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14 JUNI 1971

Ödamål. Kville sn, Bohuslän

Hällristning
Fiskare från
bronsåldern

Rock carving
Bronze age
fishermen



**MEDDELANDE från
HAVSFISKELABORATORIET • LYSEKIL**

nr
109

Hydrografiska avdelningen, Göteborg.

Observations at Swedish Lightships and in
the Central Baltic.

Hydrography of the Kattegatt and the Skagerrak
Area, Swedish Observations, 1970.

(Contribution to ICES "Annales Biologiques")

by

Stig H. Fonselius and Artur Svansson

April 1971

Observations at Swedish Lightships and in the Central Baltic
during 1970.

Hydrographic observations have only been carried out at the lightships "Västra Banken" in the Gulf of Bothnia and "Falsterborev" at the southern entrance to the Öresund. It is not possible to draw any conclusions from comparisons of the salinity and temperature deviations at these two lightships in quite different parts of the Baltic.

Table 1 shows the deviations from the long-time-mean at the "Falsterborev". The observations at the "Västra Banken" are not complete and no long-time-mean exists there.

Table 2 shows the hydrographic parameters observed in the deep basins during expeditions on the Swedish research ships during 1970.

There has not occurred any new inflow of oxygen rich water through the Belts during the year. The high oxygen values in the bottom water of the Arkona basin, observed during 1969 have continuously decreased during 1970. The bottom water contained in October only 1.06 ml oxygen/l.

The same trend can be observed in the Bornholm basin, the Gotland basin and the Landsort Deep. The oxygen values are now very low in all the basins, but no hydrogen sulfide has been found in the bottom water. All the chemical parameters indicate stagnant conditions in the Baltic central basin. If no inflow of oxygen rich water will occur during 1971, hydrogen sulfide formation will soon begin in the Gotland basin and the conditions in the Baltic deep water will return to the conditions in 1968.

Stig H. Fonselius

Table 1.

Monthly means of salinity and temperature in 1970 at surface and bottom at the lightship Falsterborev with deviations from means 1923-52.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
<u>Salinity</u>													
						Surface							
Deviation	8.2 +0	--	--	8.0 +0.5	7.7 +0.3	7.7 ^x (8.2) ^{xx}	8.0 +0.1	8.3 +0.3	8.4 +0	8.4 +0.8	9.1 +0.4	8.7 +0.4	8.2 +0.3
						Bottom							
Deviation	8.4 -0.1	--	--	8.0 +0.4	7.8 +0.3	(7.7)	(8.3)	8.0 -0.2	8.7 +0.5	8.9 +0.2	9.2 +0.9	8.7 +0.2	8.3 +0.2
<u>Temperature</u>						Surface							
Deviation	1.0 -1.9	--	--	1.6 -2.1	6.2 -1.6	(11.2) -1.2	(14.1)	15.9 -0.6	13.6 -1.1	11.3 -0.4	8.1 -0.3	5.4 +0.3	7.7 -0.9
						Bottom							
Deviation	1.1 -1.8	--	--	1.5 -2.1	6.0 -1.5	(10.4) -1.4	(12.5)	14.4 -2.1	13.2 -1.4	11.4 -0.3	8.1 -0.3	5.4 +0.3	7.3 -1.0

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Table 2a.

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 ₃ -N µgat/l	NO ₂ -N µgat/l	NH ₄ ⁻ -N µgat/l	Tot.N µgat/l	H ₂ S µgat/l
January 13													
000	1.90	8.33	9.15	8.10	0.36	0.46	1.562	14.0	1.17	0.03	1.35	27.8	
010	1.87	8.34	9.19	8.10	0.30	0.47	1.593	14.0	1.12	0.12	1.41	30.3	
030	2.12	16.13	9.04	8.12	0.26	0.45	1.598	13.5	1.12	0.15	1.35	41.1	
040	7.20		4.22	7.73	1.25	1.45	1.872	51.5	2.24	0.11	0.95		
May 26													
000	7.12	7.645	9.06	8.29	0.13	0.35	1.541	10.5					
010	7.09	7.648	9.03	8.29	0.09	0.37	1.560	10.5					
030	3.33	8.791	8.66	8.14	0.15	0.41	1.623	10.0					
049	1.32	15.206	5.57		0.27	1.36	1.890	19.5					
June 10													
000	11.15	7.96	8.21	8.39	0.08	0.26		10.0	0.20	0	0.80	17.27	
010	11.14	7.95	8.20	8.39	0.06	0.28		10.0	0	0.02	0.45		
030	1.41	12.89	7.46	8.04	0.24	0.49		7.5	0.40	0.24	0.34	15.59	
049	2.35	16.80	3.43	7.63	0.71	1.18		32.0	0.85	0.41	1.90	59.29	
August 18													
000	16.03	7.879	7.27	8.52	0.10	0.14	1.584						
010	15.97	7.899	6.97	8.52	0.09	0.17	1.517						
030	11.46	10.314	5.84	8.21	0.31		1.642						
045	11.19	16.182	1.65	7.74	1.49		1.860						

Table 2b.

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 ₃ -N µgat/l	NO ₂ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	H ₂ S µgat/l
September 9													
000	15.39	8.115	6.97	8.28	0.03	0.49		13.5					
010	15.32	8.124	6.97	8.28	0.04	0.46		13.0					
030	13.79	10.819	5.70	8.05	0.29	0.57		17.5					
045	11.28	17.848	2.14	7.65	1.33	1.48		52.0					
October 13													
000	12.39	7.588	7.56	8.23	0.11	0.78	1.571	11.0					
010	12.41	8.038	7.27	8.20	0.09	0.59	1.563	11.5					
030	11.43	9.663	6.49	7.99	0.30	0.55	1.620	15.5					
045	13.40	18.007	1.80	7.55	1.82	2.07	1.898	64.0					
October 28													
000	10.50	8.201	7.35	8.00		0.39	1.592						
010	10.48	8.202	7.29	7.95	0.09	0.37	1.584						
030	10.43	8.204	7.29	8.04	0.14	0.37	1.592						
045	12.85	17.591	1.06	7.48	2.00	2.08	1.916						

Table 2c.

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 ₃ -N µgat/l	NO ₂ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	H ₂ N µgat/l
January 14													
000	3.15	7.92	8.82	8.12	0.35	0.50	1.577	15.0	0.89	0.11	0.58		
010	3.13	7.92	8.72	8.11	0.37	0.49	1.570	15.0	0.48	0.12	0.91	3.11	
030	3.10	8.00	8.82	8.12	0.40	0.46	1.578	15.0	0.46	0.06	0.26	19.96	
050	3.00	8.16	8.65	8.11	0.38	0.52	1.573	15.0	0.58	0.06	0.87	9.44	
070	9.92	14.74	4.36	7.70	0.91	1.01	1.816	32.5	3.93		0.84		
080	8.51	16.60	2.76	7.77	1.72	1.83	1.888	53.0	1.36	0	0.97	14.38	
May 27													
000	7.30	7.578	9.67	8.28	0.21	0.46	1.552	15.0					
010	5.05	7.527	9.65	8.29	0.23	0.47	1.555	15.5					
030	3.16	7.745	9.56	8.14	0.19	0.41	1.577	15.00					
050	2.79	8.185	6.26	8.12	0.18	0.35	1.601	13.0					
070	4.35	15.118	5.00	7.68	0.90	1.10	1.871	39.5					
089	5.36	16.719	1.68	7.34	1.32	1.80	1.909	70.0					
June 10													
000	9.14	7.527	9.20	8.56	0.12	0.48			0.02	0.02	0.13	11.8	
010	9.11	7.529	9.17	8.53	0.12	0.96			0.05		0.03		
030	3.29	7.784	9.27	8.27	0.26	0.47			0.03	0	0.12	15.47	
050	1.47	8.489	8.70	8.12	0.26	0.43			0	0.02	0.19		
070	3.81	14.624	4.97	7.75	0.81	1.11			1.07	0.08	0.44		
091	5.13	16.745	1.25	7.42	1.32	1.68			2.90	0.04	0.39	55.68	

Table 2d.

		Borrholm 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 ₃ -N µgat/l	NO ₂ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	H ₂ S µgat/l				
														August 19			
000	15.62	7.467	7.35	8.42	0.07	0.25	1.493										
010	15.56	7.455	7.11	8.54	0.11	0.26	1.488										
030	5.00	7.742	7.96	8.28	0.25		1.525										
050	2.49	9.802	6.96	8.00	0.39	0.47	1.621										
070	4.68	15.006	2.65	7.69	1.18	1.25	1.812										
087	5.65	16.560	0.33	7.53	1.77	1.82	1.860										
000	15.49	7.580	6.76	8.36	0.04	1.44							13.0				
010	15.52	7.579	6.77	8.40	0.06	0.32							12.0				
030	4.26	7.737	7.83	7.99	0.19	0.41							14.5				
050	2.34	9.472	6.75	7.77	0.43	0.65							18.5				
070	5.54	15.120	2.77	7.55	1.25	1.54							53.0				
087	5.37	16.737	0.19	7.41	1.63	1.88							85.0				
000	12.37	7.603	7.24	8.16	0.09	0.33	1.542						8.5				
010	12.39	7.601	7.20	8.20	0.06	0.33	1.542						8.5				
030	10.20	7.673	7.10	8.03	0.14	0.30	1.560						11.5				
050	3.55	9.314	6.40	7.63	0.46	0.61	1.636						18.0				
070	5.60	15.510	1.56	7.31	1.38	1.76	1.849						55.0				
087	5.57	16.516	0.39	7.26	1.74	2.13	1.901						72.0				

Table 2e.

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 ₃ -N µgat/l	NO ₂ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	H ₂ S µgat/l
January 15													
000	2.59	7.46	8.90	8.15	0.32	0.28	1.563	16.5	0.89	0.33	0	33.8	
070	4.40	9.50	2.38	7.33	1.34	1.41	1.667	45.5	1.09	0.06	0.28	25.2	
100	4.89	10.82	0.35	7.22	2.41	2.48	1.731	70.0	1.12	0.05	0	32.0	
150	5.16	11.93	1.03	7.28	2.42	2.36	1.752	67.0	1.78	0.07	0.22	34.2	
200	5.50	12.55	0.16	7.28	3.62	3.55	1.813	81.5	1.61	0.09	0.30	33.5	
240	5.59	12.84	0.92	7.31	2.38	2.47	1.807	63.0	2.61	0	0.14	31.1	
January 23													
000	1.70	7.40	8.98	8.07	0.41	0.50	1.578	16.5					
070	4.55	8.95	3.18	7.36	1.22	1.34	1.654	42.0					
100	5.02	10.85	1.13	7.20	1.80	1.85	1.738	58.0					
150	4.98	12.11	1.02	7.23	2.22	2.25	1.777	66.5					
200	5.48	12.62	0.56	7.20	3.08	3.07	1.804	74.0					
240	6.43	13.05	1.07	7.28	2.04	2.10	1.796	61.5					
June 8													
000	10.40	7.505	9.34	8.69	0.05	0.24	1.612	8.0	0.27	0.01	0.44	17.12	
070	3.63	9.319	3.60	7.50	0.90	1.49	1.714	40.0	2.01		0.13		
100	5.12	11.297	1.79	7.38	1.48	1.75	1.736	52.5	2.43	0.10	0.06	8.25	
150	5.20	12.333	2.27	7.43	1.70	1.96	1.769	56.4	2.53	0.07	0	12.29	
200	6.20	12.973	0.28	7.35	1.58	1.91	1.806	68.0	3.27	0.04	0.45	20.11	
237	6.18	12.975	0.37	7.39	1.54	1.78	1.942	68.0	3.25	0.12	1.02	49.48	

Table 2f.

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 ₃ ⁻ N µgat/l	NO ₂ ⁻ N µgat/l	NH ₄ ⁻ N µgat/l	Tot.N µgat/l	H ₂ S µgat/l
June 9													
000	10.85	7.457	9.20		0.05	0.32			0.06	0	0.42		
070	2.50	8.972	5.66		0.44	0.66			0.15	0.04	0.39		
100	4.97	11.185	2.14		1.43	1.65			2.22	0.05	0.24		
150	5.15	12.380	2.08		1.75	2.06			2.53	0.03	0.23		
200	6.12	12.816	0.80		2.00	2.25			2.73	0.04	0.18		
240	6.12	12.983	0.31		1.60	1.95			3.19	0.14	0.49		
September 3													
000	17.18	7.116	6.88	8.62	0.03	0.36	1.515	8.5					
070	3.29	9.319	3.04	7.54	0.99	1.23	1.616	43.5					
100	5.13	11.378	1.39	7.42	1.69		1.690	59.0					
150	5.66	12.489	1.18	7.40	2.39		1.759	71.6					
200	5.69	12.775	0.94	7.43	2.16		1.738	69.5					
240	5.73	12.966	0.40	7.41	2.20		1.754	74.5					
October 15													
000	10.93	7.423	7.40	8.21	0.10	0.21	1.620	9.0					
070	2.84	8.977	4.12	7.35	0.77	0.77	1.631	33.0					
100	4.57	11.172	1.46	7.21	1.49	1.59	1.722	50.0					
150	5.36	12.372	1.23	7.24	2.10	2.28	1.760	60.0					
200	5.65	12.764	0.88	7.23	2.00	2.27	1.768	62.0					
237	5.71	12.912	0.22	7.21	2.17	2.53	1.786	67.0					

Table 2g.

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 ₃ -N µgat/l	NO ₂ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	H ₂ S µgat/l
January 20													
000	0.91	7.14	9.55	8.04	0.60	0.60	1.500	21.5	0.88	0.28	0.26	16.2	
070	3.59	8.05	6.29	7.61	1.18	1.20	1.595	34.0	0.57	0.13	0.46	9.4	
100	4.71	10.49	0.24	7.15	2.98	3.04	1.752	72.0		0.05	0.96	9.9	
150	4.78	10.65	0.15	7.15	3.24	3.21	1.744	74.0	0.10		1.15		
200	4.84	10.75	0.16	7.16	3.67	3.60	1.747	75.0	0	0.03	1.71	19.6	
440	4.96	10.86		7.16	3.84	4.05	1.755	77.0	0	0.05	2.71	40.5	17.3
June 2													
000	7.16	6.478	9.32	8.49	0.06	0.55	1.425	16.5	0.15	0	0.94	10.67	
070	4.32	9.414	1.70	7.37	1.86	2.06	1.687	58.5	0.93	0.09	0.23	14.44	
100	4.74	10.615	0.12	7.36	2.64	2.97	1.760	72.0	1.12	0.52	0.19	28.84	
150	4.92	10.977	0.12	7.33	2.66	2.98	1.747	72.0	1.12				
200	4.95	11.039	0.16	7.33	2.50	2.79	1.752	71.0	1.22	0.06	0.06	17.40	
440	5.00	11.159	0.33	7.35	4.12	4.68	1.769		1.42	0.16	0.80	37.51	
September 1													
000	16.24	6.239	6.93	8.38	0.02	0.25	1.345	17.5					
070	4.45	9.913	0.26	7.35	2.45	2.91	1.693	71.5					
100	4.87	10.799	0.08	7.42	2.76	3.05	1.695	79.0					
150	4.96	11.056	0.02	7.40	2.54	2.76	1.709	77.0					
200	5.15	11.280	0.10	7.34	2.66	2.94	1.714	76.0					
425	5.27	11.445	0.25	7.35	2.47	2.74	1.717	75.0					

Table 2h.

Depth		Landsort Deep											
58°35'N 18°14'E													
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 ₃ -N µgat/l	NO ₂ -N µgat/l	NH ₄ -N µgat/l	Tot.N µgat/l	H ₂ S µgat/l
October 21													
000	9.33	6.814	7.81	8.05	0.09	0.38	1.470	17.5					
070	4.37	9.935	0.81	7.14	2.42	2.75	1.683	62.5					
100	4.55	10.343	0.60	7.13	2.40	2.74	1.729	64.5					
150	4.66	10.531	0.17	7.13	2.65	3.08	1.722	68.5					
200	4.94	10.864	0.10	7.12	2.72	3.14	1.724	69.5					
440	5.25	11.492	0.13	7.14	2.54	2.83	1.748	66.5					

Hydrography of the Kattegat and the Skagerrak Area, 1970.

As there are no longer any Swedish lightvessels in the area some results of daily measurements at Bornö station (58°22.85'N 11°35.05'E) in the Gullmarfiord are presented. It was pointed out in Svansson (1970) that due to the variations in the water level of the Baltic the hydrographical variations on the whole are similar in the Kattegat as well as in the fiords of Bohuslän. Fig. 1 and 2 show the deviations in temperature and salinity from the mean values from 1939 - 1963 (Svansson 1968).

Fig. 3 presents the oxygen saturation values at the position F1 (see Fig. 4). The development during the latter part of the year is also shown in Table 1 at 4 positions A, B, C and D. (Results of stations C and D originate from the city of Göteborg investigations).

Table 2 shows the continuous change in the bottom water due to the sinking of cooled surface water during the cold winter months.

Artur Svansson

References:

- Svansson, A., 1968: Om Gullmarfjordens hydrografi. Medd. fr. Havsfiskelaboratoriet no. 44
- Svansson, A., 1970: First results of a new numerical model for Baltic water levels. Medd. fr. Havsfiskelaboratoriet no. 95.

Table 1

Percentage Oxygen Saturation at 57°33'N 11°31.5'E (A), 57°38.5'N 11°26.6'E (B),
57°41.2'N 11°31'E (C) and 57°41.2'N 11°25.2'E (D).

Depth m	57°41.2'N 11°31'E (C)				57°38.5'N 11°26.6'E (B)			
	C	D	B	A	C	D	A	C
30	108.5	91.5	94.2	113.3	84.0	88.0	93.0	84.5
40	102.0	92.0	88.9	95.9	66.5	94.5	79.2	84.5
50	90.5	91.5	82.8	85.2	65.0	95.0	73.6	79.5
60		87.5		70.8		83.5	67.1	
70				68.6			63.4	
75			82.1	73.5				
80		89.0				77.0		
85			81.3					

Depth m	57°41.2'N 11°25.2'E (D)			
	D	A	B	C
30	94.5	90.5	95.5	97.5
40	92.0	86.9	97.4	93.5
50	90.5	88.2	96.1	90.0
60	90.5	86.1		96.0
70		73.8		96.0
75		79.5	95.2	
80	83.0			90.0

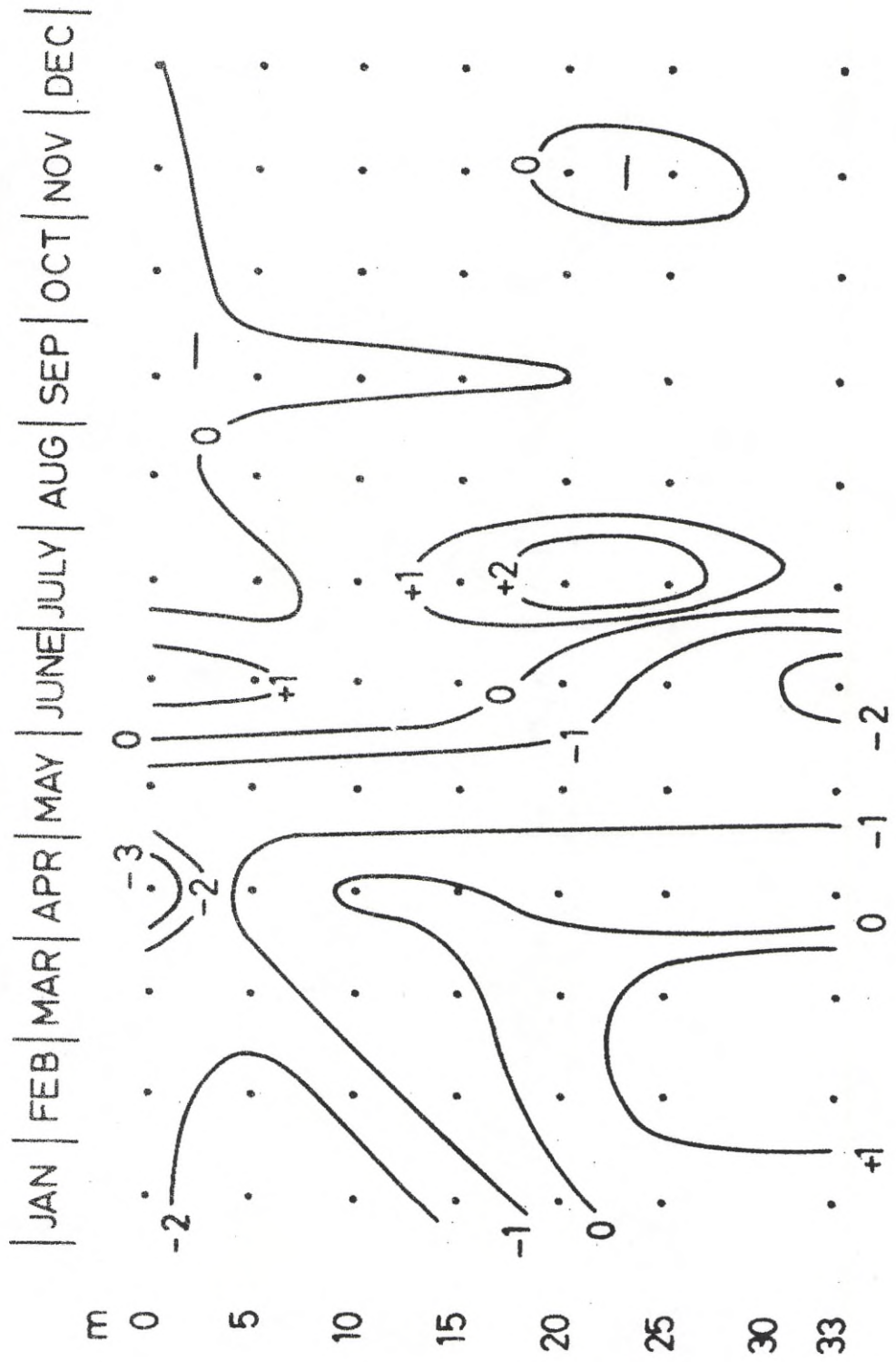
Table 2.

M 6

58°10'N 09°30'E

Depth M	Temp. °C	S ‰	O ₂ ml/l
March 3			
200	6.28	35.092	5.86
300	5.98	35.143	5.87
400	5.06	35.040	6.31
500	5.43	35.125	6.13
600	5.31	35.116	6.17
April 1			
200	5.74	35.061	6.28
300	5.36	35.063	6.41
400	5.53	35.126	6.36
500	5.48	35.133	6.26
600	4.74	35.027	6.74
June 23			
200	4.93	34.974	6.47
300	4.86	35.023	6.51
400	4.76	35.023	6.69
500	4.53	35.000	6.89
600	4.45	35.008	6.87
August 11			
200	4.87	34.959	6.49
300	4.81	35.021	6.56
400	4.77	35.023	6.63
500	4.61	35.005	6.78
600	4.55	35.010	6.82
November 26			
200	6.00	35.118	5.97
300	5.19	35.067	6.26
400	4.94	35.035	6.41
500	4.70	35.021	6.58
600	4.59	35.031	6.57

Fig. 1.



Bornö 1970
Temperature Deviations °C

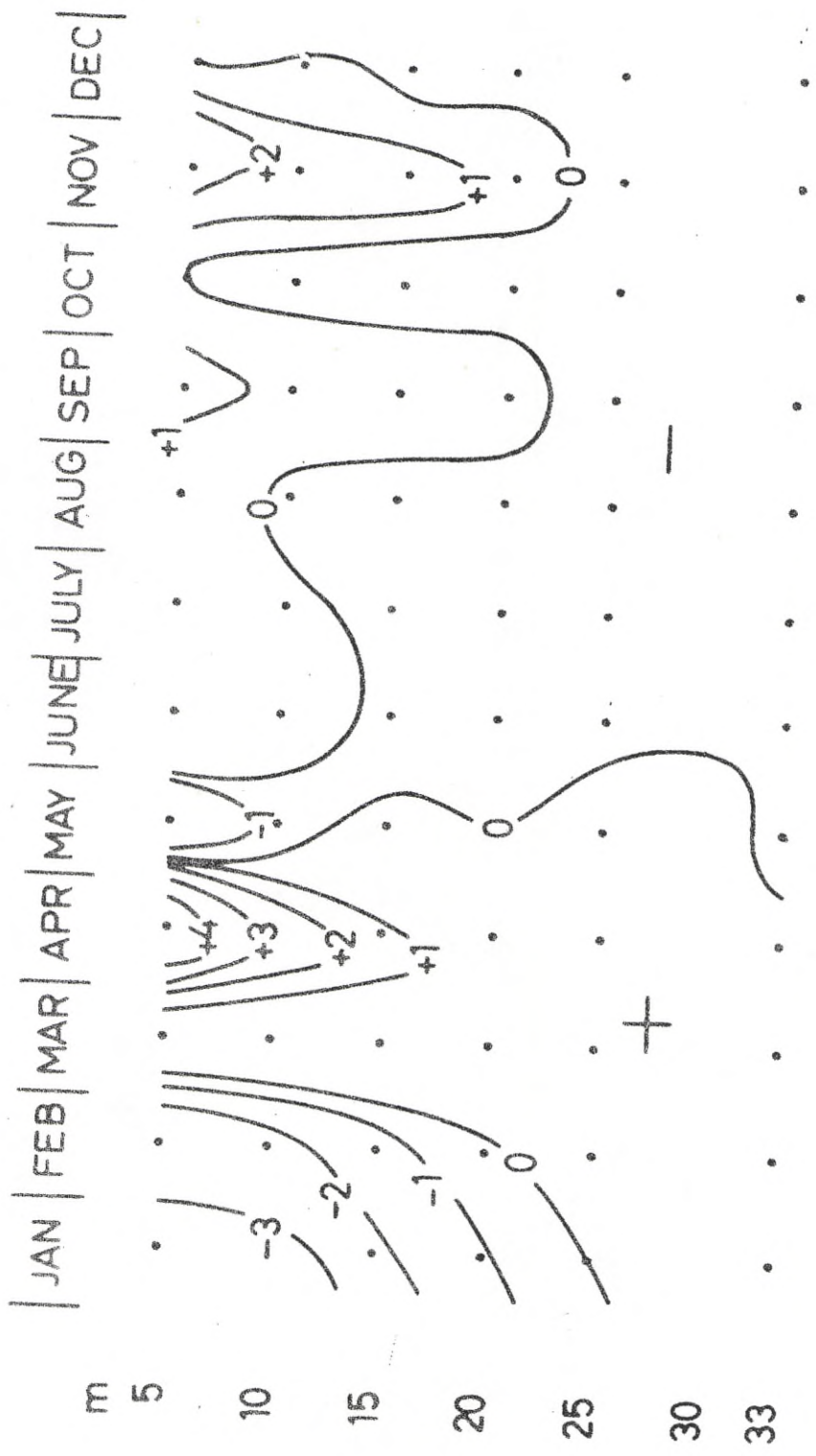
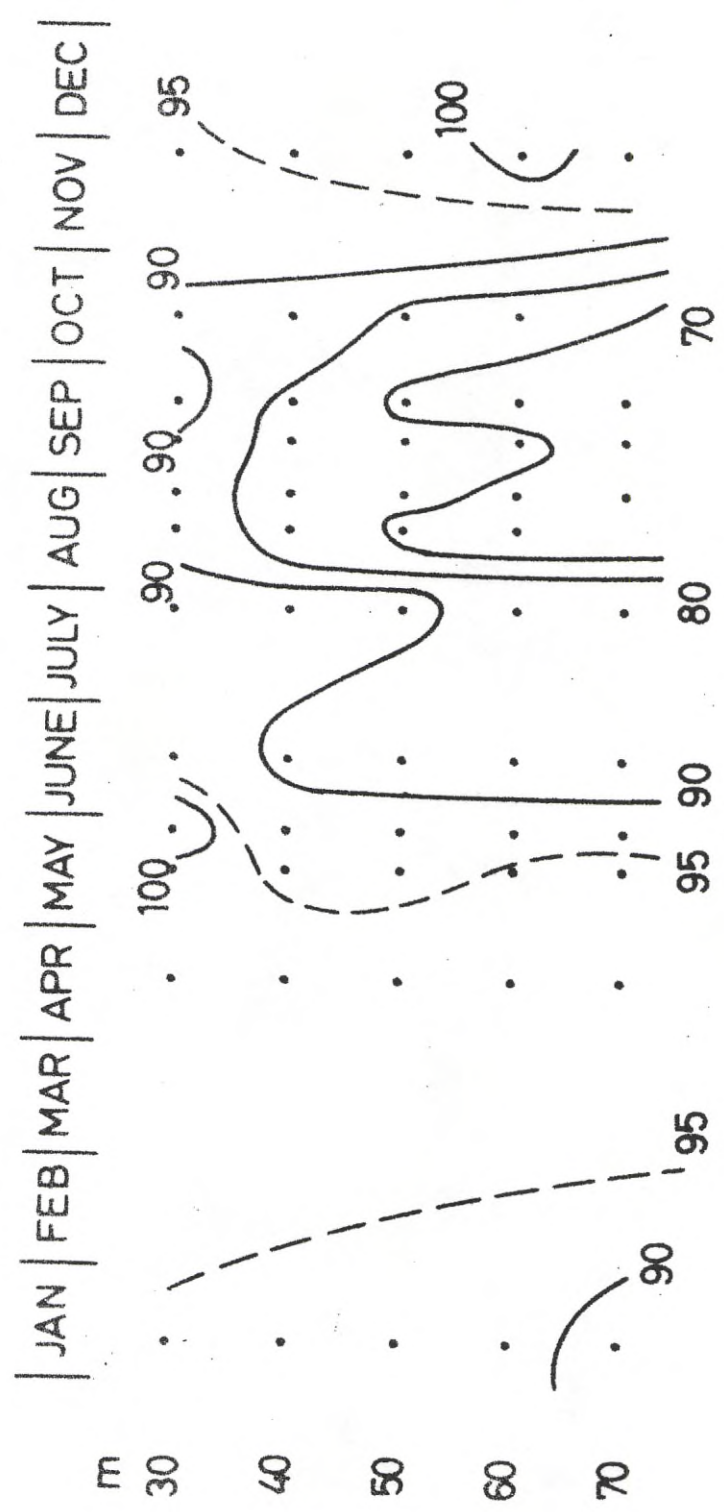


Fig. 2.

Bornö 1970
Salinity Deviations ‰

Fig. 3.



O₂ Sat.-% at N 57° 11.5' E 11° 40'
1970

Fig. 4.

Göteborg

x^D

x^C

x^B

x^A

57°30'

57°15'

11°30'

12°

x^{Fl}

