Ödsmål, Kville sn, Bohuslän

Hällristning
Fiskare från
bronsåldern

Rock carving
Bronze age
fishermen

MEDDELANDE från
HAVSFISKELABORATORIET LYSEKIL Nr 280
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Observations along the Swedish coast and in the Deep Basins in the Baltic 1980.

Hydrography of the Kattegat and the Skagerrak Area, Swedish Observations, 1980.

(Contribution to ICES "Annales Biologiques")

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April 1981

OBSERVATIONS ALONG THE SWEDISH COAST AND IN THE DEEP BASINS OF THE BALTIC IN 1980

Due to lack of ships time only three hydrographic expeditions could be carried out in the Baltic during 1980. The expeditions were performed in January, May/June and November.

During the first half year the oxygen conditions in the bottom water were relatively good in the southern and south eastern parts of the Baltic. In the Arkona basin the lowest oxygen concentrations were in January 5.4 ml/l and in the end of May 5.9 ml/l. In the Bornholm basin the conditions were also good. In January the lowest value, 1.7 ml/l was measured at 70 m and downwards the concentration increased to nearly 3 ml/l close to the bottom. At the end of May the oxygen concentration at 70 m had increased to 4.2 ml/l and close to the bottom to 5.8 ml/l. Eastwards from the Bornholm basin the oxygen concentration in the bottom water was at both occasions close to 3 ml/l. (See Table 1).

In the area east of Gotland a relatively wide water mass with oxygen concentrations below 2 ml/l was found in January. The upper boundary for this water was situated at around 70 m depth. From 175 m downwards hydrogen sulfide was found with the highest concentrations, around 25 µmol/l, close to the bottom. The area containing hydrogen sulfide extended from the station BY 10 to the sill between BY 15 and BY 20. In the Fårö Deep (BY 20) hydrogen sulfide was found from 150 m down to the bottom.

During the May expedition it was observed that oxygen containing water had penetrated to the north. At BY 10 oxygen was found in small amounts down to the bottom. The conditions in the Gotland Deep and the Fårö Deep were unchanged.

In the north eastern part of the Baltic Proper, water containing less than 2 ml/l oxygen was in January found at depths below 80 m and hydrogen sulfide was only observed in the deepest bottom cavities. At the end of May the upper boundary for the water with low oxygen concentrations, was found at 70 m depth and the areas with hydrogen sulfide had spread. The concentrations were, however, low.

In the area Landsort-Gotland-Öland-the Swedish main land, the upper boundary for the water with low oxygen concentration was in January situated at around 80 m depth. The lowest oxygen values were around 0.3 ml/l but no hydrogen sulfide was observed. At the May/June expedition it was observed that the boundary for low oxygen had moved upwards to around 70 m and that hydrogen sulfide could now be found between Öland and Gotland. The concentrations were generally low. In the Karlsö Deep (BY 38) the concentration was, however, 24 µmol/l (Fig:s 1 and 2).

During the summer and autumn a marked deterioration of the oxygen situation in the whole Baltic Proper occurred. Only in the south eastern parts the conditions were unaltered and the oxygen concentrations there were of the same magnitude as during the winter and spring.

In the Bornholm basin, the Hanö bight, the Arkona basin and areas west of this, a wide area with oxygen values around or below 2 ml/l was found. Remarcable are the low oxygen concentrations below the halocline, west of Bornholm.

As may be seen from the map from the November expedition (Fig. 3), the areas with low oxygen concentrations and with hydrogen sulfide have extended considerably east of Gotland and in the north eastern Baltic. The boundary for low oxygen concentrations is now in some areas above 60 m, while it in other areas is found at around 80 m depth. In the Gotland Deep, hydrogen sulfide is found from between 150 and 175 m depth. The concentrations are, however, low, at most 16.5 µmol/l at 240 m.

In the north eastern Baltic the hydrogen sulfide layer had increased in thickness and the upper boundary was found at 90 m depth at some stations. The highest concentration measured, was 9.0 µmol/l (at BY 27). See also Fig. 4.

In the area Landsort-Gotland-Öland the boundary for the water with low oxygen concentration was found at 60-80 m depth. Hydrogen sulfide was now present in large areas begun already at 90 m depth. The concentrations were low. In the Landsort Deep (BY 31) the concentration was e.g. maximum 2.0 µmol/l and at BY 38 10.2 µmol/l. See Fig. 5.

The development of the oxygen conditions in the Baltic indicate that several smaller inflows of oxygen containing water have occurred into the southern Baltic during the first half of the year. During the summer and autumn no renewal of bottom water seems to have occured and therefore the bottom water has become stagnant, loosing its oxygen. Hydrogen sulfide has been formed mainly in the northern Baltic Proper.

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Arkona Deep

55°00′N 14°04′E

Depth m	Temp. °C	S ‰	O_2 ml/l	pH	PO_4-P µmol/l	Tot.P µmol/l	Alkal. Mmol/l	SiO_2 µmol/l	NO_2-N µmol/l	NO_3-N µmol/l	NH_4-N µmol/l	Tot.N µmol/l	Urea µmol/l
						15 January							
000	2.17	8.455	8.76	8.27	0.53	0.71	1.617	11.5	0.59	2.53	0.31	23.0	0.07
010	2.11	8.468	8.94	8.27	0.50	0.68	1.607	11.5	0.53	2.13	0.23	21.1	0.15
030	2.98	9.329	8.50	8.28	0.48	0.68	1.685	11.5	0.15	3.07	0.13	22.3	0.15
049	5.51	16.962	5.42	8.06	1.46	2.06	1.742	24.8	0.04	5.02	0.78	32.3	0.11
						28 May							
000	8.83	8.142	8.66	8.77	0.04	0.55	1.584	2.0	0.10	1.22	0.28	20.1	0.72
010	8.73	8.144	8.79	8.67	0.08	0.50	1.611	1.8	0.10	1.29	0.20	18.4	0.40
030	6.90	8.325	8.72	8.44	0.06	0.59	1.714	3.1	0.02	0.22	0.31	14.5	0.28
045	4.03	16.204	4.91	7.99	0.21	0.96	1.796	12.6	0.12	0.57	3.95	20.9	0.52
						13 November							
000	7.72	8.167	7.71	8.27	0.20	0.40	1.584	4.2	0.40	0.81	0.28	14.8	0.15
010	7.68	8.167	7.70	8.32	0.18	0.39	1.592	4.3	0.39	0.80	1.17	14.8	0.19
030	7.48	8.233	7.68	8.31	0.25	0.44	1.584	6.3	0.44	0.89	0.35	12.6	0.25
047	12.45	14.823	2.08	7.67	3.51	4.51	1.809	45.4	0.32	9.28	1.07	32.3	0.20

Gotland Deep

57°20′N 20°03′E

Depth m	Temp. °C	S ‰	O_2 ml/l	pH	PO_4-P µmol/l	Tot.P µmol/l	Alkal. Mmol/l	SiO_2 µmol/l	NO_2-N µmol/l	NO_3-N µmol/l	NH_4-N µmol/l	Tot.N µmol/l	Urea µmol/l	H_2S
					16 January									
000	3.77	7.878	8.37	8.22	0.45	0.65	1.683	8.3	0.12	2.77	0.18	22.0	0.19	
070	3.88	9.875	2.11	7.46	2.30	2.47	1.685	35.6	0.02	8.23	0.11	26.1	0.14	
100	4.96	11.185	0.78	7.38	2.95	3.11	1.769	42.4	<0.02	8.60	0.11	27.9	0.15	
150	5.81	12.116	0.23	7.37	3.29	3.63	1.832	49.7	<0.02	0.28	0.72	16.2	0.24	
200	6.67	12.552		7.43	3.81	4.71	1.898	57.4	<0.02	0.14	4.08	20.3	0.11	10.7
240	6.56	12.749		7.47	3.82	5.91	1.920	61.5	<0.02	0.09	7.72	26.5	0.16	25.0
					29 May									
000	5.92	7.542	11.14	8.62	0.09	0.55	1.465	2.2	0.05	<0.10	0.16	20.4	0.27	
070	3.00	8.923	4.72	7.71	1.52	1.79	1.650	17.3	0.17	5.78	0.38	23.3	0.28	
100	4.98	11.165	0.95	7.39	2.80	2.95	1.702	28.7	0.02	8.44	0.19	20.7	0.43	
150	5.87	12.242	0.26	7.41	4.49	4.70	1.712	34.9	0.03	0.20	4.04	15.0	0.28	
200	6.22	12.573	0	7.44	4.30	4.94	1.737	38.1	<0.02	<0.10	6.06	19.3	0.18	6.0
240	6.37	12.678		7.47	4.70	5.92	1.789	41.5	<0.02	<0.10	8.77	22.4	0.15	15.2
					28 October									
000	10.01	7.671	7.30	8.36	0.23	0.56	1.617	6.3	0.21	0.83	1.47	16.0	0.29	
070	2.88	8.931	4.72	7.66	1.14		1.639	27.1	0.04	6.06	0.13	17.2	0.19	
100	4.57	11.316	1.29	7.44	2.10	2.58	1.752	50.5	0.11	9.29	0.68	18.6	0.32	
150	5.47	12.304	0.24	7.38	3.00	3.53	1.765	69.5	0.05	3.49	0.25	18.2	0.17	
200	5.72	12.565	9.97	7.44	3.58	5.06	1.773	84.5	<0.02	0.13	5.82	17.2	0.18	8,5
240	5.62	12.656		7.44	3.34	4.86	1.776	87.5	<0.02	0.07	7.84	20.5	0.22	16.5

Fig. 1

R/V ARGOS 1980 01 14 – 1980 01 31

--- Oxygen concentration less than 2 ml/l

Area with hydrogen sulfide containing water

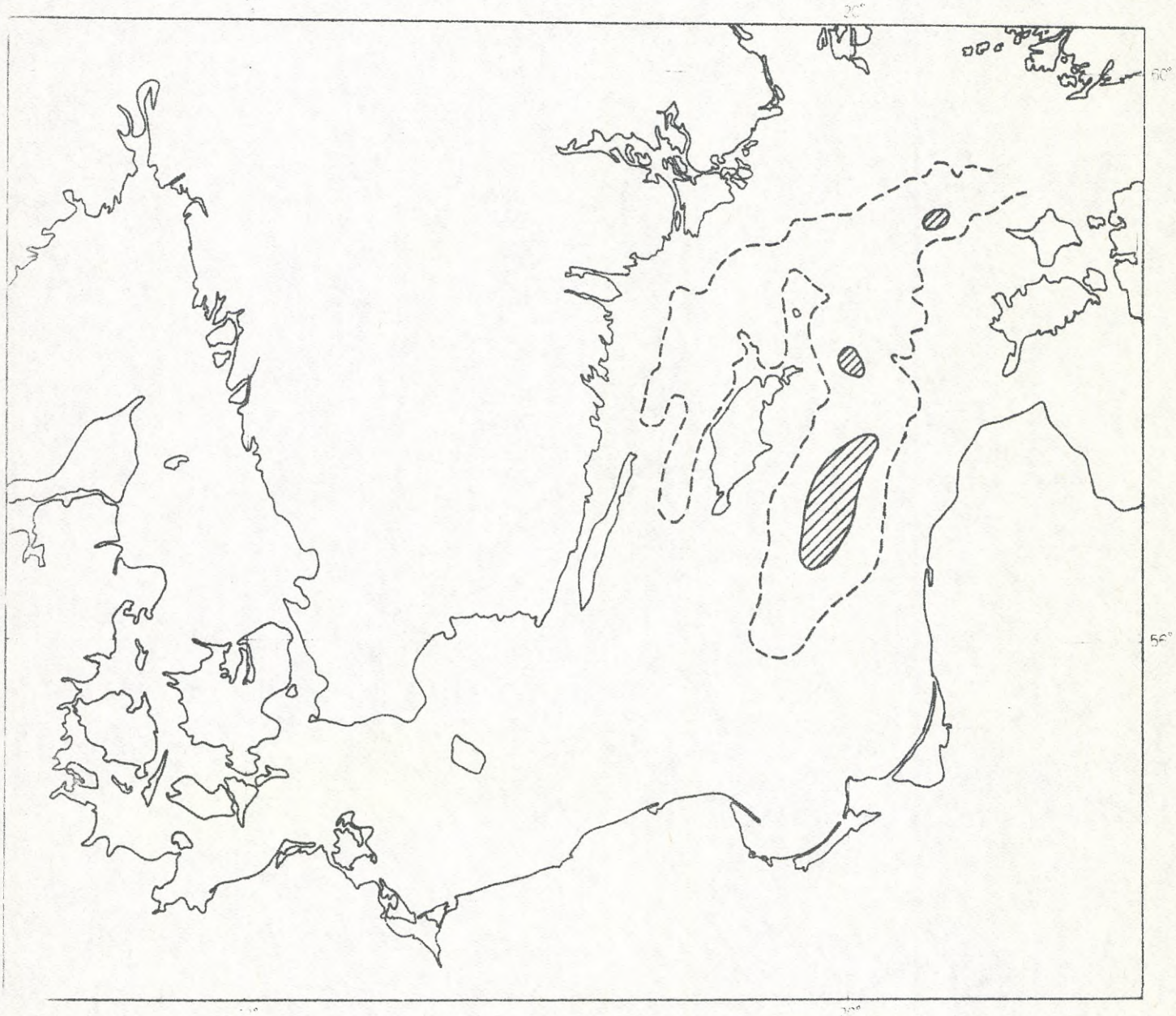


Fig. 2

R/V ARGOS 1980 05 27 – 1980 06 14

--- Oxygen concentration less than 2 ml/l

Area with hydrogen sulfide containing water

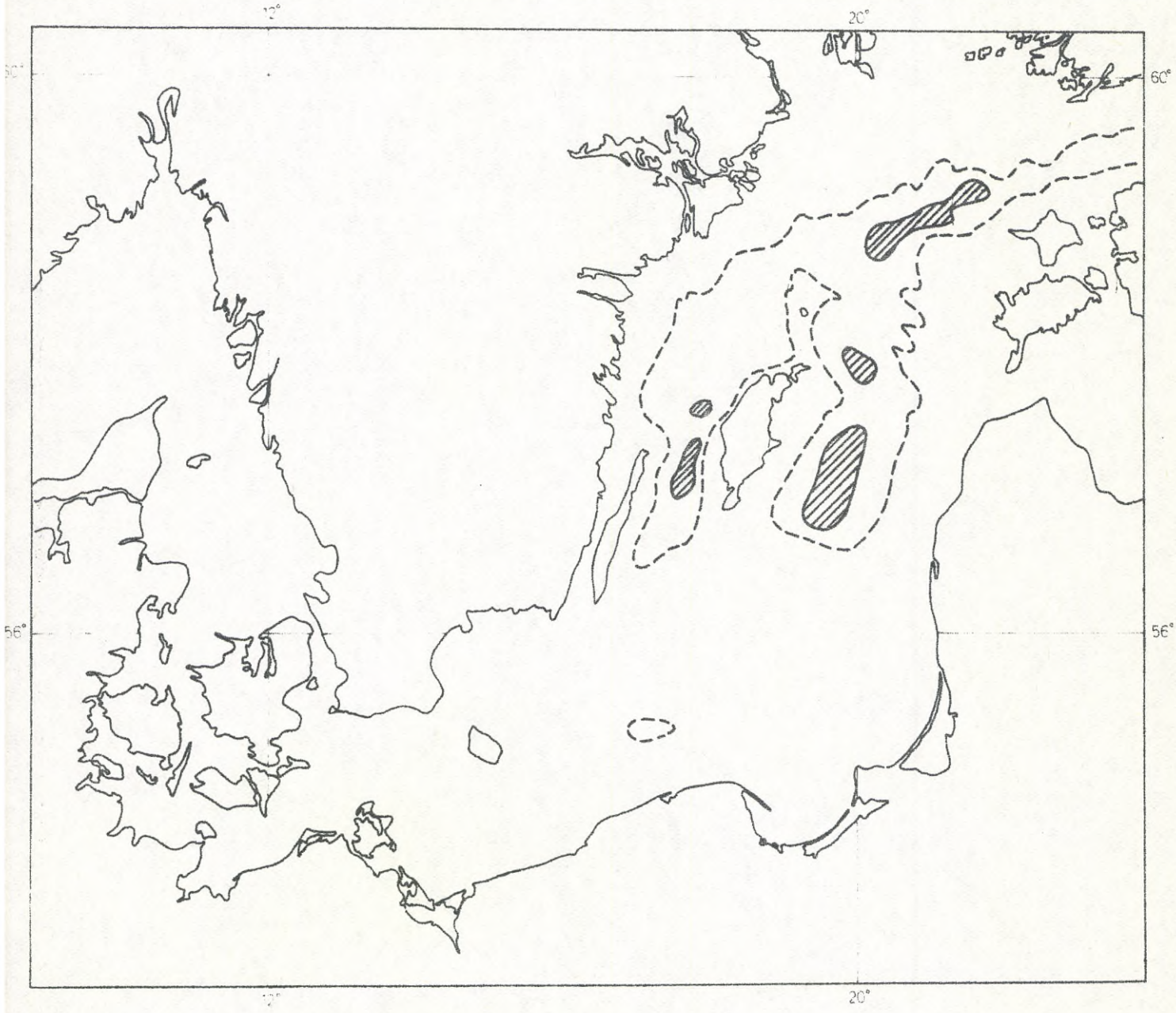
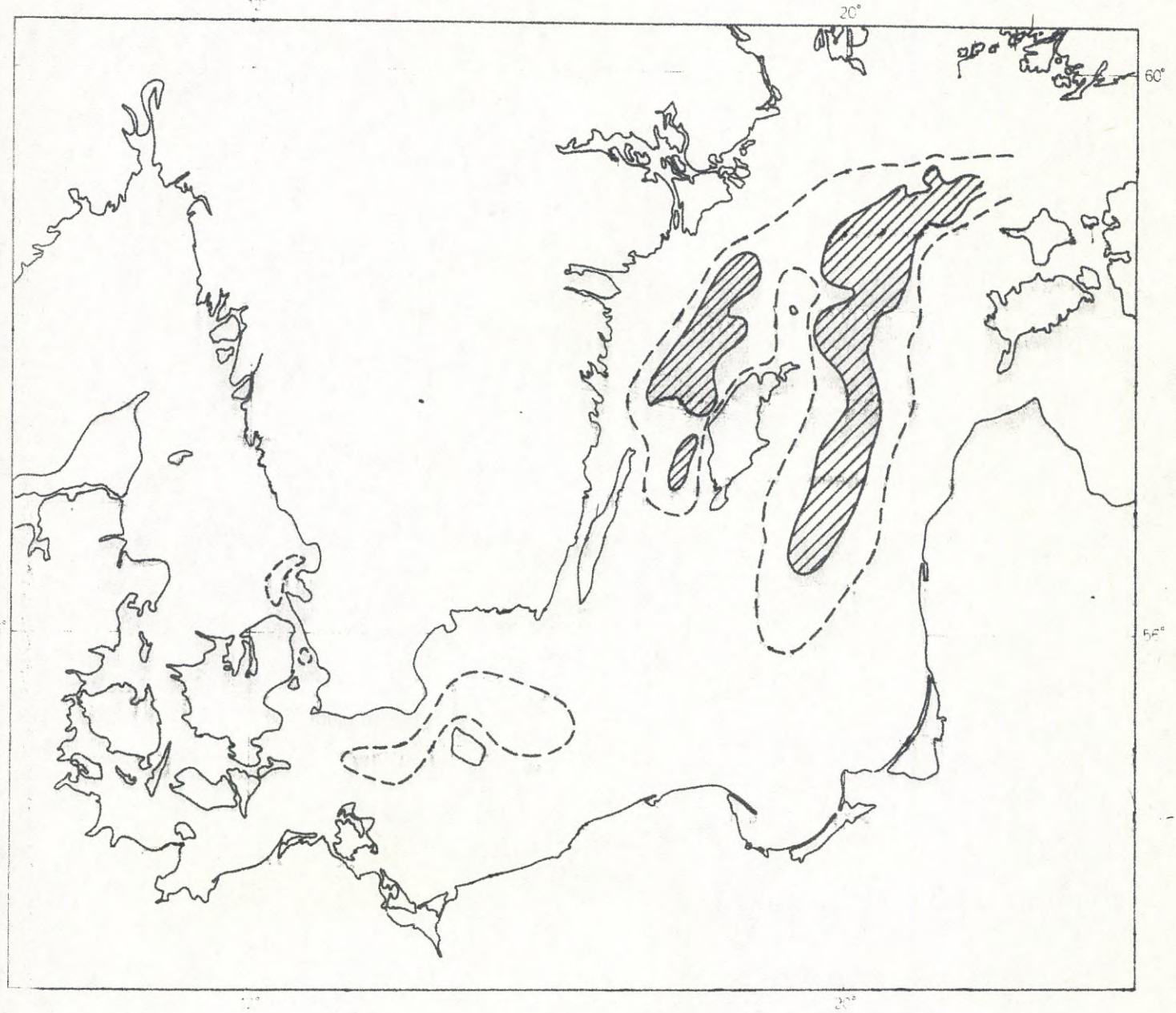


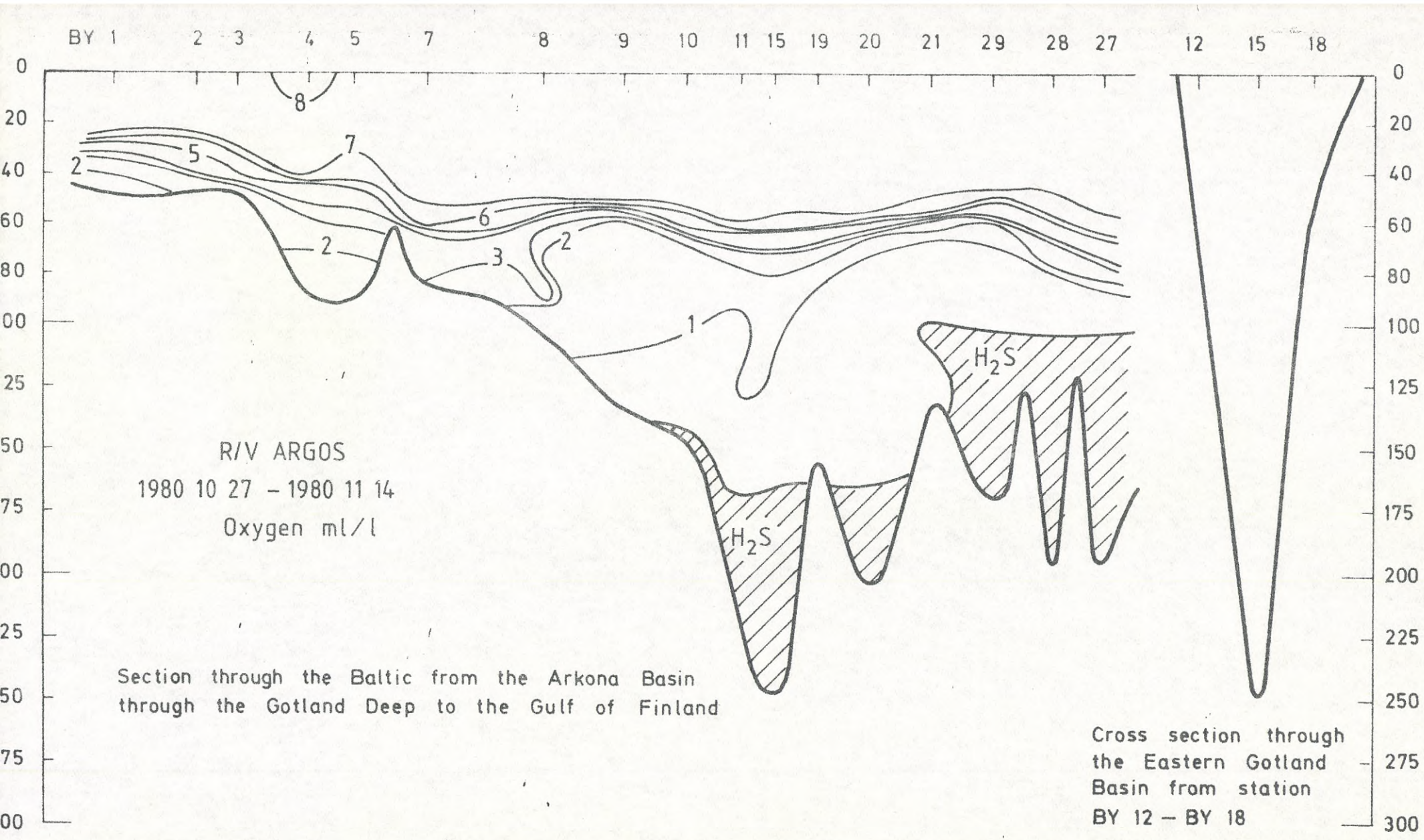
Fig. 3

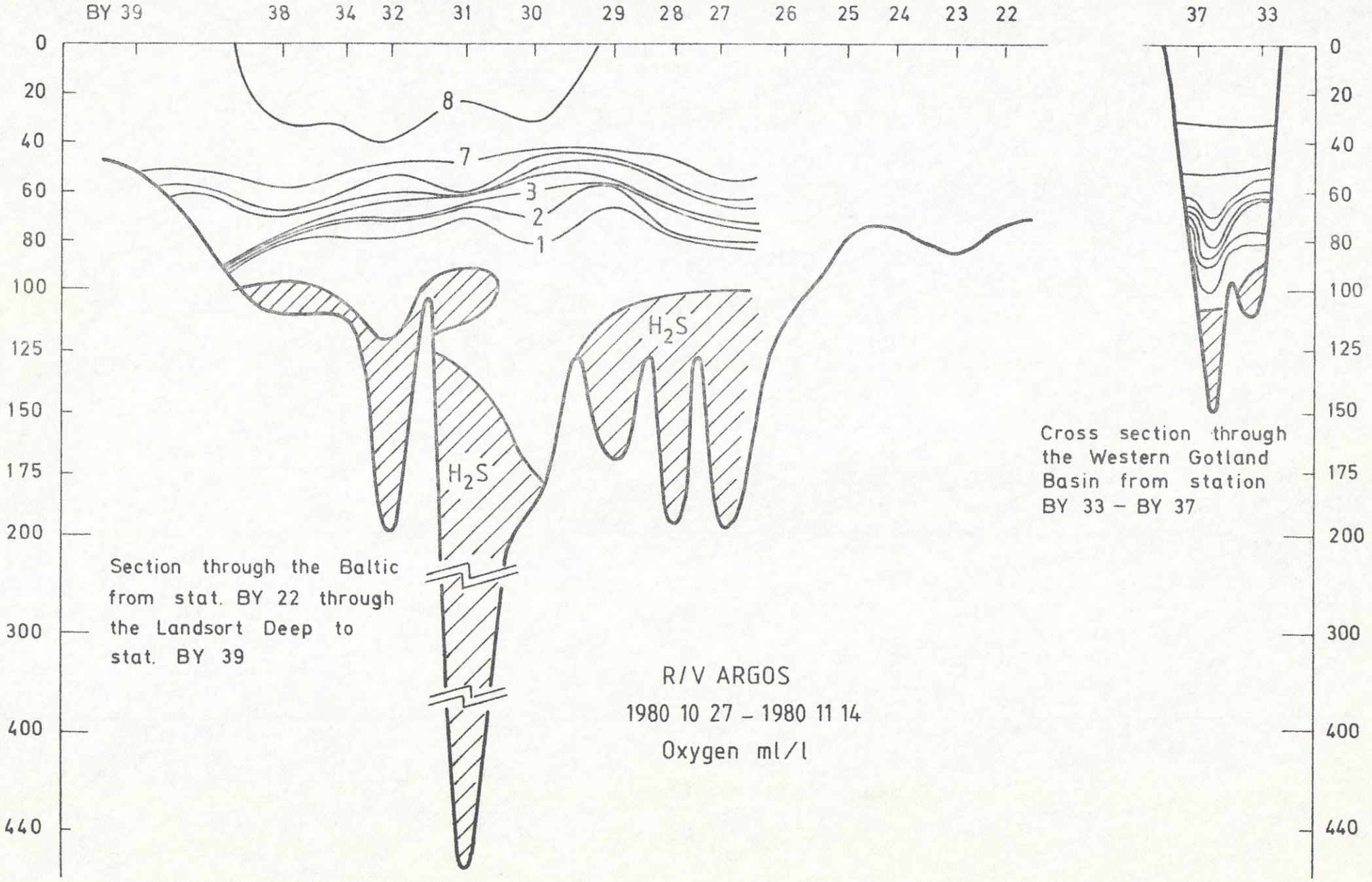
R/V ARGOS 1980 10 27 – 1980 11 14
1980 11 24 – 1980 11 28

--- Oxygen concentration less than 2 ml/l

Area with hydrogen sulfide containing water




BY 1 2 3 4 5 7 8 9 10 11 15 19 20 21 29 28 27
12 15 18
0 20 40 60 80 100 125 150 175 200 225 250 275 300
8
7
5
2
6
2
3
2
1
H_2S
H_2S
R/V ARGOS
1980 10 27 – 1980 11 14
Oxygen ml/l
Section through the Baltic from the Arkona Basin through the Gotland Deep to the Gulf of Finland
Cross section through the Eastern Gotland Basin from station BY 12 – BY 18



Section through the Baltic from stat. BY 22 through the Landsort Deep to stat. BY 39

Cross section through the Western Gotland Basin from station BY 33 – BY 37

R/V ARGOS

1980 10 27 – 1980 11 14

Oxygen ml/l

Landsort Deep

58°35'N 18°14'E

Depth m	Temp. °C	S ‰	O_2 ml/l	pH	PO_4-P µmol/l	Tot.P µmol/l	Alkal. Mmol/l	SiO_2 µmol/l	NO_2-N µmol/l	NO_3-N µmol/l	NH_4-N µmol/l	Tot.N µmol/l	Urea µmol/l	H_2S µmol/l
						21 January								
000	2.20	7.192	9.05	8.22	0.55	0.68	1.546	13.2	0.07	3.29	0.17	21.2	0.16	
070	3.70	9.091	3.49	7.58	1.75	1.95	1.580	30.4	<0.02	4.13	0.20	21.4	0.22	
100	4.51	10.255	0.43	7.39	2.88	3.04	1.629	44.6	0.02	2.30	0.09	20.3	0.19	
150	4.69	10.617	0.44	7.39	2.92	3.15	1.663	44.8	0.02	2.83	0.11	19.5	0.22	
200	4.97	10.853	0.33	7.41	3.09	3.33	1.676	45.8	<0.02	1.43	0.03	16.9	0.27	
440	5.10	11.062	0.30	7.43	3.74	4.09	1.678	47.6	0.02	0.11	0.58	15.8	0.21	
						12 Juni								
000	12.46	7.185	8.70	8.54	0.05	0.26	1.460	4.3	<0.02	<0.10	0.20	14.8	0.42	
070	2.21	7.992	8.18	8.12	0.59	0.92	1.542	9.3	0.21	0.89	0.29	16.4	0.66	
100			0.23		2.89	3.19	1.593	30.2	0.63	2.16	0.37	18.3	0.27	
150	4.93	10.887	0.11	7.40	2.93	3.30	1.665	31.4	0.34	1.22	0.33	15.3	0.60	
200	4.98	11.043	0.13	7.38	2.94	3.15	1.658	31.2	0.04	3.30	0.38	14.7	0.47	
440	5.03	11.177	0.13	7.40	2.89	3.19	1.700	31.2	<0.02	3.90	0.36	18.0	0.33	
						11 November								
000	6.10	6.970	7.98	8.08	0.27	0.48	1.483	8.1	0.24	1.15	0.37	14.9	0.20	
070	4.01	9.821	1.18	7.39	2.56	2.66	1.662	33.7	0.04	4.07	0.22	10.9	0.19	
100	4.64	10.530		7.33	3.04	3.31	1.707	53.0	<0.02	<0.10	1.48	12.1	0.18	0.5
150	4.89	10.926		7.34	3.06	3.36	1.713	54.0	<0.02	<0.10	0.90	11.3	0.17	0.2
200	4.97	11.086		7.35	3.20	3.50	1.736	54.5	<0.02	<0.10	0.96	13.4	0.16	0.2
440	5.03	11.178			3.39	3.77		55.5	<0.02	<0.10	1.81	12.5		2.0

Bornholm Deep

55°15′N 15°59′E

Depth m	Temp. °C	S ‰	O_2 ml/l	pH	PO_4-P µmol/l	Tot.P µmol/l	Alkal. Mmol/l	SiO_2 µmol/l	NO_2-N µmol/l	NO_3-N µmol/l	NH_4-N µmol/l	Tot.N µmol/l	Urea µmol/l
					15 January								
000	3.13	8.254	8.68	8.22	0.59	0.71	1.614	7.8	0.38	2.02	0.35	20.1	0.11
010	3.17	8.222	8.62	8.23	0.50	0.69	1.629	8.6	0.33	1.96	0.57	24.1	0.07
030	3.08	8.224	8.64	8.22	0.52	0.68	1.680	10.0	0.33	2.38	0.26	18.1	0.13
050	5.23	9.630	5.97	7.86	0.80	1.05	1.739	14.3	0.02	4.43	0.18	20.6	0.07
070	7.71	14.613	1.74	7.55	1.65	1.89	1.874	32.4	0.05	7.60	0.23	22.9	0.09
					28 May								
000	7.05	7.992	9.76	8.84	0.18	0.57	1.462	3.8	<0.02	<0.10	0.24	16.3	0.23
010	7.04	7.993	9.79	8.74	0.20	0.59	1.480	3.9	<0.02	<0.10	0.27	16.2	0.41
030	3.85	8.190	9.55	8.48	0.20	0.55	1.556	4.1	<0.02	<0.10	0.27	16.0	0.37
050	2.08	9.056	8.76	8.40	0.18	0.51	1.593	3.0	<0.02	<0.10	0.22	14.1	0.32
070	5.18	15.375	4.22	7.92	1.01	1.48	1.655		0.13	4.23	0.17	20.1	0.42
087	3.63	18.016	5.82	8.17	0.59	1.03	1.843	7.7	0.07	1.90	2.00	18.5	0.42
					28 October								
000	9.70	7.876	7.39	8.32	0.17	0.46	1.848	7.5	0.20	0.56	0.45	11.0	0.19
010	9.67	7.874	7.43	8.34	0.18	0.38	1.861	7.4	0.20	0.41	0.50	15.0	0.20
030	9.65	7.894	7.38	8.34	0.16	0.63	1.749	7.5	0.20	0.37	0.43	12.9	0.22
050	6.16	11.028	4.89	7.87	0.73	1.00	1.691	18.5	0.03	5.27	0.15	17.2	0.22
070	7.33	15.188	2.64	7.67	1.14	1.40	1.870	37.5	0.03	8.42	0.66	25.3	0.23
085	4.15	16.810	2.00	7.63	1.38	1.68	1.924	45.4	0.02	8.78	0.09	24.9	0.25

Hydrography of the Kattegat and the Skagerrak Area 1980

In figures 2 and 3 results of daily measurements of temperature and salinity at Bornö hydrographical station in the Gullmar Fiord are presented as deviations from the mean values 1931-1960. Both parameters were below normal in January-March indicating a surplus of Baltic water.

The Skagerrak Deep (M6) was visited 4 times (Table 1). Conditions are rather constant during January- August whereas the November data are indicative of the stagnation phase.

Table 2 shows oxygen saturation deviations at 50 m depth in the Kattegat during 1966-1980. The individual figures usually represent only one measurement. In 1980 all but one of the deviations were negative. In the autumn the oxygen content was so low in the SE Kattegat that in the Laholm Bay dead bottoms were found from where fish had escaped. It is unclear if it was unusually high primary production, or a weak water exchange or something else that caused this special situation. The negative January-March deviations may hint at a weak water exchange.

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M 6 58°10′N 09°30′E

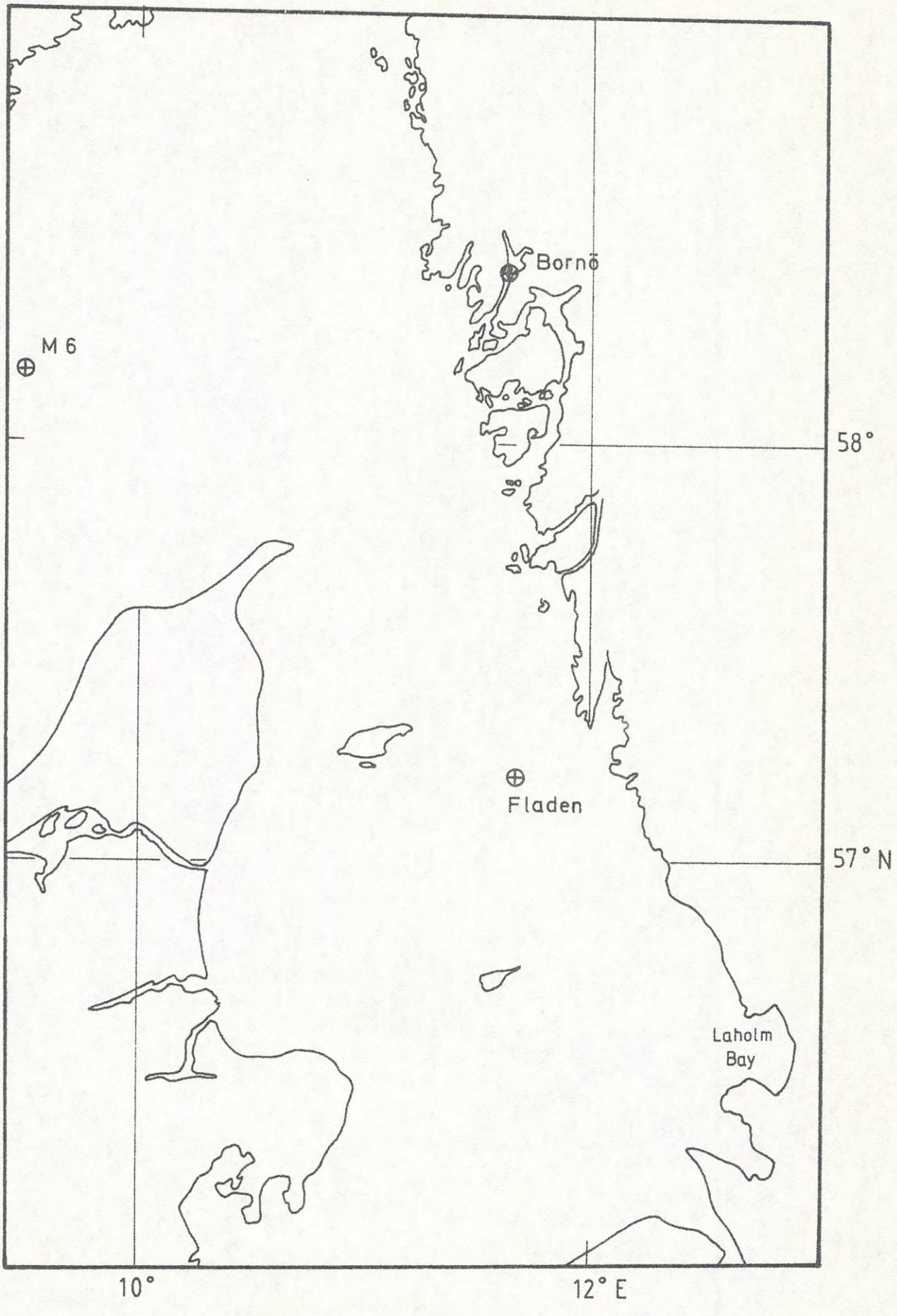
Depth	Temp.	S	σ_t	O_2	O_2
m	°C	‰		ml/l	%
		31 January			
200	6.12	35.015	27.57	5.85	85
300	5.62	35.008	27.63	6.07	87
400	5.02	34.976	27.68	6.37	90
500	4.80	34.984	27.71	6.70	94
600	4.86	34.986	27.70	6.63	93
		6 May			
200	6.05	34.903	27.49	6.02	87
300	5.60	35.007	27.63	6.12	88
400	5.13	34.986	27.67	6.36	90
500	4.88	34.982	27.70	6.57	92
600	4.85	34.999	27.71	6.47	91
		25 August			
200	5.72	34.973	27.59		
300	5.42	34.993	27.64		
400	5.48	35.031	27.66		
500	5.14	34.999	27.68		
600	4.91	34.981	27.69		
		26 November			
200	6.36	35.047	27.56	5.67	83
300	6.18	35.066	27.60	5.76	84
400	5.62	35.029	27.64	5.97	86
500	5.50	35.022	27.65	5.97	85
600	5.30	35.005	27.66	5.95	85

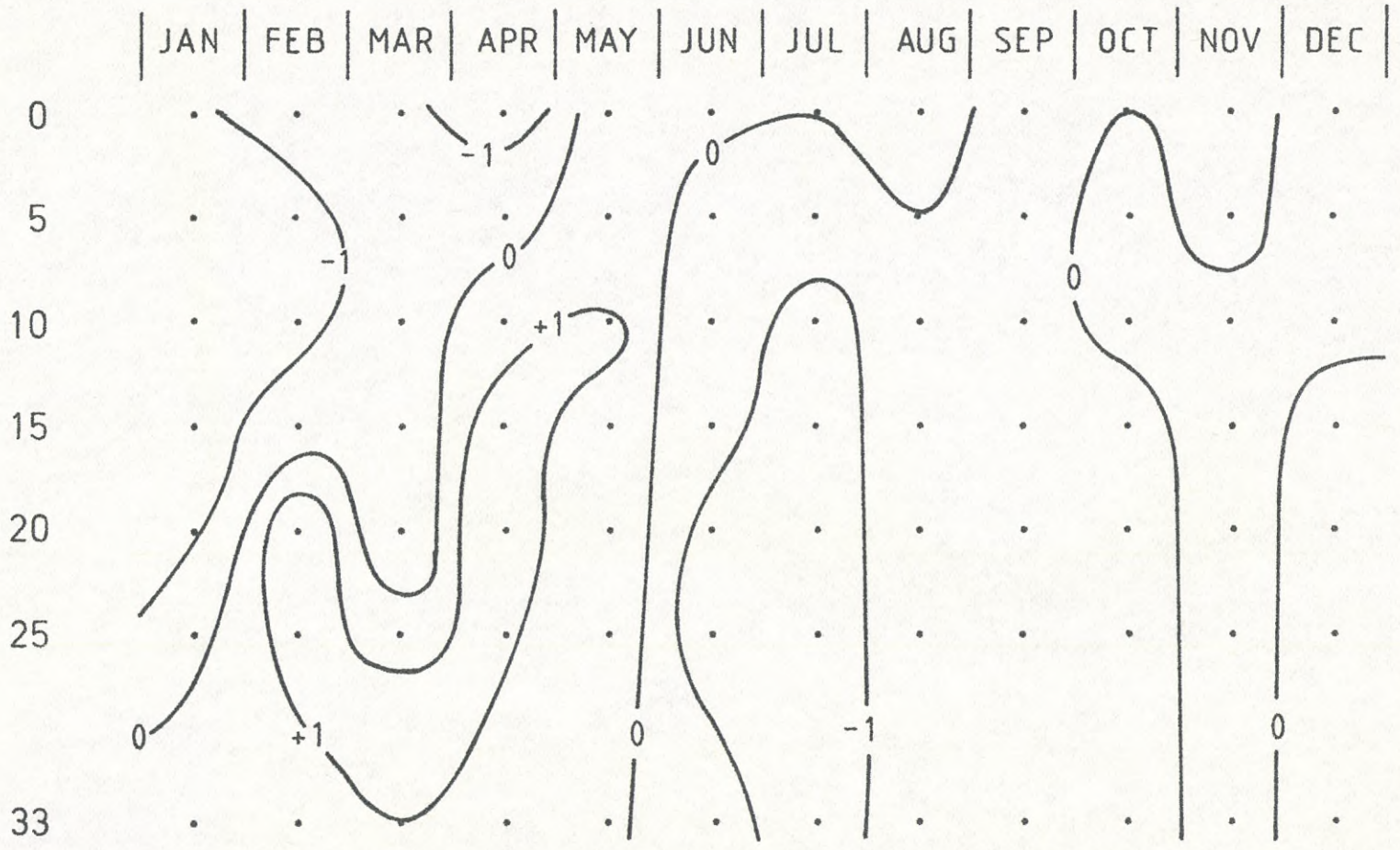
Table 2

Percentage of Oxygen Saturation.

Deviations from means 1966-1980 at 57°11.5′N, 11°40′E (Fladen) at 50 m depth.

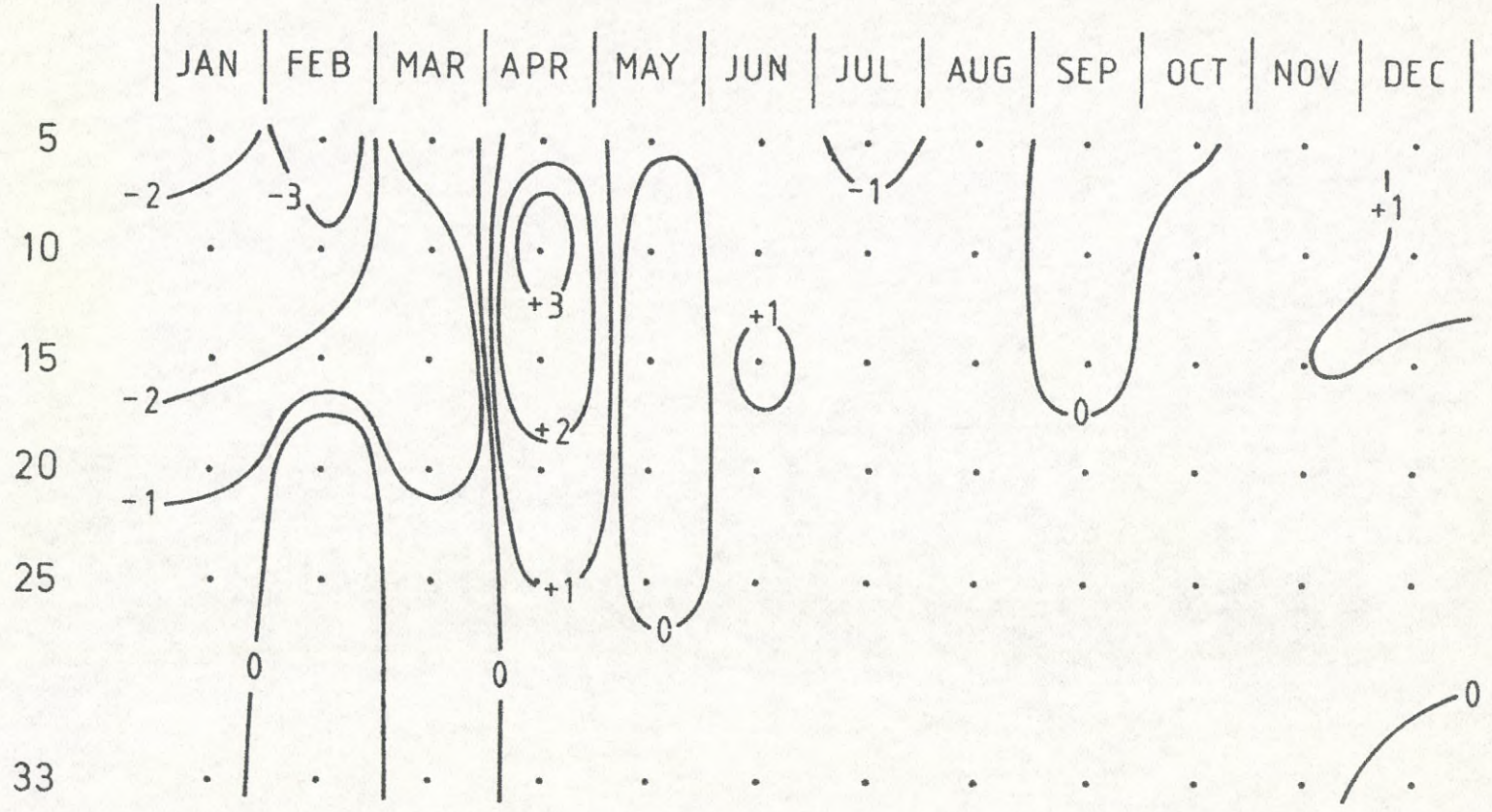
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Means 1966-1980	93%	96%	93%	90%	90%	87%	81%	71%	71%	79%	86%	89%
1966					+ 1			- 8	- 3	- 2		
1967		- 3			+ 3							0
1968		- 1				0			- 4		-21	
1969	- 2			- 9					+ 2		+12	
1970	- 3			+ 8	+ 2	+ 2	+ 9	- 2	0	+ 6	+10	
1971	0		0	+ 5			- 8	+11		+11	+ 6	
1972		- 3	- 4	- 8	+ 5	+ 5	- 3	+ 7	- 3	-14		+ 2
1973	+ 3	+ 2	+ 1	0	- 2	- 3		+ 5	- 4	+ 4	+ 6	
1974		+ 3	+ 1	+ 1	- 4	+ 1		- 3	- 1	+ 3	- 7	+ 4
1975	- 1	+ 4	+ 4	+ 4	+ 2	- 3		- 2	+ 2	+ 3		+ 9
1976	+ 6	- 1	- 1	+ 4	- 2	+ 6	- 7	- 5	+ 4	1		- 9
1977			0		- 2	- 4		+ 4	0	-12	0	+ 7
1978	+ 2		- 7	- 1	- 3			- 2		+ 9	+ 3	
1979			+ 9		- 3					- 4	- 6	- 1
1980	- 4	- 4	- 4		0	- 2	+ 9	- 9	- 4		- 6	-13


Bornö
M 6
58°
Fladen
57° N
Laholm
Bay
10°
12° E



BORNÖ 1980

Temperature Deviations °C



BORNÖ 1980

Salinity ~~Deviations~~ ‰