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Ödsmål, Kville sn, Bohuslän

Hällristning
Fiskare från
bronsåldern

Rock carving
Bronze age
fishermen



MEDDELANDE från
HAVSFISKELABORATORIET LYSEKIL Nr 268
INSTITUTE OF HYDROGRAPHIC RESEARCH
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Observations along the Swedish coast and
in the Deep Basins in the Baltic 1979.

Hydrography of the Kattegat and the
Skagerrak Area, Swedish Observations, 1979.

(Contribution to ICES "Annales Biologiques")

by S. Engström, S. Fonselius and A. Svansson

January 1981

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1981-01-08

6		8		7 MI projekter	
8 Projekt					
<input type="checkbox"/> 1 Uppläggning		<input type="checkbox"/> 2 Komplettering		<input type="checkbox"/> 3 Avslutat	
10 Införartär		11 Kontraktär		12 Startär	
				13 Slutär	
14 MI projekter (i förekommande fall)					
15 Finansierande organ					
Fiskeristyrelsen					
16 Projektets/Rapportens titel och undertitel					
Observations along the Swedish coast and in the Deep Basins in the Baltic 1979.					
Hydrography of the Kattegat and the Skagerrak Area, Swedish observations, 1979.					
17 Projektledare/Rapportförfattare					
Sven Engström Stig Fonselius Artur Svansson					
18 Sammanfattning av projektet/rapporten (enligt gärna målsättning, metod, teknik resultat m m)					
<ol style="list-style-type: none"> 1. Deviations of monthly means of temperature and salinity at Bornö. 2. Temp., sal. and oxygen at 4 occasions at the Skagerrak Deep. 3. Oxygen saturation in the northern Kattegat on 6 occasions. 4. Temp., sal., nutrients etc. on 5 occasions in the Baltic Proper. 5. Maps on oxygen distribution in the deep water of the Baltic at 4 occasions. 					
<ol style="list-style-type: none"> 1. Avvikelser från 30-åriga månadsmedelvärden av temperatur och salt-halt vid Bornö hydrografiska station i Gullmarsfjorden. 2. Mätdata av temperatur, salthalt och syrgas vid 4 tillfällen på Skagerrakdjupet (M 6). 3. Syrgasmättnad på en position i norra Kattegatt (Fladen) vid 6 tillfällen. 4. Mätdata av temperatur, salthalt, syrgas, närsalter m.m. vid 5 tillfällen på djupstationerna i egentliga Östersjön. 5. Kartor över syrgas- och svavelväteutbredningen i Östersjöns djup- 					
19 Sammanfattningen skriven av					
Stig H. Fonselius					
20 Förslag till nyckelord					
Hydrografi, salthalt, temperatur, syrgashalt, svavelväte, närsalter, Kattegatt, Skagerrak, Östersjön					
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Observations along the Swedish coast and
in the deep basins in the Baltic 1979.

The severe ice conditions during the winter 1978 - 1979 prevented observations from coast guard vessels and until May only few observations could be made. Therefore it is difficult to draw any general conclusions from these observations. The responsibility for the coast guard observations were from July 1979 transferred entirely to the Meteorological Institute.

Figures 1, 2, 3 and 4 show the oxygen conditions in the deep water of the Baltic Proper. The coast guard observations support the observations and the conclusions drawn below.

During the end of 1978 a drastic change of the oxygen conditions in the deep water of the Baltic Proper occurred. At the beginning of 1979 areas with low oxygen content (less than 2 ml/l) were found in the Bornholm Basin, east of Gotland and in the deeper parts of the northern Baltic Proper, but only in a very limited area between Gotland and Öland. Hydrogen sulfide was found, in low concentrations, only in the Gotland Deep and the Norrköping Deep.

Smaller inflows of oxygen containing Kattegat water continued during the winter and spring. In June only a very limited area with oxygen concentrations less than 2 ml/l was found north-east of Christiansö. In the other investigated parts of the southern Baltic the bottom water contained 3 - 4 ml O₂/l. The bottom water in the northern Baltic Proper had changed only slightly since the winter. Some very small areas containing hydrogen sulfide were found in the Gotland Deep, the Fårö Deep and some few stations in the northern part.

During the summer and autumn the areas with low oxygen content increased and in the late autumn these areas had a much larger extension than during the spring. Hydrogen sulfide was now found over large areas in the Gotland Deep, the Fårö Deep, at many stations in the northern Baltic, over a rather large area west of Gotland and between Gotland and Öland. The concentrations of hydrogen sulfide had increased considerably. In November the hydrogen sulfide layer in the Gotland Deep begun already at 150 m.

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Arkona Deep
55°00'N 14°05'E

Depth m	Temp. °C	S ‰	O ₂ ml/l	pH	PO ₄ -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO ₂ µgat/l	NO ₂ -N µgat/l	NO ₃ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	Urea µgat/l
January 16													
000	0.56	8.289	9.71	8.28		0.86	1.550	15.2	0.26	3.87	0.52	20.1	0.34
010	0.63	8.277	9.68	8.31	0.58	0.73	1.578	14.9	0.24	4.29	0.89	16.3	0.97
030	1.15	8.710	9.44	8.30	0.56	0.74	1.657	14.2	0.16	4.32	0.78	20.2	0.38
045	0.65	14.142	8.95	8.30	0.78	0.96	1.771	15.9	0.27	4.78	0.58	21.4	0.36
May 29													
000	9.88	7.908	8.77	8.50	0.06	0.42	1.802	2.3	0.09	0.23	0.97	24.6	0.42
010	8.80	8.006	9.13	8.56	0.06	0.81	1.809	1.7	0	0.22	0.63	19.2	0.45
030	2.52	8.816	8.65	8.25	0.17	0.54	1.807	2.2	0.15	3.54	0.44	23.4	0.52
047	4.34	15.848	4.50	7.75	0.73	1.51	1.581	16.6	0.17	3.66	0.97	24.6	0.42
August 21													
000	17.40	8.403	6.84	8.57	0.09	0.52	1.308	9.0	0.06	0.12	0	23.4	0.54
010	17.33	8.408	6.81	8.64	0.02	0.39	1.315	9.3	0.07	0.05	0.13	23.7	0.60
030	3.29	8.616	7.38	8.07	0.45	0.62	1.451	13.6	0.26	0.18	0.69	18.6	0.76
040	11.48	14.433	4.12	8.08	0.61	0.87	1.472	23.8	0.19	2.13	2.74	20.9	0.34
November 6													
000	7.90	8.501	7.60	8.26	0.22	0.50	1.649	9.0	0.16	0.47	0.75	18.92	0.32
010	7.81	8.500	7.58	8.25	0.23	0.57	1.658	9.4	0.15	0.45	1.02	20.28	0.31
030	7.79	8.504	7.59	8.25	0.23	0.53	1.739	10.0	0.14	0.63	0.92	19.25	0.27
048	11.23	16.701	1.47	7.66	4.94	6.86	1.871	50.4	0.18	10.82	1.96	56.82	1.05

Bornholm Deep
55°15'N 15°59'E

Depth m	Temp. °C	S ‰	O ₂ ml/l	pH	PO ₄ -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO ₂ µgat/l	NO ₂ -N µgat/l	NO ₃ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	Urea µgat/l
January 16													
000	2.57	8.244	9.13	8.21	0.55	0.72	1.565	14.8	0.06	2.91	0.35	17.5	0.32
010	2.61	8.249	9.14	8.27	0.54	0.70	1.572	14.3	0.06	3.11	0.30	17.3	0.45
030	2.53	8.247	9.10	8.27	0.55	0.78	1.655	15.1	0.05	3.05	0.26	18.0	0.76
050	2.69	8.262	9.09	8.27	0.54	0.82	1.622	15.1	0.05	2.94	0.35	18.7	1.06
070	4.42	9.787	7.36	8.19	0.75	1.05	1.660	20.0	0.04	4.32	0.34	19.8	0.47
090	8.64	16.030	1.07	7.56	2.24	2.69	1.764	54.0	0.05	5.90	0.21	19.7	0.47
May 29													
000	6.88	8.041	9.58	8.40	0.05	0.70	1.546	4.6	0.03	0.07	0.34	18.5	0.59
010	6.78	8.044	9.59	8.47	0.01	0.46	1.588	4.4	0	0.07	0.34	17.0	0.52
030	3.08	8.082	9.49	8.30	0.17	0.49	1.603	5.8	0	0.06	0.35	13.2	0.52
050	1.47	8.313	9.08	8.09	0.32	0.63	1.612	9.5	0.05	0.06	0.30	14.3	0.86
070	3.74	13.686	4.60	7.64	1.34	1.46	1.831	30.9	0.09	6.36	0.17	19.0	0.63
080	5.34	15.163	1.85	7.42	1.76		1.850	45.4	0.06	7.59	0.20	15.1	0.42
August 21													
000	16.84	8.023	7.08	8.72	0.04	0.36	1.567	7.5	0.02	0.12	0	21.5	0.32
010	16.89	8.023	7.06	8.80	0.05	0.38	1.605	8.1	0.03	0.17	0	21.7	0.47
030	3.66	8.025	7.47	8.25	0.25	0.43	1.627	12.2	0.42	0.14	0	17.0	0.29
050	1.94	9.372	6.51	8.01	0.58	0.75	1.641	18.0	0.36	0.95	0.34	16.8	0.32
070	5.26	13.332	3.77	7.85	0.74	1.00	1.717	27.6	0.03	4.10	0	19.6	0.42
092	5.80	15.375	0.35	7.66	2.24	2.62	1.866	80.0	0.56	6.39	1.50	26.5	1.03

Bornholm Deep
55°15'N 15°59'E

Depth m	Temp. °C	S ‰	O ₂ ml/l	pH	PO ₄ -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO ₂ µgat/l	NO ₂ -N µgat/l	NO ₃ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	Urea µgat/l
000	7.83	8.010	7.51	8.25	0.36	0.48	1.585	8.3	0.12	0.32	0.75	17.69	0.38
010	7.83	8.008	7.66	8.26	0.20	0.47	1.605	8.6	0.11	0.25	0.77	17.15	0.36
030	7.70	8.006	7.59	8.25	0.26	0.47	1.646	8.5	0.12	0.28	0.87	17.42	0.40
050	7.08	8.032	7.42	8.21	0.27	0.62	1.656	9.5	0.15	0.74	0.94	18.65	0.43
070	6.29	14.757	0.65	7.50	1.68	2.16	1.661	46.1	0.04	7.86	0.16	26.20	0.22
080	5.76	15.329	0.22	7.56	4.21	4.84	1.671	55.9	0.40	2.11	2.49	22.38	0.16

November 7

Gotland Deep

57°20'N 20°03'E

Depth m	Temp. °C	S ‰	O ₂ ml/l	pH	PO ₄ -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO ₂ µgat/l	NO ₂ -N µgat/l	NO ₃ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	Urea H ₂ S µgat/l
January 17													
000	3.05	7.860	9.00	8.16	0.45	0.56	1.584	11.0	0.17	2.34	0.58	18.3	0.54
070	3.09	7.864	8.83	8.23	0.43	0.59	1.596	11.1	0.16	2.40	0.58	17.8	0.49
100	4.96	10.941	0.78	7.42	2.38	2.64	1.617	48.7	0.05	7.65	0.17	23.8	0.58
150	5.71	12.116	0.64	7.43	2.43	2.70	1.653	52.7	0.03	9.27	0.16	23.8	0.92
200	6.13	12.570	0.21	7.44	3.24	3.65	1.710	59.4	0.02	0.15	0.74	14.1	0.36
240	6.42	12.761	0	7.52	4.85	5.20	1.800	66.6	0.01	0.11	5.27	21.8	0.50
June 6													
000	11.10	7.684	9.30	8.35	0.05	0.39	1.629	4.5	0	0.17	0.314	14.2	0.54
070	1.85	8.460	6.55	7.68	1.14	1.49	1.684	24.2	0.15	5.45	0.261	20.8	0.43
100	5.12	10.943	1.05	7.22	2.43		1.717	49.9	0	9.25	0.282	18.8	0.47
150	5.97	12.366	0.34	7.20	2.96	3.05	1.757	65.0	0	5.90	0.230	15.1	0.41
200	6.38	12.643	0.27	7.27	3.77	3.75	1.833	73.0	0	0.04	1.055	12.8	0.41
240	6.80	12.897	0	7.30	5.90	6.18	1.871	79.4	0	0	0.928	16.3	0.59
August 22													
000	17.04	7.575	6.89	8.70	0.05	0.49	1.608	7.2	0.19	0.09	0	21.8	0.40
070	1.31	8.151	8.45	8.07	0.56	0.76	1.657	18.8	0.56	0.71	0.14	15.6	0.42
100	4.58	10.328	8.26	7.48	2.21	2.42	1.731	60.7	0.11	7.72	0	23.8	0.25
150	5.85	12.080	0.51	7.48	2.42	2.71	1.809	70.8	0.03	8.92	0	22.0	0.24
200	6.18	12.583		7.56	3.47	3.97	1.833	82.4	0.03	0.18	1.72	14.5	0.22
235	6.55	12.751		7.59	3.80	4.48	1.871	83.8	0	0.14	2.36	14.3	0.38

Gotland Deep
57°20'N 20°03'E

Depth m	Temp. °C	S ‰	O ₂ ml/l	pH	PO ₄ -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO ₂ µgat/l	NO ₂ -N µgat/l	NO ₃ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	Urea µgat/l	H ₂ S µgat/l
October 17														
000	11.18	7.596	7.38		0.09	0.41								
070	3.11	8.289	6.31		0.46	0.80								
100	5.03	11.110	0.77		1.41	2.38								
150	5.94	12.304	0.13		1.75	3.10								
200	6.31	12.675			1.99	3.84								15
225	6.57	12.792			2.09	4.37								20
November 8														
000	8.22	7.645	7.55	8.27	0.24	0.53		6.6	0.32	0.67	1.90	19.22	0.43	
070	3.01	9.101	3.79	7.57	1.50		1.683	29.6	0.07	5.69	0.20	21.21	0.40	
100	4.92	11.030	0.73	7.38	2.54	2.83	1.756	45.5	0.06	9.15	0.12	26.30	0.22	
150		12.274	0	7.41	3.59	3.95	1.827	52.3	0.04	0.19	1.74	16.77	0.36	0.6
200	6.32	12.644		7.28	3.84	4.29	1.864	61.0	0.03	0.31	3.12	19.63	0.34	4.8
240	6.57	12.836		7.47	4.80	6.20	1.872	68.1	0	0.02	8.24	28.81	0.27	20.6

Landsort Deep

58°35'N 18°14'E

Depth m	Temp. °C	S ‰	O ₂ ml/l	pH	PO ₄ -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO ₂ µgat/l	NO ₂ -N µgat/l	NO ₃ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	Urea µgat/l
January 18													
000	1.32	7.478	9.32	8.15	0.53	0.58	1.543	14.7	0.20	1.95	0.46	18.8	0.47
070	4.04	8.947	4.25	7.63	1.53	1.77	1.629	33.9	0.03	3.74	0.23	18.6	0.36
100	4.27	9.603	2.78	7.51	1.99	2.23	1.686	42.0	0.02	4.16	0.09	17.7	0.34
150	4.93	10.683	0.46	7.41	2.71	2.73	1.725	53.0	0.02	5.38	0.13	16.9	0.74
200	5.18	11.086	0.18	7.42	2.78	3.06	1.736	53.9	0.08	7.17	0.25	21.3	0.79
440	5.32	11.304	0.20	7.40	2.78	3.05	1.755	53.8	0.32	8.13	0.45	22.1	0.65
June 5													
000	10.22	7.175	9.21	8.39	0.03	0.33	1.539	7.8	0	0.04	2.72	16.4	0.49
070	3.56	9.185	3.41	7.37	1.77	1.97	1.612	39.8	0.09	4.17	0.314	19.1	0.43
100	4.88	10.622	0.68	7.20	2.62	2.93	1.738	56.6	0	6.35	0.282	19.7	0.41
150	4.97	10.908	0.64		2.59	2.93	1.745	53.0	0.03	6.09	0.293	16.8	0.34
200	5.06	11.008	0.36	7.17	2.81	3.07	1.748	60.6	0.03	6.69	0.345	19.5	0.34
440	5.29	11.227	0.34	7.23	3.13	3.44	1.779	52.3	0	3.38	1.28	16.7	0.40
August 23													
000	17.59	6.709	6.72	8.56	0.03	0.34	1.517	9.5	0.05	0.09	0	19.1	0.32
070	3.78	9.487	2.03	7.53	1.89	2.13	1.622	43.2	0.05	2.27	0	17.1	0.60
100	4.79	10.522	0.55	7.46	2.55	2.92	1.757	66.7	0.05	6.05	0	20.0	0.31
150	4.99	11.000	0.31	7.44	2.69	3.11	1.767	69.4	0.04	6.71	0	20.3	0.31
200	5.05	11.041	0.21	7.45	2.81	3.21	1.767	70.3	0.06	6.54	0	18.8	0.22
440	5.22	11.205	0.25	7.54	3.02	3.44	1.807	72.3	0.32	2.31	0.26	14.7	0.43

Landsort Deep
58°35'N 18°14'E

Depth m	Temp. °C	S ‰	O ₂ ml/l	pH	PO ₄ -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO ₂ µgat/l	NO ₂ -N µgat/l	NO ₃ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	Urea µgat/l
October 8													
000	8.95	7.185	7.87		0.08	0.55							
075	3.72	9.677	2.06		1.14	2.34							
100	4.71	10.679	0.26		1.43	2.85							
200	5.02	10.997	0.12		1.56	3.38							
440	5.22	11.170	0.15		1.84	3.99							
November 13													
000	5.78	7.134	8.02	8.23	0.25	0.53	1.602	10.4	0.25	0.38	0.64	18.16	0.47
070	3.05	9.027	3.40	7.63	1.62	1.78	1.693	33.1	0.04	3.68	0.20	20.88	0.43
100	4.61	10.343	0.45	7.37	2.66	2.90	1.749	48.6	0.04	4.88	0.20	21.67	0.22
200	5.02	10.992	0.17	7.38	2.97	3.19	1.756	53.0	0.36	1.95	0.16	17.91	0.29
440	5.15	11.140	0.26	7.41	3.43	3.72	1.835	54.0	0.31	0.47	0.24	16.74	0.42

Figure 1. The oxygen-deficient areas and hydrogen sulfide distribution in Baltic deep water, 15-20 January 1979.

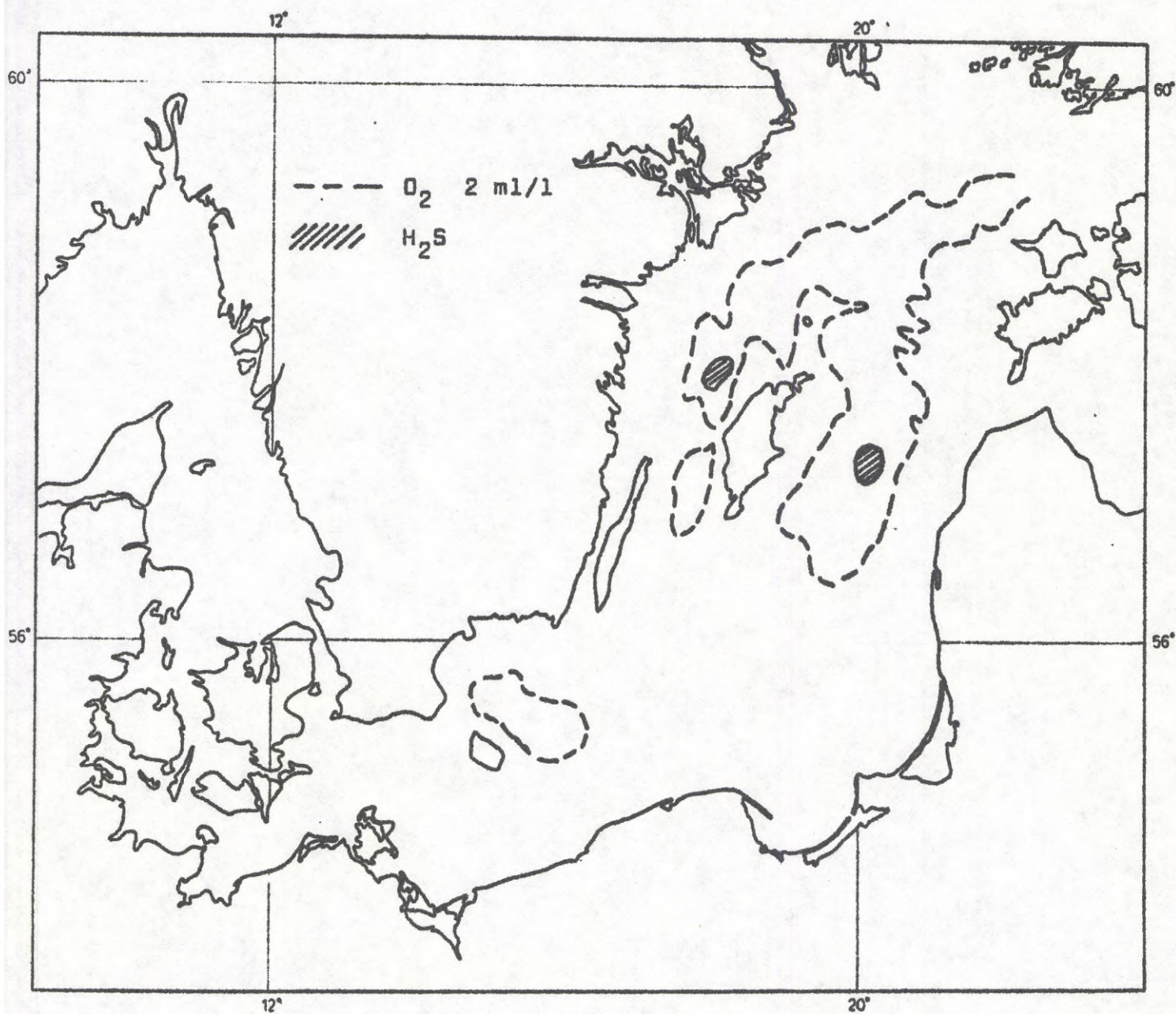


Figure 2. The oxygen-deficient areas and hydrogen sulfide distribution in Baltic deep water, 14 May - 17 June 1979.

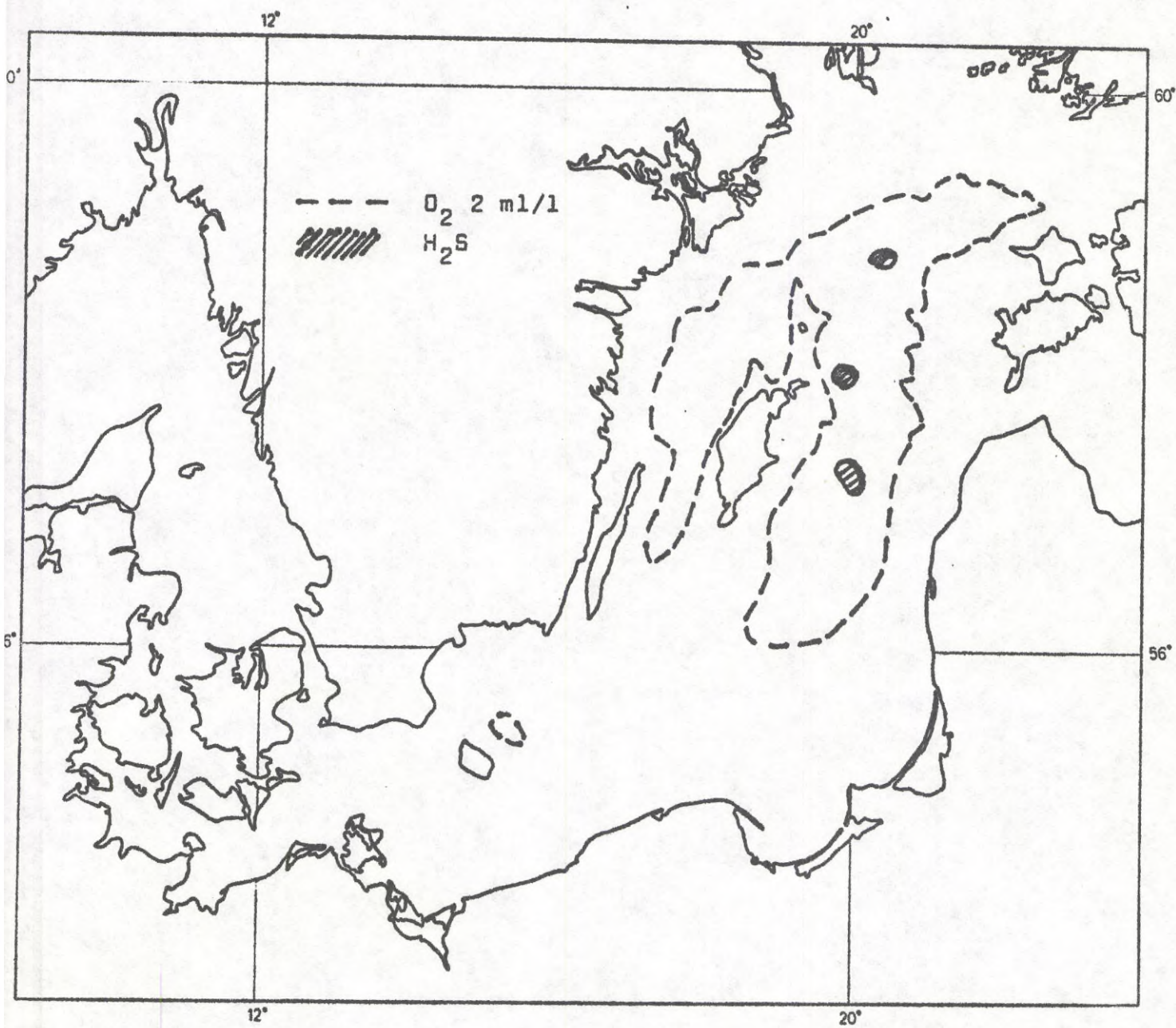


Figure 3. The oxygen-deficient areas and hydrogen sulfide distribution in Baltic deep water, 20-24 August 1979.

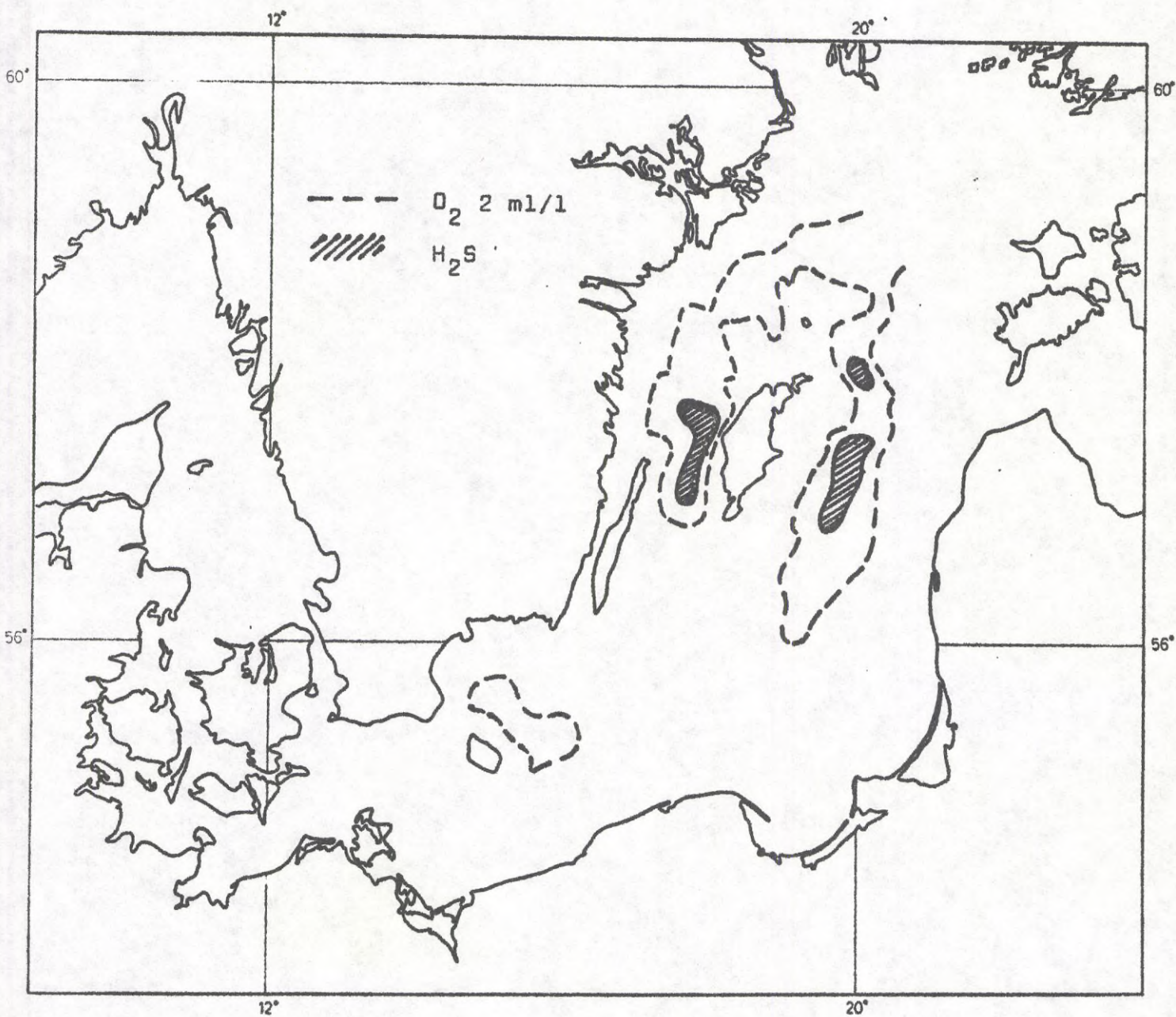
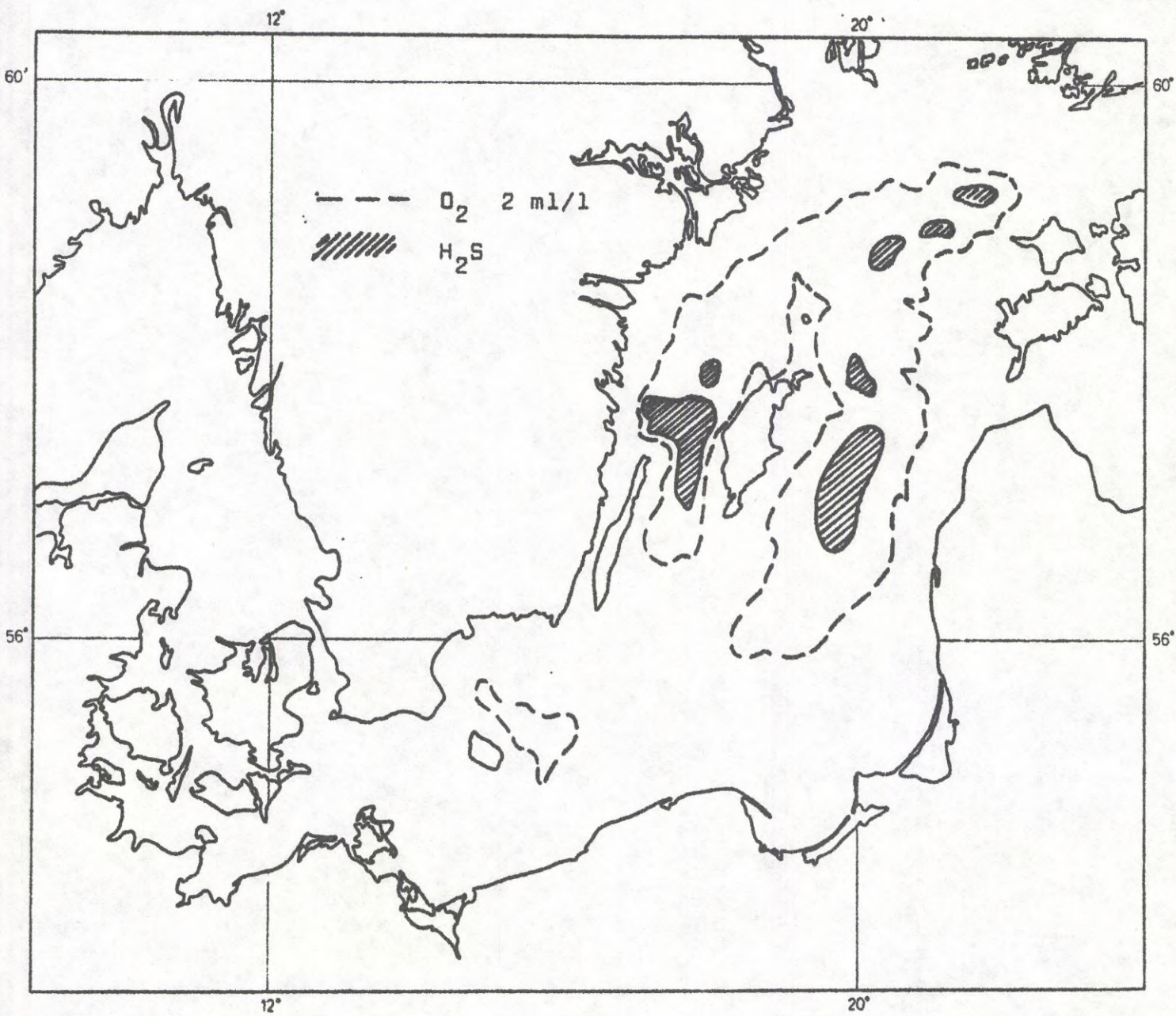


Figure 4. The oxygen-deficient areas and hydrogen sulfide distribution in Baltic deep water, 22 Oct.-29 Nov. 1979.



Hydrography of the Kattegat and the Skagerrak Area 1979.

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. Temperature was below normal during large parts of the year. At greater depths also salinity had a similar distribution.

The Skagerrak Deep (M 6) was visited 4 times (Table 1). Greater depth data indicate a renewal of bottom water after the March measurement. The new water is colder, and has lower concentration of phosphorus.

Table 2 shows the oxygen saturation values at station Fladen in northern Kattegat.

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Table 1.

M 6 58°10'N 09°30'E

January 31

Depth m	Temp. °C	S ‰	σ_t	O ₂ ml/l	O ₂ %	Tot.P µgat/l	Tot.N µgat/l
200	6.74	34.978	27.46	6.14	90	1.04	14.4
300	6.17	35.014	27.56	6.02	87	1.02	14.5
400	5.86	35.011	27.60	6.13	88	1.05	13.1
500	5.55	34.994	27.63	6.15	88	1.09	13.0
600	5.20	34.963	27.64	5.87	83	1.10	13.3

March 20

200	6.14	34.916	27.49	6.22	90		
300	6.32	35.024	27.55	5.70	83		
400	6.01	35.030	27.60	5.82	84		
500	5.32	34.933	27.61	6.33	90		
600	5.37	35.044	27.69	6.63	94		

May 16

200	5.23	34.985	27.66	6.19	88		15.1
300	4.98	34.971	27.68	6.50	92		13.4
400	4.77	35.047	27.76	6.68	94		13.0
500	4.79	35.006	27.73	6.97	98		14.5
600	4.81	35.039	27.75	6.80	95		13.0

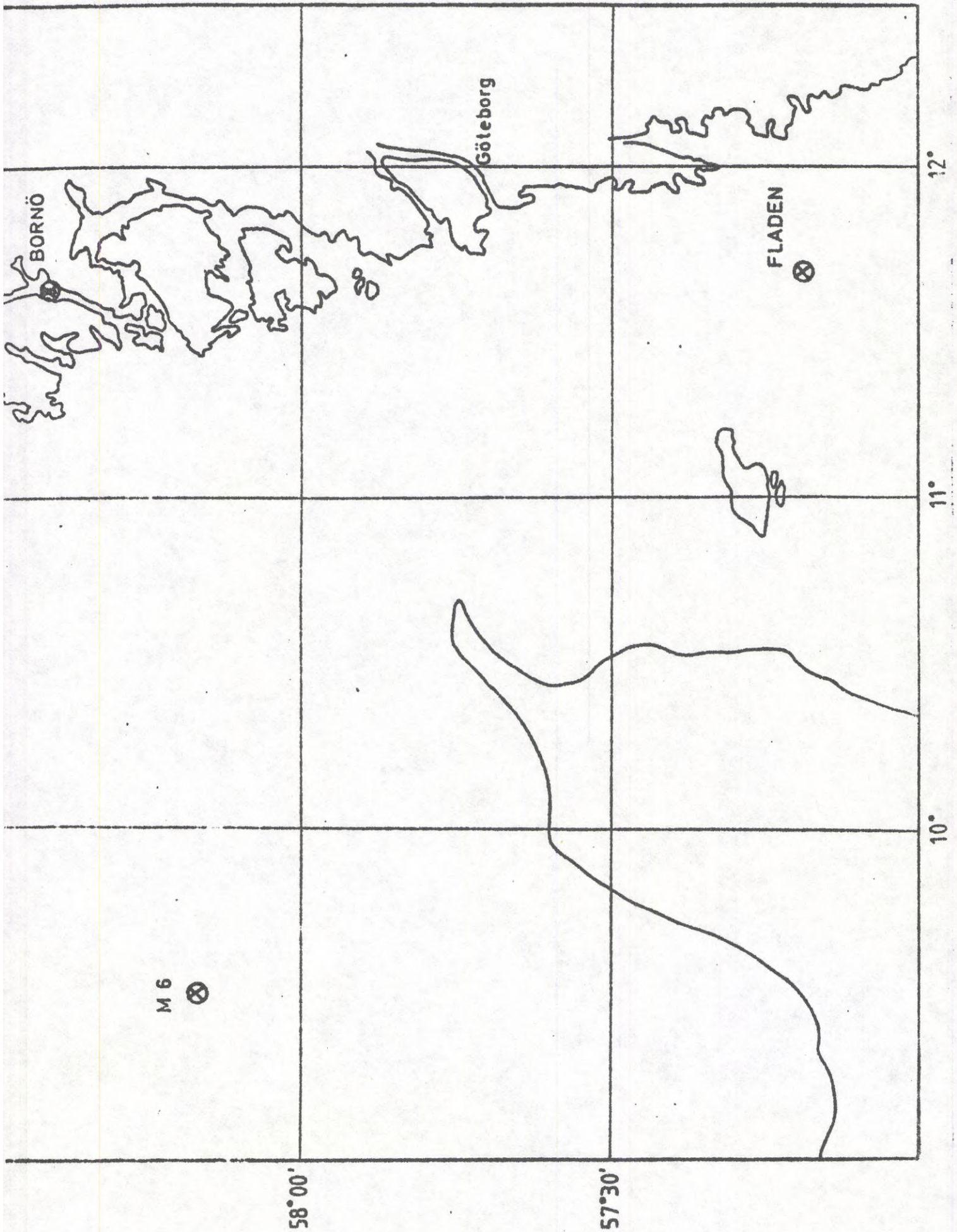
October 25

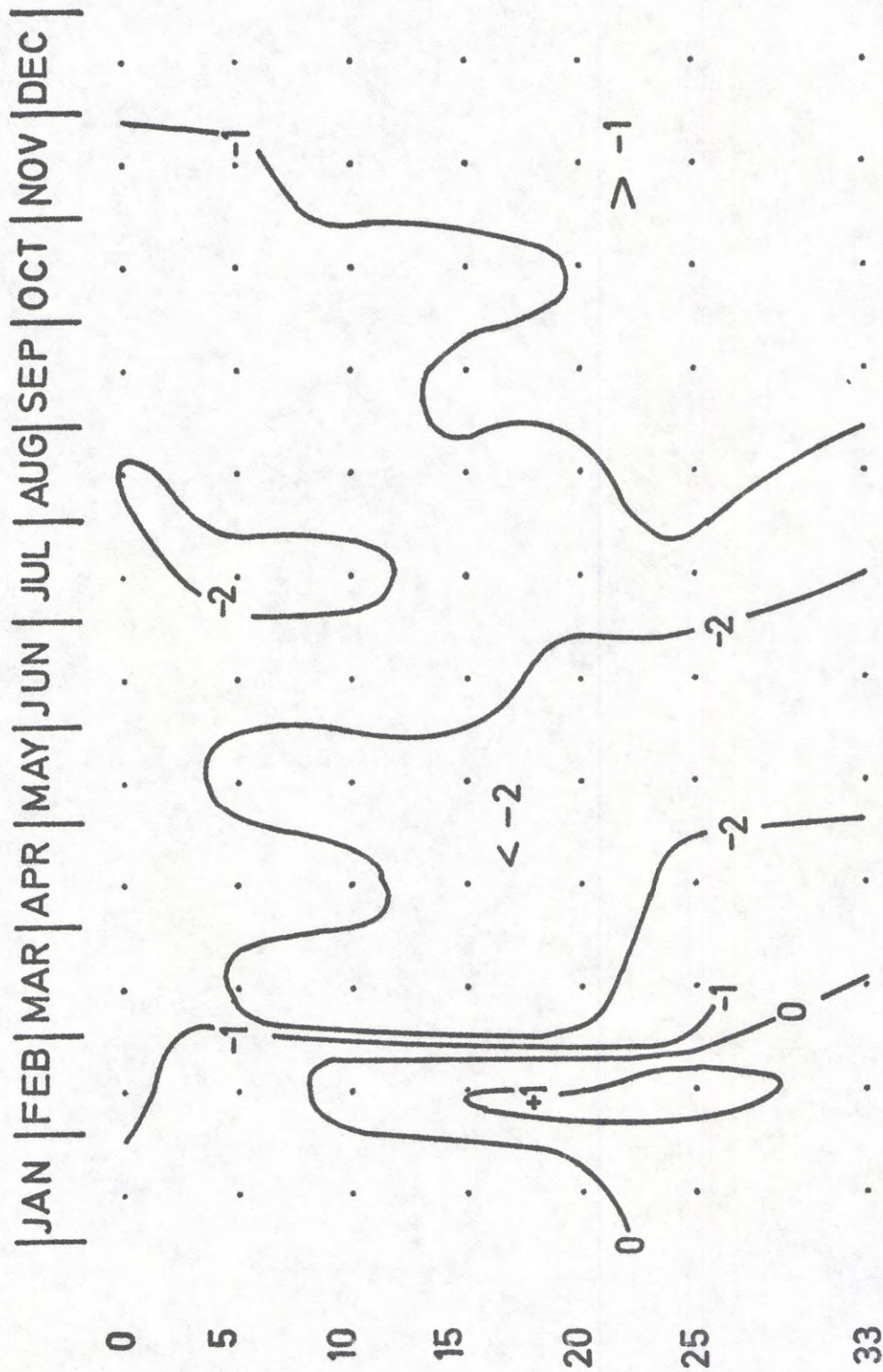
200	5.42	35.011	27.65	6.09	87	0.73	14.9
300	4.89	35.004	27.71	6.54	92	0.68	14.8
400	4.82	34.980	27.70	6.67	94	0.64	15.2
500	4.86	34.987	27.70	6.59	93	0.63	15.1
600	4.81	34.998	27.72	6.63	93	0.65	13.6

Percentage Oxygen Saturation at 57°11.5'N 11°40'E (Fladen O₂ %)

Depth m	Jan. 15	March 12	May 28	Oct. 9	Nov. 5	Dec. 26
30	98	103	91	65	81	96
40	94	103	89	62	83	86
50	--	102	87	75	80	88
60	90	100	86	73	80	85
70	85	100	87	73	79	85
77			86			

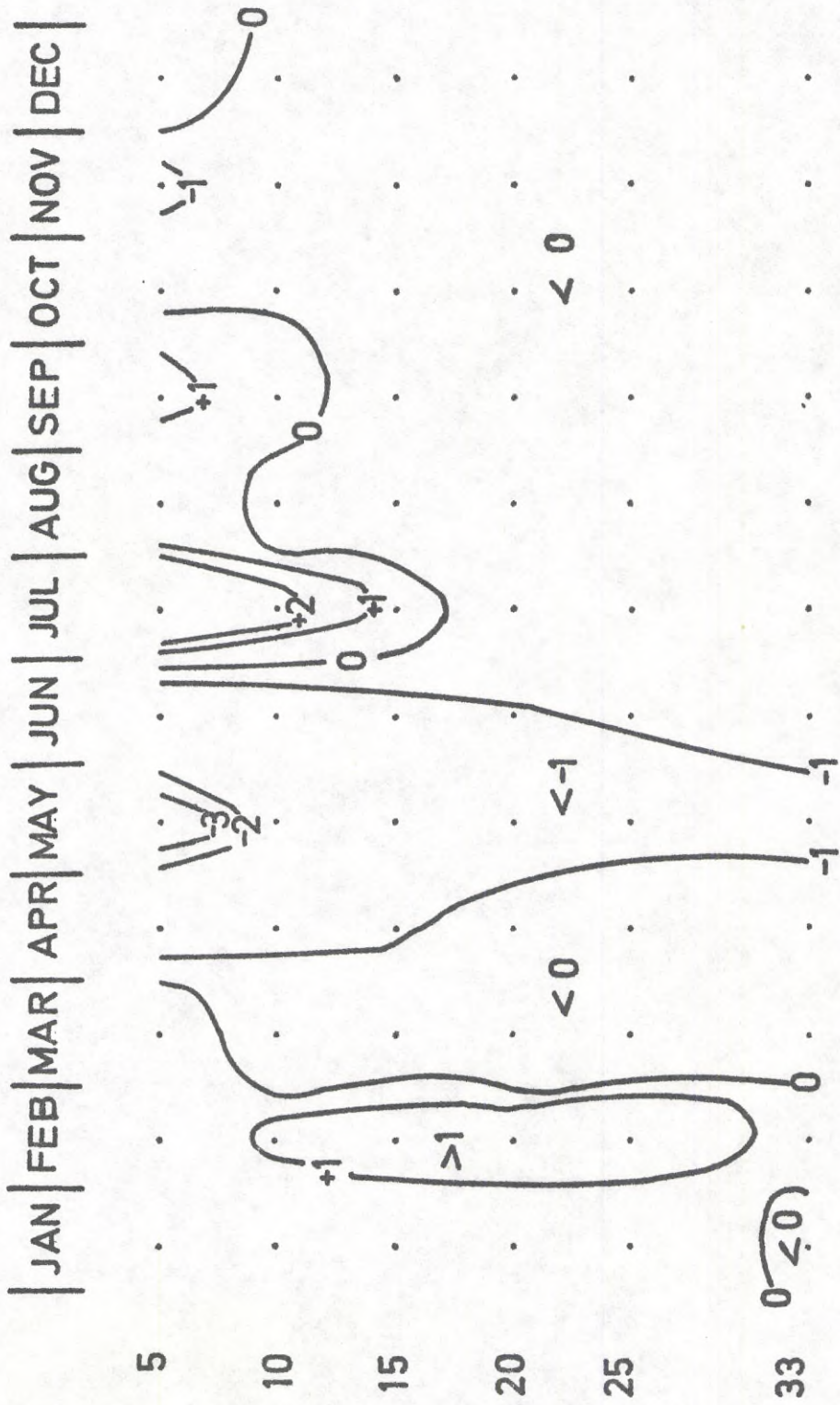
Fig. 1





BORNÖ 1979

Temperature Deviations °C



BORNÖ 1979
Salinity Deviations ‰

