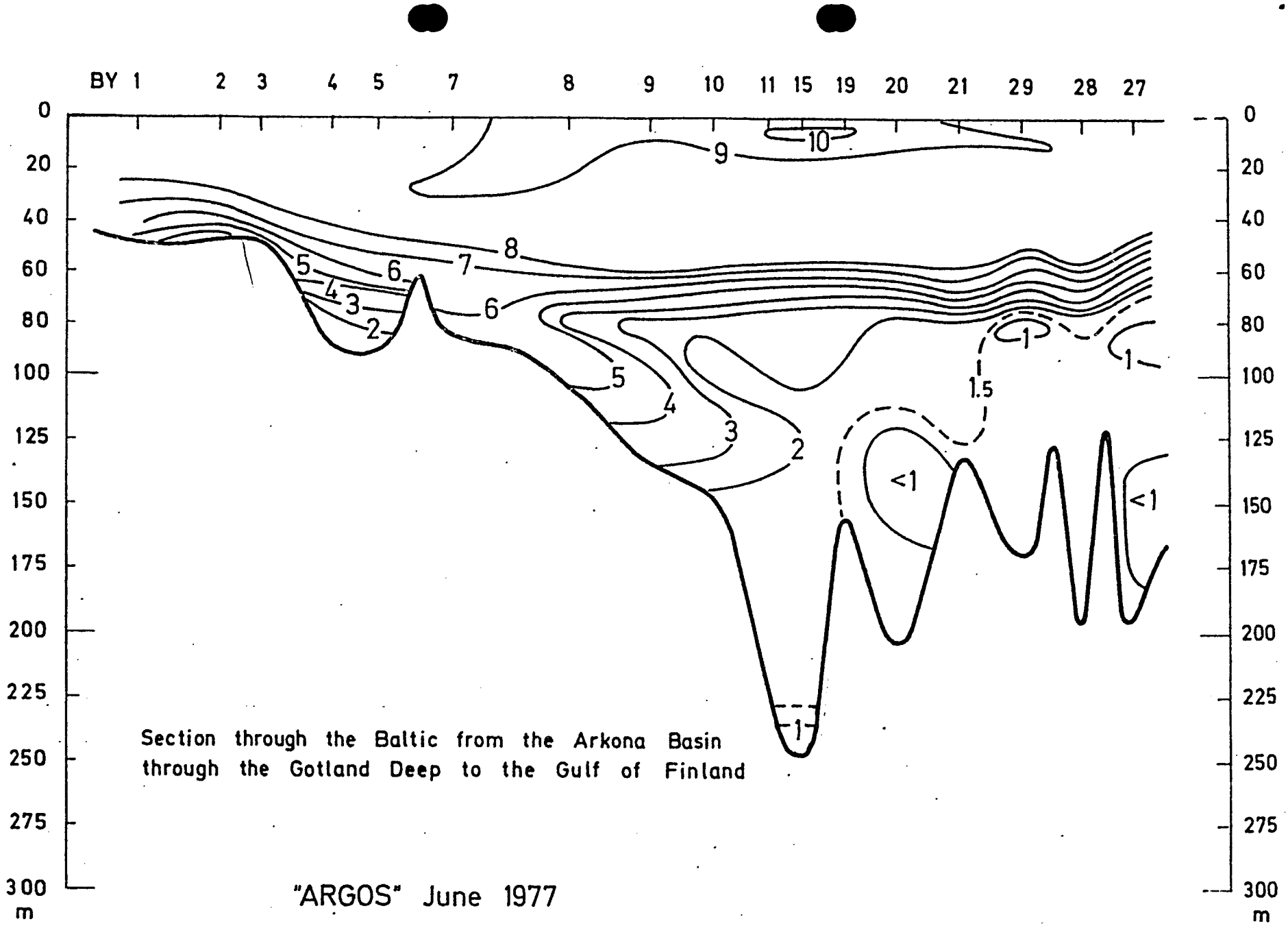
BY 1 2 3 4 5 7 8 9 10 11 15 19 20 21 29 28 27
0 20 40 60 80 100 125 150 175 200 225 250 275 300 m
10
9
8
7
6
5
4
3
2
1
1.5
<1
Section through the Baltic from the Arkona Basin through the Gotland Deep to the Gulf of Finland
"ARGOS" June 1977
O_2 ml/l

FIG. 10

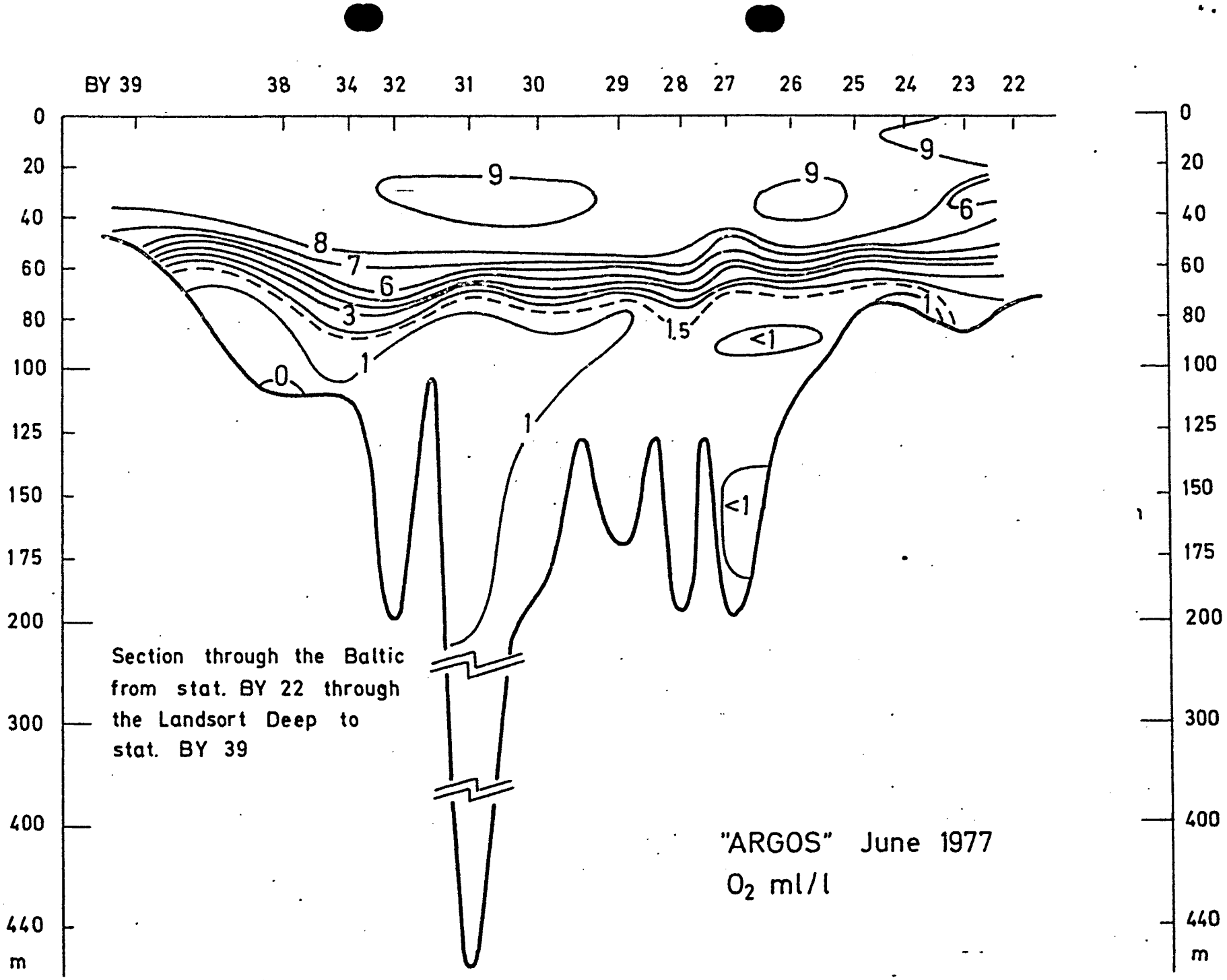
BY 39
38
34
32
31
30
29
28
27
26
25
24
23
22
0
20
40
60
80
100
125
150
175
200
300
400
440
m
9
9
9
6
8
7
6
3
1.5
<1
1
0
1
<1
1
Section through the Baltic from stat. BY 22 through the Landsort Deep to stat. BY 39
"ARGOS" June 1977
O_2 ml/l

FIG. 11

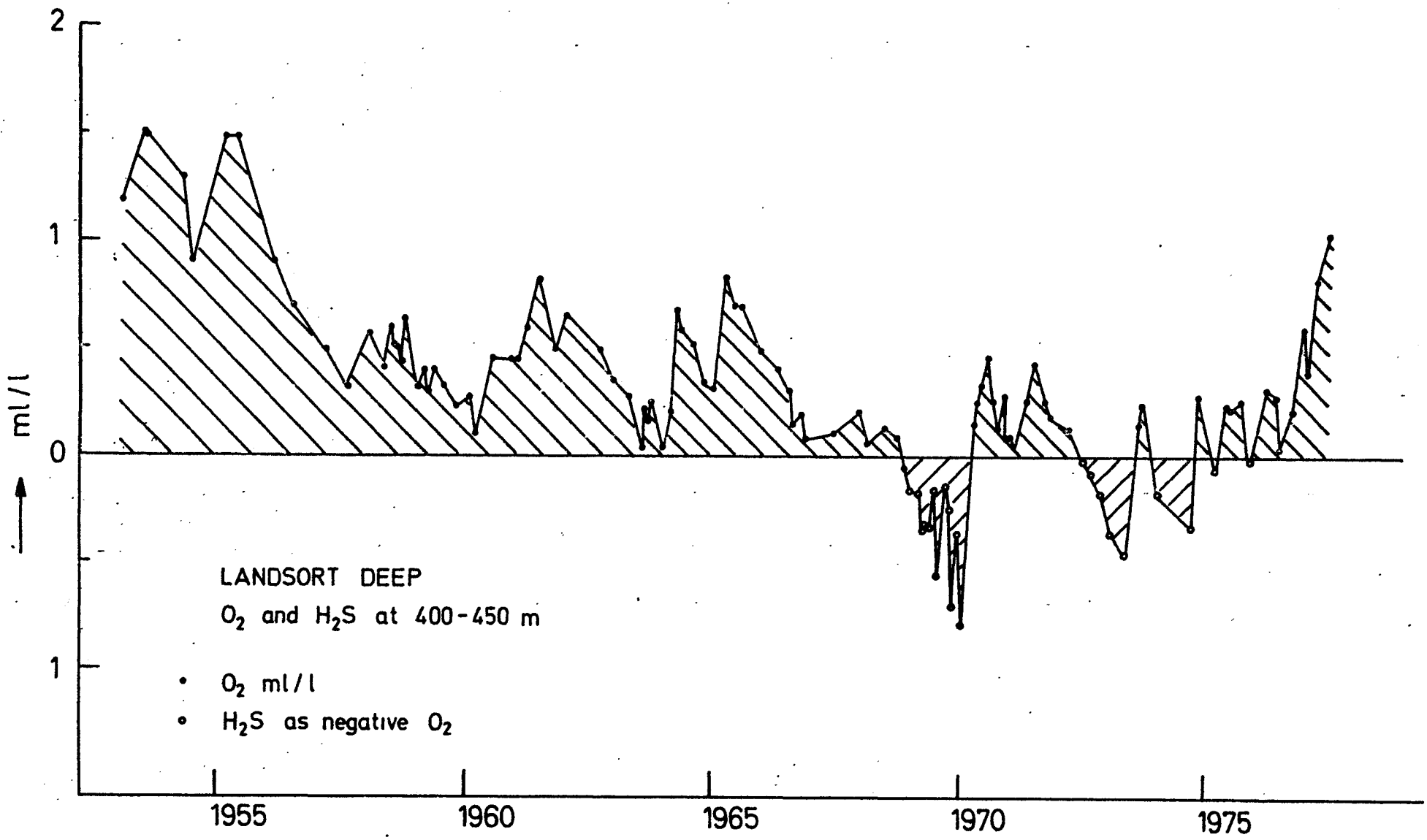
2
1
0
1
ml/l
LANDSORT DEEP
O_2 and H_2S at 400-450 m
O_2 ml/l
H_2S as negative O_2
1955
1960
1965
1970
1975

FIG. 12