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Fiskare från
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Rock carving
Bronze age
fishermen



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HAVSFISKELABORATORIET LYSEKIL Nr 289

INSTITUTE OF HYDROGRAPHIC RESEARCH

GÖTEBORG SERIES

No 18

Observations in the Deep Basins of the Baltic in 1981.

Hydrography of the Kattegat and the Skagerrak Area,
Swedish Observations, 1981.

(Contribution to ICES "Annales Biologiques")

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

January 1983

Fyll bara i en sida. Bifoga om möjligt ett ex av rapporten !

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REGISTRERINGSUPPGIFT **RAPPORT**

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Projekttitel och ev SERIX projektnr	
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Observations along the Swedish coast and in the deep basins of the Baltic in 1981. Hydrography of the Kattegat and the Skagerrak Area, Swedish Observations, 1981.

(Contribution to ICES "Annales Biologiques")

Sammanfattning av rapport (fakta med huvudvikt på resultatet)

Första delen av årsrapporten visar på en liten förbättring av vattnet i Östersjöns djuphålur, men det fanns fortfarande stora områden med H₂S. Den andra delen av årsrapporten visar bl.a. på överskott av baltiskt vatten på svenska Skagerrak-kusten i mars. Under denna tid var planktonvårblomningen ovanligt kraftig. Även hösten karakteriserades av kraftiga blomningar samt låga syrgasvärden i SE Kattegatts djupvatten.

The first part of the report shows a small improvement in the deeps of the Baltic, but there were still large areas of H₂S. The second part of the report shows a surplus of Baltic water along the Swedish Skagerrak coast, contemporaneous with a strong spring bloom of plankton. Also the autumn was characterized of low oxygen in the SE Kattegat and large blooms in the both Kattegat and Skagerrak.

Förslag till nyckelord samt ev anknytning till geografiskt område, näringsgren eller vattendrag

Östersjön, Kattegatt, Skagerrak, djupbassänger, syrgasförhållanden, temperatur, salthalt

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Inrapportör	Dokumenttyp	Projektnummer	Rapportnummer
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Observations in the Deep Basins of the Baltic in 1981.

The oxygen concentrations in the bottom water of the Baltic Proper were during the autumn 1980 relatively low. Remarkable was that the deep water in the Arkona basin had values below 2 ml/l. Large areas in the eastern and northern Baltic Proper were covered by hydrogen sulphide containing bottom water (Engström and Fonselius 1982).

During the winter 1980/81 a considerable improvement had occurred. In March the oxygen conditions in the Arkona basin were satisfying and the area with low oxygen content north-east of Bornholm had also diminished in extension.

In the south-eastern parts of the Baltic the oxygen concentrations were still low, but anyhow higher than 2 ml/l. East of Gotland a certain improvement had occurred but hydrogen sulphide was still found in the Gotland Deep (BY 15). In the Fårö Deep (BY 20) and outside the Gulf of Finland, as well as in the western Gotland basin, all hydrogen sulphide had disappeared, with the exception of the Landsort Deep, where small amounts were found from 300 m down to the bottom (Fig. 1).

In the south-eastern, eastern and northern parts of the Baltic Proper the water with oxygen values below 2 ml/l was found from approximately 80 m downwards, while this limit in the western parts was found at around 90 m (Figs 2-3). During the late autumn and the winter 1980/81 the high frequency of storm winds forced the thermohaline convection to penetrate deeper than usually. This caused a considerably improved oxygen situation and also an increased transport of nutrient rich water from the deeper layers to the surface. The phosphate concentration in the surface water increased to 0.6 - 0.7 $\mu\text{mol/l}$. Normally the winter values are around 0.4 - 0.5 $\mu\text{mol/l}$.

During spring and early summer no larger changes occurred in the Baltic. The area with low oxygen values increased anyhow in extension in the south-eastern part. In the Landsort Deep the small traces of hydrogen sulphide, observed in March had disappeared (Figs. 4, 5 and 6).

During summer and autumn the oxygen conditions again deteriorated in the whole Baltic Proper. During the November expedition with the

ARGOS the area with low oxygen concentration in the Bornholm basin had increased considerably (Fig. 7). The isoline for 2 ml/l was situated close below 60 m and hydrogen sulphide was found at 72 - 74 m. The highest concentration of hydrogen sulphide was measured at the station Christiansö (BY 4), around 20 $\mu\text{mol/l}$. In the south-eastern Baltic no larger changes had occurred. The oxygen values were, however, low. In the area east of Gotland the isoline for 2 ml O_2/l was situated between 60 - 70 m depth and the hydrogen sulphide containing water had increased in extension horizontally and vertically. Hydrogen sulphide was found from 125 m downwards and the highest concentrations were above 50 $\mu\text{mol/l}$. The values were twice as high as during the spring expedition (Fig 8).

In the north-eastern Baltic the isoline for 2 ml/l oxygen was situated deeper, around 80 m. The hydrogen sulphide had increased in extension, but the concentrations were low. In the area west of Gotland the conditions had also deteriorated. The limit for 2 ml O_2/l was close to 80 m, but hydrogen sulphide was again observed in the Norrköping Deep (BY 32) and at the stations between Visby and Västervik. Between Gotland and Öland the oxygen values in the deep water had decreased slightly, but the area was free from hydrogen sulphide (Fig. 9).

Reference

Engström , S. and S. Fonselius 1982: Observations along the Swedish coast and in the deep basins of the Baltic.
Ann. Biol. Vol. 37 - 1980 (1982).

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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	Alk. 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
0	1.58	8.154	9.25	8.25	0.62	0.80	1.477	17.5	0.21	3.94	0.27	23.2	0.18
10	1.54	8.150	9.13	8.21	0.61	0.82	1.469	18.3	0.19	4.13	0.15	23.2	0.43
30	1.45	8.257	9.34	8.21	0.60	0.77	1.432	17.3	0.20	4.37	0.06	22.7	0.31
49	3.10	15.033	6.72	8.00	2.29	3.14	1.533	25.7	0.04	9.46	0.78	39.8	0.25

March 10

May 12

0	6.27	8.065	9.14	8.62	0.05	0.46	1.615	4.6	<0.02	<0.10	0.25	21.8	0.10
10	6.25	0.066	9.14	8.64	0.05	0.44	1.615	4.6	<0.02	<0.10	0.20	21.0	0.18
30	5.02	8.287	8.86	8.58	0.07	0.46	1.621	3.1	<0.02	0.10	0.28	22.6	0.20
48	3.62	13.935	3.22	7.61	1.63	2.00	1.816	21.9	0.06	1.21	0.87	30.1	0.75

November 19

0	7.25	8.550	7.80	7.92	0.41	--	1.491	13.4	--	--	--	--	--
10	7.25	8.555	7.77	8.02	0.42	--	1.518	13.0	--	--	--	--	--
30	7.24	8.584	7.81	8.07	0.45	--	1.527	12.9	--	--	--	--	--
48	9.82	17.822	5.13	7.85	3.44	--	1.696	23.0	--	--	--	--	--

BORNHOLM DEEP 55°15'N 15°59'E

Depth	Temp.	S	O ₂	pH	PO ₄ -P	Tot.P	Alk.	SiO ₂	NO ₂ -N	NO ₃ -N	NH ₄ -N	Tot.N	Urea	H ₂ S
m	°C	‰	ml/l		μmol/l	μmol/l	mmol/l	μmol/l	μmol/l	μmol/l	μmol/l	μmol/l	μmol/l	μmol/l
March 10														
0	1.68	7.864	9.16	8.08	0.77	1.14	1.352	18.5	0.17	3.34	--	20.6	0.13	
10	1.69	7.864	9.14	8.13	0.76	0.91	1.346	18.7	0.14	3.16	0.07	18.0	0.13	
30	1.70	7.867	9.16	8.12	0.77	0.88	1.459	15.6	0.14	3.63	0.05	17.7	0.13	
50	2.38	8.330	7.91	7.96	0.89	0.98	1.496	16.7	0.06	4.01	0.14	17.3	0.17	
70	6.56	12.504	3.44	7.57	1.27	1.35	1.555	33.0	0.04	7.81	0.04	21.5	0.12	
91	5.55	15.964	0.60	7.38	3.30	3.91	1.689	65.0	0.18	7.32	0.34	27.2	0.12	
May 12														
0	5.50	7.925	9.74	8.50	0.25	0.62	1.573	4.7	0.02	<0.10	0.13	17.3	0.29	
10	5.44	7.910	9.79	8.56	0.22	0.73	1.570	7.1	0.02	<0.10	0.27	22.1	0.27	
30	3.85	7.938	9.67	8.40	0.34	0.59	1.562	4.8	<0.02	0.10	0.37	18.2	0.27	
50	3.28	7.978	6.90	8.27	0.44	0.71	1.581	13.8	0.07	0.23	0.29	18.1	0.19	
70	6.41	14.338	1.89	7.49	1.42	1.65	1.814	45.0	0.04	8.66	0.27	25.4	0.28	
90	6.00	--	--	--	--	--	--	--	--	--	--	--	--	
November 19														
0	7.44	7.875	7.70	8.02	0.39	--	1.488	11.2	--	--	--	--	--	
10	7.41	7.887	7.69	8.04	0.38	--	1.507	12.7	--	--	--	--	--	
30	7.45	7.875	7.73	8.05	0.47	--	1.521	12.2	--	--	--	--	--	
50	7.48	7.921	7.66	8.04	0.82	--	1.586	12.5	--	--	--	--	--	
70	6.41	13.858	0.19	7.40	4.17	--	1.667	65.0	--	--	--	--	--	
89	6.20	15.265	--	7.34	9.60	--	1.767	103.8	--	--	--	--	--	12.6

LANDSORT DEEP 58°35'N 18°14'E

Depth	Temp.	S	O ₂	pH	PO ₄ -P	Tot.P	Alk.	SiO ₂	NO ₂ -N	NO ₃ -N	NH ₄ -N	Tot.N	Urea	H ₂ S
m	°C	‰	mL/l		μmol/l	μmol/l	Mmol/l	μmol/l	μmol/l	μmol/l	μmol/l	μmol/l	μmol/l	μmol/l
March 12														
0	1.26	7.484	9.09	8.21	0.59	0.70	1.400	15.7	0.11	4.29	0.08	19.9	0.32	
70	4.01	9.369	2.85	7.51	2.24	2.27	1.499	46.9	0.03	3.72	0.02	19.2	0.27	
100	4.42	10.148	0.98	7.35	--	2.88	1.512	62.5	0.02	2.75	--	17.1	0.23	
150	4.37	10.367	0.59	7.34	--	3.07	1.525	66.0	0.03	2.12	0.14	19.3	0.22	
200	4.72	--	1.21	7.35	2.85	2.86	1.574	61.9	0.03	2.67	0.42	19.4	0.29	
440	4.88	10.917	--	7.35	3.83	3.98	1.616	72.6	0.03	<0.10	2.06	18.2	0.21	1.3
May 21														
0	7.57	6.849	9.88	8.63	0.09	0.49	1.420	7.7	0.03	0.18	0.15	18.6	0.29	
70	4.32	9.924	1.29	7.55	2.56	2.82	1.559	52.2	0.04	3.05	0.10	15.5	0.27	
100	4.60	10.453	0.51	7.50	2.92	3.19	1.638	58.4	0.02	2.51	0.05	14.6	0.23	
150	4.76	10.808	0.31	7.52	3.18	3.42	1.703	61.9	0.04	0.77	0.17	13.1	0.26	
200	4.76	10.923	0.42	7.52	3.03	3.27	1.723	57.7	0.03	3.29	0.05	15.5	0.26	
440	4.76	11.023	0.54	7.53	2.82	2.98	1.757	57.9	0.03	4.51	0.06	16.9	0.39	
November 16														
0	6.06	7.049	7.96	8.20	0.35	--	1.422	14.2	--	--	--	--	--	--
70	3.58	8.944	3.91	7.59	1.69	--	1.587	36.7	--	--	--	--	--	--
100	4.46	10.337	0.37	7.34	2.94	--	1.540	25.3	--	--	--	--	--	--
150	3.83	--	1.40	7.40	2.60	--	1.619	55.2	--	--	--	--	--	--
440	4.77	11.085	0.19	7.35	3.21	--	1.692	62.9	--	--	--	--	--	--

R/V ARGOS 1981 03 09 - 1981 03 14

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

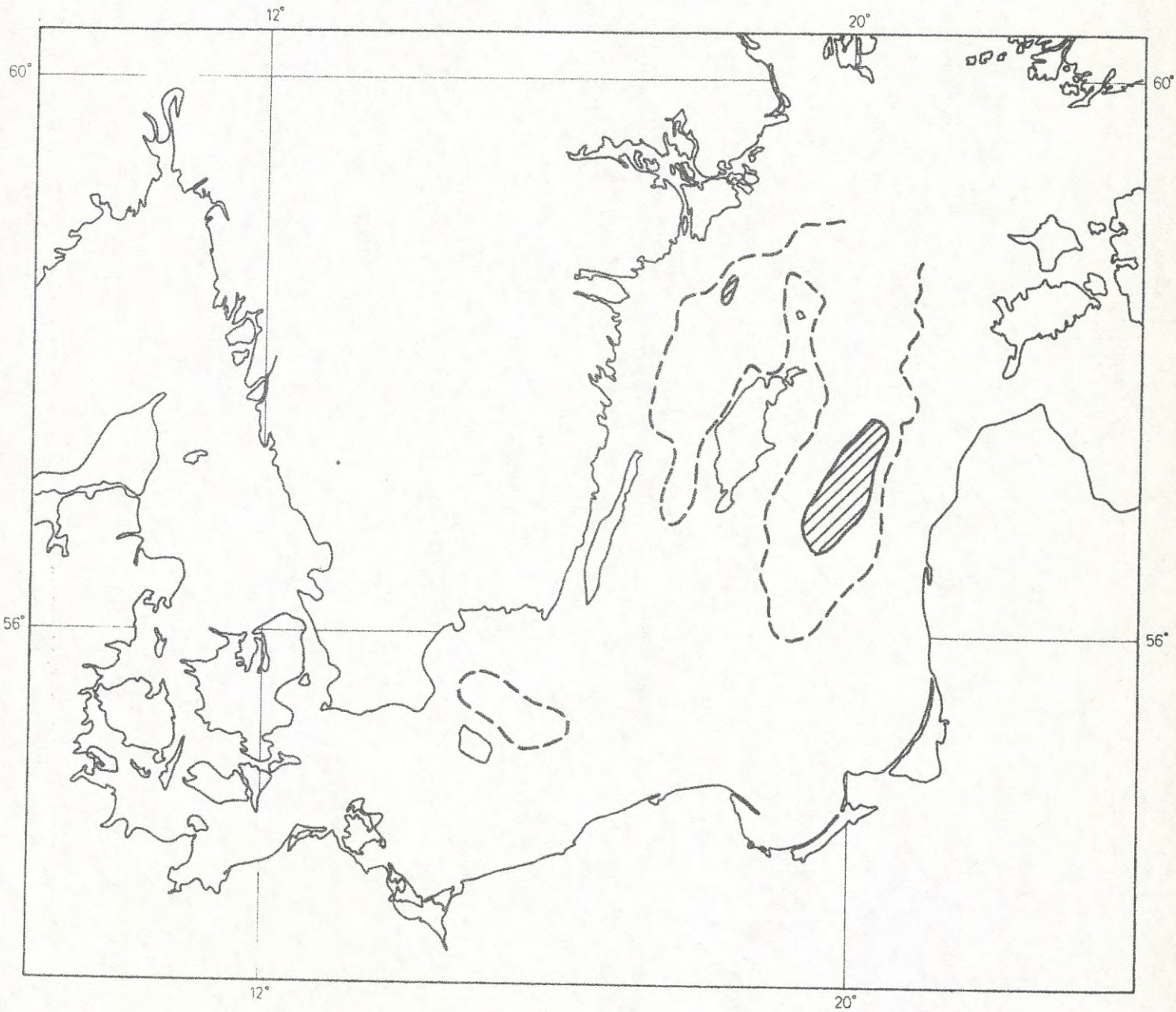


Fig. 1

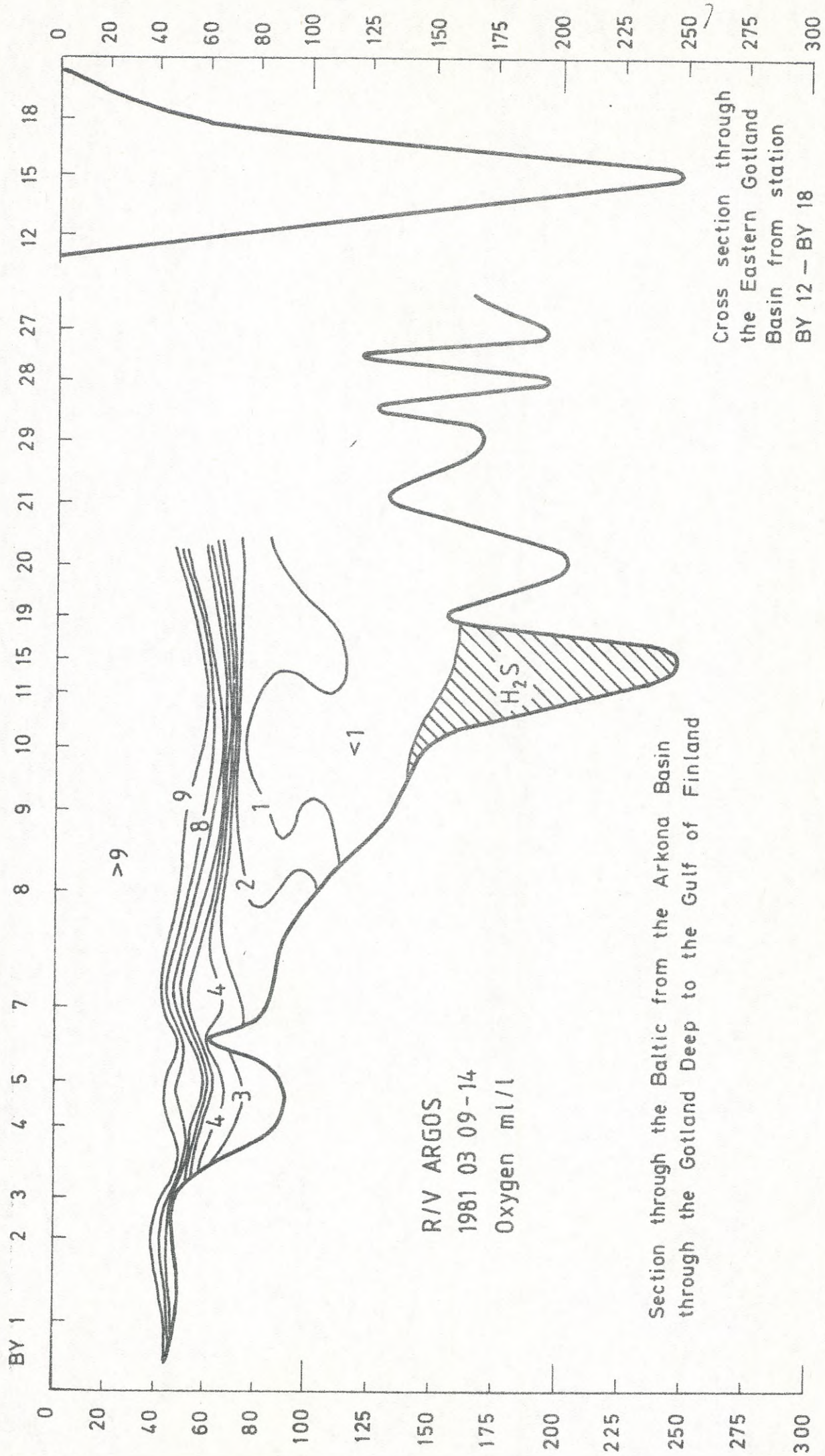


Fig. 2

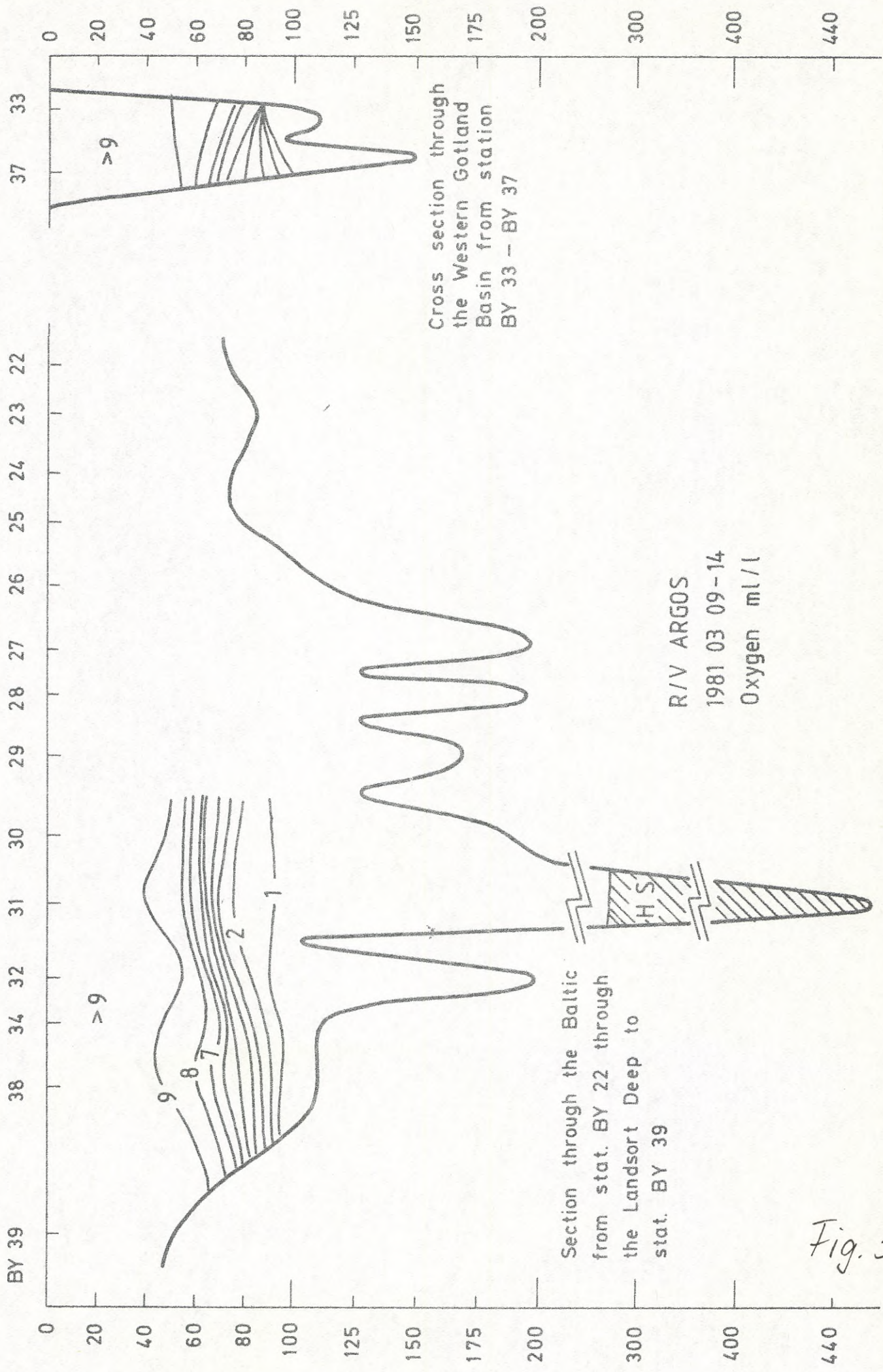


Fig. 3

R/V ARGOS 1981 05 11 - 1981 05 14
1981 05 18 - 1981 05 31

----- Oxygen concentration just around or less than 2 ml/l
⊘ Area with hydrogen sulphide containing water

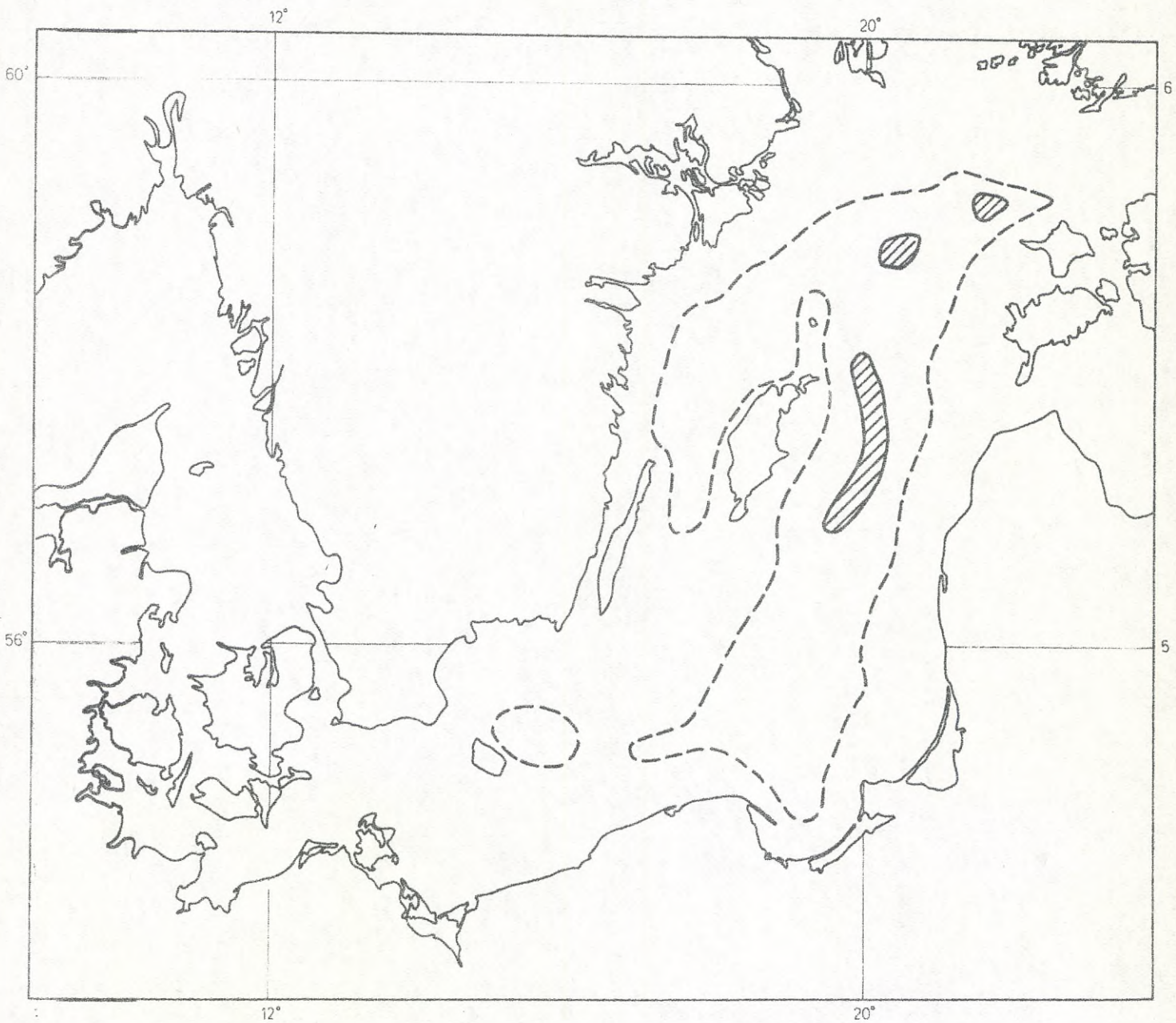


Fig. 4

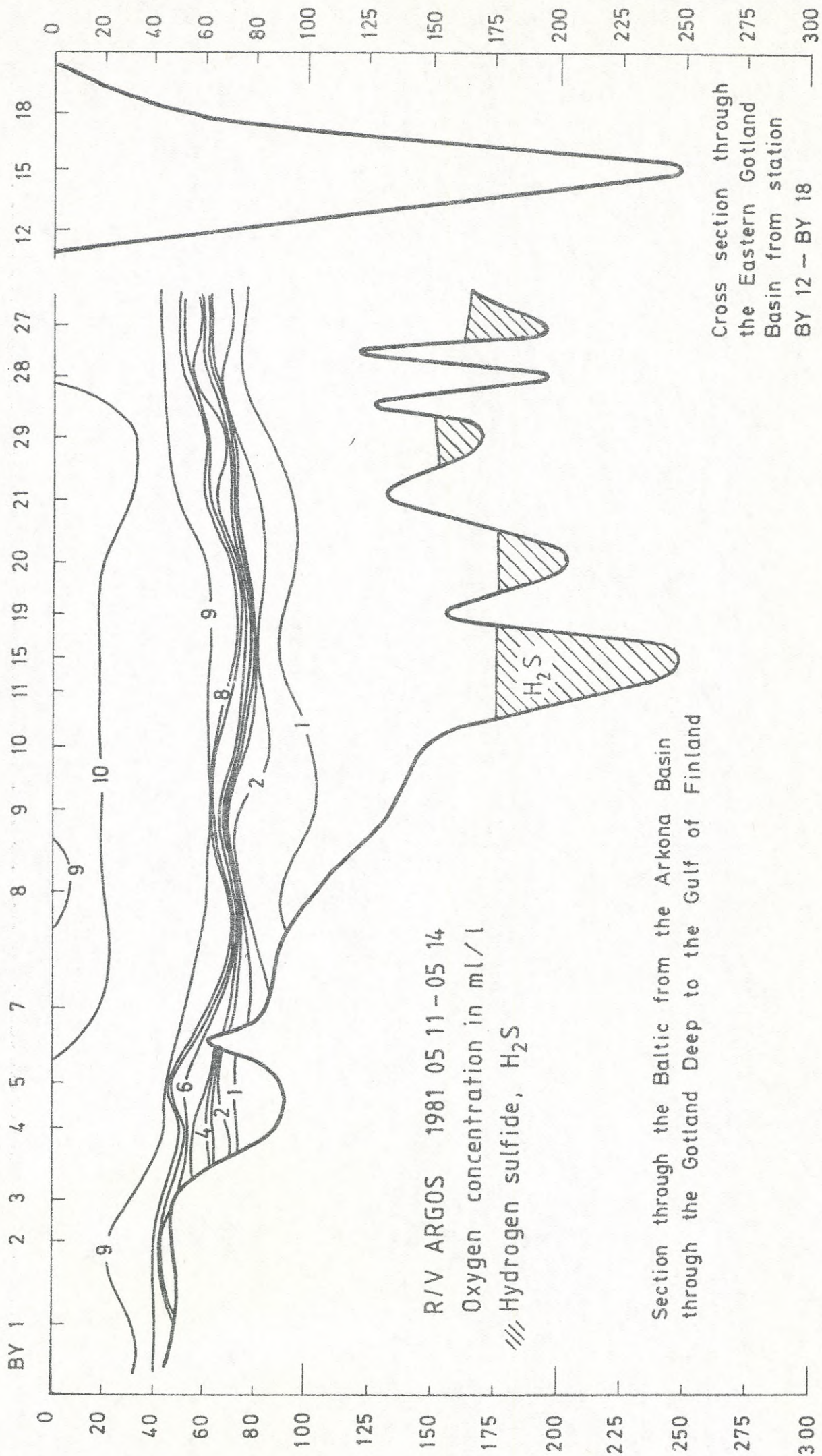


Fig. 5

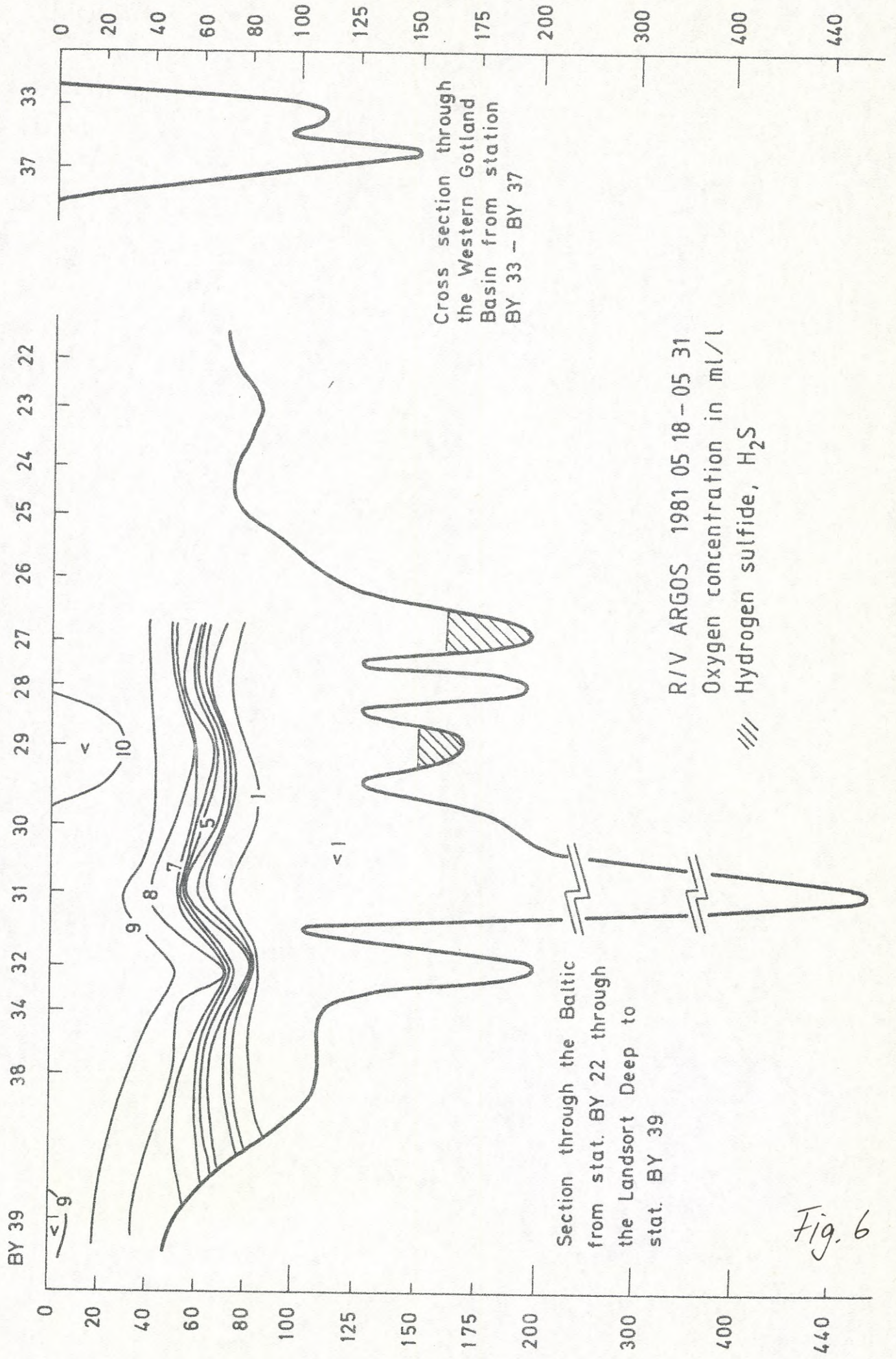


Fig. 6

R/V ARGOS 1981 11 08 - 1981 12 04



Oxygen concentration less than 2 ml/l



Area with hydrogen sulphide containing water

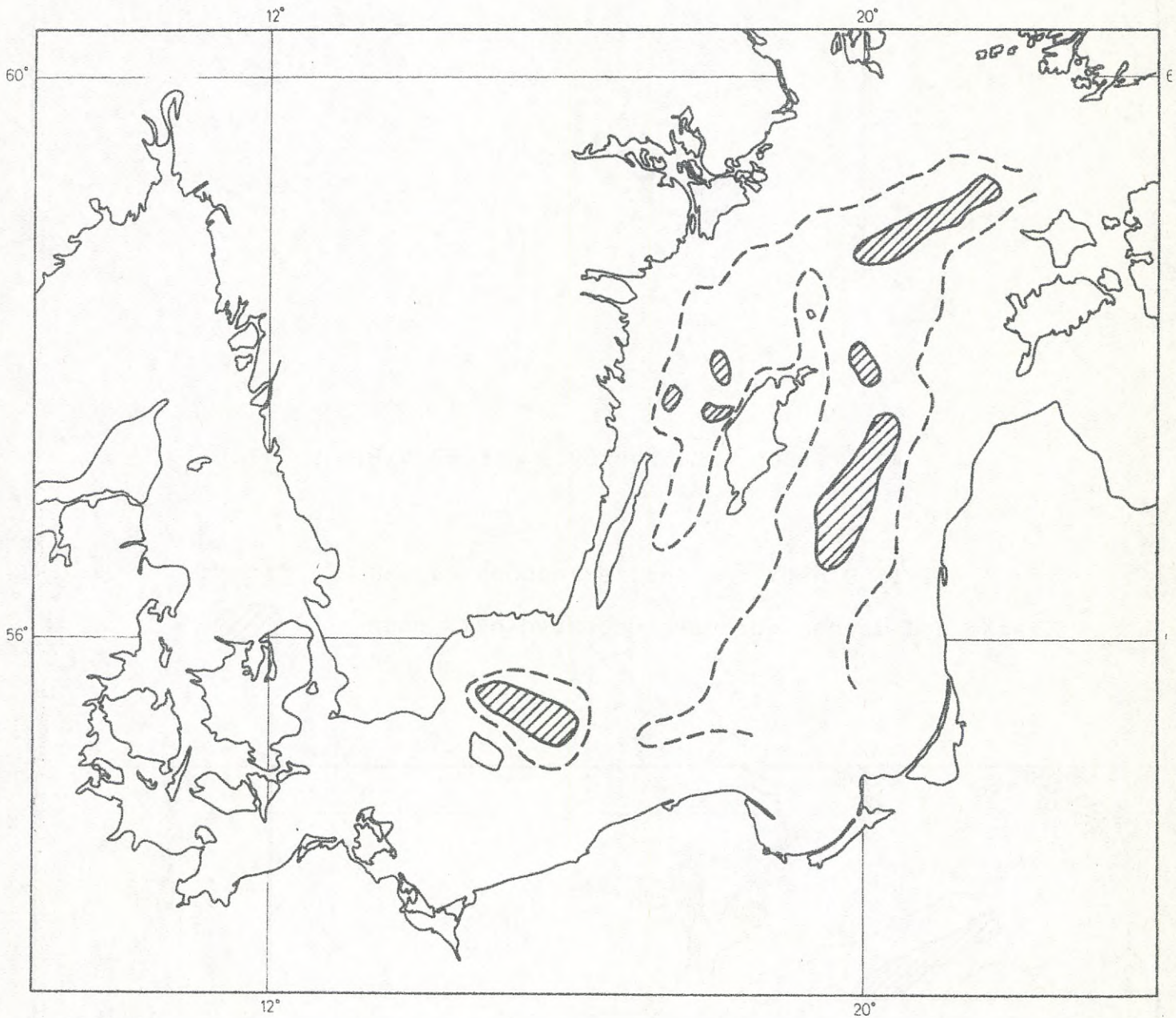


Fig. 7

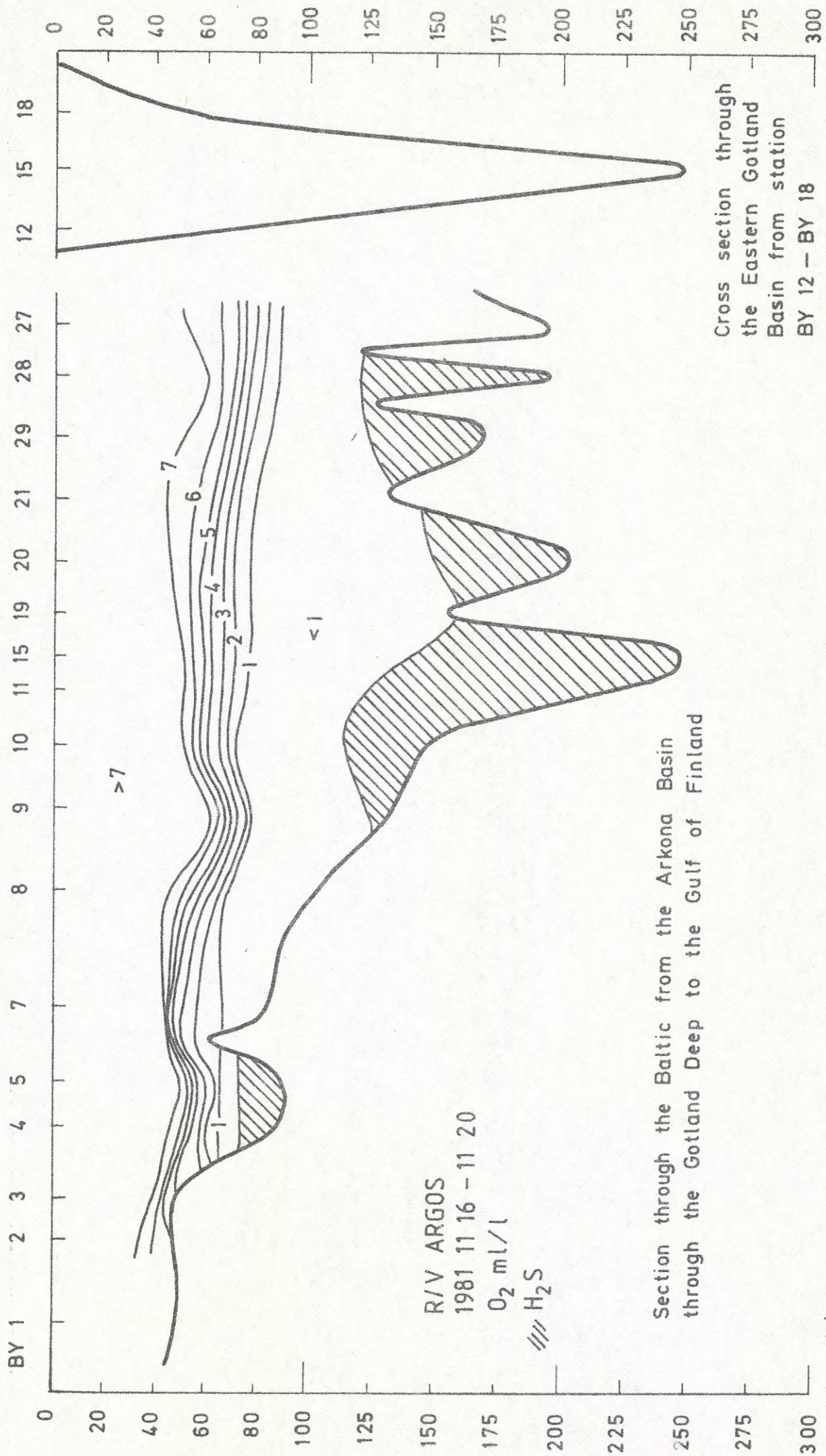


Fig. 8

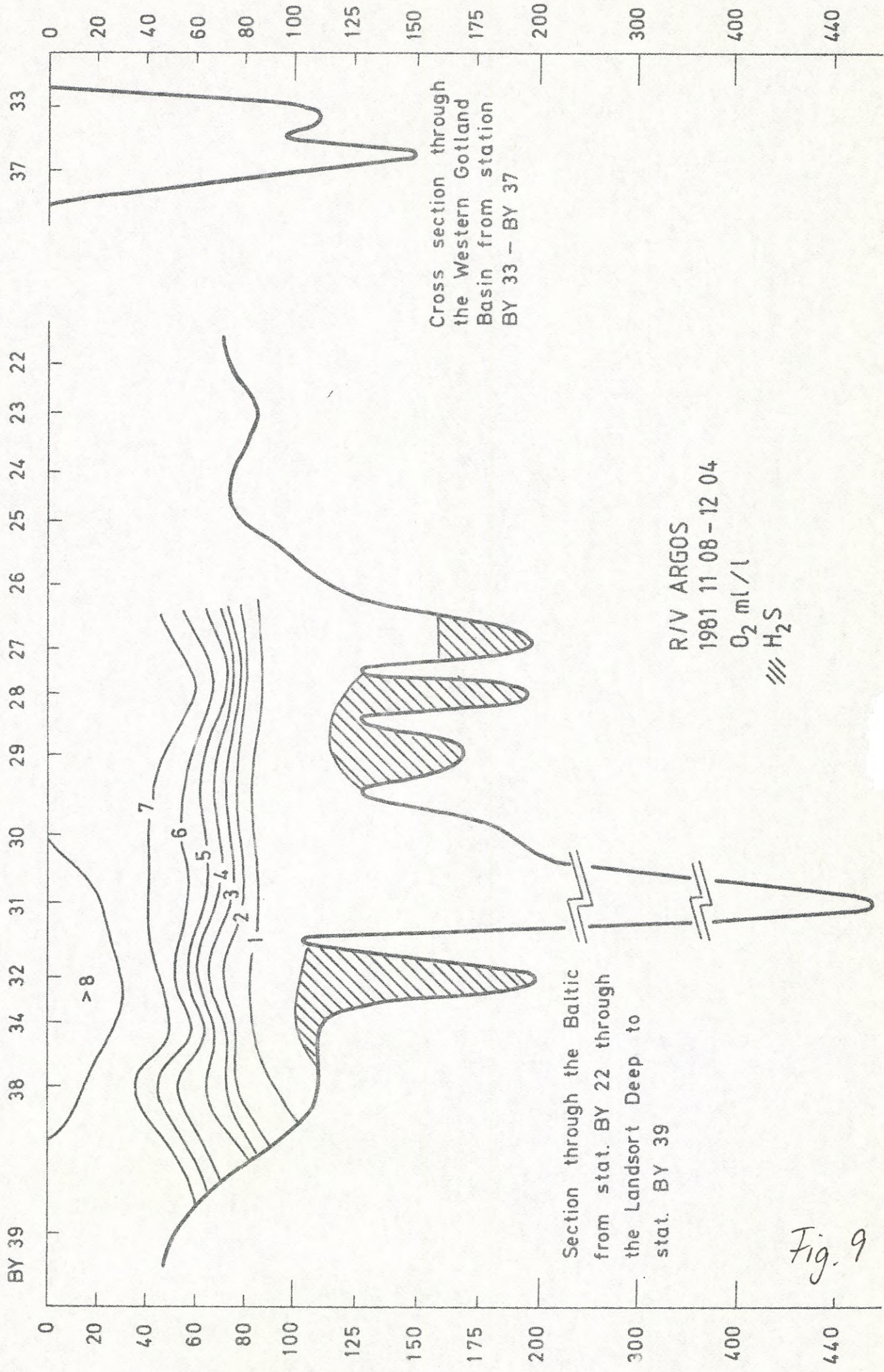


Fig. 9

Hydrography of the Kattegat and the Skagerrak Area 1981

In figures 2 and 3 results of daily measurements of temperature and salinity at Bornö hydrographical station in the Gullmar Fjord are presented as deviations from the mean values 1931-1960. There was surplus of Baltic water in spring, especially in March with extreme deviations (in temperature as well), but also in September-October.

The Skagerrak Deep (M6) was visited 3 times (Table 1). There has been a slight renewal with denser water, this time, however, due to raised salinity.

Table 2 shows oxygen saturations at depth in the Kattegat (Fladen). Related to means 1966-80 (Ann.Biol.1980) conditions during January-April were normal whereas during August-October deviations were large negative (6 to 18%). Also this autumn dead bottoms were found in the Laholm Bay, from which fish escaped. Special investigations are being made in the SE Kattegat with funds granted by the Swedish Environment Board.

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Table 1

M 6 58°10'N 09°30'E

Depth m	Temp. C	S	σ_t	O ₂ ml/l	O ₂ %
January 26					
200	6.34	35.069	27.58	5.78	84
300	5.90	35.073	27.64	5.80	84
400	5.61	35.061	27.67	5.90	85
500	5.45	35.045	27.68	5.99	85
600	5.28	35.031	27.69	5.94	84
May 5					
200	5.80	35.022	27.62	6.46	93
300	5.73	35.046	27.64	6.40	92
400	5.48	35.093	27.71	6.30	90
500	5.34	35.078	27.72	6.78	96
600	5.32	35.103	27.74	7.14	102
December 1					
200		35.138		5.54	
300	6.30	35.104	27.62	5.87	85
400	5.86	35.095	27.67	5.84	84
500	5.72	35.113	27.70	6.20	89
600	5.53	35.112	27.72	6.32	90

Table 2

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

Depth	17 Jan.	4 Mar.	6 April	7 May	11 May	3 June
30	93	97	94	90	85	93
40		95	94	88	86	93
50	93	96	92	88	85	89
60	91	93	91	89	84	88
70	94	95	91	88	84	87

Depth	24 June	5 Aug.	1 Sep.	18 Oct.	30 Nov.	17 Dec.
30	91	80	64	88	96	90
40	89	71	55	79	96	91
50	86	65	53	70	96	90
60	83	64	53	66	95	90
70	85	64	53	65	96	91

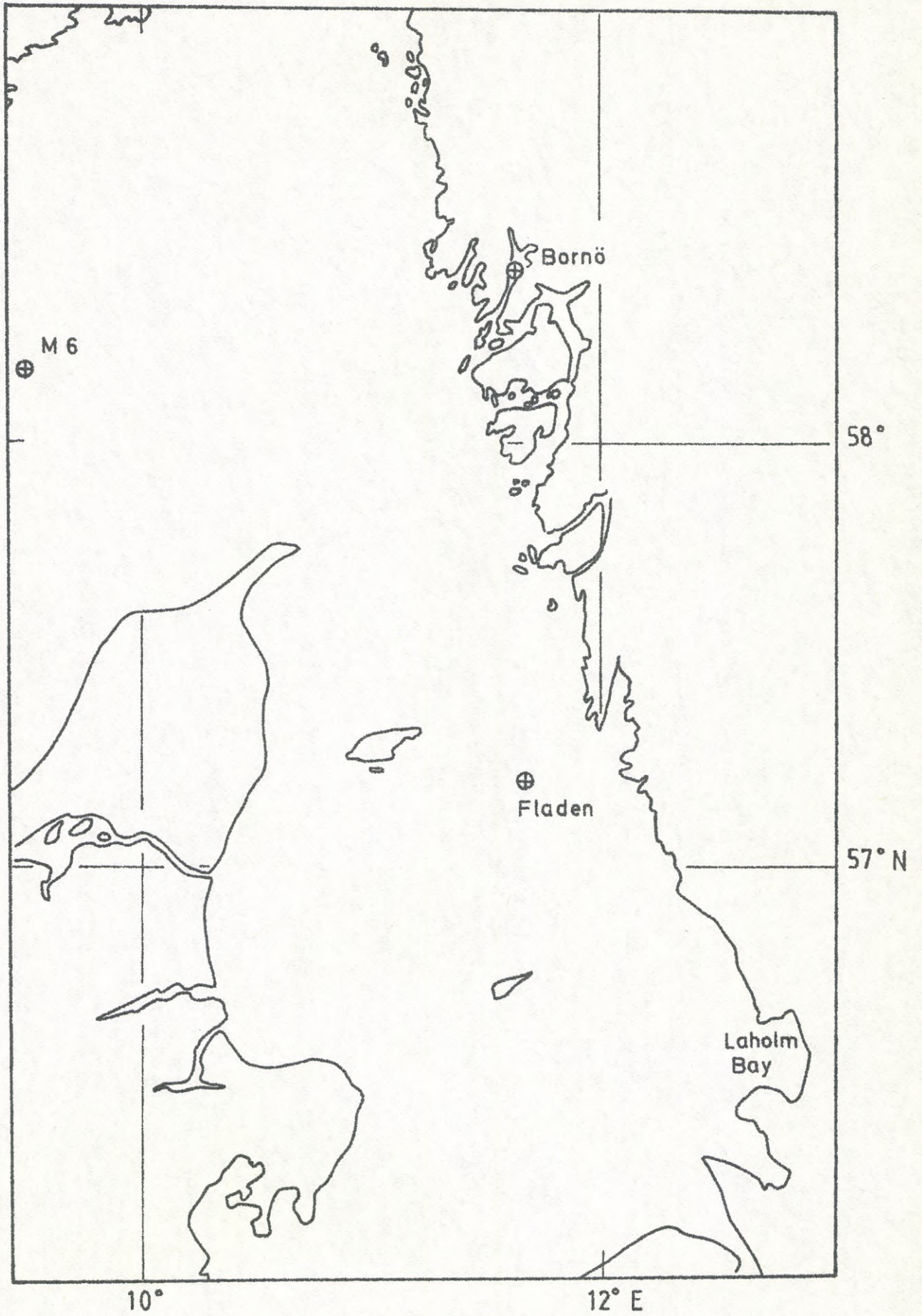
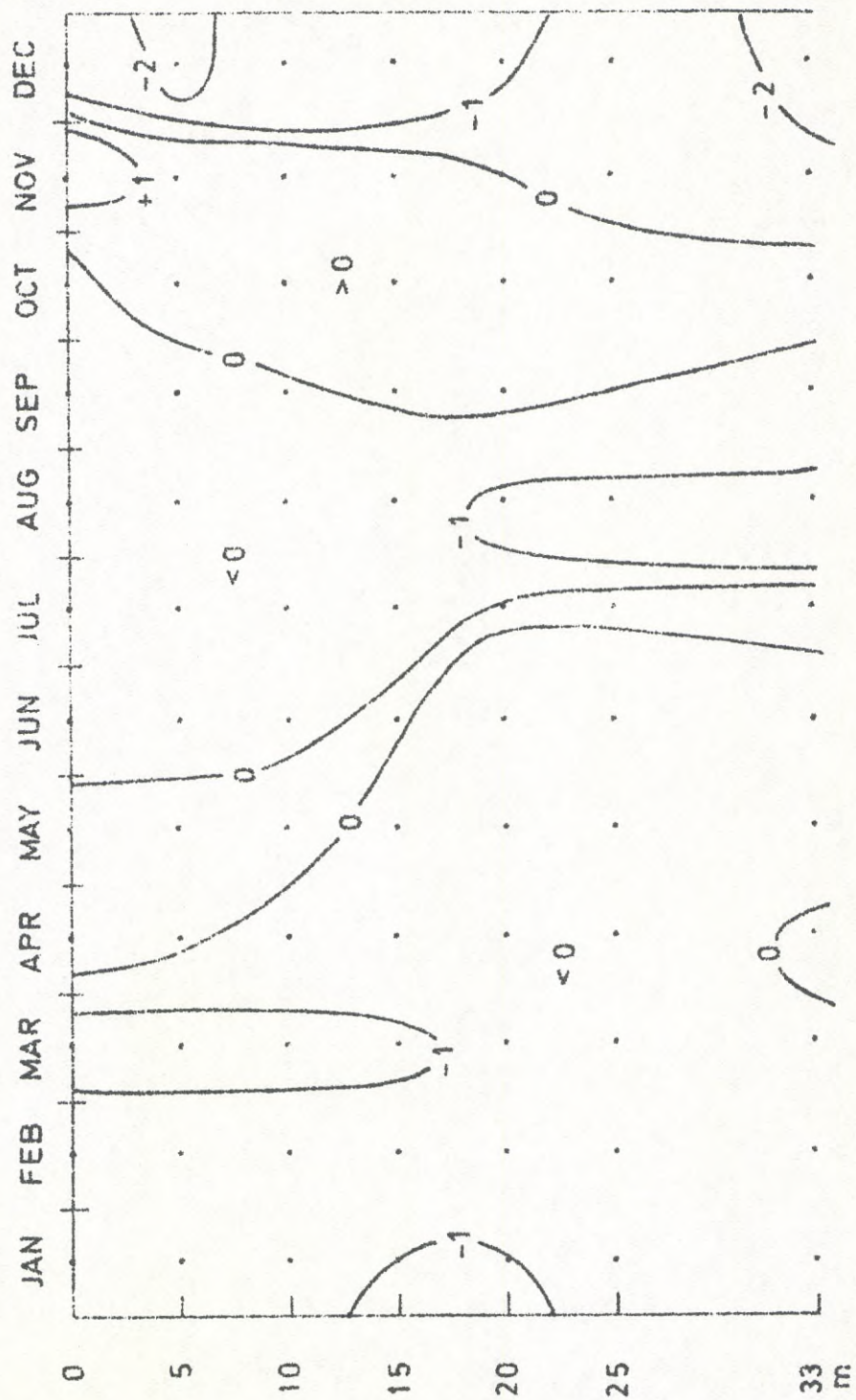
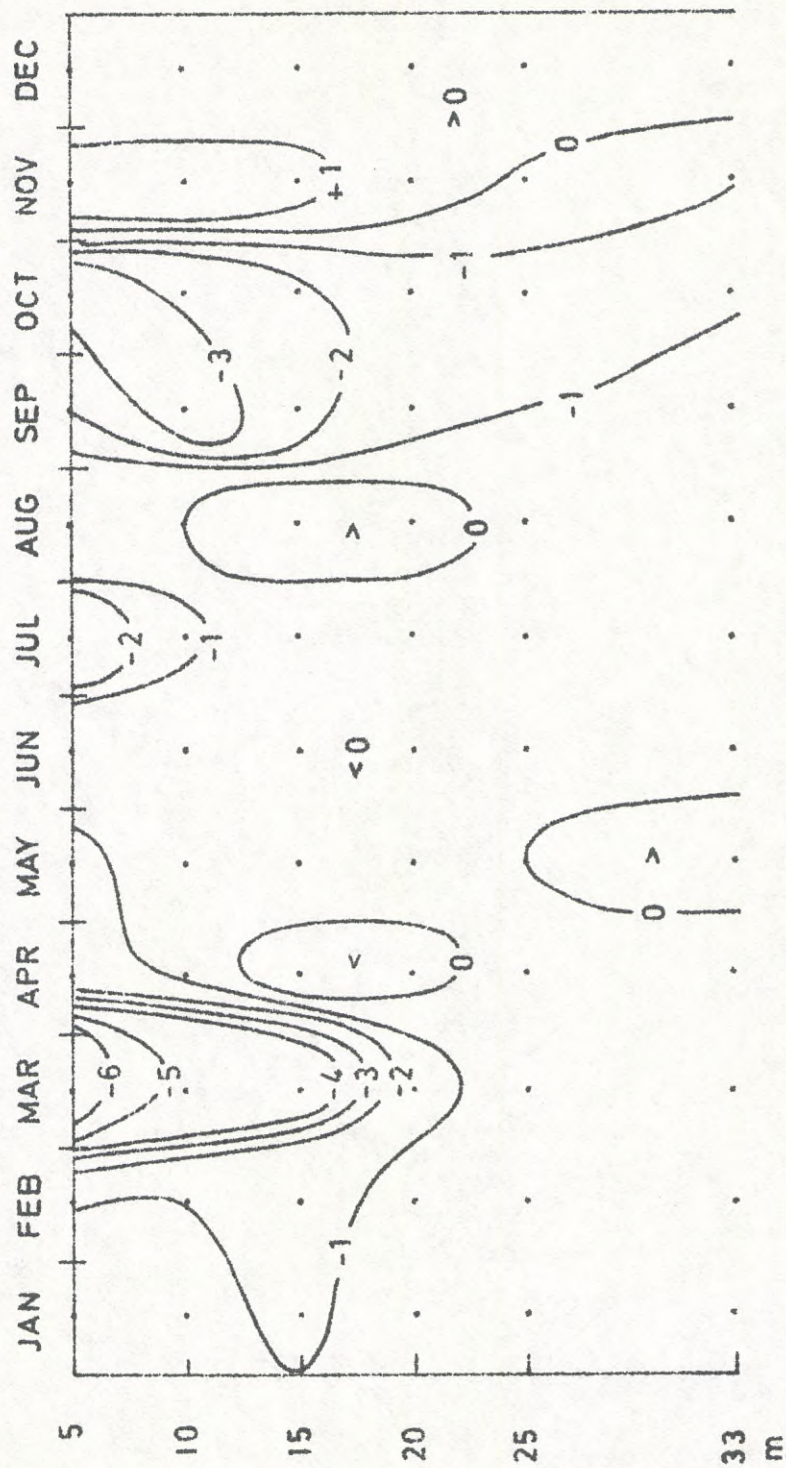


FIG. 1



BORNÖ 1981
Temperature Deviations °C

FIG. 2



BORNÖ 1981
Salinity Deviations ‰

FIG. 3

