R.R.S. CHALLENGER

Cruise 10/1973

CRUISE REPORT AND DATA LIST

by

R.I. Currie, A. Edwards
and D.J. Ellett

ICES - EXPEDITION

OVERFLOW '73

August-September 1973

Dunstaffnage Marine Research Laboratory

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Including observations made by
R.V. Cirolana, O.W.S. Weather Adviser
and O.W.S. Weather Monitor

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ICES OVERFLOW EXPEDITION

Cruise Report

The Scottish Marine Biological Association has recently started a programme of oceanographical observations in the Rockall Trough and thus the opportunity to investigate the inflow of Norwegian Sea Deep Water into the northernmost parts of the Trough concurrently with the other work taking place along the Scotland-Greenland Ridge, in the ICES Overflow Expedition '73 was timely.

Overflow across the Wyville-Thomson Ridge had not been previously examined in detail. The route by which dense water can enter the Rockall Trough was elucidated during brief investigations in 1971 and 1972 by r.v. CIROLANA, but the exact path of overflow water into the trough between the northern Wyville-Thomson Ridge and the Ymir Ridge (which for brevity we will here call the "Ymir Trough", see Figure 4b) remained unclear, and its path into the northern Rockall Trough remained unconfirmed. Similarly, it seemed likely that the overflow was intermittent, but little direct evidence of this was available. Finally, no suitable data existed for estimating the quantities of water entering the Rockall Trough. Participation in Overflow '73 has already resolved some of these questions, and it is hoped that subsequent analysis of the data will provide at least tentative answers to the remainder.

Itinerary

A small amount of preliminary work had been carried out by r.v. CIROLANA on 15-16 July 1973, during which evidence of overflowing water was found on the upper western flank of the Wyville-Thomson Ridge and in the Ymir Trough. An echo-survey had also been made to confirm that no deep gaps existed in the Ymir Ridge in the vicinity of 08° 30' W longitude.

R.R.S. CHALLENGER sailed from the Dunstaffnage Laboratory on the evening of 21 August and made a passage west of the Hebrides to Rosemary Bank. Stations, using water bottles, were then worked north-eastwards to the Wyville-Thomson Ridge and a bathymetric survey, taking bottom water samples and temperatures was conducted along the saddle of the ridge between 07° and 08° W.

This survey on the ridge produced evidence of cold bottom water spilling over the ridge and the path of this was followed by a series of more-or-less north-south sections working to the west in about 09° 30' W, using the TSD probe, water bottles and latterly the Rosette multisampler. Nutrient and dissolved oxygen samples were taken at a variety of depths at these stations, the dissolved oxygens being titrated on board, and the nutrients deep-frozen for later analysis. This was completed by the evening of 29 August and a course was set for the Faeroe Islands, Torshavn being reached at mid-day on 30 August.

In Torshavn "Challenger" met up with some of the other ships taking part in Overflow '73, giving an excellent opportunity to discuss mutual progress.

Departure from Torshavn had been planned for 1 September, but adverse weather followed by illness of a crew member delayed departure until 06:00 on 3 September. The first station was reached that evening. This lay north of the Wyville-Thomson Ridge, in Norwegian Sea Water.

We then proceeded along a more-or-less east-west line, repeating earlier stations in the core of the overflowing water as far as 09° 20'W, then proceeded southwards working a line of stations to Rosemary Bank and yet another northwards to Bill Bailey's Bank.

We had intended thereafter to work further stations westward to Lousy Bank, but deteriorating weather conditions forced abandonment of this intention and p.m. on 6 September "Challenger" proceeded towards the Faeroes to refuel.

The ship left Torshavn at 06:00 hrs. on 8 September and in the afternoon arrived on station north of the Wyville-Thomson Ridge. Great difficulty was, however, experienced in station keeping because of a very strong shear between the surface layers and deeper water, combined with an adverse wind direction. Eventually the station was abandoned and then a repeat made of the survey between the Wyville-Thomson Ridge and Ymir Ridge. At the bottom of the Ymir Trough, between the two ridges, a 25-hour series of TSD dips (stns. 137-151) at about one-and-a-half-hour intervals was made to see if any tidal component could be identified in the overflow.

Following this, the ship returned to the deep water east of Rosemary Bank to work a short line of stations north-westwards along its axis and then returned to the Ymir Ridge and worked further stations, first across the Ymir Trough, then along its axis and finally another north-south line in about 09° 20' W. This was completed in the early morning of 13 September, and a passage was made to Dunstaffnage which was reached at 14:00 hrs on 14 September.

Station positions during the cruise are shown in Figures 1 and 2.

Following the cruise of "Challenger", r.v. Cirolana revisited the area (30 September-4 October) and obtained further data. Some observations made by the Ocean Weather Ships - "Weather Adviser" and "Weather Monitor" (8-25 August and 7-17 September) at Weather Station INDIA are also relevant. These observations, together with those of "Challenger", are listed in the inventory.

Preliminary Results

(a) Temperature-salinity characteristics of the Wyville-Thomson Ridge Overflow

To the east of the ridge crest, Atlantic water from the Rockall Trough directly overlies Norwegian Sea Deep Water and the mixing line joining the characteristics of these two water masses at depths of 500-600 m. should initially describe any dense water flowing westwards into the Rockall Trough. Near bottom observations with a potential temperature of less than 6° C. from the first, intensive, survey of the upper basin are plotted in Figure 3, and it may be seen that the agreement with this mixing line is close. Thus, in the region close to the source of the overflow we shall not be seriously in error in equating temperature with the proportion of Atlantic water entrained by overflowing Norwegian Sea Deep water and, in using bottom temperature surveys as a means of tracing the overflow. However, when the dense water reaches the greater depths found around Rosemary Bank it will be acting to displace water of comparable temperatures but relatively low salinity (due to a strong Labrador Sea water component) which is normally resident across the larger part of the Rockall Trough at depths of 1600-1900 m. The simple relationship valid to the north of, say, 59° 40' N., will then no longer hold. In Figure 3, potential temperature-salinity (θ-S) plots from stations 2-4, worked on a section running north-eastwards from Rosemary Bank illustrate the contrasting low salinity characteristics in water of southerly origin.

(b) Bottom temperature surveys

On 24 August a bottom temperature and salinity survey of the lowest part of the Wyville-Thomson Ridge crest was begun, and this was extended westwards during the following five days by transects across the Ymir Trough and into the associated hollow, where soundings of 1682 m. had previously been recorded, which may be called the Ymir Deep. The distribution of potential temperature as obtained from corrected STD and reversing thermometer temperatures (chiefly the former) at depths normally less than 5 m. above the bottom is given in Figure 4a. From this it appeared that cold water was flowing for some 15 n.mls. along the upper western flank of the Wyville-Thomson Ridge at depths of 650-700 m. in a north-westerly direction from the lowest point of the crest, subsequently dropping to the floor of the Ymir Trough at about 8° 25' W. Cold water was also found to the westward in the deepening and narrowing part of the Ymir Trough, although the pattern of observations makes it uncertain whether this formed part part of the same tongue of overflow. Figure 4a suggests that cold water was spreading eastwards over the floor of the upper Ymir Trough to the left of the core of the overflow, leaving somewhat warmer water at the foot of the ridge. This agrees with a number of previously unexplained instances from "Cirolana" cruises when water at the immediate foot of the ridge was warmer than both water above on the ridge flank and water in the adjoining trough.

The stations lying on the core of the overflow during the first phase were repeated on 4-5 September, when notably warmer temperatures were found. Conditions were apparently very similar to those found on 8-11 September, when a larger number of stations were worked (Fig. 4b). In this latter period there were no clear signs of water overflowing the ridge, but it should be borne in mind that the bottom water within the Ymir Trough was still of greater density than that at comparable depths in the Rockall Trough. Some outward flow from the area might still be expected in consequence. A temperature of $\theta = 3.65^{\circ}$C was encountered on 9 September near the junction of the Wyville-Thomson Ridge with Faroe Bank, but although work continued in the narrow western part of the Ymir Trough during the following 33 hours water of similar temperature did not occur at greater depths. Soundings at this station suggest that it may be closer to the ridge crest than Fig. 4b shows, but water of temperature below 4°C extended through much of the Ymir Trough some three days later, and this may possibly be its source.

During the third survey (when all but four stations were worked on 12 September, Fig. 4c) the rather sparse data indicate overflow passing along the western flank of the ridge, as at the time of the first survey. Whether the water in the Ymir Trough originated from this source or had come from the north-western end of the Wyville-Thomson Ridge as discussed above is not clear. Comparison of the temperature profiles suggests that either the overflow on the ridge was decreasing at this time or that the trough water had come from a previous overflow at some point.

(c) <u>Repeated Stations</u>

The stations taken along the main axis of the overflow observed during the first survey clearly illustrate the changing character of the overflow once it had left the Norwegian Sea. Near to the ridge crest it had the form of a thin layer beneath a very sharp temperature gradient (Station 39, C, Fig. 5). Soon after entering the narrower western portion of the Ymir Trough the layer had become mixed and extended to a much greater depth (Station 65, F) whereas below the 1300 m. sill depth of the Ymir Deep conditions were nearly isothermal (Station 89, H). The three subsequent sets of samples taken at the same set of positions cannot as clearly be described as modifications of a single flow: the means of the three later temperature traces at F are clearly lower than those of C, confirming that variations in flow are rapid.

In an attempt to examine this, a 25-hour station was worked at position G, where the Ymir Trough is narrow, but has a level bottom across most of its width. Isopleths of the temperature changes are given in Figure 6. Bottom temperatures did not vary as much as might have been expected if overflow is a consequence of changing tidal conditions, and by much less than the change of 1.7 deg.C. which occurred over the following 43 hours. The location does, however, seem a promising one for the future use of recording thermistors to assess variations in the overflow.

(d) The path of the overflow into the Rockall Trough

Sections radiating from Rosemary Bank to the Wyville-Thomson Ridge, to the Ymir Deep and to Bill Bailey's Bank have yet to be fully examined, and are likely to yield most information when studied in conjunction with the oxygen content and the nutrient determinations at present in hand. As an example, however, Fig.7 showing the temperature distribution between Rosemary Bank and Bill Bailey's Bank, suggests that the influence of the Wyville-Thomson Ridge overflow can be detected to the west of the Ymir Deep in addition to other evidence of its course towards the foot of Rosemary Bank. A short line of stations across the deep water in the latter location revealed evidence of overflow undercutting water with a Labrador Sea component. At one station STD traces and close sampling with water bottles showed a temperature inversion in the vicinity of the bottom of 0.24 deg.C. in 34 m., accompanied by a salinity increase of 0.057 o/oo as the overflow water was entered. It is likely that anomalies of salinity from the normal Rockall Trough θ-S relationship will prove to be the most satisfactory method of tracing the overflow southward from the Ymir Deep and this will be tested when all the data are in their final form.

Summary

RRS Challenger observed overflow occurring along the western flank of the Wyville-Thomson Ridge during the period 24-29 August. Its path lay along the ridge at depths of 650-700 m. and descended to the floor of the Ymir Trough in about 8° 25'W. A similar overflow was observed, and may have been decreasing, on 12 September. On 4-5 September and 8-11 September, and probably during the intervening dates, overflow was minimal. It is possible that overflow may have occurred at the north-western end of the Wyville-Thomson Ridge between 9 and 12 September into the Ymir Trough.

Overflow water was found to both south and west of the Ymir Deep. Conditions below the sill of the latter were cold and near homothermal in contrast to the warm homothermal conditions measured there in July 1972.

Although the overflow was intermittent, no evidence was found of a diurnal or semi-diurnal variation in bottom temperature.

R. I. Currie
A. Edwards
D. J. Ellett

LIST OF SCIENTIFIC PERSONNEL

R. I. Currie (in charge)	SMBA
A. Edwards	SMBA
D. Ellett	Fisheries Laboratory, Lowestoft
Miss L. Solorzano	SMBA
G. Coghill	SMBA
D. Eddleston	SMBA
S. Kent	SMBA
A. Souter	SMBA

R.R.S. CHALLENGER

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Time	Day	Month	Station	Lat.°N.	Long.°W.	Depth (M)	Greatest Sampled Depth	Use of TSD	No. of Samples	No. of Nutrient Samples
0704	23	8	1	59.15	9.44	1016	900	-	14	-
1149	23	8	2	59.21	9.28	1634	1570	-	16	-
1453	23	8	3	59.30	9.00	1438	1413	-	14	-
1757	23	8	4	59.38	8.34	1245	1189	-	14	-
2039	23	8	5	59.44	8.13	929	889	-	14	11
0106	24	8	6	59.49	8.00	878	866	-	14	-
0328	24	8	7	59.54	7.47	602	545	-	11	-
0512	24	8	8	59.59	7.31	552	541	-	11	-
0831	24	8	9	60.06	7.18	483	473	1	13	-
1022	24	8	10	60.08	7.23	530	527	-	1	-
1130	24	8	11	60.08	7.26	545	542	-	1	-
1226	24	8	12	60.09	7.30	542	537	-	4	-
1332	24	8	13	60.10	7.34	554	551	-	1	-
1422	24	8	14	60.11	7.37	574	571	-	1	-
1520	24	8	15	60.12	7.41	664	661	-	1	-
1616	24	8	16	60.13	7.46	659	656	-	1	-
1739	24	8	17	60.15	7.50	670	665	+	5	4
1940	24	8	18	60.15	7.54	589	585	+	2	-
2119	24	8	19	60.14	7.54	521	519	+	3	-
2251	24	8	20	60.13	7.50	559	556	+	3	-
0018	25	8	21	60.11	7.46	625	622	+	5	-
0201	25	8	22	60.09	7.41	635	631	+	5	-
0328	25	8	23	60.08	7.38	598	594	+	5	-
0500	25	8	24	60.07	7.34	560	556	+	5	-
0624	25	8	25	60.06	7.30	533	529	+	5	-
0800	25	8	26	60.05	7.27	493	491	+	5	-
0955	25	8	27	60.04	7.22	481	479	+	5	-
1101	25	8	28	60.03	7.19	472	469	+	3	-
1208	25	8	29	60.01	7.23	493	490	+	3	-
1322	25	8	30	60.02	7.27	509	505	-	3	-
1403	25	8	31	60.03	7.33	535	531	+	3	-
1509	25	8	32	60.04	7.37	577	573	+	12	-
1646	25	8	33	60.05	7.41	614	611	+	5	-

Time	Day	Month	Station	Lat. °N.	Long. °W.	Depth (M)	Greatest Sampled Depth	Use of TSD	No. of Samples	No. of Nutrient Samples
1845	25	8	34	60.09	7.53	613	610	+	5	-
2010	25	8	35	60.11	7.55	580	577	+	5	-
2129	25	8	36	60.13	7.59	520	517	+	-	-
0034	26	8	37	60.07	7.44	636	633	+	-	-
0206	26	8	38	60.14	8.01	541	538	+	-	-
0300	26	8	39	60.10	7.58	668	665	+	-	-
0420	26	8	40	60.06	7.56	897	894	+	-	-
0545	26	8	41	60.04	7.54	825	822	+	-	-
0733	26	8	42	60.01	7.53	754	751	+	-	-
0859	26	8	43	59.59	7.52	626	623	+	-	-
1008	26	8	44	59.56	7.52	587	584	+	-	-
1132	26	8	45	59.56	8.11	568	565	+	7	-
1258	26	8	46	60.00	8.10	668	665	+	8	-
1427	26	8	47	60.03	8.10	811	807	+	12	-
1630	26	8	48	60.06	8.10	899	896	+	14	-
2035	26	8	49	60.08	8.10	906	900	+	13	-
2241	26	8	50	60.10	8.12	925	923	+	14	-
0054	27	8	51	60.12	8.11	783	780	+	14	-
0258	27	8	52	60.14	8.10	610	608	+	6	-
0712	27	8	53	60.15	8.10	546	543	+	10	-
0901	27	8	54	60.17	8.16	529	526	+	11	-
1102	27	8	55	60.20	8.20	490	486	+	11	-
1247	27	8	56	60.19	8.23	522	518	+	5	-
1400	27	8	57	60.17	8.24	619	616	+	6	-
15:28	27	8	58	60.15	8.26	875	872	+	6	-
1725	27	8	59	60.11	8.28	907	904	+	6	-
1950	27	8	60	60.07	8.33	797	794	+	5	-
2147	27	8	61	60.04	8.35	554	551	+	1	-
2246	27	8	62	60.01	8.36	495	492	+	1	-
0023	28	8	63	60.09	8.52	424	420	+	1	-
0139	28	8	64	60.11	8.52	604	601	+	1	-
0309	28	8	65	60.14	8.52	1065	1060	+	12	-
0756	28	8	66	60.15	8.51	819	815	+	1	-
0858	28	8	67	60.18	8.51	684	681	+	1	-

Time	Day	Month	Station	Lat. °N.	Long. °W	Depth (M)	Greatest Sampled Depth	Use of TSD	No. of Samples	No.of Nutrient Samples
1010	28	8	68	60.22	8.52	47	471	+	1	-
1108	28	8	69	60.22	8.59	456	447	+	1	-
1205	28	8	70	60.20	9.00	546	541	+	1	-
1309	28	8	71	60.18	9.00	821	816	+	1	-
1410	28	8	72	60.15	9.00	1255	1245	+	-	-
1527	28	8	73	60.14	9.00	714	710	+	1	-
1644	28	8	74	60.11	8.57	514	509	+	1	-
1816	28	8	75	60.09	9.00	570	565	+	1	-
1950	28	8	76	60.06	9.00	1218	1215	+	1	-
2139	28	8	77	60.06	9.07	1305	1300	+	1	-
2319	28	8	78	60.06	9.12	1317	1314	+	1	-
0040	29	8	79	60.06	9.18	1300	1060	+	1	-
0202	29	8	80	60.06	9.23	1315	1310	+	1	-
0723	29	8	81	60.06	9.32	1176	1172	+	1	-
0854	29	8	82	60.05	9.42	1174	1170	+	1	-
1025	29	8	83	60.11	9.38	918	914	+	1	-
1137	29	8	84	60.15	9.35	1325	1321	+	1	-
1248	29	8	85	60.18	9.31	1365	1360	+	1	-
1358	29	8	86	60.20	9.30	1350	1345	+	1	-
1503	29	8	87	60.22	9.27	1335	1329	+	1	-
1636	29	8	88	60.21	9.12	403	400	+	1	-
1745	29	8	89	60.18	9.13	1586	1581	+	1	-
2013	29	8	90	60.17	9.13	1540	1535	+	1	-
1923	3	9	91	60.20	7.17	1124	992	+	11	9
0023	4	9	92	60.12	7.41	620	617	+	4	-
0146	4	9	93	60.11	7.46	640	635	+	5	4
1005	4	9	94	60.09	7.53	610	607	+	4	-
1117	4	9	95	60.10	7.58	644	640	+	5	-
1258	4	9	96	60.14	8.10	582	577	+	4	-
1505	4	9	97	60.11	8.26	900	895	+	5	-
1744	4	9	98	60.14	8.50	1095	1088	+	5	-
1957	4	9	99	60.14	8.47	1022	1016	+	1	1
2214	4	9	100	60.15	9.00	1258	1256	+	5	2
0011	5	9	101	60.18	9.13	1073	1063	+	5	-
0232	5	9	102	60.15	9.17	1610	1604	+	10	10

Time	Day	Month	Station	Lat. °N.	Long. °W	Depth (M)	Greatest Sampled Depth	Use of TSD	No. of Samples	No. of Nutrients Samples
0526	5	9	103	60.05	9.19	1311	1306	+	10	4
0755	5	9	104	59.55	9.23	1339	1334	+	11	5
1006	5	9	105	59.45	9.27	1376	1371	+	11	5
1202	5	9	106	59.35	9.30	1455	1448	+	10	6
1409	5	9	107	59.25	9.33	1610	1590	+	10	5
1730	5	9	108	59.25	9.56	963	955	+	11	4
1925	5	9	109	59.25	10.08	786	780	+	1	-
2141	5	9	110	59.31	10.08	1288	1285	+	7	4
0058	6	9	111	59.37	10.07	1400	1397	+	6	6
0317	6	9	112	59.44	10.09	1286	1283	-	7	3
0548	6	9	113	59.55	10.07	1150	1147	-	7	3
0738	6	9	114	60.06	10.07	1070	1067	-	6	4
0918	6	9	115	60.15	10.08	1010	1005	-	9	5
1047	6	9	116	60.19	10.08	866	863	-	9	5
1201	6	9	117	60.22	10.08	705	702	-	7	6
1321	6	9	118	60.25	10.08	465	461	+	8	2
1537	8	9	119	60.31	7.23	1081	980	+	-	-
1916	8	9	120	60.12	7.41	610	607	+	1	-
2100	8	9	121	60.10	7.58	645	642	+	1	1
2150	8	9	122	60.09	7.57	807	804	+	1	-
2300	8	9	123	60.08	8.01	858	855	+	1	-
0018	9	9	124	60.06	8.02	893	888	+	1	-
0122	9	9	125	60.03	8.04	850	847	+	1	-
0217	9	9	126	60.01	8.09	785	782	+	1	-
0328	9	9	127	60.02	8.21	790	787	+	1	-
0503	9	9	128	59.56	8.27	1100	1097	+	1	-
0735	9	9	129	60.02	8.38	510	507	+	1	-
1032	9	9	130	60.09	8.33	850	847	+	1	-
1146	9	9	131	60.11	8.32	898	895	+	1	-
1258	9	9	132	60.14	8.32	804	801	+	1	-
1404	9	9	133	60.17	8.31	852	847	+	1	-
1459	9	9	134	60.20	8.29	575	572	+	1	-
1750	9	9	135	60.14	8.52	1174	1171	+	1	-
1930	9	9	136	60.15	9.00	1076	1073	+	1	-
2108	9	9	137	60.14	9.01	1305	1302	+	1	-
2346	9	9	138	60.15	9.00	1288	1285	+	1	-
0120	10	9	139	60.14	9.00	1287	-	-	-	-
0316	10	9	140	60.14	9.01	1285	1282	+	1	-

Time	Day	Month	Station	Lat. °N.	Long. °W.	Depth (M)	Greatest Sampled Depth	Use of TSD	No.of Samples	No. of Nutrient Samples
0447	10	9	141	60.14	9.01	1310	1307	+	1	-
0625	10	9	142	60.14	9.01	1305	1301	+	1	-
0749	10	9	143	60.14	9.01	1305	1300	+	1	-
1026	10	9	144	60.14	9.01	1300	1297	+	1	-
1145	10	9	145	60.14	9.01	1312	1309	+	1	-
1332	10	9	146	60.14	9.01	1305	1302	+	1	-
1535	10	9	147	60.14	9.01	1290	1287	+	1	-
1759	10	9	148	60.14	9.00	1305	1302	+	1	-
1950	10	9	149	60.14	9.01	1306	1302	+	1	-
2115	10	9	150	60.14	9.01	1310	1305	+	1	1
2245	10	9	151	60.14	9.01	1326	1323	+	1	-
0040	11	9	152	60.15	9.17	1645	1642	+	1	-
0710	11	9	153	59.24	9.32	1855	1851	+	1	-
1006	11	9	154	59.35	9.49	1457	1454	+	10	4
1233	11	9	155	59.38	9.55	1390	1387	+	9	8
1446	11	9	156	59.41	9.59	1345	1342	+	1	-
1626	11	9	157	59.43	10.03	1317	1314	+	1	-
2207	11	9	158	59.56	8.26	945	941	+	1	-
2342	11	9	159	60.02	8.23	649	646	+	1	-
0058	12	9	160	60.05	8.20	823	820	+	1	-
0202	12	9	161	60.07	8.16	909	906	+	1	-
0256	12	9	162	60.10	8.16	924	921	+	1	-
0352	12	9	163	60.11	8.14	865	862	+	1	-
0507	12	9	164	60.14	8.12	715	712	+	1	-
0610	12	9	165	60.16	8.09	527	524	+	1	-
0828	12	9	166	60.12	7.41	595	592	+	1	-
0928	12	9	167	60.11	7.46	615	612	+	1	-
1041	12	9	168	60.10	7.59	654	650	+	1	-
1206	12	9	169	60.14	8.10	618	615	+	1	-
0302	12	9	170	60.13	8.19	867	864	+	1	-
1402	12	9	171	60.11	8.28	901	898	+	-	-
1625	12	9	172	60.14	8.52	1160	1155	+	1	-
1833	12	9	173	60.14	9.00	1286	1280	+	1	-
2016	12	9	174	60.15	9.15	1680	1675	+	1	-
2133	12	9	175	60.18	9.16	1639	1633	+	1	-
2255	12	9	176	60.20	9.14	954	951	+	1	-
0001	13	9	177	60.22	9.12	383	380	+	1	-
0140	13	9	178	60.11	9.18	1325	1322	+	1	-
0248	13	9	179	60.07	9.20	1299	1295	+	1	-

WYVILLE-THOMSON RIDGE AREA

r.v. CIROLANA
Fisheries Laboratory Lowestoft

CRUISE 6b/1973

Nansen bottle samples

Time	Day	Month	Station	Lat. °N.	Long. °W.	Depth (M)	Greatest Sampled Depth	Use of TSD	No. of Samples	No. of Nutrient Samples
-	15	7	9	60.13	07.43	593	583	-	14	-
-	15	7	10	60.09	07.52	629	618	-	15	-
-	15	7	11	60.07	07.56	912	606	-	7	-
-	15	7	12	60.07	08.00	906	896	-	15	-
-	15	7	13	60.09	08.14	939	932	-	15	-
-	15	7	14	60.12	08.08	775	757	-	7	-
-	15	7	1530-2330 Bottom topography survey within rectangle 60°05' N, 08°15'W - 08°45'W; 59°55'N, 08°15'W-08°45'W (5 east-west sounding lines).							

CRUISE 8a/1973

Time	Day	Month	Station	Lat. °N.	Long. °W.	Depth (M)	Greatest Sampled Depth	Use of TSD	No. of Samples	No. of Nutrient Samples
-	30	9	2	59.59	08.00	723	713	-	10	-
-	30	9	3	60.02	07.56	760	750	-	6	-
-	30	9	4	60.05	07.52	816	815	-	6	-
-	1	10	5	60.07	07.51	780	675	-	7	-
-	1	10	6	60.09	07.46	620	612	-	7	-
-	1	10	7	60.11	07.43	650	615	-	7	-
-	1	10	8	60.11	07.41	610	565	-	7	-
-	1	10	9	60.14	07.52	685	605	-	7	-
-	1	10	10	60.12	07.55	556	548	-	7	-
-	1	10	11	60.11	07.58	630	605	-	7	-
-	1	10	12	60.09	08.01	840	810	-	7	-
-	1	10	13	60.07	08.02	912	895	-	7	-
-	1	10	14	60.04	08.07	858	830	-	7	-

Time	Day	Month	Station	Lat. °N.	Long. °W.	Depth (M)	Greatest Sampled Depth	Use of TSD	no. of Samples	No. of Nutrient Samples
-	1	10	15	60.07	08.16	912	905	-	6	-
-	1	10	16	60.11	08.13	932	875	-	7	-
-	1	10	17	60.12	08.11	838	815	-	7	-
-	1	10	18	60.14	08.09	667	655	-	7	-
-	1	10	19	60.16	08.09	522	520	-	7	-
-	2	10	22	60.23	08.31	523	515	-	7	-
-	2	10	23	60.21	08.31	583	565	-	7	-
-	2	10	24	60.18	08.29	678	655	-	7	-
-	2	10	25	60.12	08.26	918	900	-	6	-
-	3	10	29	60.15	09.10	1550	1350	-	8	-
-	4	10	35	57.00	11.00	2370	2200	-	17	-

- 2 10 1800- 3 Oct, 0230. Bottom topography survey within rectangle 60°08'N, 09° 05'W - 09°30'W, 60°20'N, 09°05'W. (6 North-South sounding lines).

OCEAN WEATHER STATION INDIA

O.W.S. WEATHER ADVISER
Ocean Weather Ship Base, Greenock

Nansen Bottle samples

Time	Day	Month	Station	Lat. °N.	Long. °W.	Depth (M)	Greatest Sampled Depth	Use of TSD	No. of Samples	No.of Nutrient Samples
-	8	8	321	59.02	19.05	2103	2000	-	6	-
-	13	8	322	58.59	19.05	2030	1950	-	19	-
-	14	8	323	58.57	19.10	2021	2000	-	19	-
-	16	8	324	59.01	19.05	2103	2100	-	19	-
-	18	8	325	58.59	19.10	2140	2150	-	19	-
-	20	8	326	59.03	19.03	2208	2150	-	19	-
-	22	8	327	59.05	19.06	2377	2350	-	19	-
-	25	8	328	59.03	19.02	2158	2130	-	19	-

O.W.S. WEATHER MONITOR
Ocean Weather Ship Base, Greenock

Nansen bottle samples

Time	Day	Month	Station	Lat. °N.	Long. °W.	Depth (M)	Greatest Sampled Depth	Use of TSD	No. of Samples	No.of Nutrient Samples
-	7	9	721	59.00	19.00	2012	1805	-	19	-
-	12	9	722	58.57	19.19	2341	1985	-	19	-
-	17	9	723	58.56	19.28	2469	2200	-	19	-

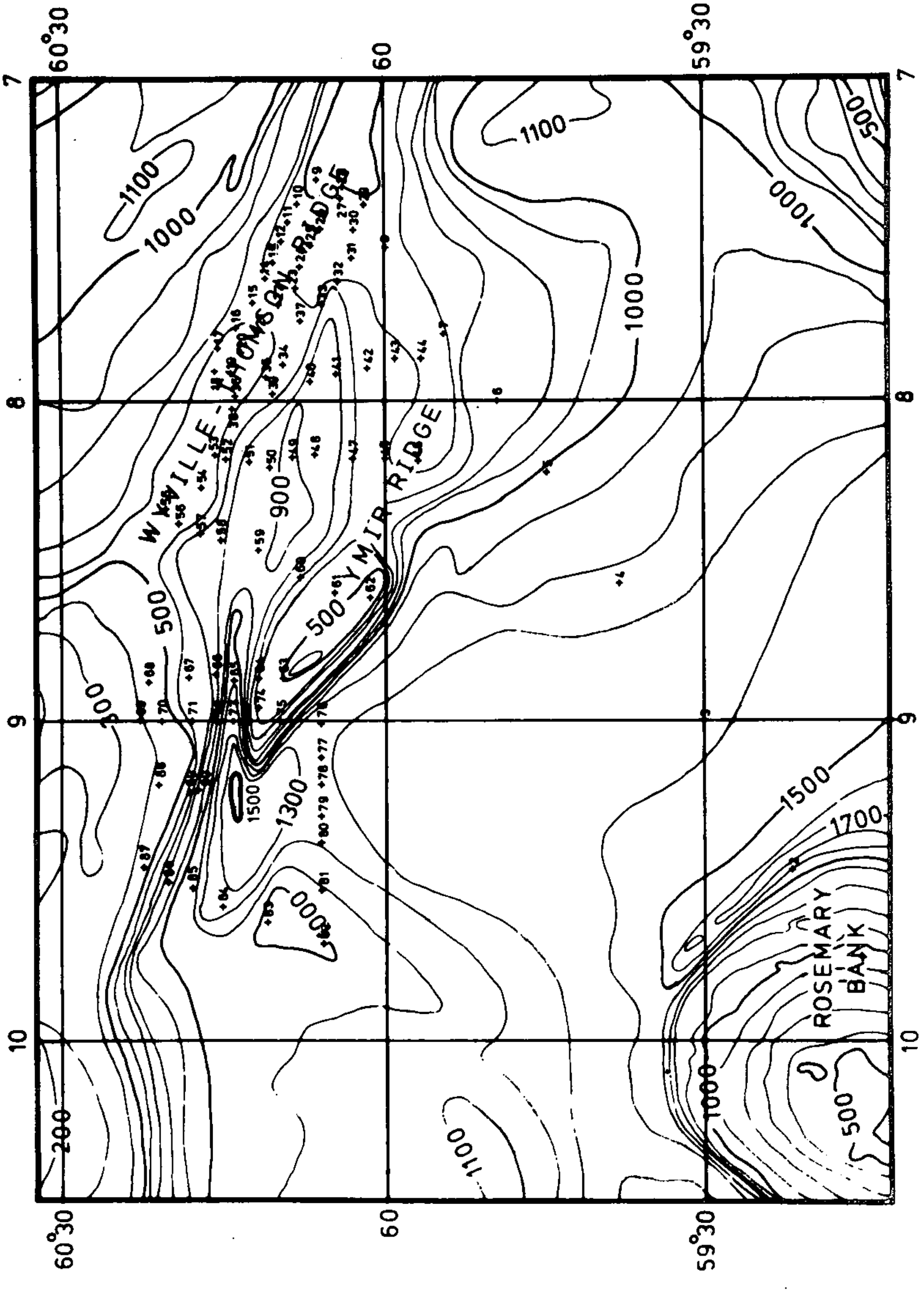

Fig. 1

Station positions and bathymetry (in metres) :
Stations 1-90

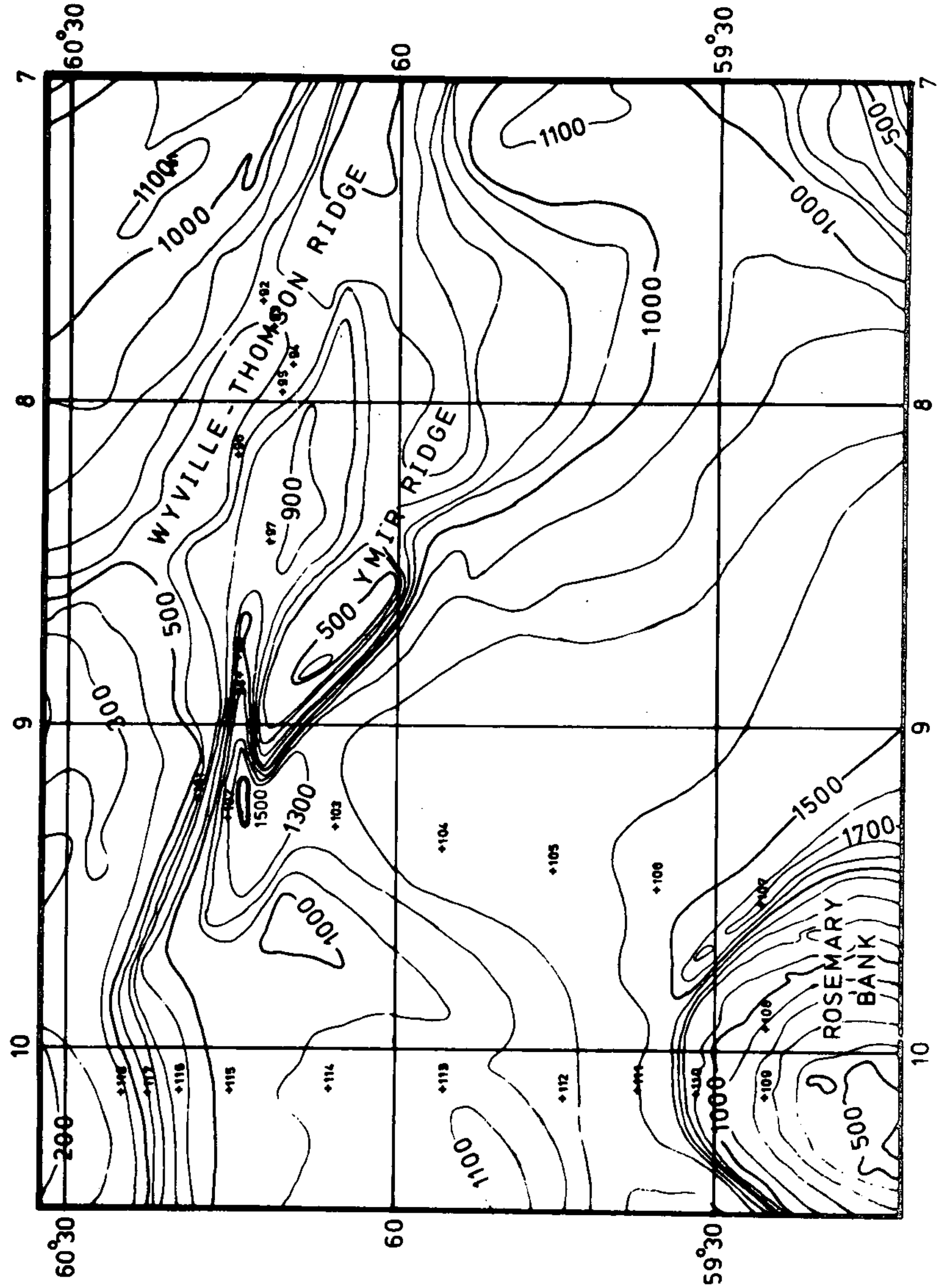

Fig. 2a

Station positions and bathymetry (in metres) :
Stations 91-118

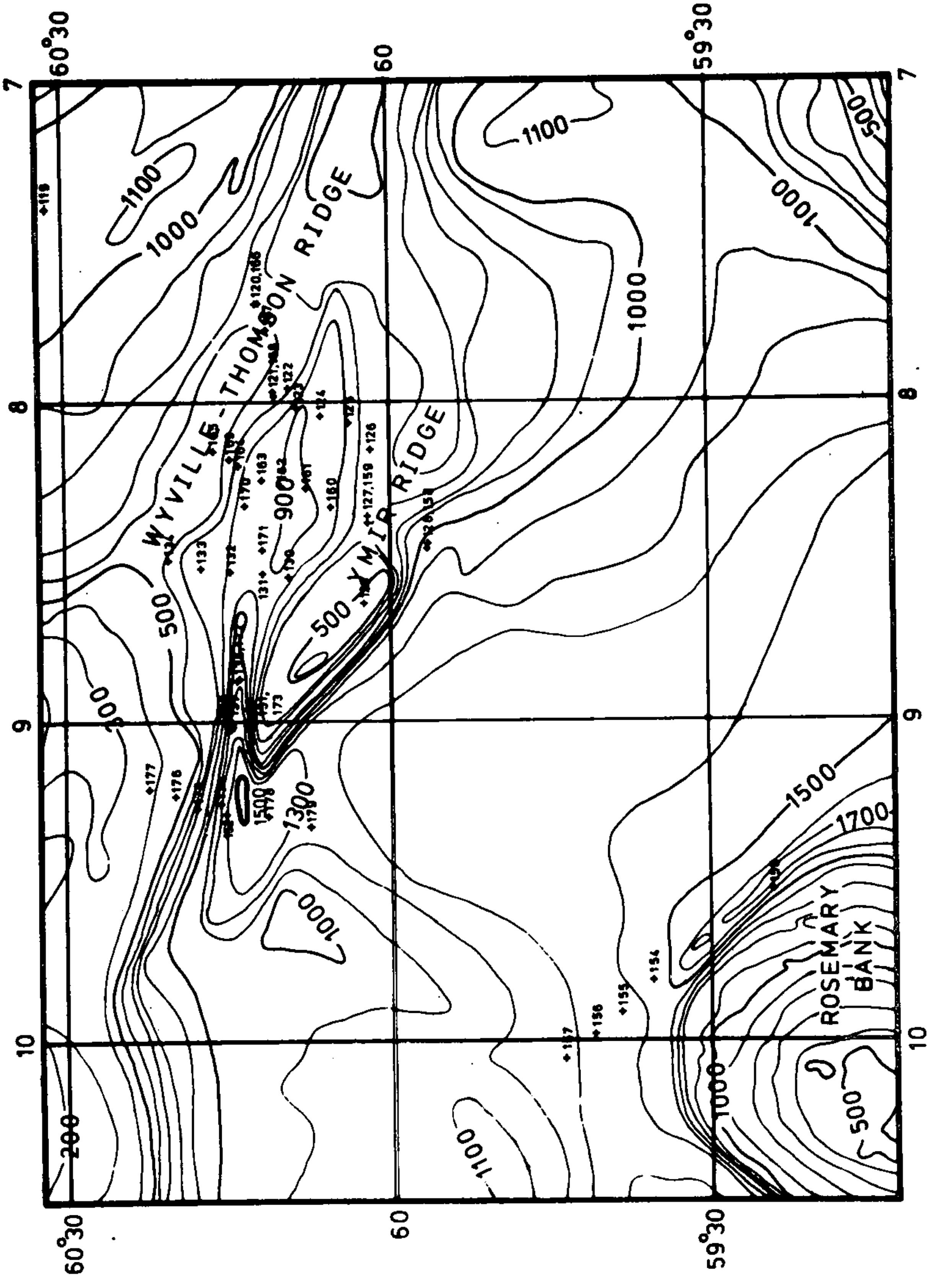

Fig. 2b

Station positions and bathymetry (in metres) :
Stations 119-179

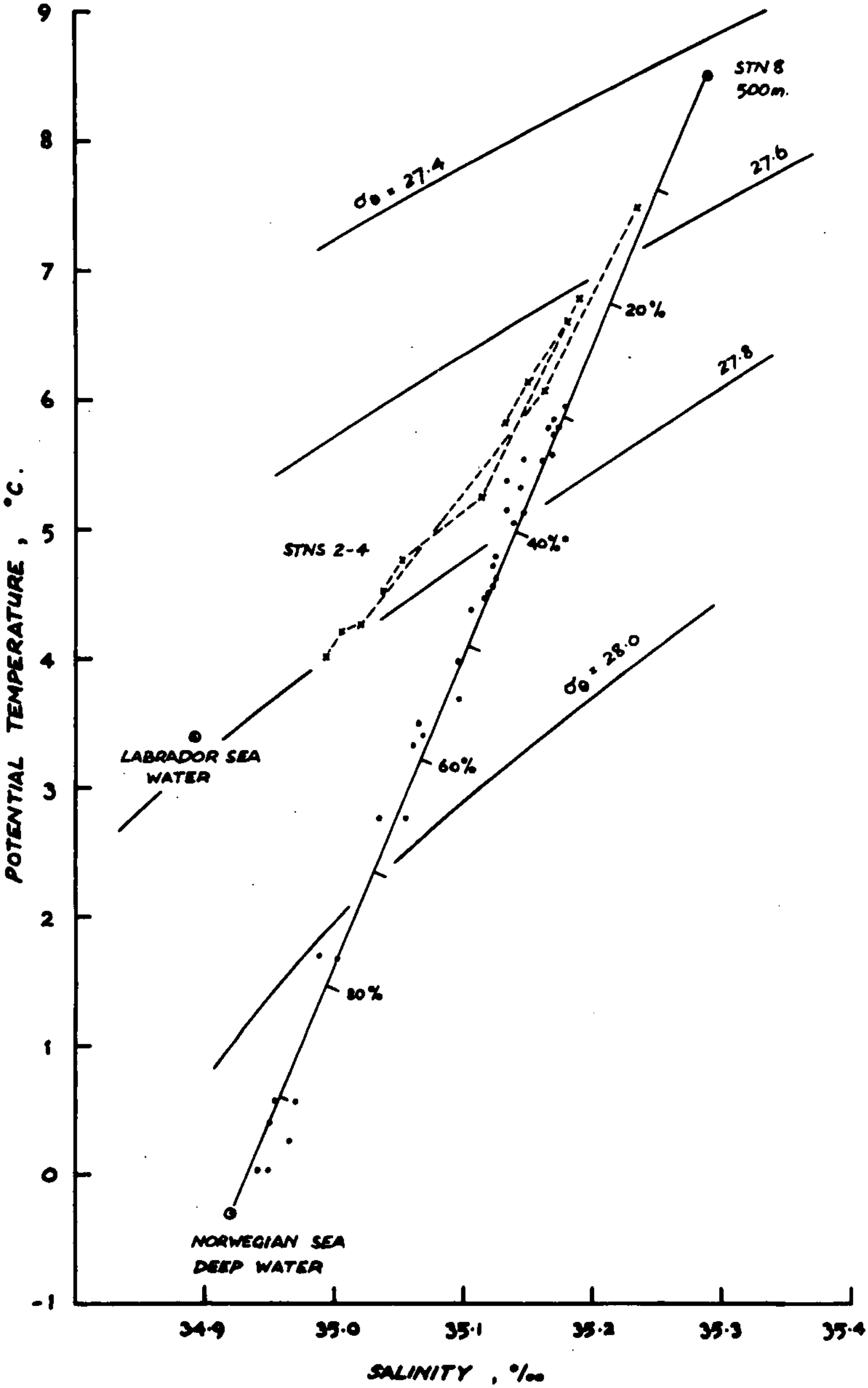

Fig. 3
Potential temperature-salinity diagram
for near bottom observations
taken during the first phase (24-29 August).

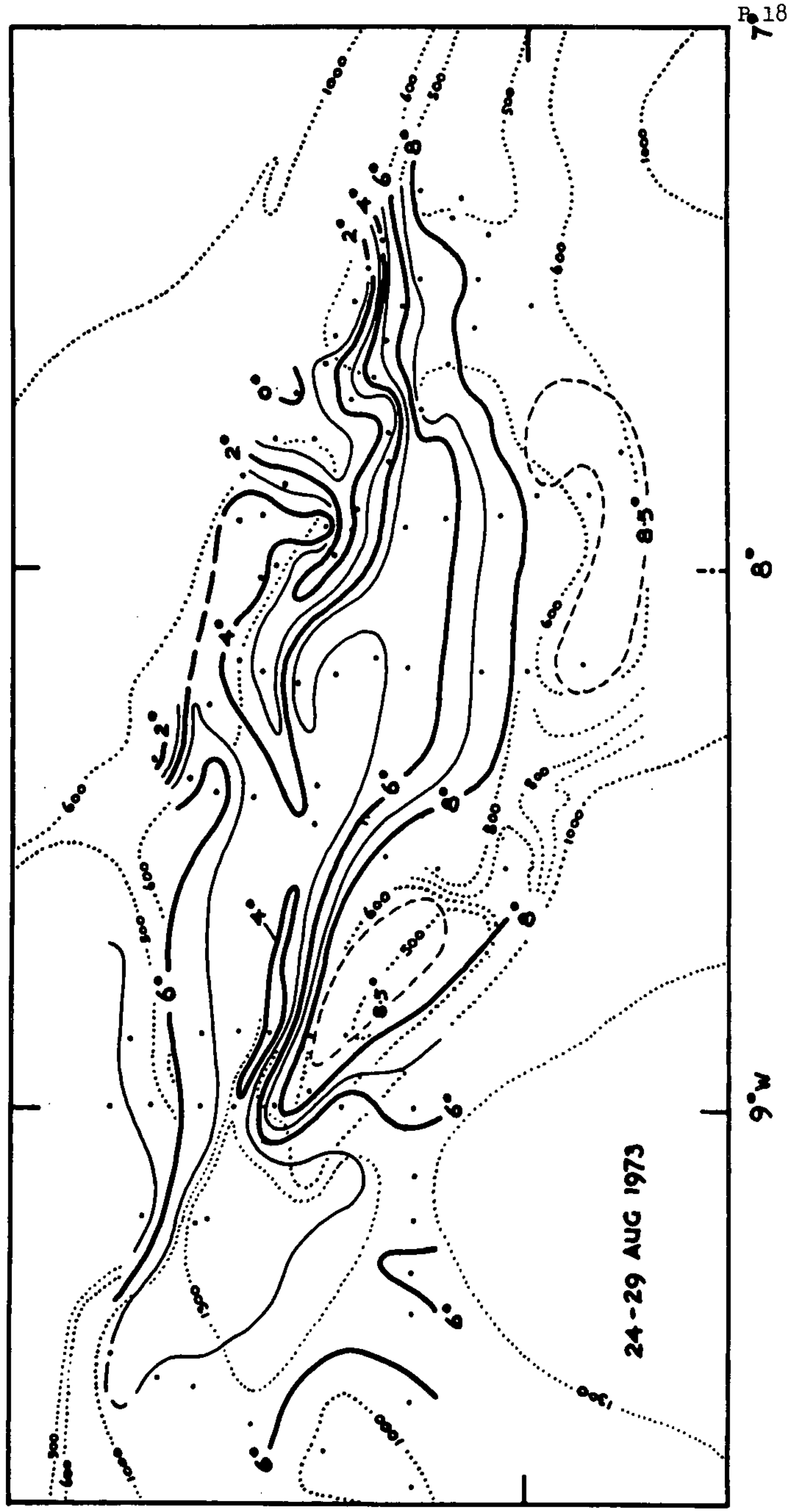

Fig. 4a

Potential temperature distribution within 5 m. of the bottom
24-29 August 1973

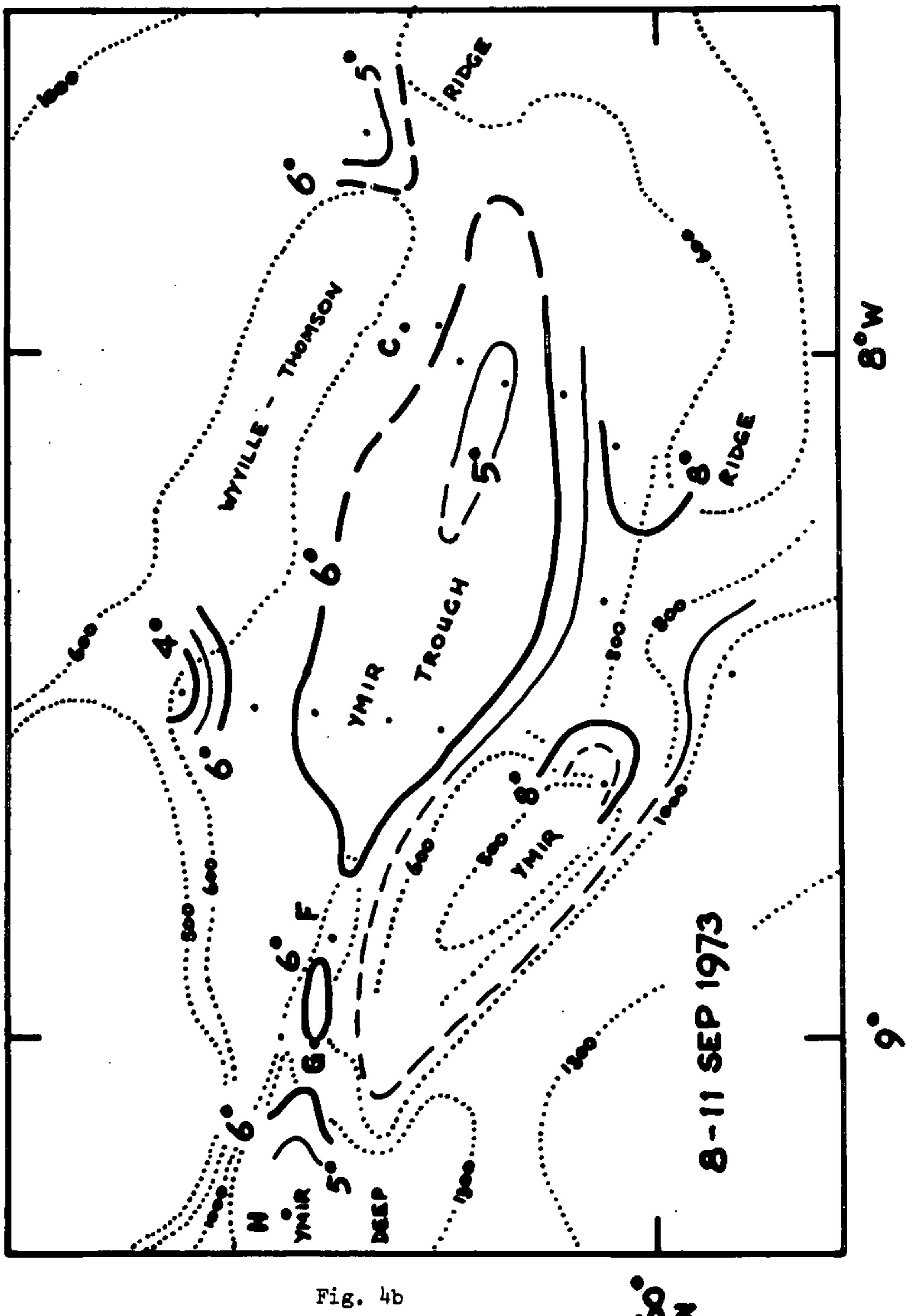

Fig. 4b

Potential temperature distribution within 5 m. of the bottom, 8-11 September. Letters mark the position of repeated stations shown in Figures 3 and 4

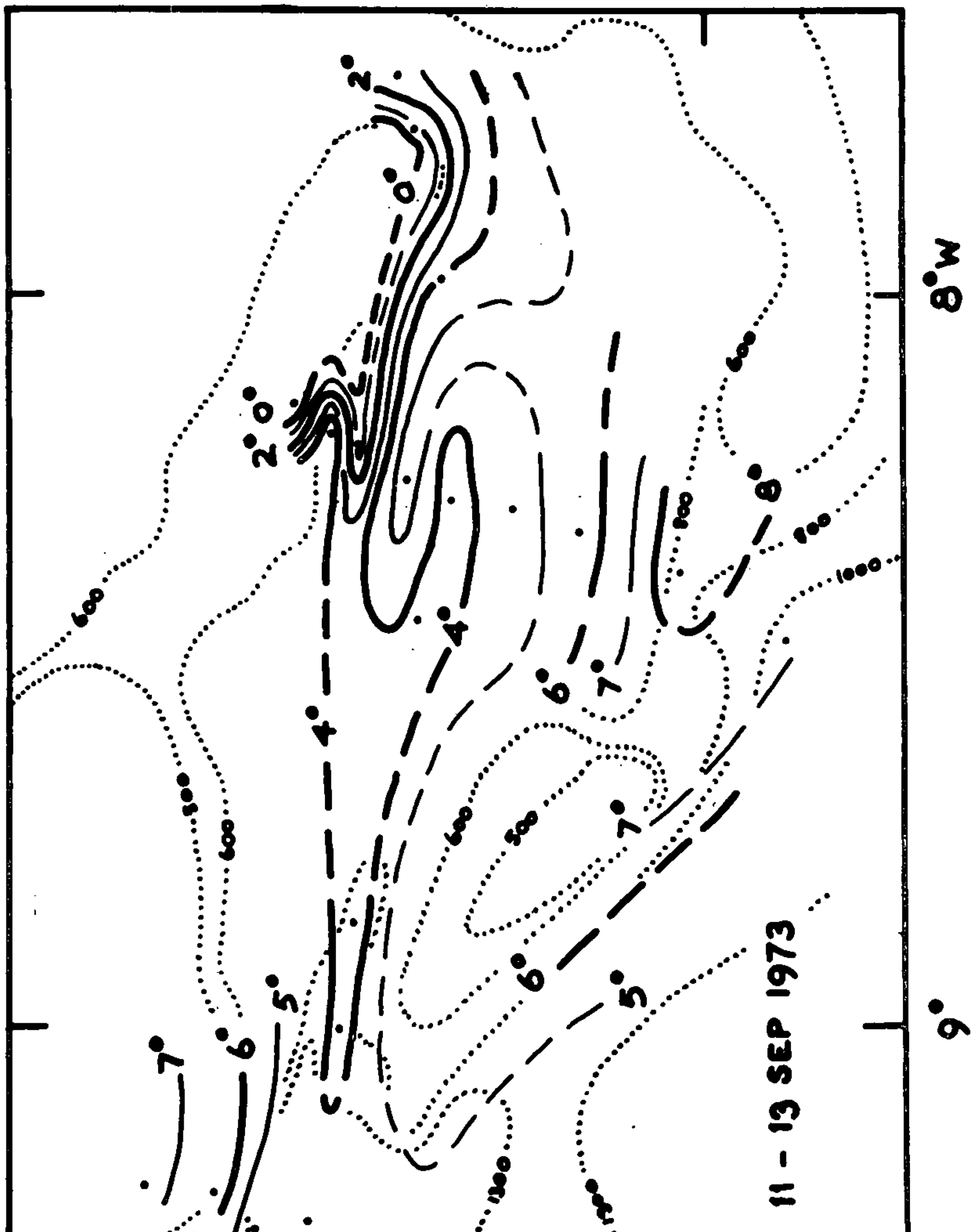

Fig. 4c

Potential temperature distribution within 5 m. of the bottom,
11-13 September

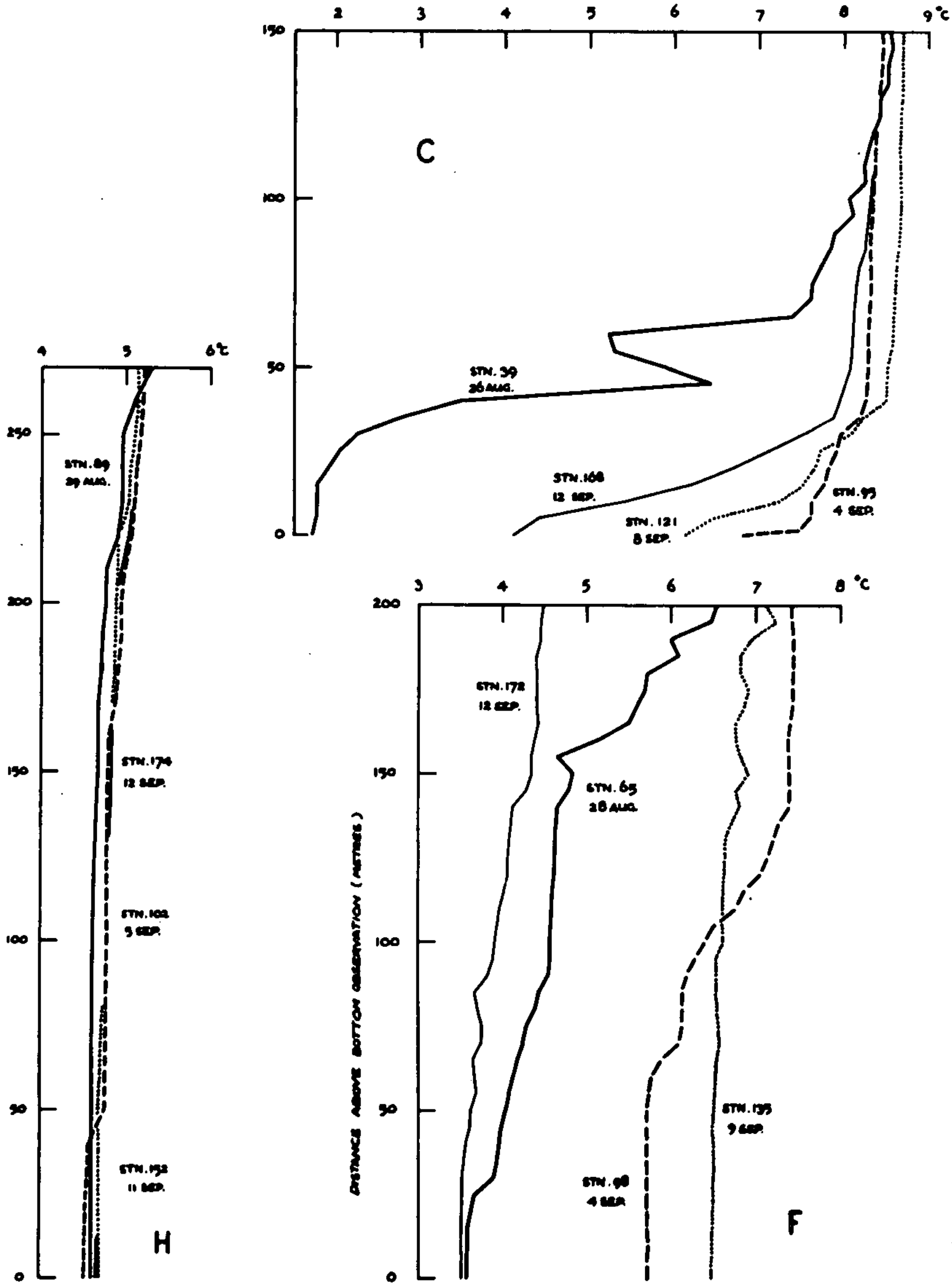

Fig. 5

Temperature-depth profiles at positions C, f and H
(from STD traces)

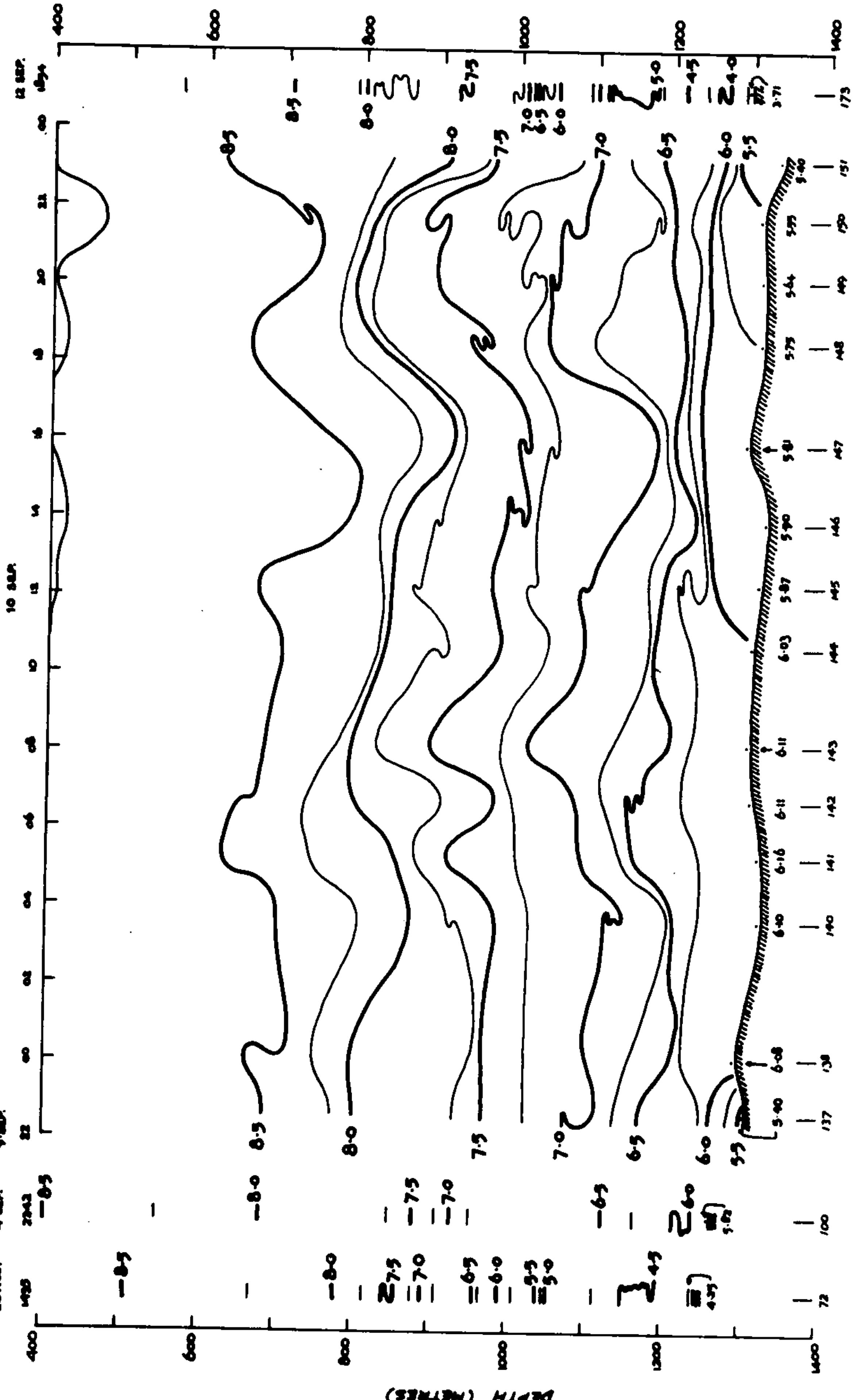

Fig. 6
Temperature-depth-time isopleths for position G (from STD traces)

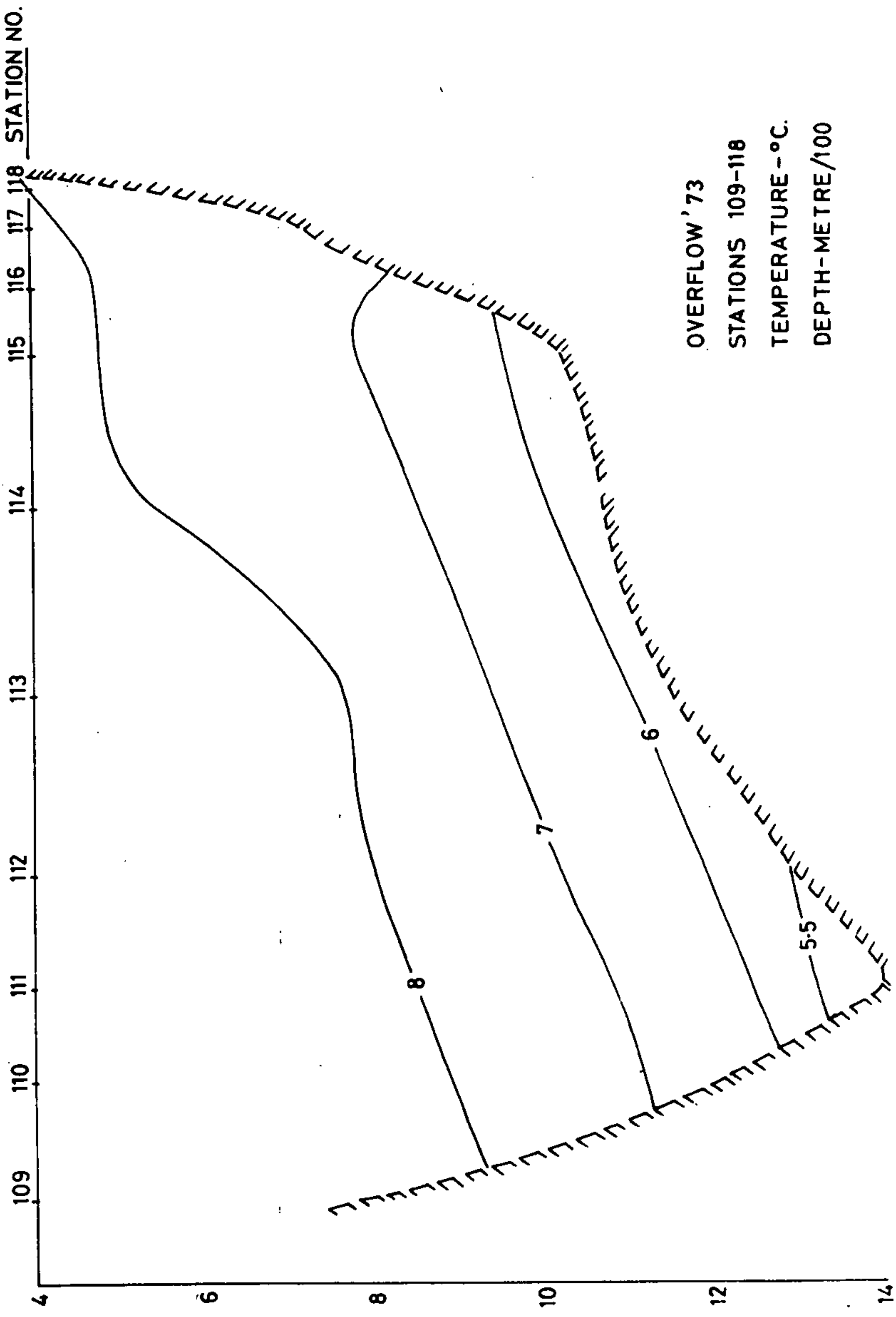

Fig. 7

Temperature section, Rosemary Bank (left)
to Bill Bailey's Bank,
5-6 September 1973