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Ödsmål, Kville sn, Bohuslän

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Fiskare från  
bronsåldern

Rock carving  
Bronze age  
fishermen



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HAVSFISKELABORATORIET LYSEKIL Nr 260  
INSTITUTE OF HYDROGRAPHIC RESEARCH 5  
GÖTEBORG SERIES No

Observations along the Swedish coast and  
in the Deep Basins in the Baltic 1978.

Hydrography of the Kattegat and the  
Skagerrak Area, Swedish Observations, 1978.

(Contribution to ICES "Annales Biologiques")

by S. Engström, S. Fonselius and S. Lööf

April 1980



1 Utförande institution/Rapportutgivare (namn, adress, telefon)

Fiskeristyrelsen  
Hydrografiska Laboratoriet  
Box 2566, 403 17 GöteborgPROJEKT BESKRIVNING  
TITELBLAD-RAPPORTER

2 REF

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3 Datum  
1980-04-20

4 Ärendebetäckning (Diarier nr)

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5	6	7 Mi projekter
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10 Inrapporter	11 Kontrakter	12 Startår
		13 Slutår
14 Mi projekter (i förekl. fall)		
15 Finansierande organ Fiskeristyrelsen		
16 Projektets/Rapportens titel och undertitel Observations along the Swedish coast and in the Deep Basins in the Baltic 1978. Hydrography of the Kattegat and the Skagerrak Area, Swedish Observations, 1978.		
17 Projektledare/Rapportförfattare Sven Engström Stig Fonselius Staffan Lööf		
18 Sammanfattning av projektet/rapporten (ange gärna målsättning, metod, teknisk resultat m.m.) 1. Deviations of monthly means of temperature and salinity at Bornö. 2. Temp., sal. and oxygen at 3 occasions on the Skagerrak Deep. 3. Oxygen saturation in northern Kattegat on 9 occasions. 4. Temp., sal., oxygen, nutrients etc. on 4 occasions in Baltic Proper. 5. Maps of O <sub>2</sub> -distribution in the Baltic Proper. Two O <sub>2</sub> -sections.  1. Avvikelser från 30-åriga månadsmedelvärden av temperatur och salthalt vid Bornö fältstation i Gullmarsfjorden. 2. Mätdata av temperatur, salthalt och syrgas vid 3 tillfällen på Skagerraksdjupet (M 6). 3. Syrgasmättnad på en position i norra Kattegatt (Fladen) vid 9 tillfällen. 4. Mätdata av temperatur, salthalt, syrgas, närsalter mm vid 4 till- fällen på djupstationer i eg. Östersjön. 5. Kartor över utbredningen vid 4 mättillfällen av koncentrationer < 2 ml/l i eg. Östersjön samt 2 längdsnitt av syrgas-koncentrationerna.		
		19 Sammanfattningen skriven av Artur Svansson
20 Förslag till nyckelord Hydrografi, salthalt, temperatur, syrgashalt, svavelväte, närsalter, Kattegatt, Skagerrak, Östersjön		
21 Klassifikationssystem och klass		
22 Indexterm		
23 Bibliografiska uppgifter Meddelande från Havsfiskelaboratoriet nr 260 IHR Göteborg Series No. 5		24 ISSN
		25 ISBN
26 Hemligt	paragraf	27 Språk
<input checked="" type="checkbox"/> Nej <input type="checkbox"/> Ja, jämlikt	5 sekretesslagen	Engelska
28 Antal sidor		
29 Pris		
30 Rapporten beställs hos Se ovan		

MON 5 1978-02 3 000

Blanketten beställs hos

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Observations along the Swedish coast and  
in the deep basins in the Baltic 1978.

The figures 1, 2, 3 and 4 show maps over the oxygen deficiency and distribution of hydrogen sulfide in the deep areas of the Baltic Proper.

As was predicted in the previous report (Engström and Fonselius 1979) formation of hydrogen sulfide begun during the summer 1978 in the deep basins. In the Landsort Deep some new water flowed in during the spring. The oxygen concentration at 440 m was in May 0.89 ml/l and the salinity had increased from 11.23 ‰ in January to 11.66 ‰.

In the Gotland Deep the salinity at 240 m has slightly decreased during the year, from 12.92 ‰ in January to 12.81 ‰ in November. Hydrogen sulfide was observed at 240 m in June, but the concentration was not measured during the June expedition. In August the concentration was 12  $\mu\text{g-at/l}$  and in November it had increased to 24  $\mu\text{g-at/l}$ . In the Bornholm Deep the salinity was almost unchanged during the year. Observations from November are, however, missing due to severe weather conditions during the expedition. No indications of important water inflows were observed in the Arkona basin. During all hydrochemistry expeditions urea was measured in addition to the other nutrients. Urea is an important nutrient and its concentration in the Baltic varies between 0.2 and 1  $\mu\text{g-at/l}$ .

Some interesting observations were made during the November expedition. Southwesterly strong winds were prevailing for a long time. The area with oxygen deficiency was unusually large between Öland and Gotland and hydrogen sulfide was found up to 40 m close to Öland. Hydrogen sulfide has not been observed at that depth earlier. The section diagrammes (Fig. 5 and 6)



show that during the prevailing strong winds the surface water had been moved towards the northern and eastern parts of the Baltic Proper. Deep water had been moved to the west and along the western coasts upwelling of water from deeper layers could be observed.

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#### Reference

Engström, S and S. Fonselius 1979. Observations along the Swedish coast and in the deep basins of the Baltic 1977. Ann. Biol. XXXIV 1977 (1979).



Arkona Deep  
55°00'N 14°05'E

Depth m	Temp. °C	S ‰	O <sub>2</sub> ml/l	pH	PO <sub>4</sub> -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO <sub>2</sub> µgat/l	NO <sub>2</sub> -N µgat/l	NO <sub>3</sub> -N µgat/l	NH <sub>4</sub> -N µgat/l	Tot.N µgat/l	Urea µgat/l
January 24													
000	3.37	8.529	8.80	8.13	0.65	0.71	1.528	26.6	0.21	3.31	0.62	18	
010	3.36	8.524	8.71	8.22	0.66	0.77	1.530	26.4	0.20	3.88	0.40	19	
030	3.75	10.623	8.49	8.24	0.62	0.69	1.615	22.7	0.06	5.02	0.24	20	
047	4.58	17.306	7.10	8.20	1.03	1.25	1.821	31.6	0.52	7.78	1.09	25	
May 17													
000	5.98	8.062	9.42	8.55	0.18	0.52	1.533	3.0	0.01	0.19	0.29	17	0.50
010	5.68	8.088	10.29	8.60	0.19	0.71	1.562	2.6	0.01	0.08	0.26	19	0.82
030	4.37	8.226	9.55	8.52	0.18	0.57	1.578	2.3	0	0.08	0.27	15	0.46
048	3.07	15.320	4.11	7.90	0.93	2.04	1.829	19.6	0.05	1.47	0.48	28	0.98
August 22													
000	18.30	8.167	7.14	8.31	0.07	0.58	1.466	11.2	0	0.11	0.87	19	0.41
010	17.81	8.180	6.95	8.44	0.05	0.53	1.576	11.9	0	0.11	0.38	19	0.53
030	10.87	10.231	4.51	7.87	0.63	0.89	1.821	23.3	0.68	0.59	0.99	18	0.21
047	10.85	18.067	0.71	7.56	3.59	4.33	1.889	71.9	0.12	10.38	1.51	27	1.86
November 14													
000	8.70	8.163	7.95	8.21	0.38	0.45	1.545	11.8	0.31	0.52	0.71	13	0.47
010	8.78	8.159	7.93	8.22	0.36	0.61	1.542	11.5	0.29	0.59	0.56	14	0.52
030	10.28	11.321	5.12	7.92	0.73	0.97	1.843	20.7	0.06	4.49	0.42	21	0.68
048	10.91	17.865	3.67	7.87	5.00	6.80		44.5	0.50	4.97	4.01	35	1.24



Bornholm Deep  
55°15'N 15°59'E

Depth m	Temp. °C	S ‰	O <sub>2</sub> ml/l	pH	PO <sub>4</sub> -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO <sub>2</sub> µgat/l	NO <sub>2</sub> -N µgat/l	NO <sub>3</sub> -N µgat/l	NH <sub>4</sub> -N µgat/l	Tot.N µgat/l	Urea µgat/l
January 24													
000	3.73	8.166	8.64	8.18	0.61	0.76	1.493	28.1	0.13	2.79	0.62	17	
010	3.74	8.166	8.64	8.21	0.65	0.76	1.501	28.3	0.13	3.05	0.30	18	
030	3.81	8.174	8.50	8.21	0.66	0.78	1.496	28.0	0.13	3.03	0.13	17	
050	4.91	8.538	7.96	8.14	0.71	0.83	1.512	30.5	0.06	3.51	0.10	17	
070	7.87	15.505	1.90	7.65	1.62	1.79	1.744	75.6	0.02	7.63	0.14	21	
092	7.38	16.462	1.71	7.65	1.81	1.98	1.770	83.3	0.01	5.89	0.20	18	
May 17													
000	5.16	7.869	9.80	8.46	0.37	0.99	1.545	7.8	0.01	0.08	0.75	20	0.77
010	5.07	7.865	9.82	8.56	0.35	1.08	1.544	7.3	0	0.05	0.31	20	1.09
030	4.15	7.888	9.53	8.49	0.40	0.71	1.551	6.8	0.01	0.03	0.50	20	0.55
050	3.58	8.149	9.05	8.38	0.44	0.69	1.578	10.7	0.02	0.03	0.58	22	0.93
070	3.40	12.650	6.33	7.99	1.08	1.34	1.722	20.8	0.07	6.83	0.64	26	0.65
091	7.21	16.356	0.62	7.54	2.40	2.55	1.862	46.0	0.03	6.32	0.78	25	0.48
June 8													
000	13.46	7.847	8.81										
010	11.57	7.823	9.84										
030	4.68	7.896	8.93										
050	4.50	8.115	8.53										
070	3.76	13.067	5.12										
090	5.32	16.349	0.19										



Bornholm Deep  
55°15'N 15°59'E

Depth m	Temp. °C	S ‰	O <sub>2</sub> ml/l	pH	PO <sub>4</sub> -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO <sub>2</sub> µgat/l	NO <sub>2</sub> -N µgat/l	NO <sub>3</sub> -N µgat/l	NH <sub>4</sub> -N µgat/l	Tot.N µgat/l	Urea µgat/l
000	9.50	7.815											
050	4.44	8.172	8.24										
070	5.77	14.909	1.75										
090	7.43	16.350	0.17										
June 13													
August 22													
000	18.04	7.818	6.08		0.09	0.41		6.9	0	0.10	0.56	19	1.00
010	17.81	7.812	6.98		0.08	0.30		5.9	0	0.10	0.36	16	0.43
030	5.14	7.941	7.82		0.45	0.41		9.8	0	0.08	0.40	14	0.64
050	4.72	8.897	6.63		(0.64)	0.55		15.3	0.41	0.52	0.99	16	0.41
070	7.06	15.104	1.57		1.70	1.87		44.6	0	7.70	0.12	19	0.75
091	7.58	16.367	0.32		5.03	6.58		79.5	0.66	9.65	3.63	25	1.43



Gotland Deep  
57°20'N 20°03'E

Depth m	Temp. °C	S ‰	O <sub>2</sub> ml/l	pH	PO <sub>4</sub> -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO <sub>2</sub> µgat/l	NO <sub>2</sub> -N µgat/l	NO <sub>3</sub> -N µgat/l	NH <sub>4</sub> -N µgat/l	Tot.N µgat/l	Urea µgat/l
January 25													
000	3.66	7.762	8.61	8.13	0.49	0.66	1.530	21.4	0.12	2.84	0.30	18	
070	4.31	9.430	3.32	7.64	1.72	1.86	1.557	59.0	0.04	5.70	0.16	18	
100	5.22	11.214	1.44	7.52	2.27	2.44	1.665	79.3	0.02	8.08	0.17	20	
150	5.67	12.299	1.10	7.51	2.36	2.52	1.670	88.1	0.02	7.73	3.83	20	
200	6.22	12.652	0.78	7.51	2.28	2.47	1.691	92.6	0.02	8.03	0.73	19	
240	6.71	12.918	0.31	7.56	2.54	2.87	1.728	>100	0.08	5.97	0.37	19	
May 18													
000	4.81	7.690	10.35	8.60	0.11	0.85	1.605	4.5	0	0.17	0.37	25	0.69
070	4.38	9.764	2.96	7.61	2.13	2.23	1.631	42.6	0.02	6.98	0.29	21	0.39
100	5.41	11.345	1.39	7.49	2.46	2.54	1.680	61.0	0.02	8.58	0.29	22	0.59
150	5.97	12.429	0.88	7.48	2.51	2.54	1.716	58.2	0.01	8.19	0.30	20	0.39
200	6.35	12.706	0.40	7.47	2.48	2.56	1.724	51.4	0.02	7.33	0.30	21	0.61
240	6.41	12.870	0.29	7.63	3.50		1.829	64.2	0.45	0.63	1.07		0.48
June 14													
000	11.57	7.706	8.94										
070													
100	5.36	11.150	1.23										
150	5.85	12.285	0.91										
200	6.32	12.684	0.34										
245	6.63	12.893	0										



Gotland Deep  
57°20'N 20°03'E

Depth m	Temp. °C	S ‰	O <sub>2</sub> ml/l	pH	PO <sub>4</sub> -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO <sub>2</sub> µgat/l	NO <sub>2</sub> -N µgat/l	NO <sub>3</sub> -N µgat/l	NH <sub>4</sub> -N µgat/l	Tot.N µgat/l	Urea µgat/l	H <sub>2</sub> S µgat/l
August 23														
000	16.35	7.410	7.02	0.60	0.07	1.546	7.5	0.02	0.10	0.66	19	0.61		
070	2.87	8.489	5.95	1.07	0.91	1.623	26.0	0.42	0.30	0.88	14	0.37		
100	5.27	11.036	1.25	2.33	2.13	1.711	53.7	0	8.65	0.18	19	0.54		
150	5.84		0.87	2.50	2.30	1.724	58.2	0.01	8.99	0.37	18	1.02		
200	6.24	12.667	0.31	2.63	2.42	1.703	67.3	0.02	6.78	0.11	18	0.50		
240	6.52	12.836		4.09	3.53	1.973	78.5	0	0.09	2.81	16	0.68		12.0
November 22														
000	7.75	7.681	7.95	0.36	0.29	1.612	9.6	0.26	0.75	0.98	17	0.56		
070	3.96	9.672	3.45	1.70	1.56	1.703	38.5	0.03	4.96	0.17	17	0.52		
100	5.17	11.285	1.31	2.30	2.12	1.773	50.1	0.03	8.32	0.22	22	0.95		
150	5.91	12.422	0.56	2.52	2.28	1.794	53.5	0.03	8.32	0.18	21	0.54		
200	6.32	12.691	0.24	3.36	2.93	1.826	63.6	0.04	0.36	0.56	14	0.51		
240	6.49	12.808	0	5.17	4.10	1.954	75.4	0.01	0.04	6.19	23	1.13		24.3



Landsort Deep  
58°35'N 18°14'E

Depth m	Temp. °C	S ‰	O <sub>2</sub> ml/l	pH	PO <sub>4</sub> -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO <sub>2</sub> µgat/l	NO <sub>2</sub> -N µgat/l	NO <sub>3</sub> -N µgat/l	NH <sub>4</sub> -N µgat/l	Tot.N µgat/l	Urea µgat/l
January 30													
000	2.64	7.311	8.92	8.14	0.43	0.55	1.435	25.1	0.09	2.79	0.14	17	
070	4.76	8.427	5.69	7.80	1.13	1.47	1.560	44.3	0.02	4.27	0.91	20	
100	4.80	10.285	0.93	7.47	2.60	2.99	1.605	87.1	0.01	5.31	0.24	19	
150	5.16	10.915	0.60	7.45	2.39	2.89	1.615	89.9	0.02	6.43	0.35	19	
200	5.23	11.004	0.59	7.45	2.64	2.95	1.618	91.1	0.03	6.67	1.02	19	
440	5.34	11.232	0.29	7.44	2.75	3.14	1.642	92.9	0.03	7.27	0.21	21	
May 30													
000	8.34	6.259	9.75	8.55	0.12	0.66	1.381	5.8	0.02	0.04	0.14	21	1.10
070	3.68	8.758	4.97	7.76	1.59	1.82	1.617	27.1	0.06	1.63	0.19	19	0.71
100	5.19	10.928	0.80	7.45	2.98	2.99	1.699	38.0	0.02	7.03	0.11	20	0.57
150	5.21	11.057	0.58	7.44	3.07	3.10	1.704	48.7	0.03	7.17	0.29	21	0.57
200	5.24	11.235	0.56	7.46	2.80	2.81	1.700	51.8	0.02	7.48	0.12	20	0.62
440	5.34	11.661	0.89	7.48	2.73	2.81	1.941	34.5	0.03	7.72	0.08	27	0.43
September 5													
000	14.12	6.582	6.86	8.36	0.05	0.50	1.347	10.4	0.02	0.09	0.37	18	0.43
070	4.64	10.074	0.44	7.40	2.53	2.94	1.616	66.1	0.03	4.72	0.28	19	0.59
100	5.00	10.792	0.41	7.42	2.51	3.00	1.642	70.4	0.01	6.94	0.40	21	0.39
150	5.20	11.084	0.66	7.42	2.70	2.84	1.640	69.9	0.01	9.29	0.25	19	0.21
200	5.32	11.281	0.69	7.43	2.48	2.93	1.650	72.2	0.04	9.36	0.49	22	0.45
440	5.42	11.450	0.78	7.44	2.36	2.84	1.658	69.9	0.04	9.11	0.30	20	0.23



Landsort Deep  
58°35'N 18°14'E

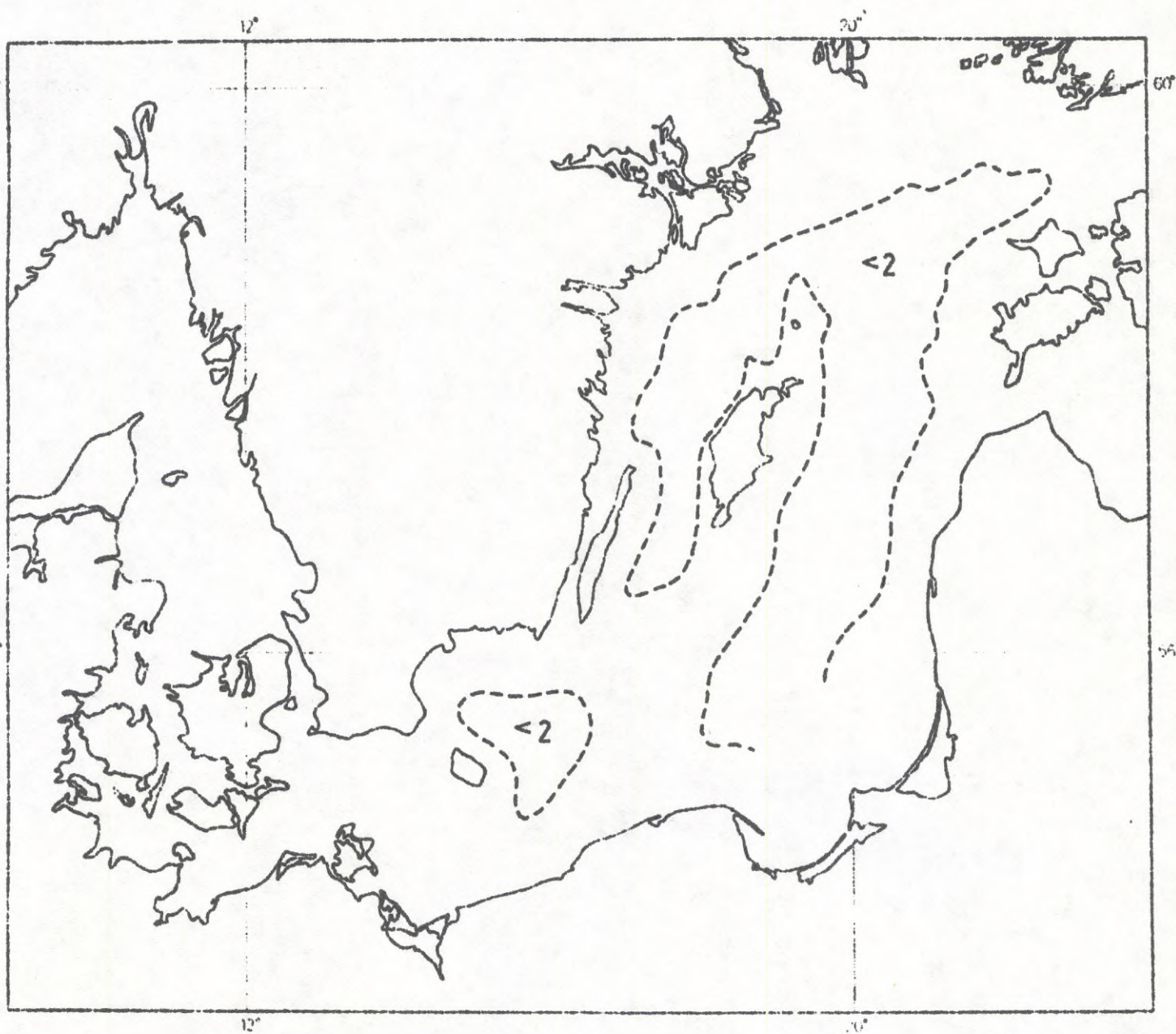
Depth m	Temp. °C	S ‰	O <sub>2</sub> ml/l	pH	PO <sub>4</sub> -P µgat/l	Tot.P µgat/l	Alkal. Mval/l	SiO <sub>2</sub> µgat/l	NO <sub>2</sub> -N µgat/l	NO <sub>3</sub> -N µgat/l	NH <sub>4</sub> -N µgat/l	Tot.N µgat/l	Urea µgat/l
000	6.47	7.244	8.13	8.05	0.37	0.63	1.545	13.2	0.29	0.43	1.25	17	0.40
070	3.86	9.271	3.11	7.51	1.46	1.82	1.675	38.0	0.03	4.23	0.47	21	0.47
100	4.66	10.502	0.76	7.36	2.53	2.93	1.752	54.3	0.03	6.47	0.48	22	0.41
150	5.08	10.929	0.31	7.34	2.63	3.07	1.766	57.2	0.03	7.57	0.47	22	0.52
200	5.22	11.121	0.24	7.34	2.60	2.84	1.773	58.0	0.03	7.57	0.42	21	0.43
440	5.39	11.378	0.41	7.36	2.64	2.94	1.777	58.0	0.10	9.20	0.63	24	0.40

November 16



R/V ARGOS 1978 01 16 - 1978 02 01

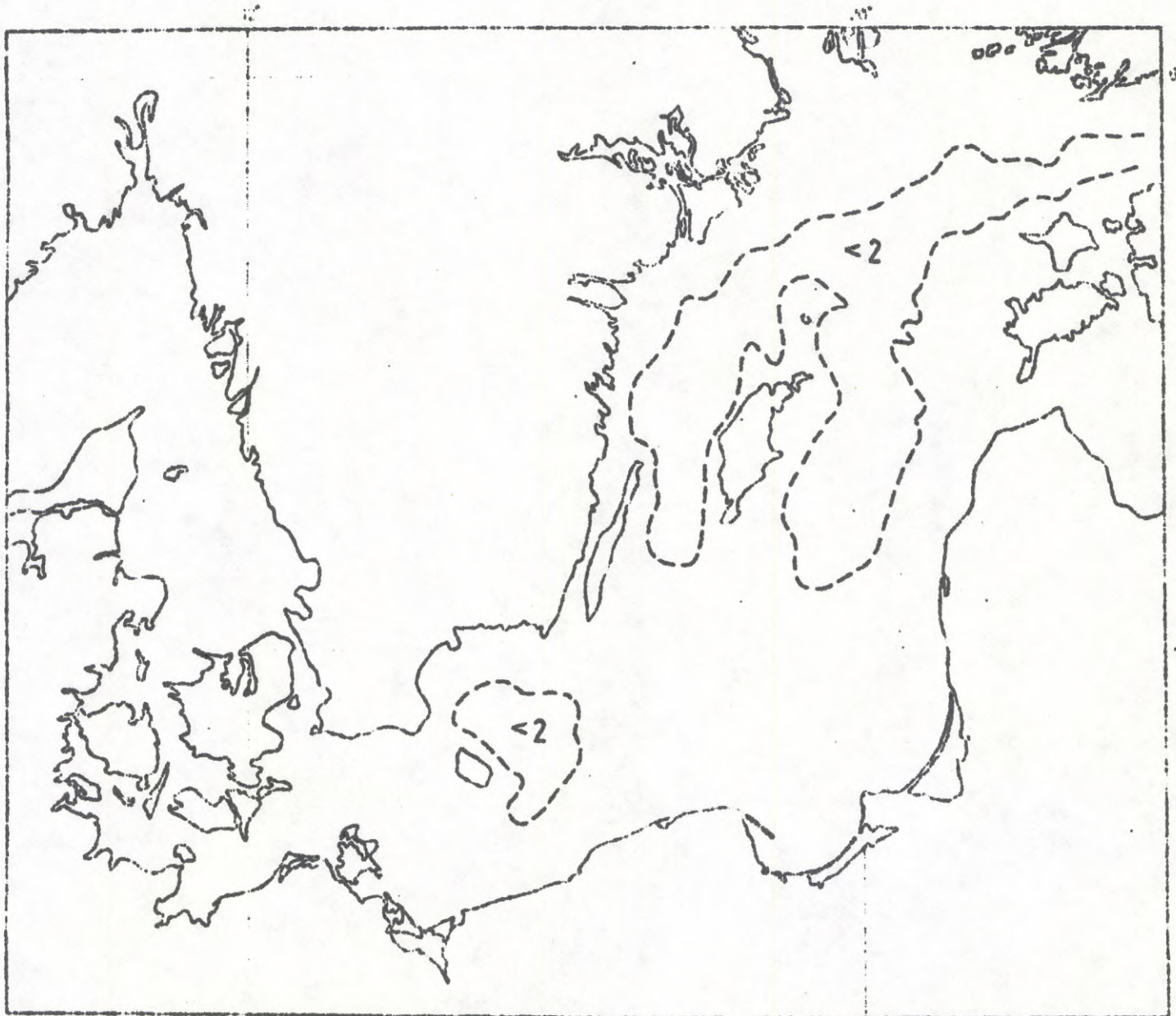
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R/V ARGOS 1978 05 16 - 1978 06 02

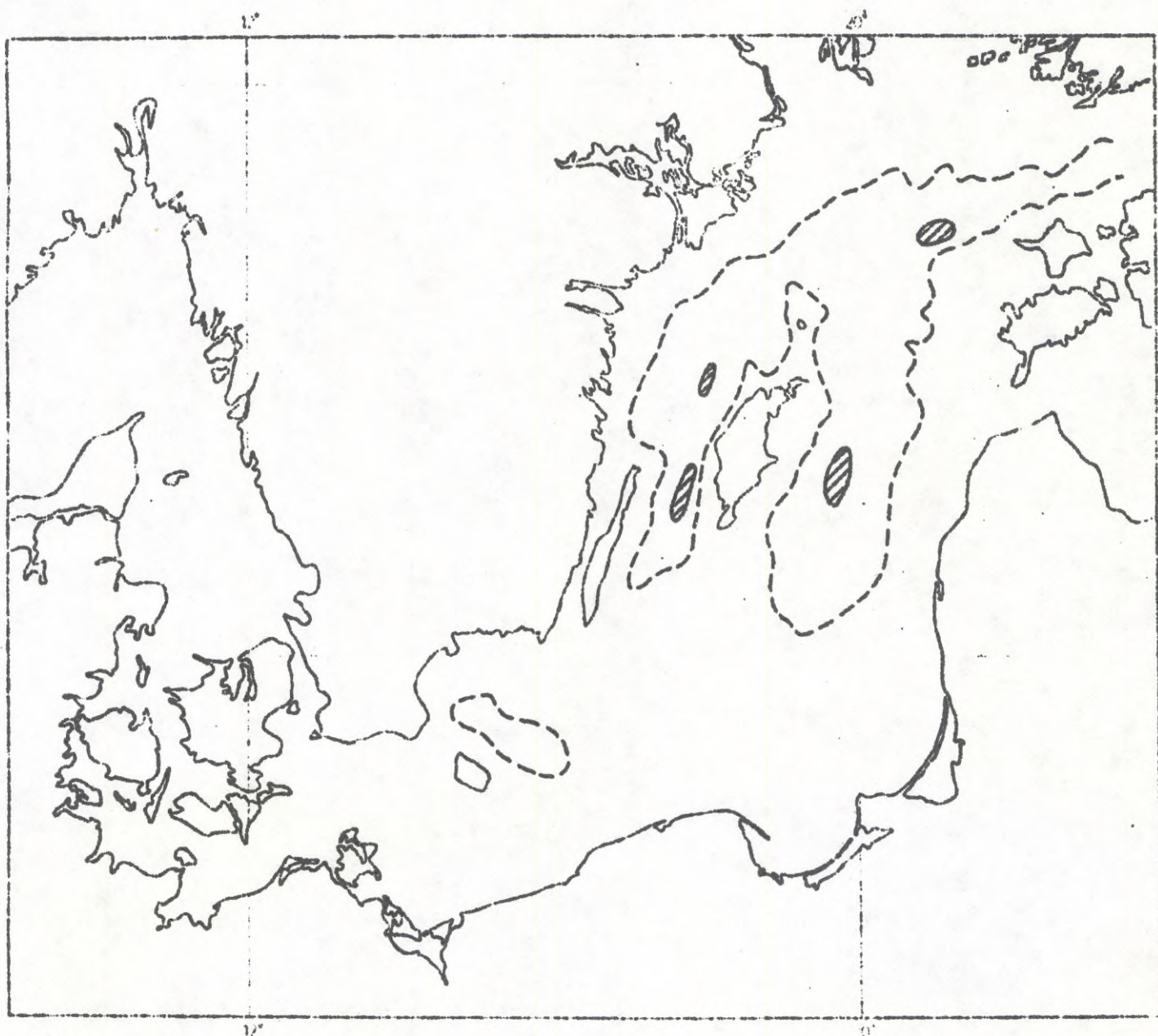
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R/V ARGOS 1978 08 21 - 1978 09 15

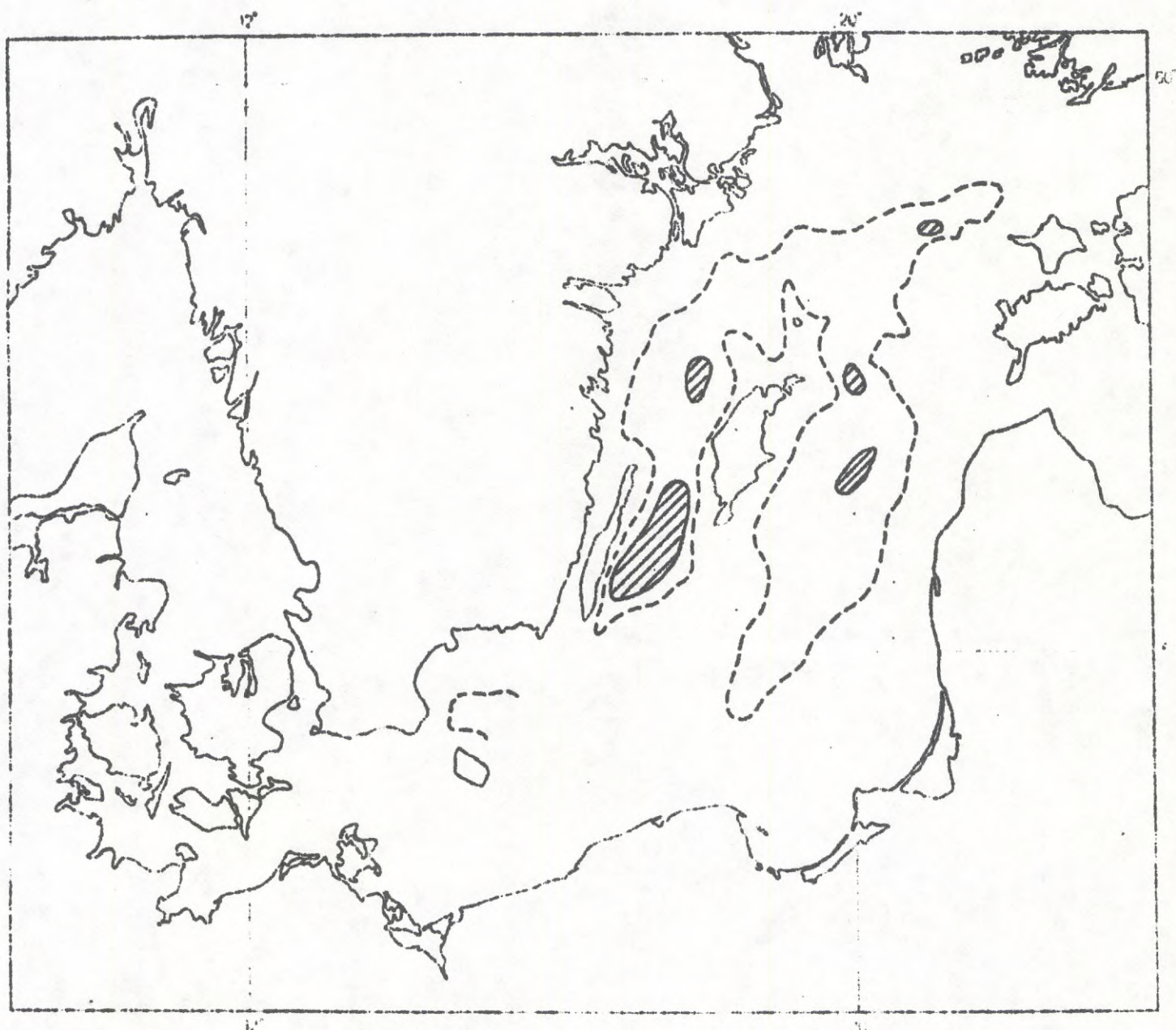
- Oxygen concentration less than 2 ml/l
- ▨ Area with hydrogen sulfide containing water



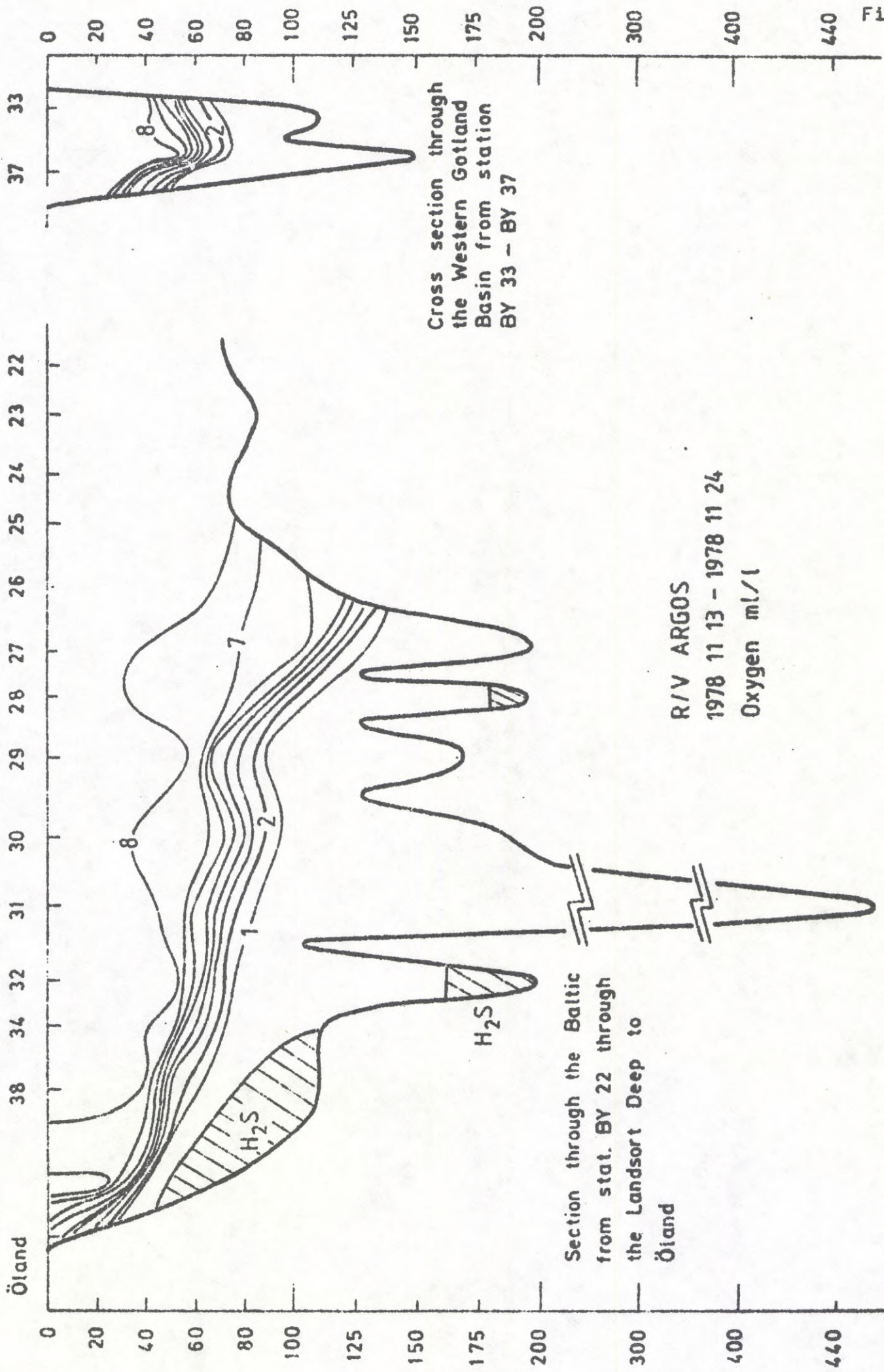


R/V ARGOS 1978 11 13 - 1978 11 24

- Oxygen concentration less than 2 ml/l
- ▨ Area with hydrogen sulfide containing water

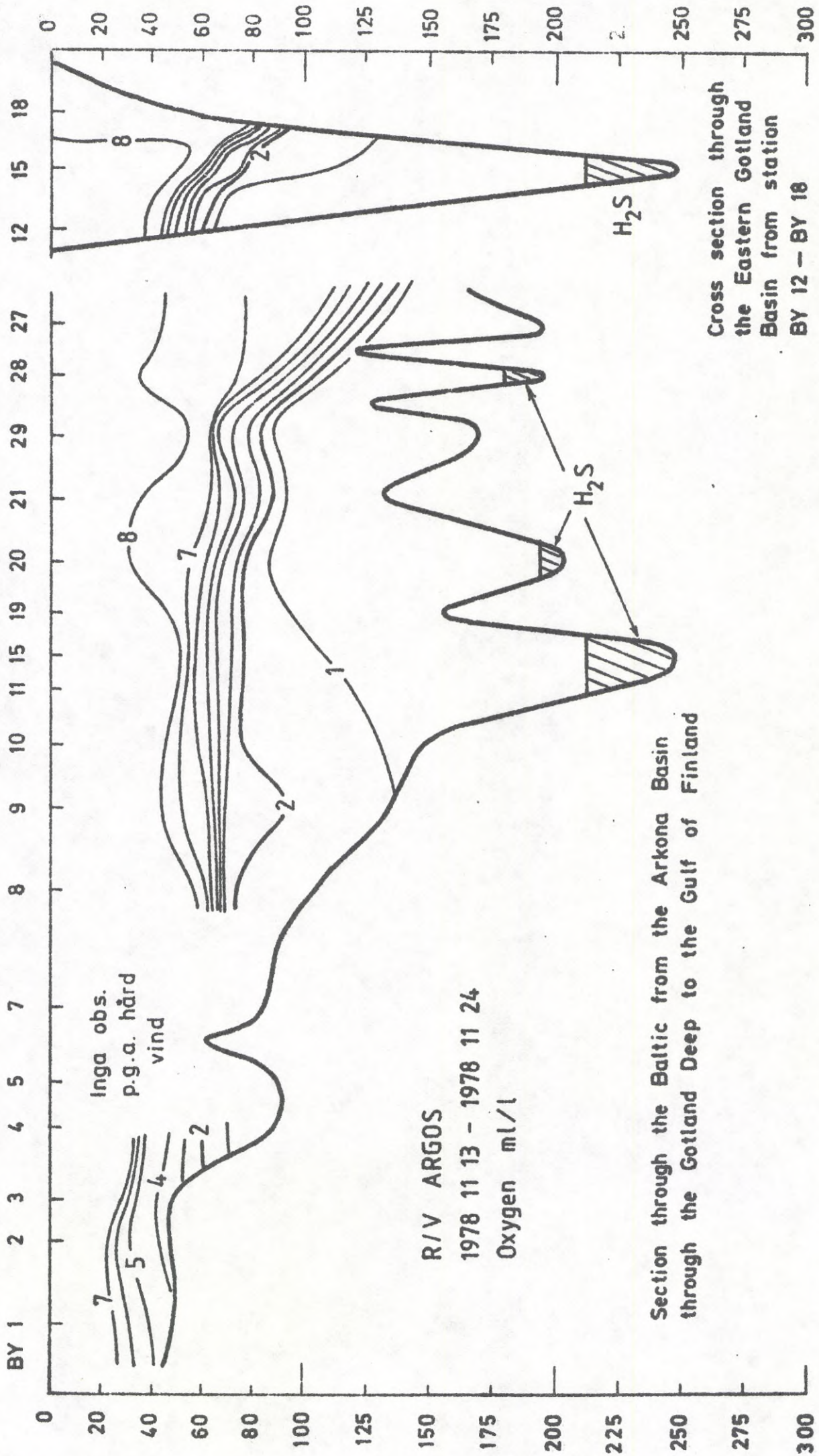






R/V ARGOS  
1978 11 13 - 1978 11 24  
Oxygen ml/l







Hydrography of the Kattegat and the Skagerrak Area 1978.

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.

The Skagerrak Deep (M6) was visited 3 times (table 1). Below the 200 m level both temperature and salinity measurements suggest higher values in the beginning of the year. There are only minor differences between the samplings in June and September.

Table 2 shows the oxygen saturation values at station Fladen in northern Kattegat. The deep minimum occurred in August (preceding year in September - October).

Data from the entire network of hydrographic stations in the area will be published during 1979 in the series "Hydrographical Data" and elsewhere.

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Table 1

M 6    58°10' N    09°30' E					
Depth m	Temp. °C	S ‰	$\sigma_t$	O <sub>2</sub> ml/l	O <sub>2</sub> %
January 18					
200	6.39	35.048	27.56	5.94	87
300	6.01	35.053	27.61	6.09	88
400	5.79	35.063	27.65	6.25	90
500	5.91	35.094	27.66	6.18	89
600	6.00	35.148	27.69	6.40	93
June 28					
200	5.73	34.982	27.59	6.26	90
300	5.60	35.007	27.63	6.32	90
400	5.56	35.031	27.65	6.13	88
500	5.52	35.064	27.68	6.17	88
600	5.41	35.024	27.67	6.20	88
September 12					
200	5.81	34.990	27.59	6.16	89
300	5.57	34.987	27.62	6.17	88
400	5.63	35.032	27.65	6.16	88
500	5.57	35.041	27.66	6.09	87
600	5.34	35.027	27.68	5.99	85

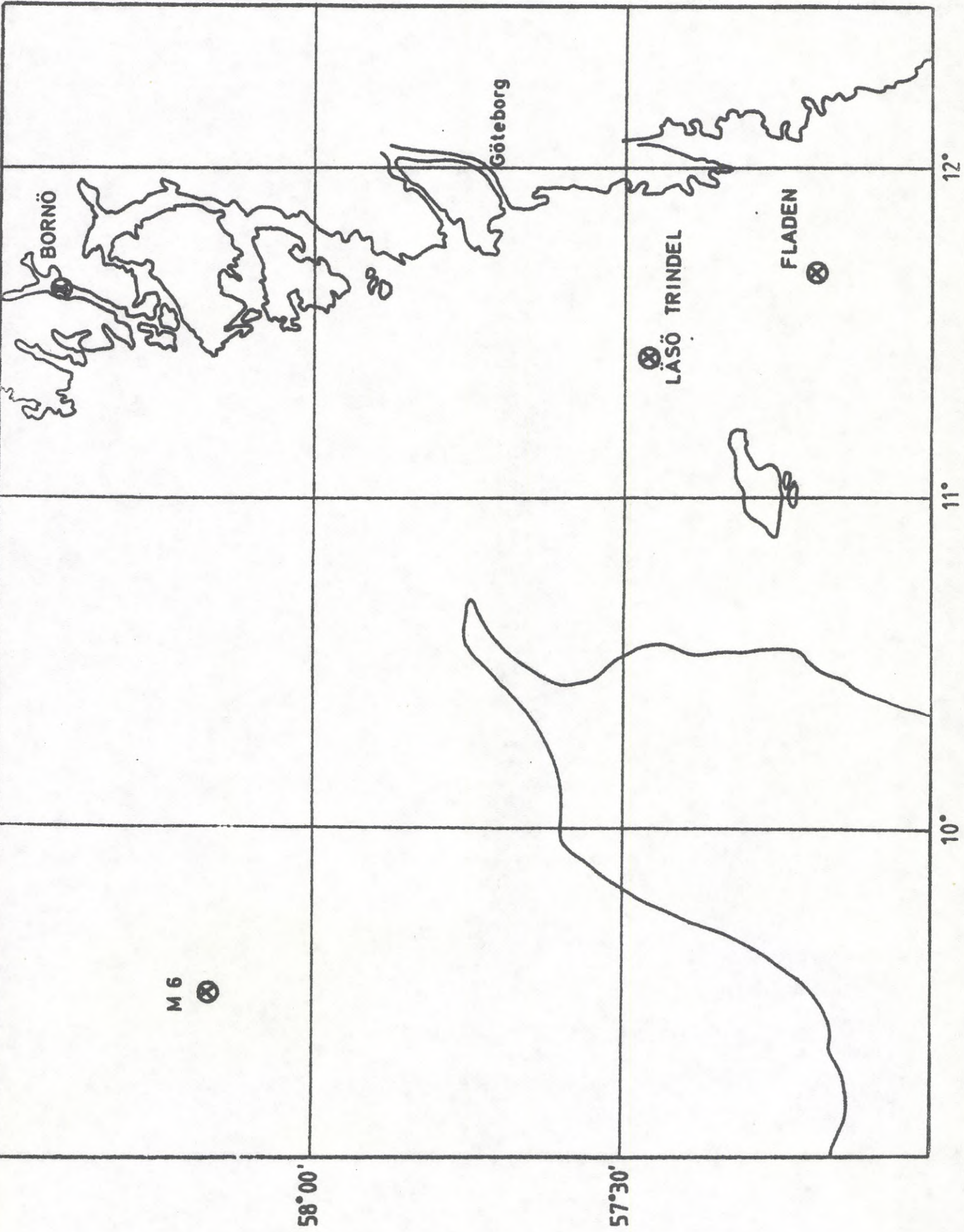


Percentage Oxygen Saturation at 57°11.5'N 11°40'E (Fladen O<sub>2</sub> %)

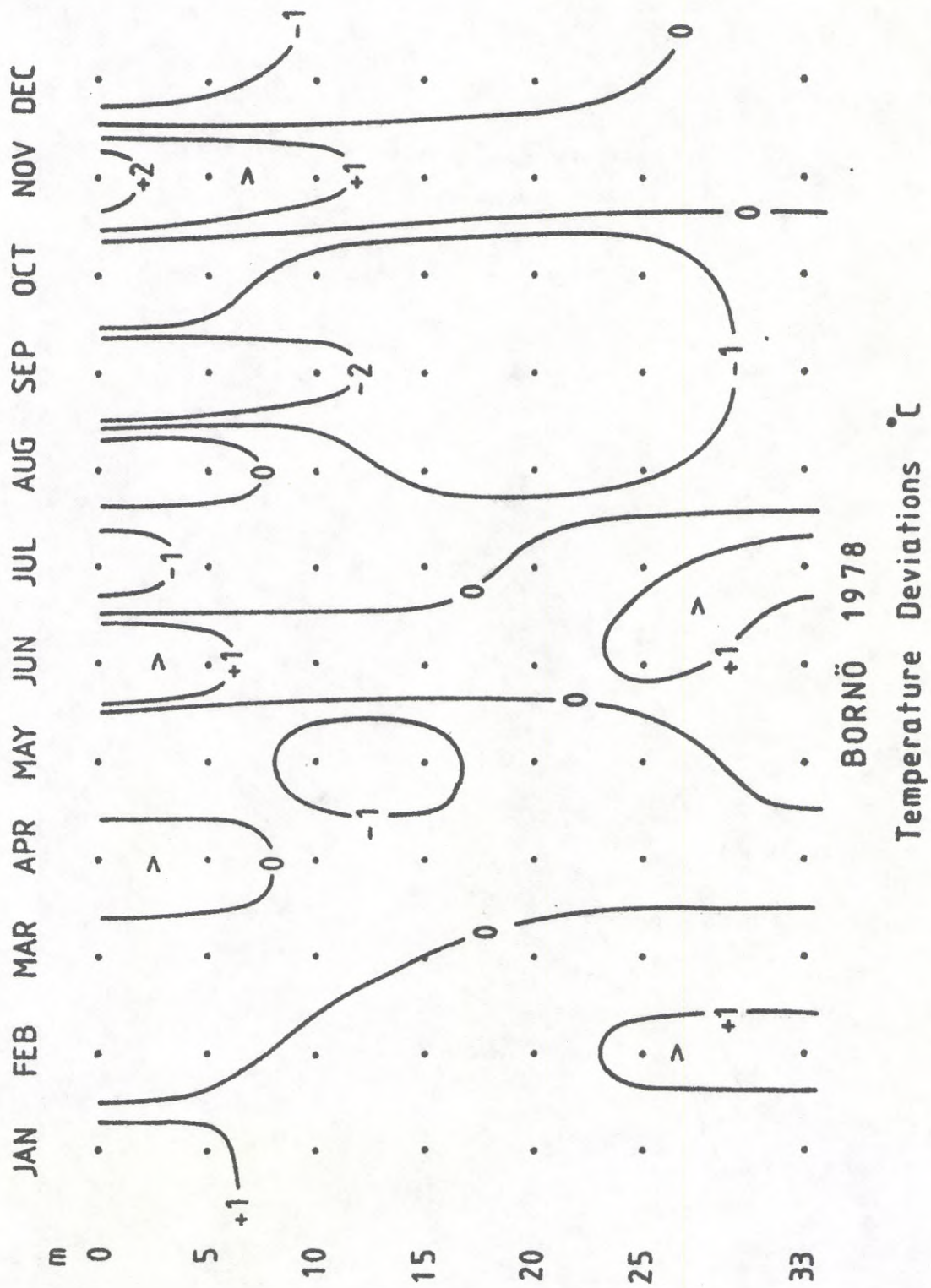
Depth m	Jan. 22	Jan. 23	Mar. 15	Apr. 14	May 16	May 29	Aug. 21	Oct. 26	Nov. 13
30	92	94	87	89	88	94	83	98	99
40	92	94	88	89	87	88	69	91	95
50	95	95	86	89	87	87	69	88	89
60	94	95	86	89	86	88	54	81	89
70	96	95	85	87	86	88	57	79	88



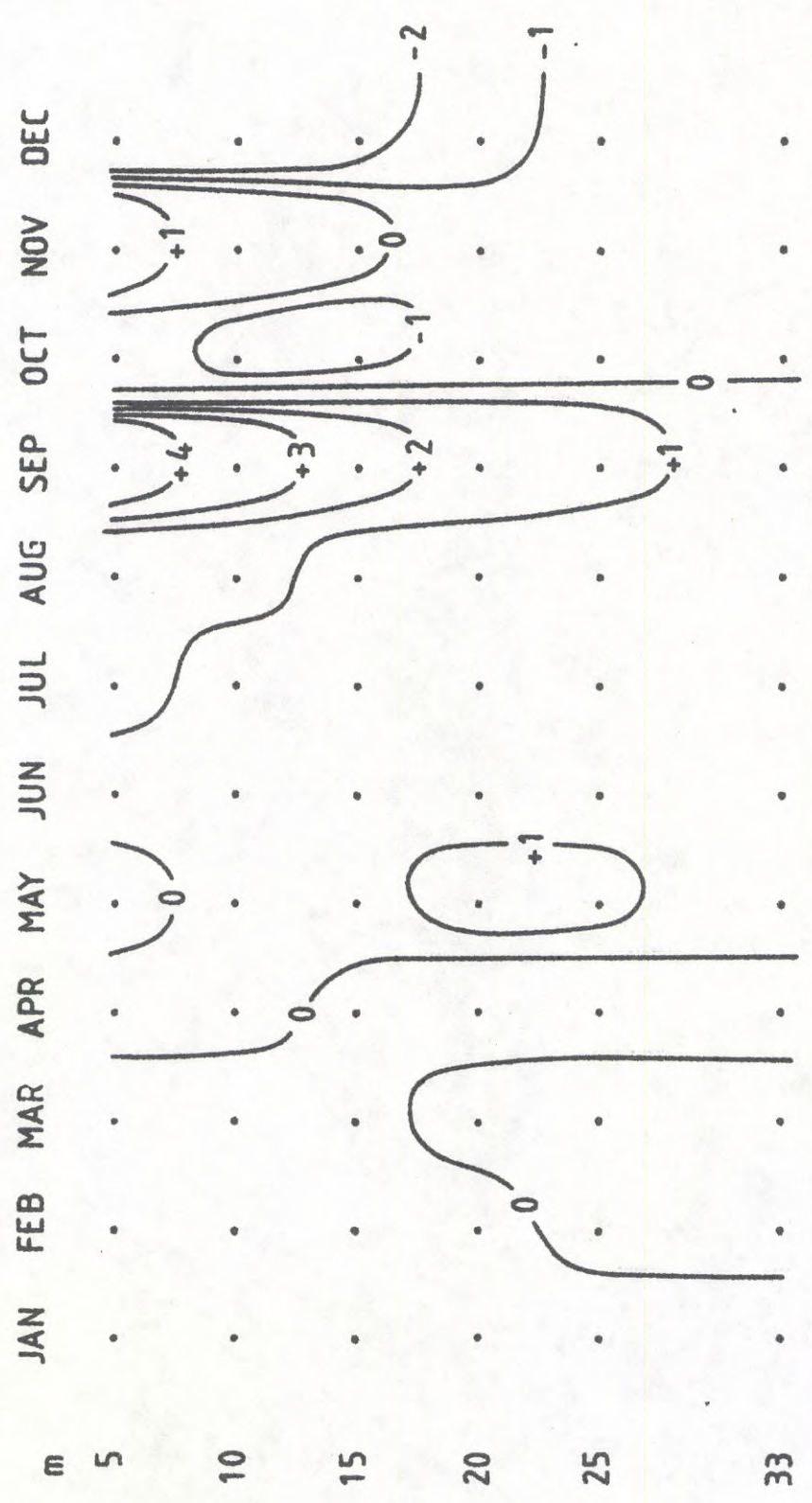
Fig. 1











BORNÖ 1978  
Salinity Deviations ‰



