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Oceanographic and Biological Data Relating to Short-Finned Squid (*Illex illecebrousus*) Southern Florida, January 1986

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Canadian Data Report Of Hydrography and Ocean Sciences

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Canadian Data Report of
Hydrography and Ocean Sciences No. 111

1992

OCEANOGRAPHIC AND BIOLOGICAL DATA RELATING TO SHORT-FINNED SQUID (*ILLEX ILLECEBROSUS*) SOUTHERN FLORIDA, JANUARY 1986

by

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ABSTRACT

Petrie, L. 1992. Oceanographic and biological data relating to short-finned squid (*Illex illecebrosus*), southern Florida, January 1986. Can. Data Rep. Hydrog. Ocean Sci. 111: vii + 47 pp.

Measurements of abundance, distribution and biological characteristics of larval and juvenile *Illex illecebrosus* taken in January 1986 are presented together with temperature (T), salinity (S), sigma-theta (σ_θ), nutrients and chlorophyll-a in the vicinity of the western edge of the Gulf Stream off the Atlantic coast of Florida between 25°25′N and 29°00′N latitude.

RESUME

Petrie, L. 1992. Oceanographic and biological data relating to short-finned squid (*Illex illecebrosus*), southern Florida, January 1986. Can. Data Rep. Hydrog. Ocean Sci. xxx: vi + 47 pp.

On présente des mesures de l'abondance, de la distribution et des caractéristiques biologiques de *Illex illecebrosus* à l'état larvaire et à l'état juvénile, prises en janvier 1986. On présente également des données sur la temperature (T), sur la salinité (S), sur sigma-theta (σ_θ), sur les matières nutritives et sur la chlorophylle-a aux alentours de limite ouest du Gulf Stream au large de la côte atlantique de Floride, entre 25°25′ et 29°00′ de latitude Nord.

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INTRODUCTION

This report presents biological and physical oceanographic data collected during R/V Alfred H. Needler cruise number 56, off south Florida, during 8-28 January, 1986. This was one in a series of cruises to determine the abundance, distribution, and types of larval and juvenile short-finned squid (*Illex Illecebrosus*) in the frontal zone between Gulf Stream Water and Slope Water from Chesapeake Bay to Florida. An additional goal was to determine the role oceanographic processes, including the Gulf Stream, play in the squid distribution and transport. Two other cruises in this series were C.S.S. Hudson Cruise 84-049, sampling from Jacksonville, Florida to Cape Hatteras from 11-14 December, 1984, and R/V Alfred H. Needler Cruise 85-001, sampling from southern Florida to Cape Hatteras from 7-22 January, 1985 (Trites and Rowell, 1985).

R/V Alfred H. Needler Cruise Number 56

After departing Halifax, Nova Scotia, the ship steamed to approximately 29°00'N, 76°30'W and commenced Transect I, a line of 12 stations running southwestward to 27°14'N, 79°58'W. The sampling at each station consisted of an oblique bongo net tow, a CTD cast and a mid-water trawl. XBTs were released between stations, beginning after station 6 (Table I).

At the shoreward end of Transect I, a series of 15 bottom trawls were conducted in the area roughly bounded by 27°15'N to 27°50'N and 79°49'W to 80°10'W (Fig. 1). Hydrographic sampling (bottle casts) or XBTs were done at all but two of these trawl stations (Table I).

Following the bottom trawling phase, an effort was made to locate a patch of water bearing a high concentration of larvae and/or juveniles. Ten stations were occupied on two separate tracks and consisted of oblique bongo net tows, mid-water trawls, and XBTs (Fig.1, Table I).

The majority of sampling took place during multiple occupations of three transect lines. The first, (**N**), was located north of Cape

Canaveral along 29°00'N, from 79°20'W to 80°20'W. The second was line (**C**), west of Grand Bahama Island along 26°30'N, from 79°21'W to 80°00'W, and the final sampling line, (**S**), was east of Key Largo along 25°25'N, from 79°41'W to 80°04'W (Fig. 1).

Lines **N** and **C** were each occupied 6 times; line **N** from 17-21 January, and line **C** from 22-26 January . Sampling on both lines consisted of bongo net tows, CTDs, XBTs, and Tucker trawls. Additionally, during one occupation of each line, temperatures, salinities, nutrients, and chlorophylls were measured. Another occupation of each of these lines included mid-water trawling.

The sampling procedure on line **S** corresponded to that for lines **N** and **C**; however, line **S** was occupied only 4 times. Details of the measurements taken along these three lines appear in Table I.

METHODS AND SAMPLING

Physical Oceanography

The temperature and salinity measurements were taken using a portable, continuous profiling Guildline CTD (Model 8770) and recorded on cassette tape. The temperature resolution was ±0.02°C, ±0.04 for salinity and ±2.0 dBar for pressure. The data were processed at BIO using a Hewlett-Packard 1000 computer. Potential densities were calculated from the temperature and salinity measurements using the UNESCO 1980 formulation and are expressed in sigma-θ units. Calibration of temperature and salinity measurements was accomplished by comparison with surface bucket samples taken during each cast.

Water samples from hydrographic casts were obtained using Niskin bottles (5 l). The series of hydrographic stations during the bottom trawling phase of the cruise consisted of two bottles only, surface and near bottom, fitted with reversing thermometers and generating *in situ* measurements of both temperature and salinity. The hydrographic stations of Lines **N** , **C** , and **S** contained as many as ten Niskin bottles, depending on station depth. Reversing

thermometers were placed on the surface and deepest bottles. Salinity, phosphate, nitrate, silicate and chlorophyll-a samples were drawn from all bottles. The samples for nutrient analysis (phosphate, nitrate and silicate) were taken in 30 ml Nalgene vials, quickly frozen and stored at approximately -20°C. Samples were analyzed at BIO using standard methods (Strickland and Parsons, 1968) with a Technicon AutoAnalyzer II, sub-sampling the 30 ml vials to obtain triplicate results. Averaged values were used in reporting the nutrient concentrations. In cases where one of the three values differed appreciably from the other two, it was discarded. Values reported are micromolar (μM). Chlorophyll-a samples (250 ml) along with one drop of 1% magnesium carbonate ($MgCO_3$) were filtered through Millipore type HA 0.45 μm filters. The filters were then frozen pending analysis at BIO. The analysis followed standard methods (Yentsch and Menzel, 1963; Holm-Hansen *et al.*, 1965) using a Turner Model 10 Fluorometer. Values are reported in micrograms/litre (μg/l).

Biology

Biological sampling consisted of various combinations of bongo tows, Tucker trawls, mid-water trawls and bottom trawls (Table I). Standard MARMAP bongo nets of 505 μm mesh were towed obliquely with a ship's speed of 2.0-2.5 knots to maintain a 45° wire angle. Wire was deployed at 50 m/min and retrieved at 20 m/min. For all stations of sufficient depth, the tow was taken to 150 m. General Oceanics flow meters were centered in both bongo net openings.

The Tucker trawling operations were the same as those for the bongo tows. The mesh on the Tucker trawl was also 505 μm, and the net opening was 2.5 m x 2 m. It is important to note that the effective opening of the net would vary with depth and towing speed. Flow meters were not used with the Tucker trawl.

The mid-water trawls (Diamond IX) were also towed obliquely. Where depth permitted, the tows were to a maximum of 150 m. Trawl time was approximately 30 minutes.

Bottom trawling operations off Fort Pierce (Fig. 1) consisted

of 30 minute tows with a Western IIA trawl.

Processing of Biological Samples

All plankton were preserved in 5% buffered formalin for at least two days. As time permitted, the formalin was exchanged for, or the sample transferred to, 70% ethanol.

Catches from the mid-water trawls were sorted and all juvenile *Illex* and other cephalopods removed. Where time permitted, dorsal mantle lengths of up to 50 *Illex* were measured to the nearest millimeter. A random sub-sample of up to 2 litres of each mid-water catch was fixed in 10% formalin.

Juvenile *Illex* were initially fixed in 10% formalin for 3 days, then transferred to 70% ethanol. Occasionally, samples of a maximum of 50 individuals were preserved directly in 70% ethanol for aging studies.

Adult *Illex* were examined in detail and frozen. Representative samples were preserved in 70% ethanol. Gonads from mature specimens were preserved in Bouin's solution; the specimen from which they were taken was preserved in ethanol.

DATA PRESENTATION

Detailed information on tabular and graphic presentations is available in the List of Tables and List of Figures. Some further information is presented below.

Table I presents station and sampling information for the cruise. The order of sampling at stations was normally bongo tow, hydrographic measurements and then trawling. Dates are January, 1986 and times are UCT. The start and stop times refer to the start of the first sampling procedure and the end of the last. All latitudes are north, all longitudes are west. The positions shown refer to the start of the first sampling procedure. The reader should be aware that a difference of several nautical miles between the start and end positions of sampling were not uncommon.

Table II shows catches of squid (labelled **A**, **B**, **C** and

UNIDENTIFIED types of larvae/early juveniles). Type **C** is *Illex Illecebrosus.* Also presented are some larvae/early juveniles identified as **A-B** (definitely not **C**) and some as **B-C** (definitely not **A**). Tables III through V present lengths of those samples which were identified by type. Lengths that appear in parentheses represent early juveniles.

In Figures 3-8, 10-15 and 17-20; which are cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram, the numbers on the diagrams refer to sequential CTD numbers, as presented in Table I.

Figures 23-25 show the size distribution of clearly identified larvae and early juveniles. In viewing these diagrams it is important for the reader to remember that lines **N** and **C** were sampled 6 times and line **S** was sampled only 4 times.

ACKNOWLEDGEMENTS

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TABLE I

STATION INFORMATION AND SAMPLING SUMMARY

STN#	DATE	START	STOP	LATITUDE	LONGITUDE	CTD	XBT	HYD	BON	TUC	MWT	BTM
		TRANSECT I										
1	13	08:24	10:32	29°00.07′	76°30.05′	1			X		X	
2	13	13:50	15:27	28°44.01′	76°59.88′	2			X		X	
3	13	19:11	21:06	28°28.80′	77°29.65′	3			X		X	
4	14	00:57	02:37	28°13.25′	77°59.60′	4			X		X	
5	14	05:58	07:46	27°51.89′	78°30.00′	5			X		X	
6	14	10:35	12:12	27°41.61′	79°00.21′	6			X		X	
	14	13:20		27°39.07′	79°02.20′		1					
7	14	13:58	15:27	27°36.03′	79°08.42′	7			X		X	
	14	15:55		27°34.78′	79°14.38′		2					
8	14	16:35	18:11	27°30.66′	79°18.66′	8			X		X	
	14	18:42		27°28.14′	79°25.16′		3					
9	14	19:17	20:53	27°25.94′	79°28.95′	9			X		X	
	14	21:30		27°22.74′	79°34.89′		4					
10	14	22:11	23:45	27°20.85′	79°38.48′	10			X		X	
	15	00:05		27°17.74′	79°48.92′		5					
11	15	01:24	01:39	27°15.96′	79°47.53′	11			X		X	
	15	04:06		27°13.73′	79°53.20′		6					
12	15	04:41	06:00	27°13.74′	79°57.76′	12			X		X	
		BOTTOM TRAWLING										
13	15	08:50	09:20	27°14.90′	80°02.48′			X				X
14	15	10:04	10:34	27°13.41′	79°49.35′			X				X
15	15	11:44	12:14	27°20.81′	79°48.56′			X				X
16	15	14:25	14:55	27°20.65′	80°03.32′			X				X
17	15	15:40	16:10	27°27.15′	80°03.11′			X				X
18	15	18:11	18:41	27°27.94′	79°48.76′			X				X
19	15	19:47	20:18	27°32.97′	79°49.67′			X				X
20	15	22:21	22:51	27°33.94′	79°59.74′		7	X				X
21	15	23:50	00:20	27°34.71′	80°08.27′							X
22	16	00:54	01:24	27°39.82′	80°09.78′		8					X

TABLE I continued

STN#	DATE	START	STOP	LATITUDE	LONGITUDE	CTD	XBT	HYD	BON	TUC	MWT	BTM
23	16	02:16	02:46	27°40.64′	79°59.82′		9					X
24	16	04:20	04:50	27°40.80′	79°50.07′		10					X
25	16	05:47	06:17	27°47.85′	79°49.04′		11					X
26	16	07:48	08:18	27°47.99′	80°00.09′		12					X
27	16	09:25	09:55	27°48.14′	80°09.06′							X
		LARVAL/JUVENILE SEARCH TRACK										
28	16	12:15	13:26	27°57.11′	79°59.18′		13		X		X	
29	16	14:19	15:24	27°56.93′	79°54.16′		14		X		X	
30	16	16:25	17:44	27°58.65′	79°49.32′		15		X		X	
31	16	19:55	21:09	28°00.06′	79°44.09′		16		X		X	
32	16	23:49	00:59	28°23.46′	79°30.20′		17		X		X	
33	17	02:15	03:21	28°25.25′	79°34.66′		18		X		X	
34	17	04:03	05:21	28°27.45′	79°40.52′		19		X		X	
35	17	06:07	07:27	28°29.21′	79°45.77′		20		X		X	
36	17	08:08	09:30	28°31.03′	79°50.85′		21		X		X	
37	17	11:11	12:42	28°33.94′	79°56.16′		22		X		X	
	17	13:21		28°34.77′	80°01.21′		23					
		LINE **N**										
38	17	16:15	18:07	28°59.66′	80°19.58′	13			X	X		
39	17	18:48	19:47	29°00.00′	80°13.88′	14			X	X		
40	17	20:24	21:11	28°59.92′	80°08.45′	15			X	X		
41	17	22:02	23:07	29°00.51′	80°02.94′	16			X	X		
42	17	23:49	01:36	29°00.92′	79°57.13′	17			X	X		
43	18	02:35	04:02	29°00.20′	79°50.76′	18			X	X		
44	18	04:42	06:27	29°00.00′	79°45.22′	19			X	X		
45	18	07:21	08:41	28°59.84′	79°39.36′	20			X	X		
46	18	09:27	11:25	28°59.81′	79°33.59′	21			X	X		
47	18	12:04	13:20	29°00.30′	79°28.33′	22			X	X		
	18	13:50		29°00.14′	79°22.95′		24					
48	18	15:47	17:48	29°00.30′	79°45.37′	23			X	X		
	18	18:15		28°59.87′	79°47.42′		25					
49	18	18:38	20:19	29°00.01′	79°51.15′	24			X	X		
	18	20:45		29°00.39′	79°53.70′		26					

TABLE I continued

STN#	DATE	START	STOP	LATITUDE	LONGITUDE	CTD	XBT	HYD	BON	TUC	MWT	BTM
50	18	21:03	23:07	29°00.04′	79°56.94′	25			X	X		
	18	23:20		29°00.64′	80°00.96′		27					
51[1]	18	23:31	00:57	29°00.24′	80°02.48′	26			X	X		
52	19	01:27	03:45	29°00.13′	79°57.34′	27			X	X		
53	19	04:30	06:16	29°00.04′	79°50.97′	28			X	X		
54	19	06:54	08:43	28°59.92′	79°45.23′	29	28		X	X		
55[2]	19	09:15	10:37	28°59.94′	79°51.02′	30			X			
56	19	12:12	14:10	29°00.35′	79°39.73′	31			X	X		
57	19	14:54	16:26	29°00.22′	79°33.23′	32	29		X	X		
58	19	17:12	18:58	29°00.04′	79°39.55′	33			X	X		
59	19	19:36	21:14	29°00.08′	79°45.40′	34			X	X		
60	19	22:08	23:37	29°00.33′	79°50.92′	35			X	X		
61	20	00:09	02:10	29°00.32′	79°56.83′	36	30		X	X		
62	20	03:30	06:27	29°00.11′	80°01.97′	37			X	X	X	
63	20	07:10	09:06	29°00.23′	79°57.14′	38			X		X	
64	20	10:07	12:08	29°00.73′	79°51.34′	39			X		X	
65	20	12:57	14:47	29°00.17′	79°45.38′	40			X		X	
66	20	15:52	20:03	29°00.37′	79°40.32′	41		X	X	X	X	
67	20	20:41	00:12	29°00.40′	79°45.84′	42		X	X	X	X	
68	21	01:02	05:21	29°00.31′	79°51.08′	43		X	X	X	X	
69	21	05:59	09:26	29°01.37′	79°57.62′	44		X	X	X	X	
70	21	10:25	16:41	29°00.17′	80°02.41′	45		X	X	X	X	
71	21	16:24	17:18	29°01.10′	80°08.67′	46		X	X	X		
72	21	18:14	19:06	29°00.40′	80°14.07′	47		X	X	X		
73[3]	21	19:52	20:43	29°00.40′	80°19.93′	48		X	X	X		
		LINE C										
74	22	18:11	19:07	26°30.00′	79°59.97′	49			X	X		
75	22	19:40	21:10	26°30.03′	79°54.33′	50			X	X		
76	22	21:58	23:55	26°30.92′	79°48.25′	51			X	X		
77	23	00:19	01:54	26°30.32′	79°43.59′	52			X	X		
78	23	02:33	04:04	26°30.54′	79°38.52′	53			X	X		

1 TUCKER TRAWL, BONGO TOW ORDER REVERSED THIS SET

2 BRIDGE HEADED WEST IN ERROR ON THIS **W →→ E** TRANSECT

3 TUCKER TRAWL, BONGO TOW ORDER REVERSED THIS SET

TABLE I continued

STN#	DATE	START	STOP	LATITUDE	LONGITUDE	CTD	XBT	HYD	BON	TUC	MWT	BTM
79	23	04:43	06:36	26°30.00′	79°32.60′	54			X	X		
80	23	06:57	08:32	26°30.02′	79°27.28′	55			X	X		
81	23	09:07	10:36	26°30.03′	79°21.44′	56			X	X		
82	23	11:08	12:46	26°30.44′	79°27.76′	57			X	X		
83	23	13:23	14:46	26°30.37′	79°33.27′	58			X	X		
84	23	15:12	16:29	26°30.04′	79°37.77′	59			X	X		
85	23	17:16	19:04	26°30.56′	79°43.49′	60			X	X		
86	23	19:46	21:38	26°30.52′	79°48.03′	61			X	X		
87	23	22:18	23:45	26°30.28′	79°54.23′	62			X	X		
88	24	00:16	01:32	26°30.13′	79°59.65′	63			X	X		
89	24	01:58	03:42	26°30.09′	79°54.78′	64			X	X		
90	24	04:25	05:47	26°30.05′	79°47.90′	65			X	X		
91	24	06:19	08:51	26°30.01′	79°43.35′	66			X	X		
92	24	08:27	10:11	26°29.89′	79°38.07′	67			X	X		
93	24	10:40	12:21	26°30.32′	79°32.88′	68			X	X		
94	24	12:50	14:31	26°30.02′	79°27.68′	69			X	X		
95	24	15:11	17:07	26°32.50′	79°35.04′	70	31		X	X		
96	24	17:39	19:08	26°29.91′	79°38.40′	71			X	X		
97	24	19:39	21:16	26°29.74′	79°43.57′	72			X	X		
98	24	22:02	23:49	26°29.77′	79°47.42′	73			X	X		
99	25	00:16	01:48	26°30.18′	79°54.32′	74			X	X		
100	25	02:15	03:25	26°31.37′	80°00.25′	75			X	X		
101	25	03:59	05:19	26°30.23′	79°54.64′	76			X	X		
102	25	05:51	07:36	26°30.30′	79°48.20′	77			X	X		
103	25	08:03	09:51	26°30.28′	79°43.07′	78			X	X		
104	25	10:48	13:45	26°30.26′	79°38.33′	79	32		X	X		
105	25	14:14	15:33	26°30.15′	79°33.12′	80			X	X		
106	25	16:09	19:42	26°30.09′	79°27.47′	81		X	X	X	X	
107	25	20:16	23:35	26°29.93′	79°32.57′	82		X	X	X	X	
108	26	00:06	03:17	26°30.18′	79°38.04′	83		X	X	X	X	
109	26	03:44	07:19	26°30.26′	79°42.97′	84		X	X	X	X	
110	26	07:49	11:16	26°29.70′	79°47.82′	85		X	X	X	X	
111	26	12:01	13:08	26°30.01′	79°54.42′	86		X	X			

TABLE I continued

STN#	DATE	START	STOP	LATITUDE	LONGITUDE	CTD	XBT	HYD	BON	TUC	MWT	BTM
112	26	14:09	17:02	26°29.95′	79°59.86′	87		X	X	X	X	
		LINE S										
113	26	23:13	00:14	25°25.27′	80°04.11′	88			X	X		
114	27	01:07	03:05	25°24.64′	79°58.19′	89			X	X		
115	27	04:03	05:46	25°24.99′	79°53.06′	90			X	X		
116	27	06:34	08:21	25°25.30′	79°47.21′	91			X	X		
117	27	10:03	11:50	25°25.23′	79°41.57′	92			X	X		
118	27	12:17	14:06	25°25.62′	79°47.40′	93			X	X		
119	27	14:36	16:20	25°25.23′	79°53.07′	94			X	X		
120	27	16:58	18:40	25°25.18′	79°58.64′	95	33		X	X		
121	27	19:21	20:45	25°25.31′	80°04.03′	96			X	X		
122	27	21:17	22:53	25°25.28′	79°58.32′	97			X	X		
123	27	23:28	01:19	25°25.81′	79°52.04′	98			X	X		
124	28	01:58	03:52	25°25.37′	79°46.89′	99			X	X		
125	28	04:39	07:29	25°25.47′	79°41.49′	100		X	X		X	
126	28	08:32	11:37	25°25.20′	79°47.54′	101		X	X		X	
127	28	12:24	14:49	25°25.40′	79°53.03′	102		X	X		X	
128	28	15:38	18:08	25°24.81′	79°58.86′	103		X	X		X	
129	28	18:39	20:23	25°25.12′	80°03.98′	104		X	X		X	

TABLE II

CATCHES OF LARVAE / EARLY JUVENILES

STN#	TYPE A		TYPE B		TYPE C		UNIDENTIFIED
30	1						1
36	1						
38			3		7		
40					1		
41							1
42	7		4		7		1
44	1		2		1		
45	1		1		1		
48	1				2		
49	5		2		2		1
50			5				
51	1						
52	2				5		1
53	6	1[1]	5		10		1
54			1				
58	1						
59					1		
60	2						
61	4		5		5		5
64							1
66	1			1[2]			
67	1		2				1
68	3		3		2		1
69	2	1	1		1		1

1 NUMBERS IN THIS INTERCOLUMNAR AREA OF TABLE II REPRESENT LARVAE THAT ARE TYPE A OR B BUT DEFINITELY NOT TYPE C .LENGTHS OF "A-B" TYPES WILL APPEAR WITH TYPE A LENGTHS IN TABLE III.

2 NUMBERS IN THIS INTERCOLUMNAR AREA OF TABLE II REPRESENT LARVAE THAT ARE TYPE B OR C BUT DEFINITELY NOT TYPE A .LENGTHS OF "B-C" TYPES WILL APPEAR WITH TYPE B LENGTHS IN TABLE IV.

TABLE II continued

CATCHES OF LARVAE / EARLY JUVENILES

STN#	TYPE A		TYPE B		TYPE C	UNIDENTIFIED
70	17		4		4	1
71	3		4		4	2
72			1			
74	2		1		9	2
75	2		1			2
76	1		1		1	1
77	4		2		1	1
78	3		1		3	3
79			2		5	
80			2			
81	5		1		4	
82			1			
83	5	2			1	
84	7		5		2	5
85	8		5		8	4
86	1		2		2	
87	1				1	
88				1	12	6
89	3				3	
90						3
91	1		2			
92	5		4			1
93					2	1
94	5					
95					1	1
96					1	
97	6		4			1
98	3		1		5	2
99					2	
100			3		8	3
101	1				3	1

TABLE II continued

CATCHES OF LARVAE / EARLY JUVENILES

STN#	TYPE A		TYPE B	TYPE C	UNIDENTIFIED
102	6	1	4	4	4
103	1		3	6	
104	5		4	6	9
105			1		
106	2				
107	1				
108	5		1		
109	3		4	2	
110	8	9	5	8	1
111				2	
112			1	16	3
113			1	5	
114	4		4		2
115	6	3	4	8	7
116	1				
117	3	4	3	5	2
118	2		1	1	
119	4		3	2	1
120	5	11		9	6
121	4	2	1	17	1
122	5	1	1		5
123	2		3		3
125			1	1	
128				1	

TABLE III

TYPE A LARVAE / EARLY JUVENILES

STN#		CATCH-LENGTHS (mm)	TOTAL
30		3.6	1
36		2.6	1
42		2.5 2.8 3.8 2.7 2.3 3.5 3.1	7
44		2.8	1
45		2.5	1
48		3.7	1
49		3.5 1.9 2.0 2.4 3.4	5
51		2.3	1
52		2.1 2.0	2
53		1.9 2.0 2.3 4.2 4.2 2.5	6
53	A-B	3.0	1
58		1.5	1
60		2.6 3.8	2
61		3.2 3.5 3.3 3.1	4
66		3.0	1
67		2.7	1
68		4.4 2.8 3.4	3
69		2.1 2.4	2
69	A-B	5.0	1
70		1.7 2.2 2.6 3.2 3.4 3.6 3.8 3.8 4.0	
		4.0 4.2 5.6 1.9 3.0 3.0 2.8 3.8	17
71		2.3 2.4 3.8	3
74		1.7 1.8	2
75		2.8 3.5	2
76		4.8	1
77		2.4 2.5 2.2 2.8	4
78		2.2 2.8 2.9	3
81		2.0 3.4 3.6 3.6 4.8	5
83		2.2 3.0 3.3 4.8 2.7	5
83	A-B	2.4 5.1	2
84		2.0 2.3 3.0 2.5 4.0 4.0 3.8	7

TABLE III continued

TYPE A LARVAE / EARLY JUVENILES

STN#		CATCH-LENGTHS (mm)	TOTAL
85		1.9 2.0 2.2 2.6 2.8 3.5 3.4 4.4	8
86		1.6	1
87		5.1	1
89		2.0 3.3 5.0	3
91		2.3	1
92		1.6 3.0 3.1 3.5 2.4	5
94		3.0 3.2 3.5 3.8 4.2	5
97		1.8 1.8 2.0 2.0 2.6 2.8	6
98		2.3 2.6 3.2	3
101		2.9	1
102		2.2 1.9 3.5 4.2 4.2 5.3	6
102	A-B	3.9	1
103		2.1	1
104		1.7 2.0 2.2 3.5 3.7	5
106		2.0 1.7	2
107		3.9	1
108		1.6 2.0 2.6 2.0 2.2	5
109		1.4 1.9 4.2	3
110		2.0 2.5 2.8 2.8 3.1 3.7 4.0 4.6	8
110	A-B	2.0 2.6 3.0 3.4 3.4 3.2 3.6 3.8 5.6	9
114		3.3 3.6 5.0 5.0	4
115		1.7 1.7 3.3 3.9 4.6 1 head	6
115	A-B	2.2 2.2 3.4	3
116		3.9	1
117		2.5 2.0 3.0	3
117	A-B	3.0 7.5 4.4 4.7	4
118		2.4 2.4	2
119		2.1 2.5 3.0 4.6	4
120		2.1 2.2 2.8 3.0 (5.4)	5
120	A-B	1.8 1.8 2.0 2.2 2.6 2.8 2.8 2.9 3.4 3.6 3.6	11
121		3.5 4.0 3.5 3.6	4

TABLE III continued

TYPE A LARVAE / EARLY JUVENILES

STN#		CATCH-LENGTHS (mm)	TOTAL
121	A-B	3.5 1.8	2
122		2.7 3.5 3.8 4.1 1 head	5
122	A-B	2.4	1
123		2.2 2.4	2

TABLE IV

TYPE B LARVAE / EARLY JUVENILES

STN#		CATCH-LENGTHS (mm)	TOTAL
38		2.0 2.8 3.3	3
42		2.4 2.4 3.0 4.0	4
44		3.6 5.0	2
45		2.9	1
49		2.3 3.2	2
50		2.7 3.5 3.7 4.0 5.0	5
53		2.3 2.4 2.6 3.7 2.5	5
54		3.8	1
61		3.6 2.0 3.0 3.2 4.2	5
66	B-C	1.5	1
67		1.7 2.0	2
68		4.2 4.2 4.6	3
69		5.2	1
70		2.6 3.0 3.4 4.8	4
71		4.2 4.7 4.8 5.4	4
72		4.5	1
74		1.8	1
75		3.1	1
76		3.1	1
77		4.0 4.8	2
78		3.6	1
79		2.6 2.8	2
80		4.6 2.9	2
81		5.5	1
82		4.4	1
84		4.0 5.4 2.0 2.5 4.0	5
85		2.8 3.5 4.2 4.6 5.2	5
86		4.3 4.8	2
88	B-C	4.3	1
91		2.5 3.3	2
92		4.8 5.2 2.0 3.0	4

TABLE IV continued

TYPE B LARVAE / EARLY JUVENILES

STN#	CATCH-LENGTHS (mm)	TOTAL
97	2.8 2.0 2.0 3.0	4
98	(5.4)	1
100	1.9 2.5 2.8	3
102	2.8 3.1 4.0 (5.2)	4
103	1.7 4.0 3.0	3
104	1.6 1.8 2.1 2.6	4
105	4.4	1
108	3.1	1
109	2.0 4.7 3.8 (5.0)	4
110	1.7 2.2 2.8 3.2 4.4	5
112	5.0	1
113	2.5	1
114	2.6 (4.5) (5.0) (5.3)	4
115	1.5 2.0 2.2 3.0	4
117	2.1 3.0 2.9	3
118	4.1	1
119	1.5 2.0 2.2	3
121	1.8	1
122	3.8	1
123	1.6 2.0 2.1	3
125	3.2	1

TABLE V

TYPE C LARVAE / EARLY JUVENILES

STN#	CATCH-LENGTHS (mm)	TOTAL
38	2.2 2.6 2.6 3.1 3.1 3.2 3.5	7
40	2.9	1
42	2.2 2.8 3.2 3.5 5.2 3.1 2.2	7
44	2.5	1
45	4.8	1
48	(5.4) (7.0)	2
49	2.0 3.1	2
52	1.5 1.5 1.5 1.5 1.6	5
53	2.0 2.0 2.2 2.5 2.5 2.8 2.8 3.0 2.0 2.5	10
59	3.2	1
61	2.2 3.7 4.6 2.2 1-no mantle	5
68	2.6 1.6	2
69	3.0	1
70	2.0 2.2 3.2 3.9	4
71	1.5 1.6 2.2 1-no mantle	4
74	2.3 1.4 1.4 1.5 1.5 1.6 1.6 1.7 1.8	9
76	2.5	1
77	4.0	1
78	1.9 2.5 (6.0)	3
79	1.8 1.9 2.0 2.8 (6.5)	5
81	2.4 2.3 2.5 2.8	4
83	1.5	1
84	2.3 2.1	2
85	1.6 2.4 2.4 3.0 3.2 3.4 2.5 4.0	8
86	2.3 2.0	2
87	2.5	1
88	1.5 1.8 2.0 3.0 4.5 5.2 5.6 2.5 3.2 3.5 4.5 2.0	12
89	1.6 1.9 2.0	3
93	2.0 2.0	2
95	2.0	1

TABLE V continued

TYPE C LARVAE / EARLY JUVENILES

STN#	CATCH-LENGTHS (mm)	TOTAL
96	2.1	1
98	1.8 3.2 3.8 2.6 5.0	5
99	1.6 1.8	2
100	1.5 1.7 1.8 2.0 2.4 3.8 2-dried,unmeasurable	8
101	2.0 2.4 2.2	3
102	2.6 1.5 3.5 2.6	4
103	2.0 2.2 1.9 3.1 3.4 (6.3)	6
104	1.5 1.5 1.6 2.1 2.3 3.0	6
109	1.9 3.5	2
110	1.3 1.4 1.7 2.4 2.5 2.6 1.4 2.3	8
111	1.7 2.1	2
112	1.9 1.9 2.1 2.2 2.3 2.3 2.4 2.8 2.9 3.0 3.3 3.8 4.4 4.4 1.8 1.7	16
113	1.7 2.0 2.4 2.6 2.0	5
115	1.5 1.5 1.7 2.1 2.2 3.0 3.0 1-unmeasurable	8
117	1.5 1.8 2.2 2.6 3.0	5
118	2.2	1
119	2.2 2.6	2
120	2.1 2.2 2.8 3.0 2.1 2.2 2.3 2.5 2.8	9
121	1.8 2.0 2.0 2.0 2.0 2.2 2.2 2.4 2.4 2.5 2.7 2.8 2.8 2.9 3.0 2.8 1-head	17
125	3.4	1
128	2.0	1

TABLE VI

ADULT SQUID CAPTURED

STN#	SEX	CATCH-LENGTHS (mm)	MATURITY STAGE	COMMENTS
7				Two illex captured, total weight 0.014 kg.
15	M	160	3	Mature
	F	165	3	Maturing
	F	175	3	Maturing
18	M	113	1	Immature
	M	145	4	Spent
	M	159	4	Spent
	F	165	5	Fully mature
19	M	125	2	Maturing
	M	130	2	Maturing
	F	124	3	Maturing
	F	130	3	Maturing
24	M	115	1	Immature
	M	120	2	Maturing
25	F	165	5	Fully mature

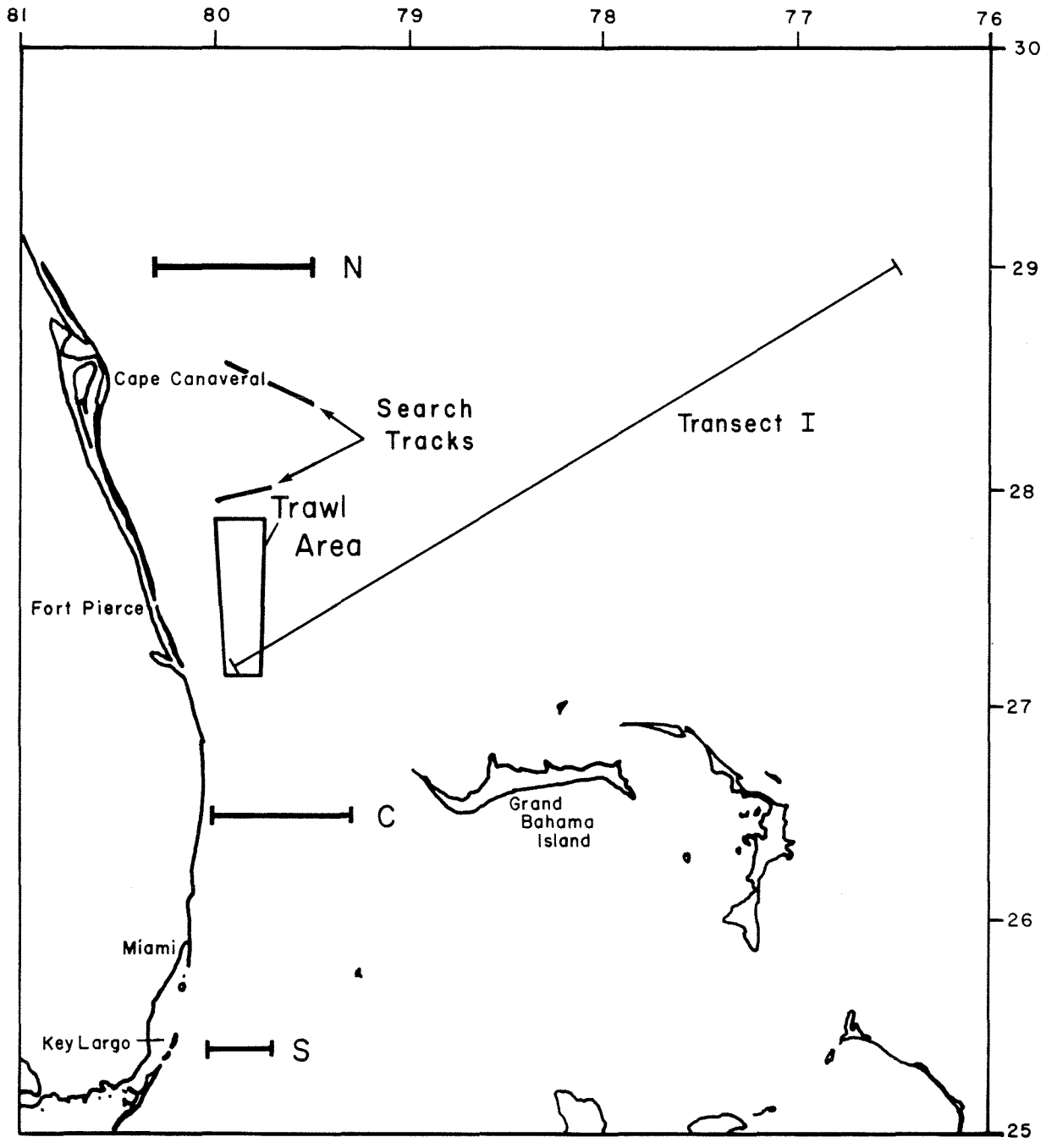

Fig. 1. Map depicting area of operation.

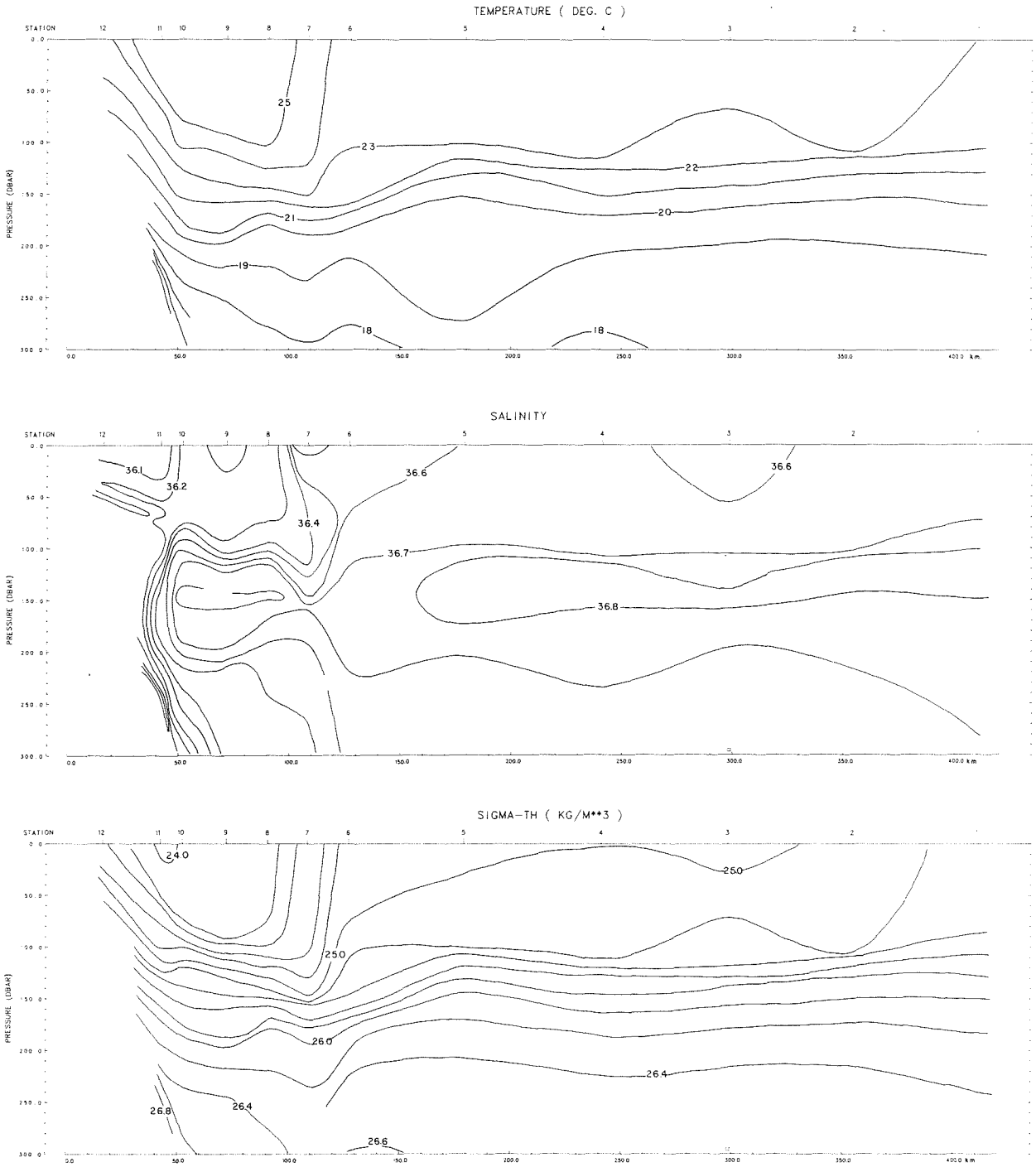

Fig. 2. Transect I , Stn. 1-12, CTDs 1-12. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

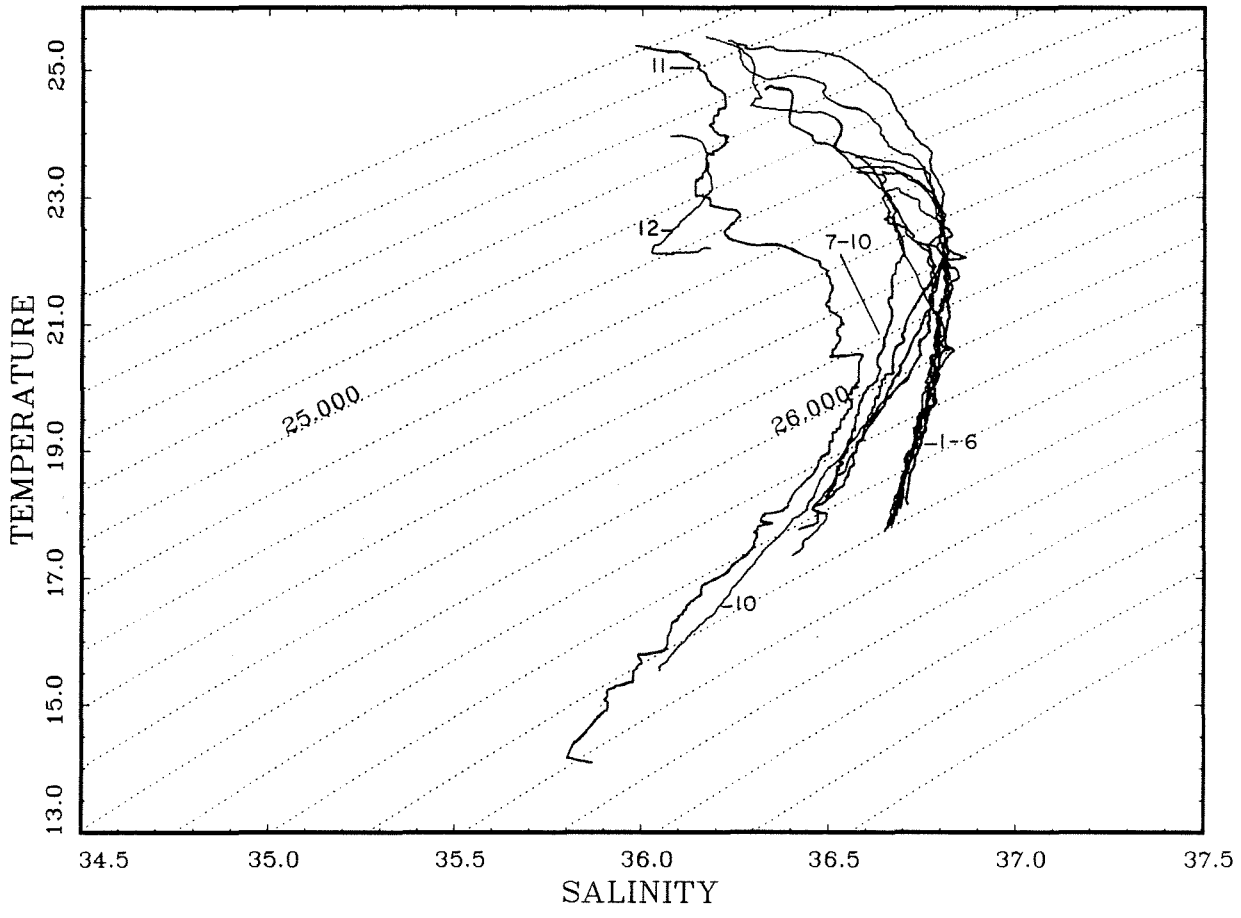

Fig. 3. Transect I , Stn. 1-12, CTDs 1-12. TS diagram.

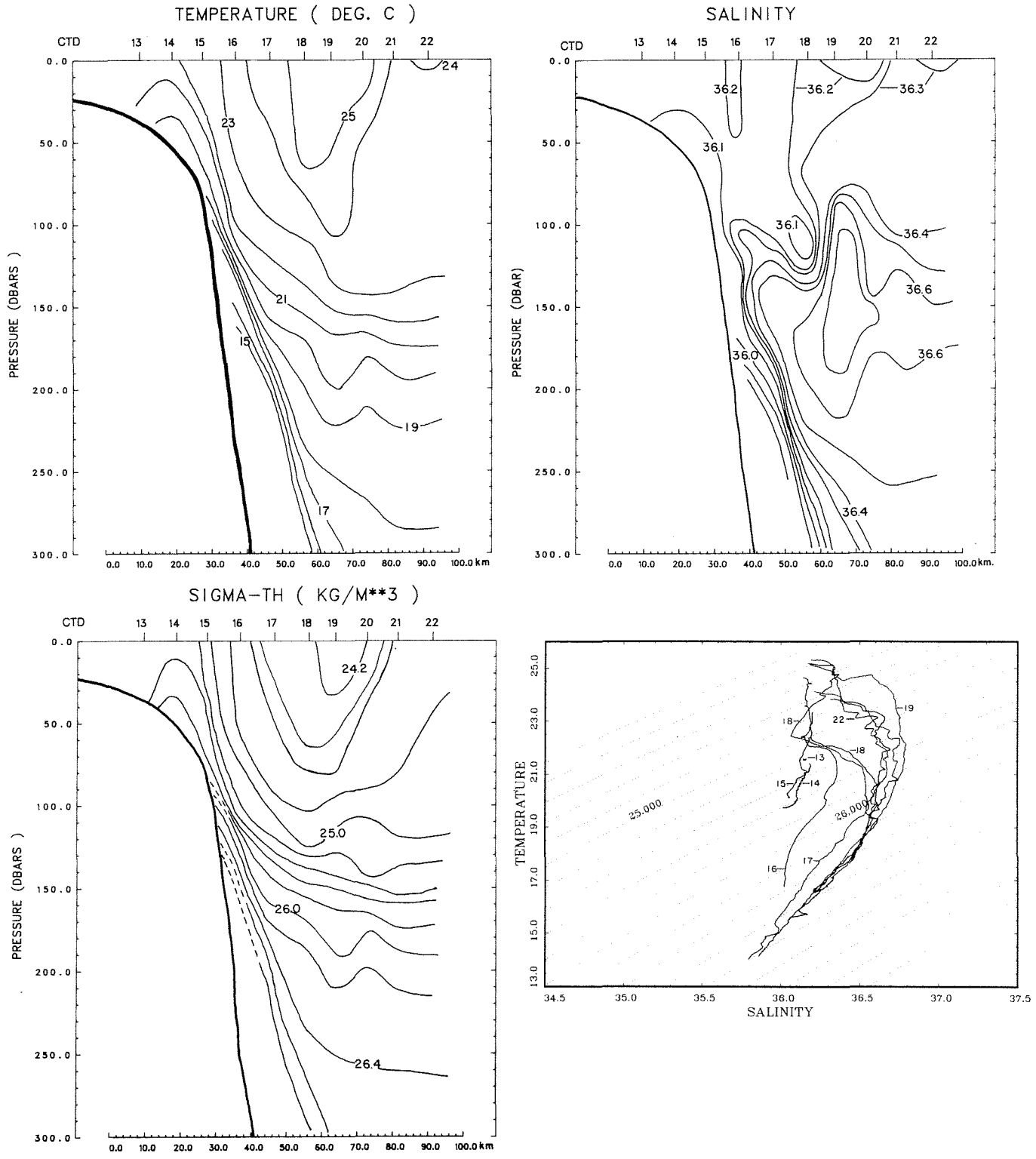

Fig. 4. Line **N** , Stn. 38-47, CTDs 13-22. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

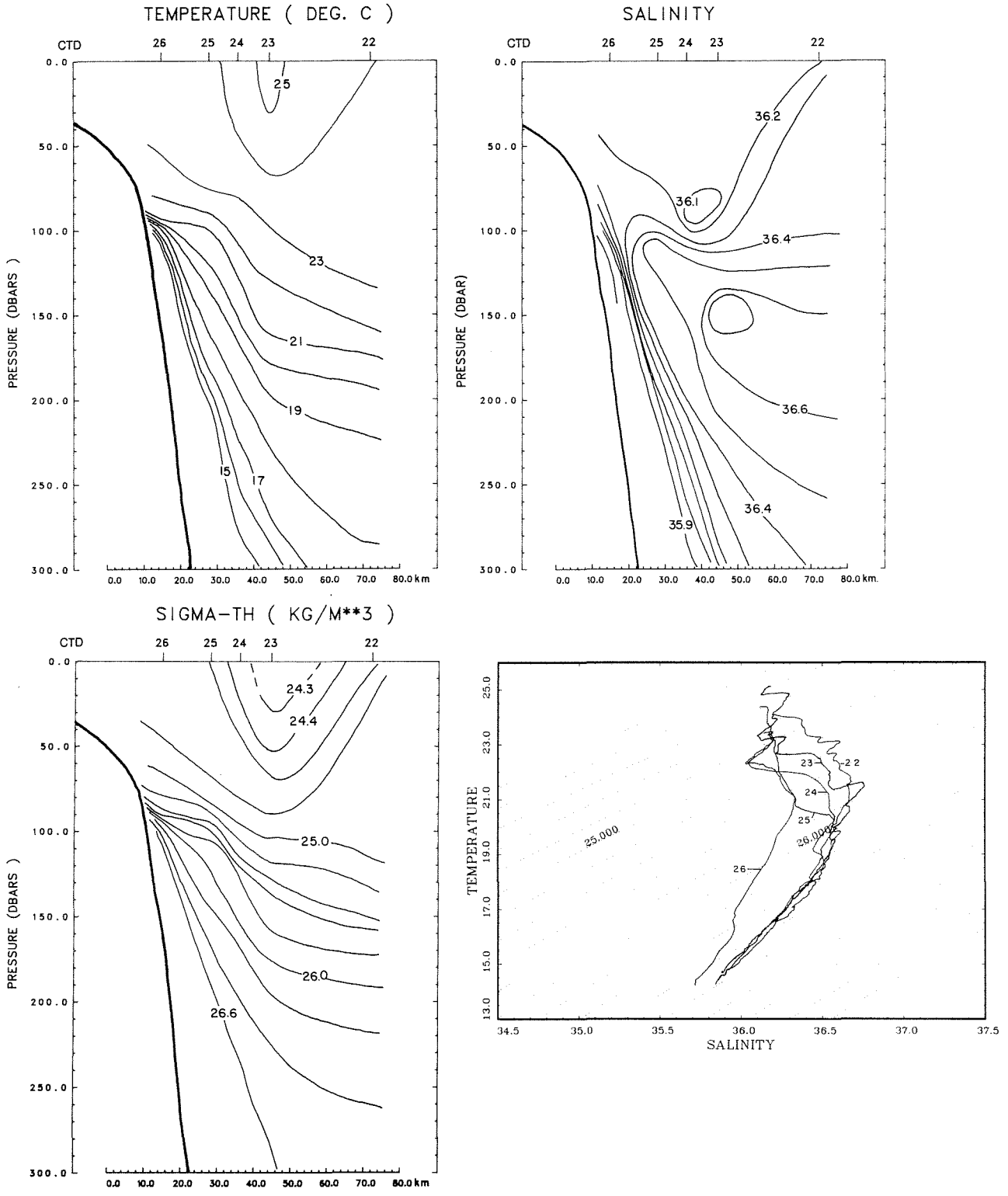

Fig. 5. Line **N** , Stn. 47-51, CTDs 22-26. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

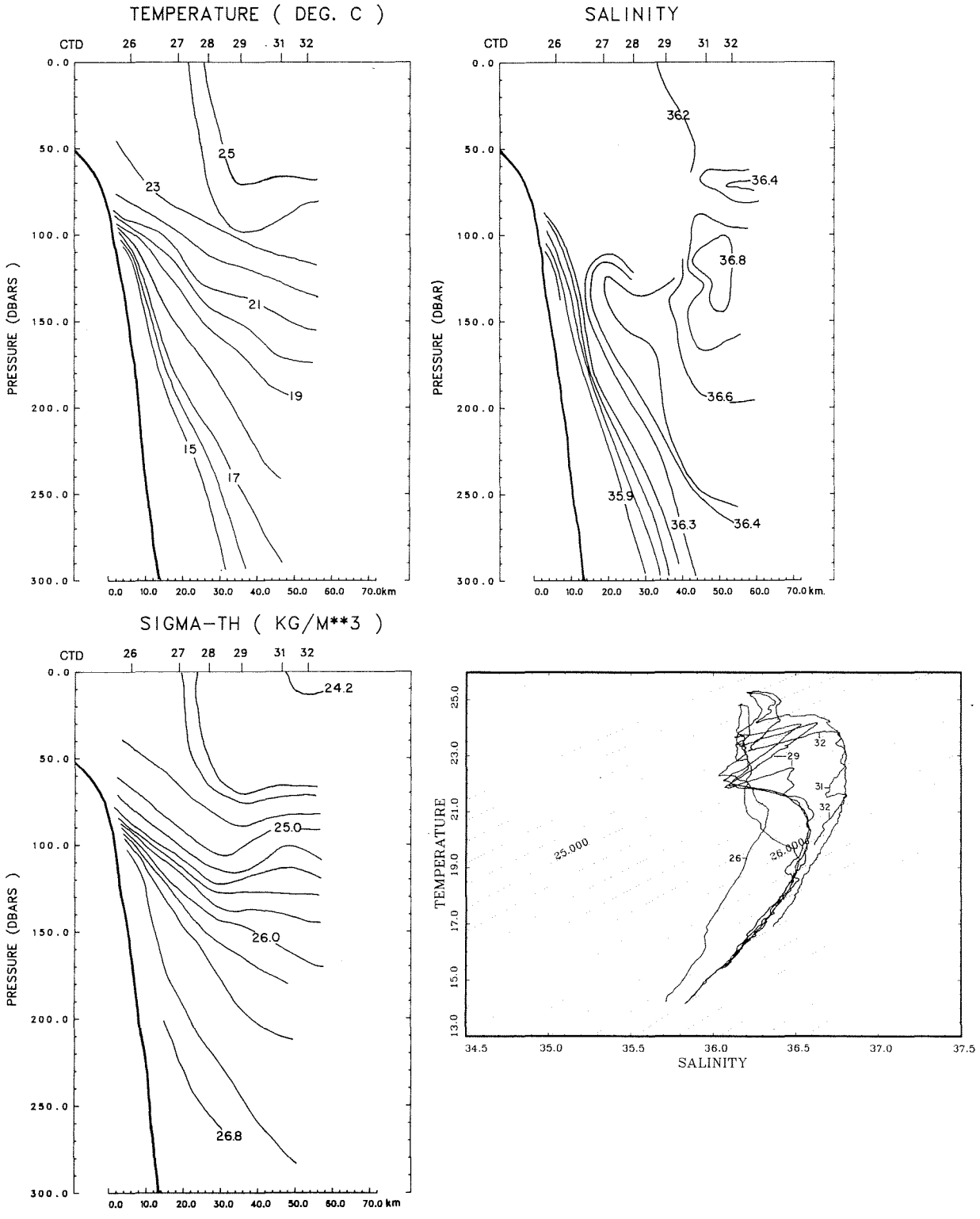

Fig. 6. Line **N** , Stn. 51-57, CTDs 26-32. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

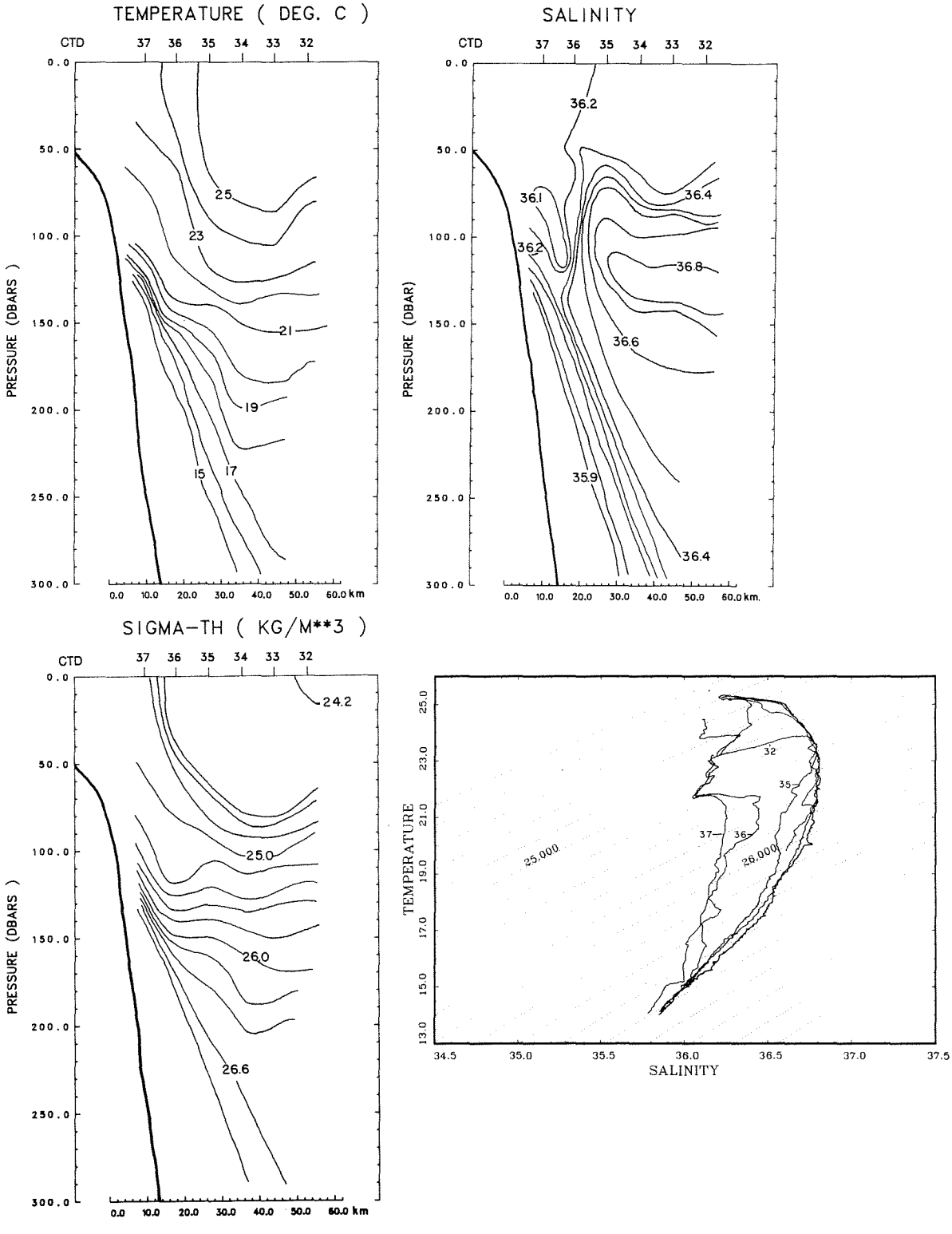

Fig. 7. Line **N** , Stn. 57-62, CTDs 32-37. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

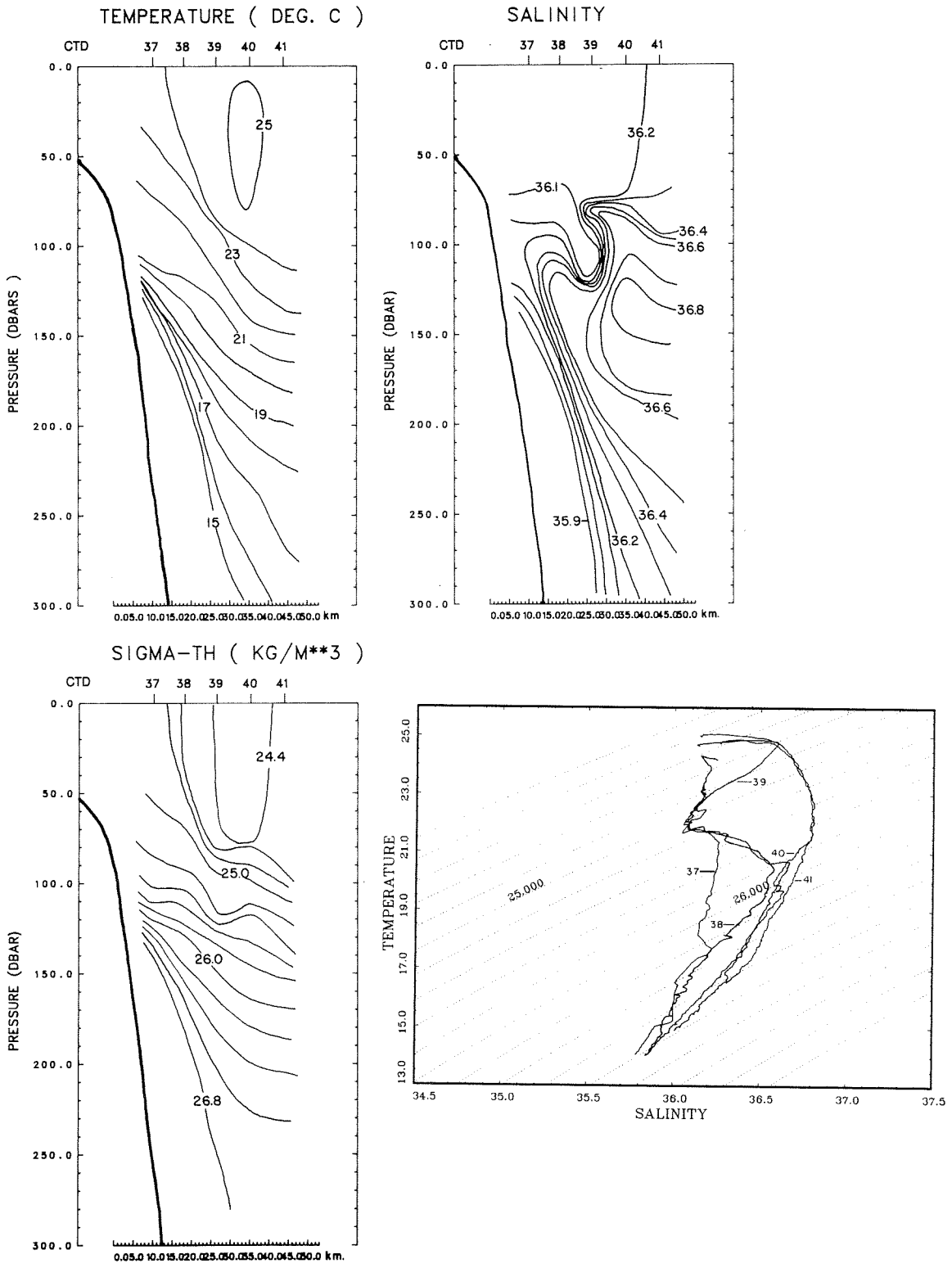

Fig. 8. Line **N** , Stn. 62-66, CTDs 37-41. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

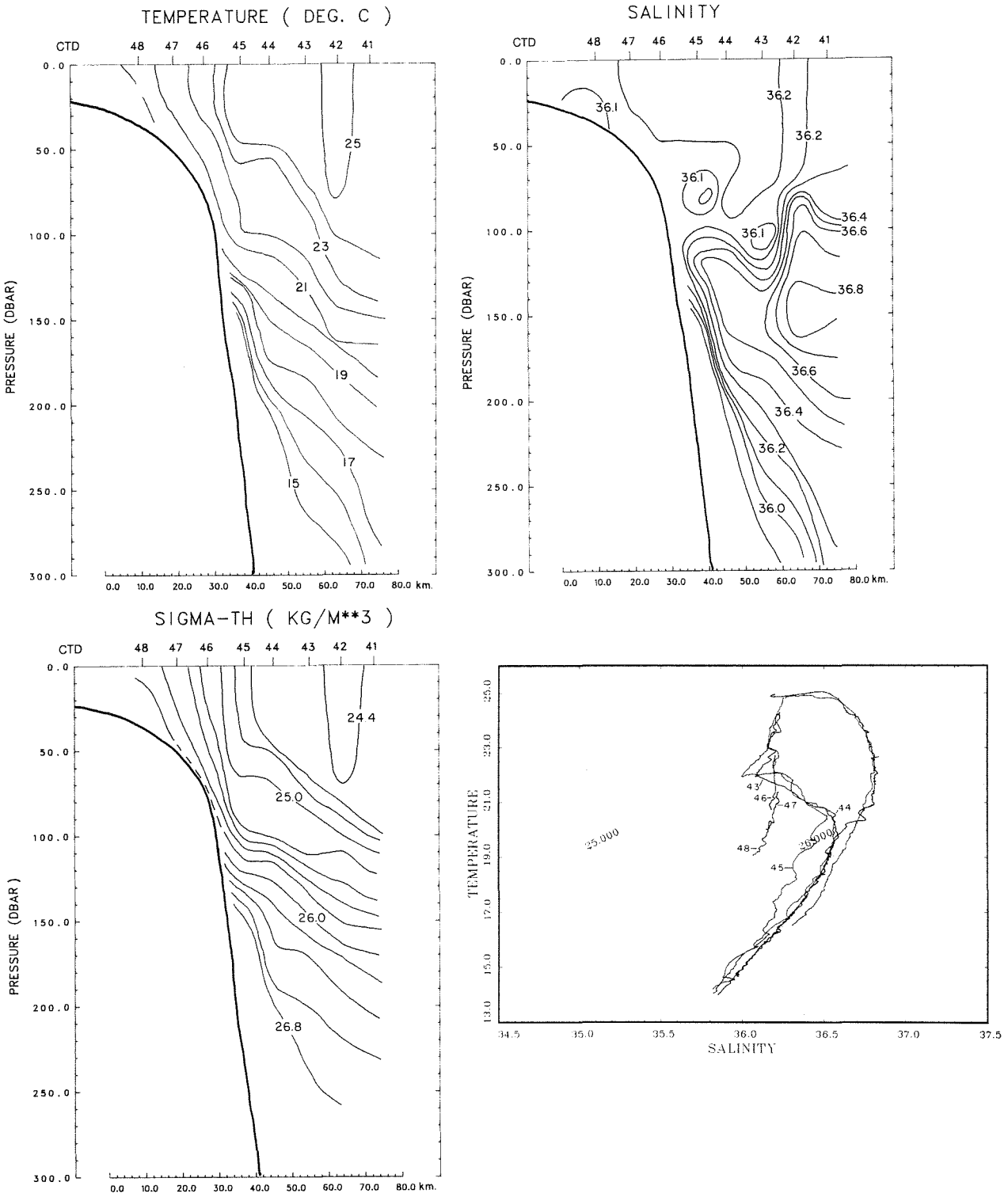

Fig. 9. Line **N** , Stn. 66-73, CTDs 41-48. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

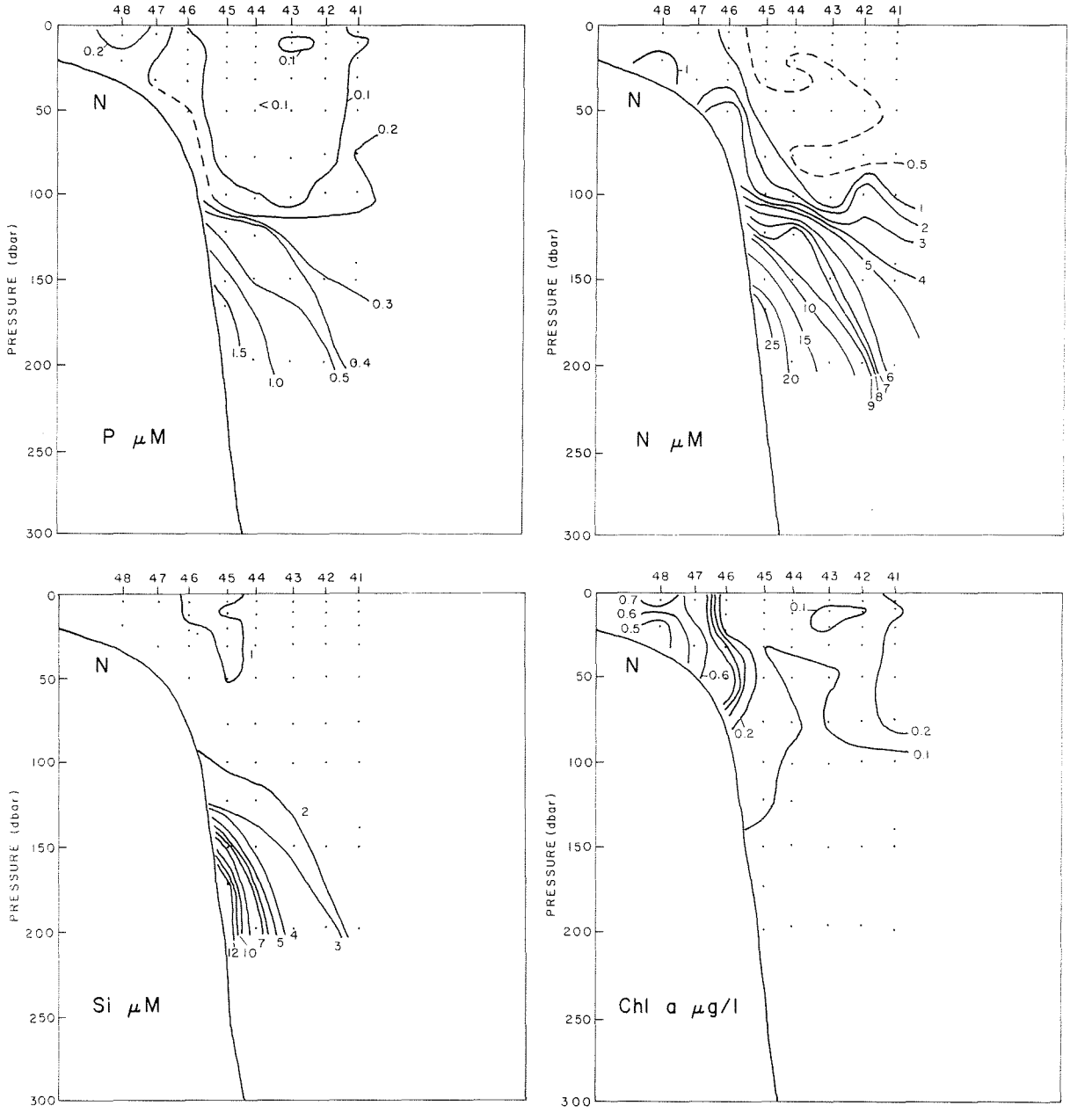

Fig. 10. Line **N** , Stn. 66-73, CTDs 41-48. Cross-section diagrams of phosphate, nitrate, silicate and chlorophyll-a.

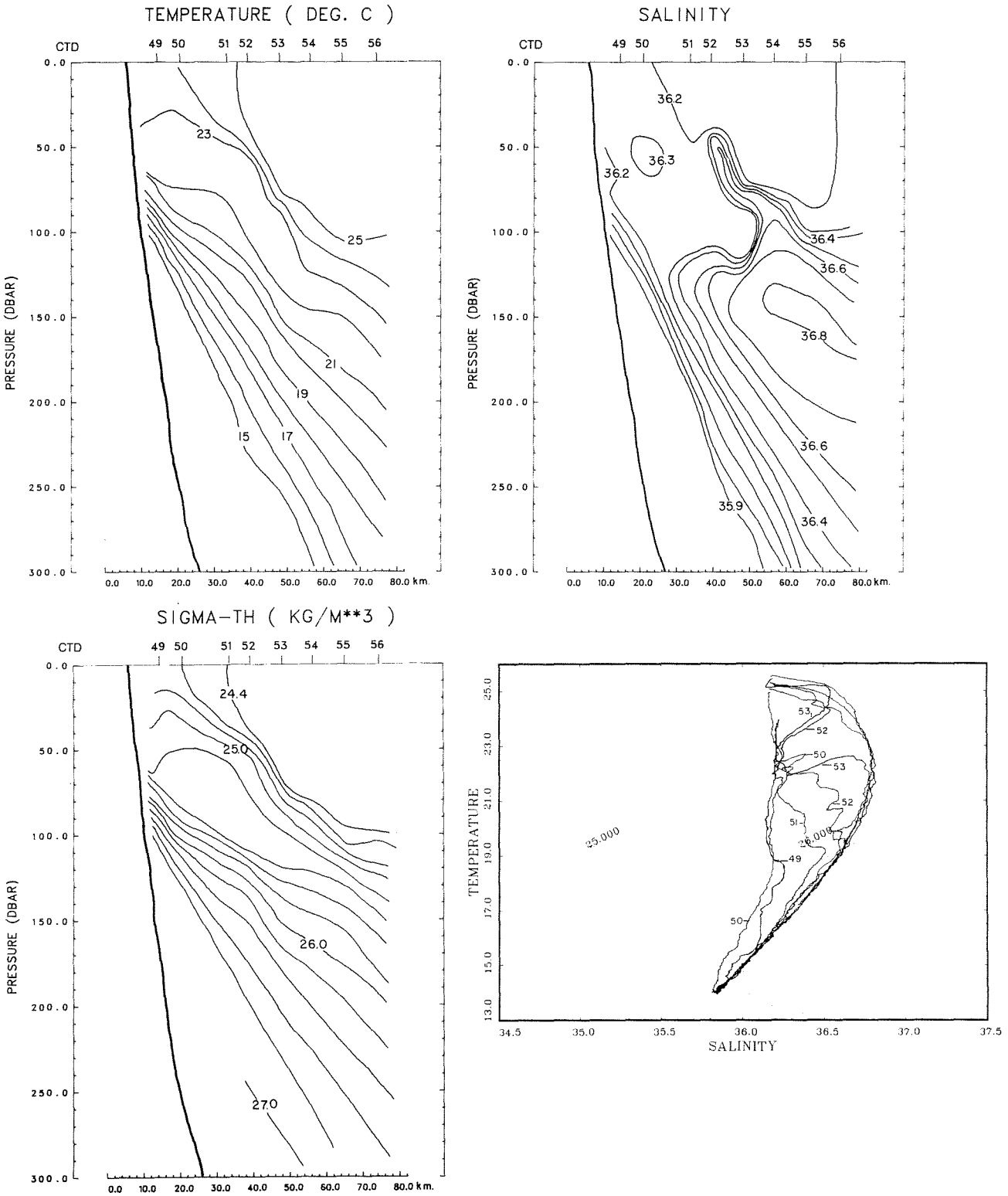

Fig. 11. Line **C** , Stn. 74-81, CTDs 49-56. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

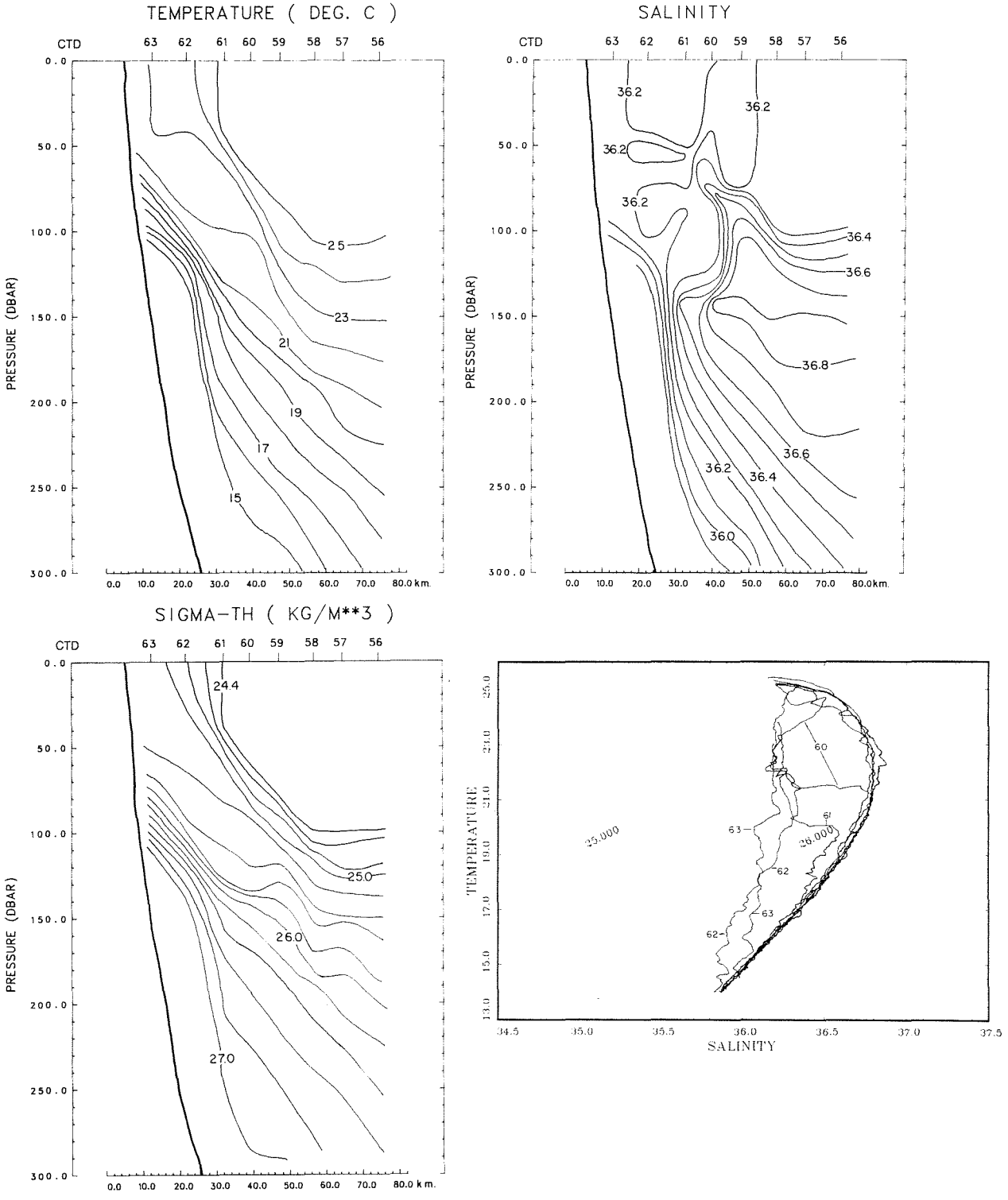

Fig. 12. Line **C** , Stn. 81-88, CTDs 56-63. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

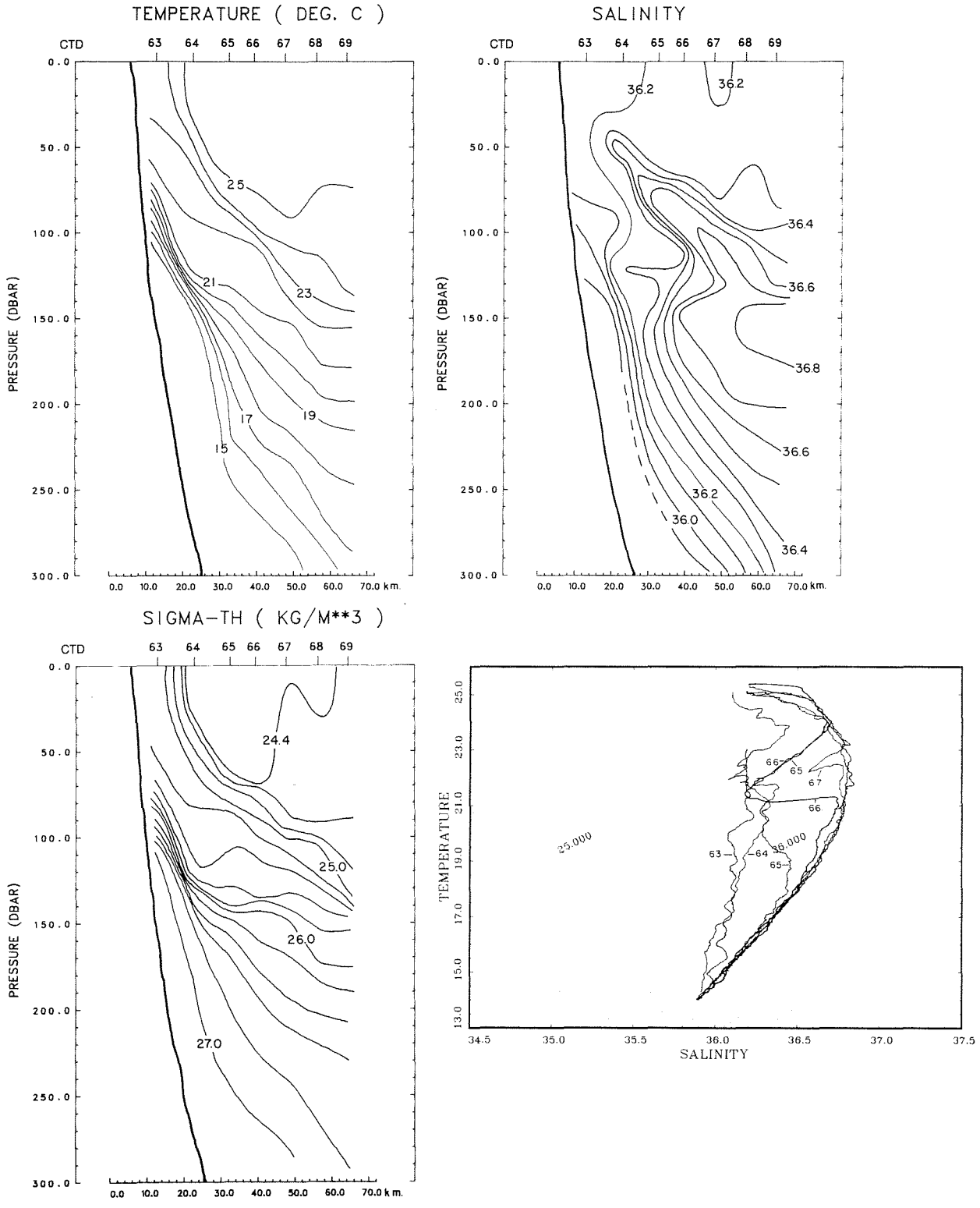

Fig. 13. Line **C** , Stn. 88-94, CTDs 63-69. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

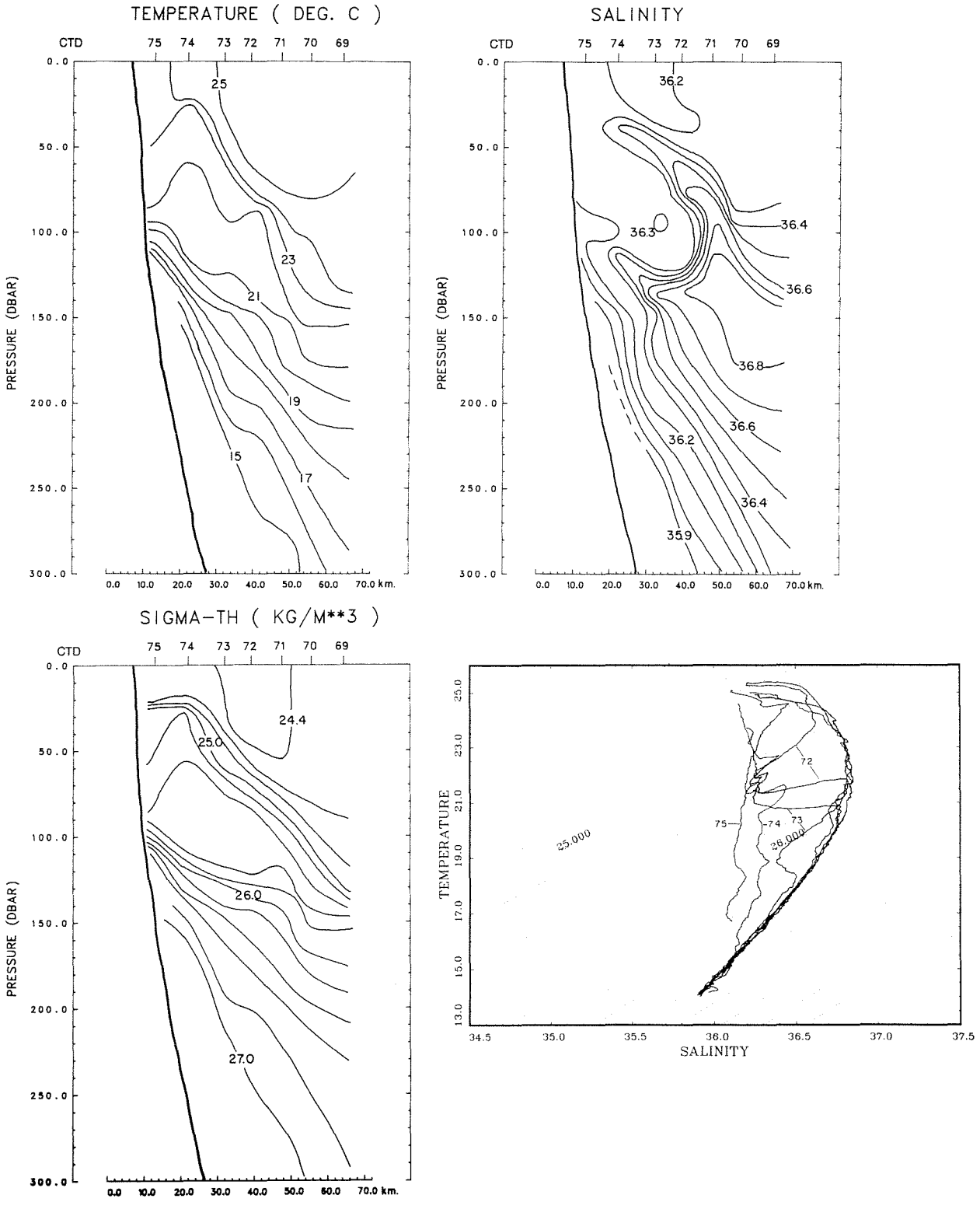

Fig. 14. Line **C** , Stn. 94-100, CTDs 69-75. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

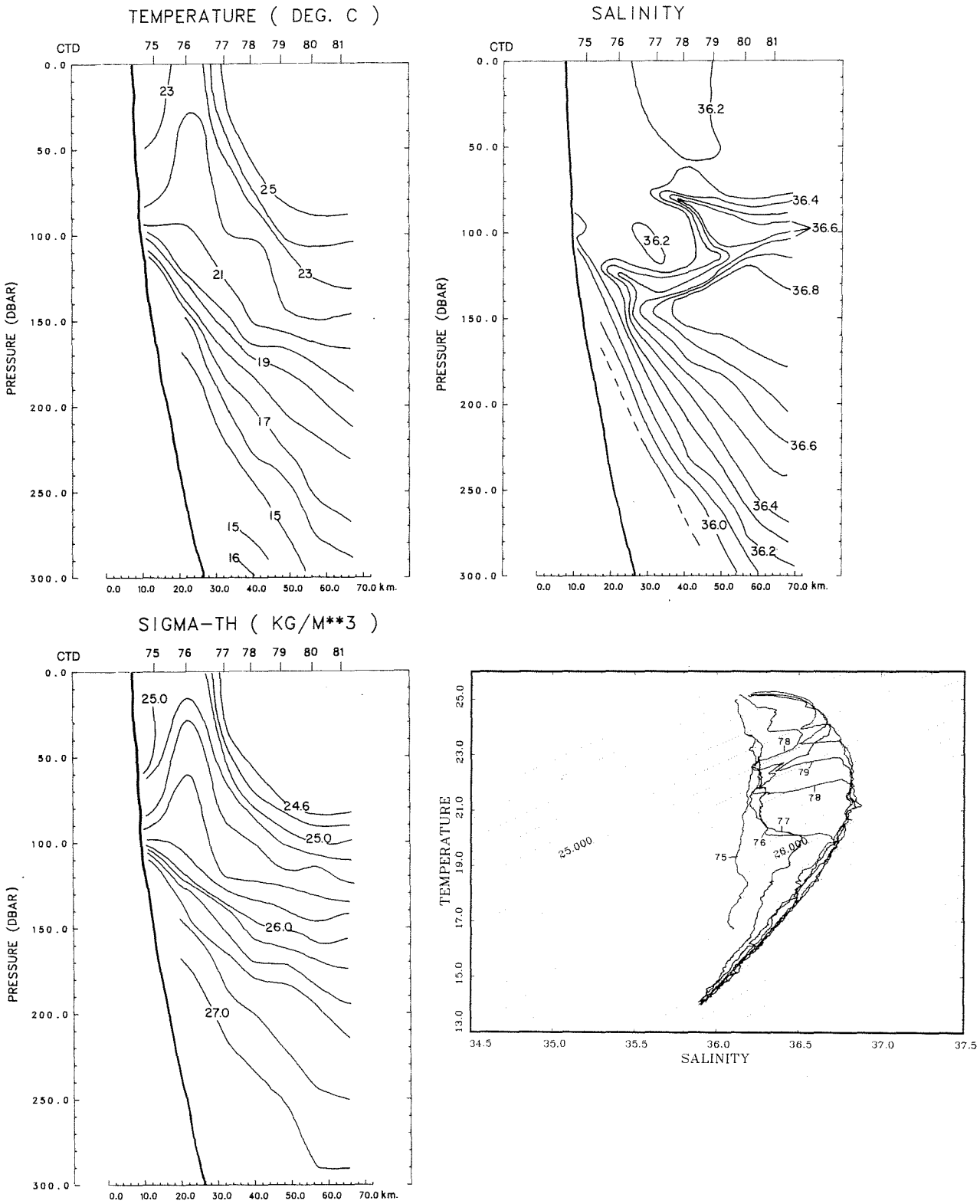

Fig. 15. Line **C** , Stn. 100-106, CTDs 75-81. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

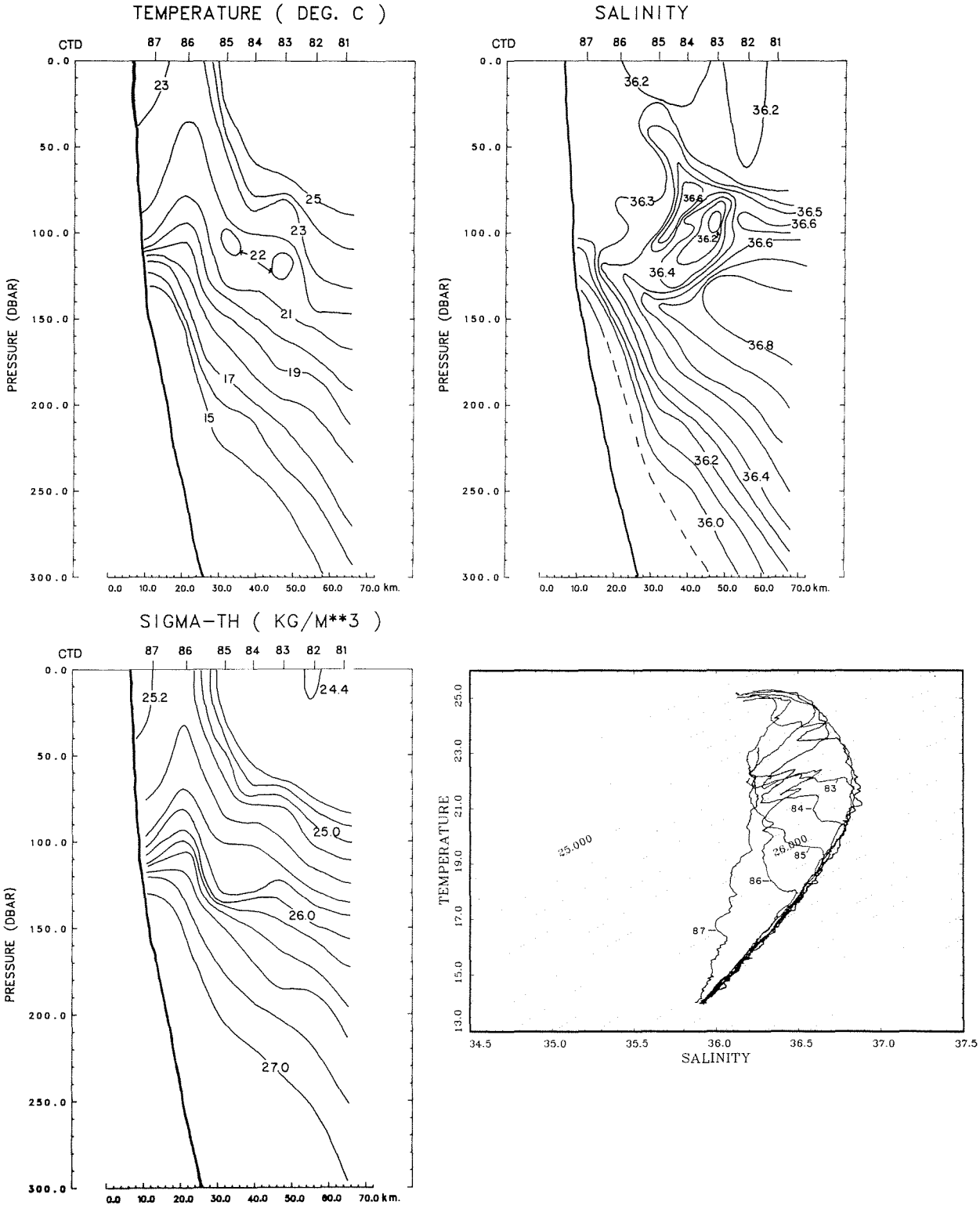

Fig. 16. Line **C** , Stn. 106-112, CTDs 81-87. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

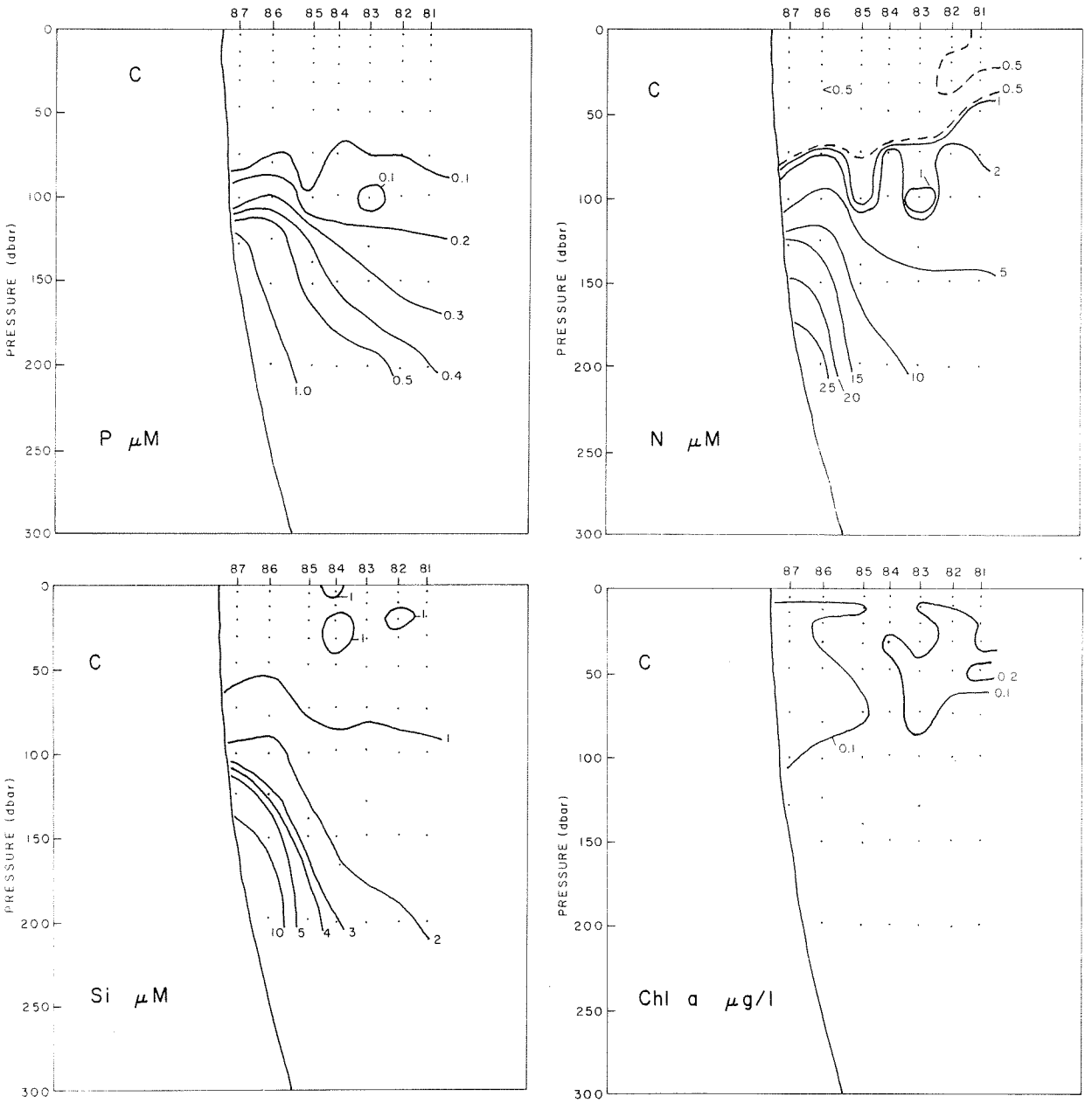

Fig. 17. Line **C** , Stn. 106-112, CTDs 81-87. Cross-section diagrams of phosphate, nitrate, silicate and chlorophyll-a.

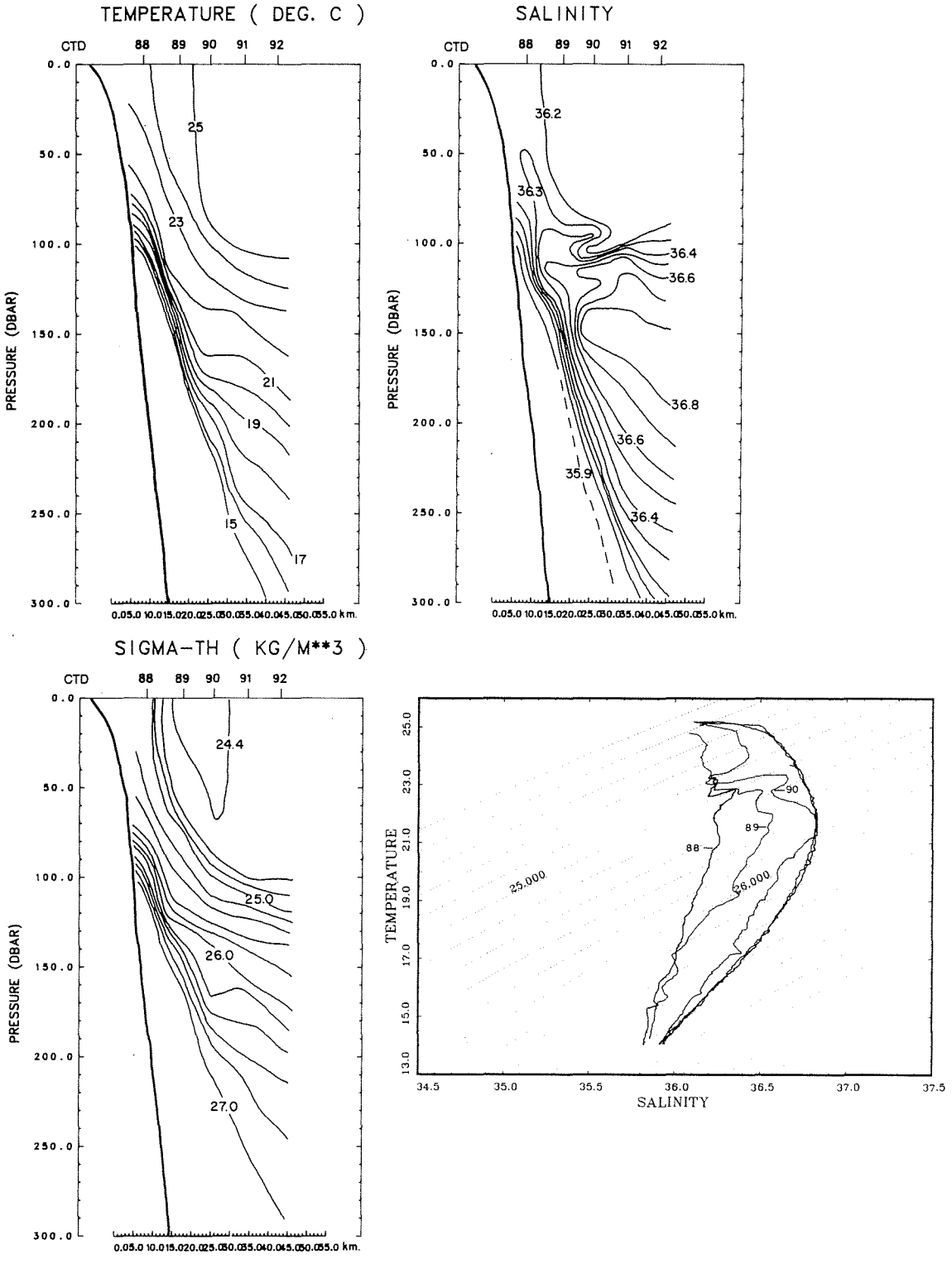

Fig. 18. Line **S** , Stn. 113-117, CTDs 88-92. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

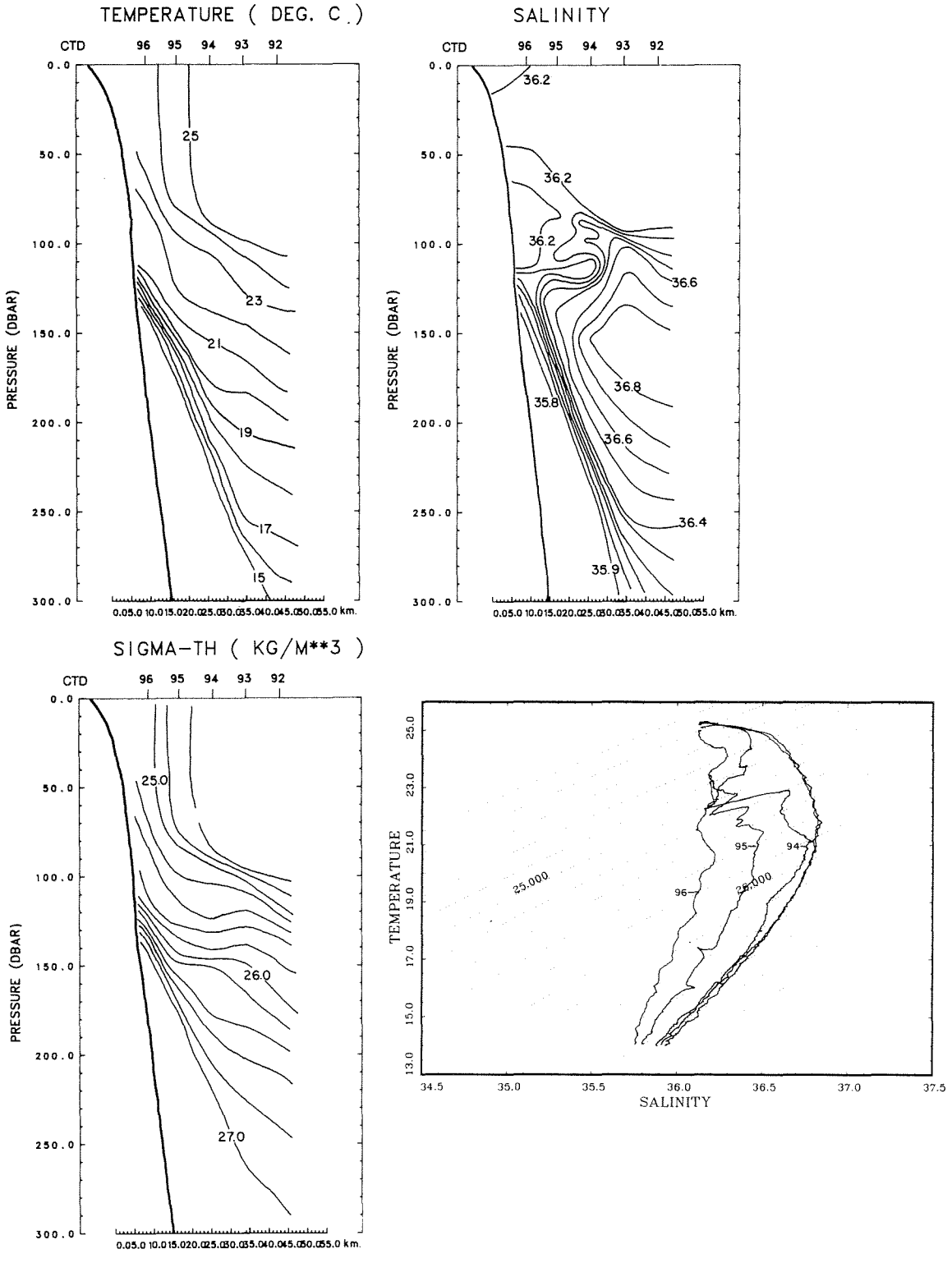

Fig. 19. Line **S** , Stn. 117-121, CTDs 92-96. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

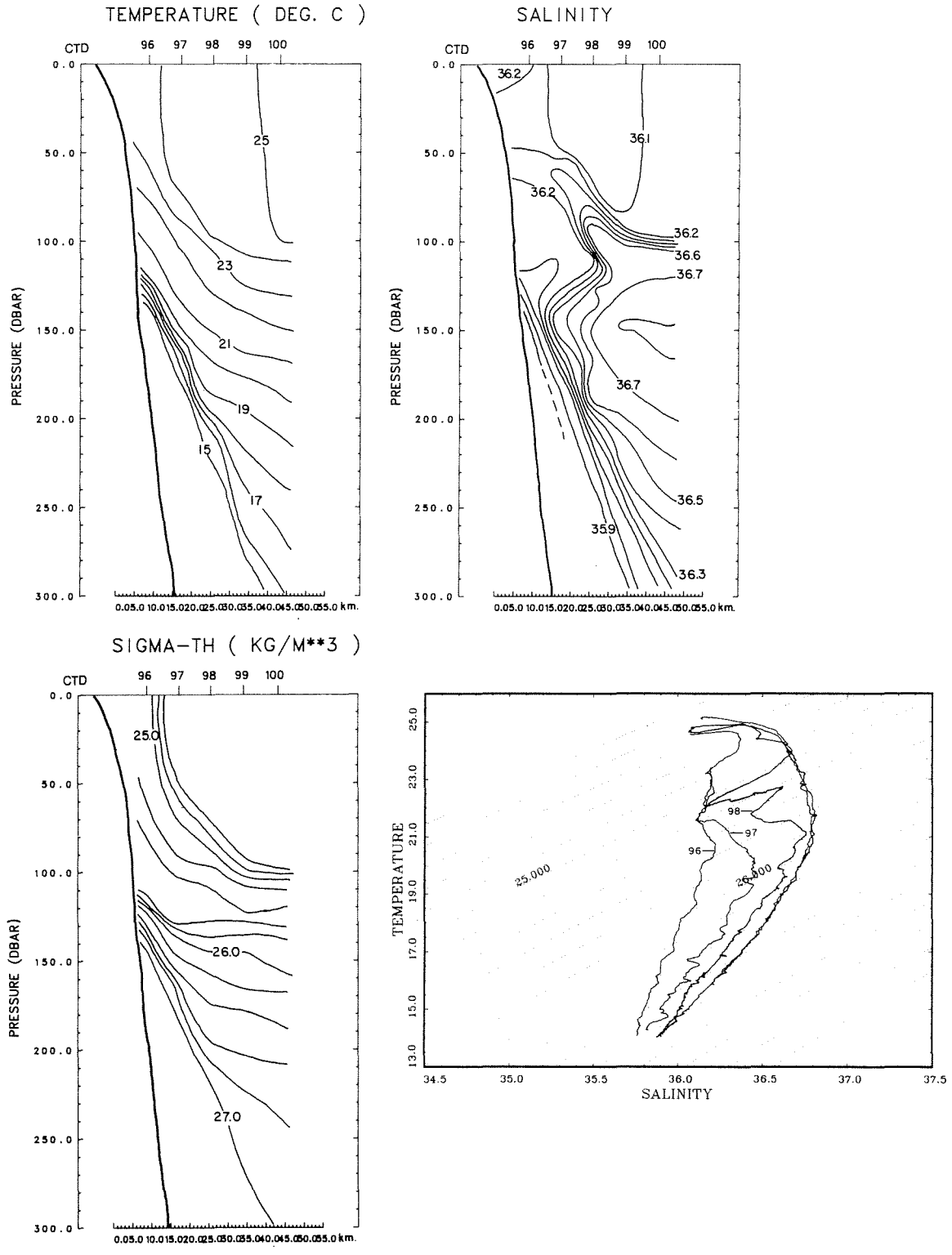

Fig. 20. Line **S** , Stn. 121-125, CTDs 96-100. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

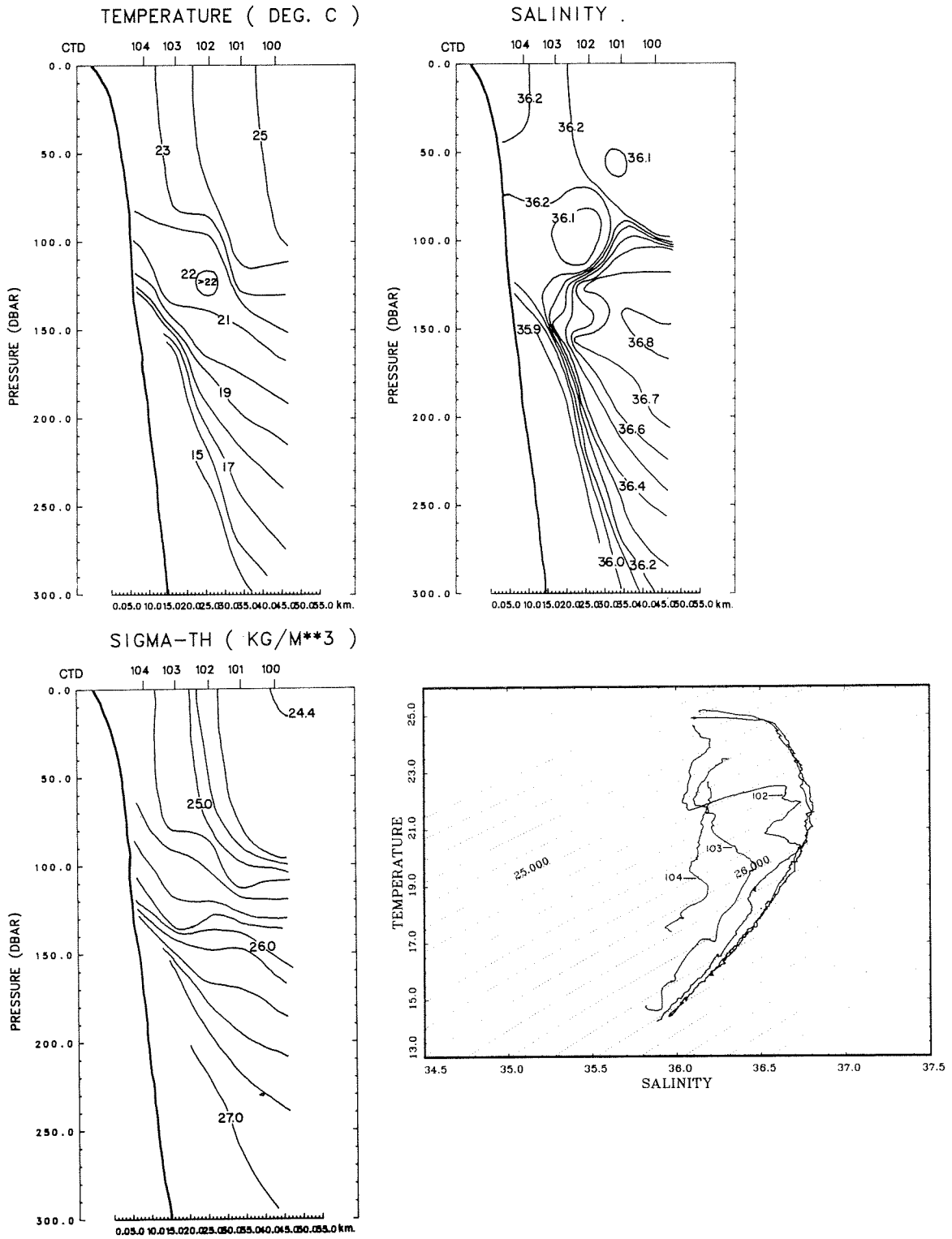

Fig. 21. Line **S** , Stn. 125-129, CTDs 100-104. Cross-section diagrams of temperature, salinity, sigma-θ and a TS diagram.

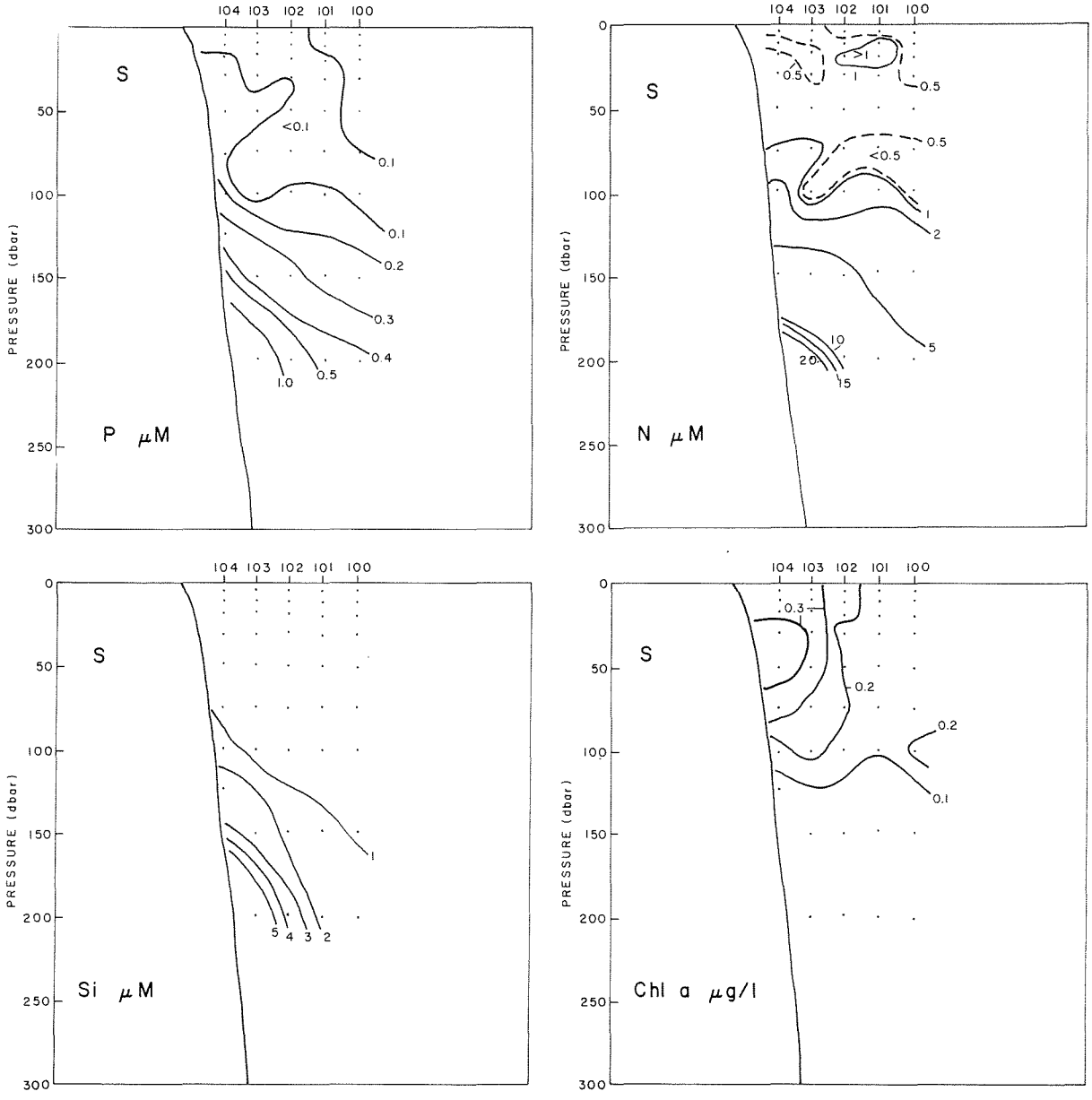

Fig. 22. Line **S** , Stn. 125-129, CTDs 100-104. Cross-section diagrams of phosphate, nitrate, silicate and chlorophyll-a.

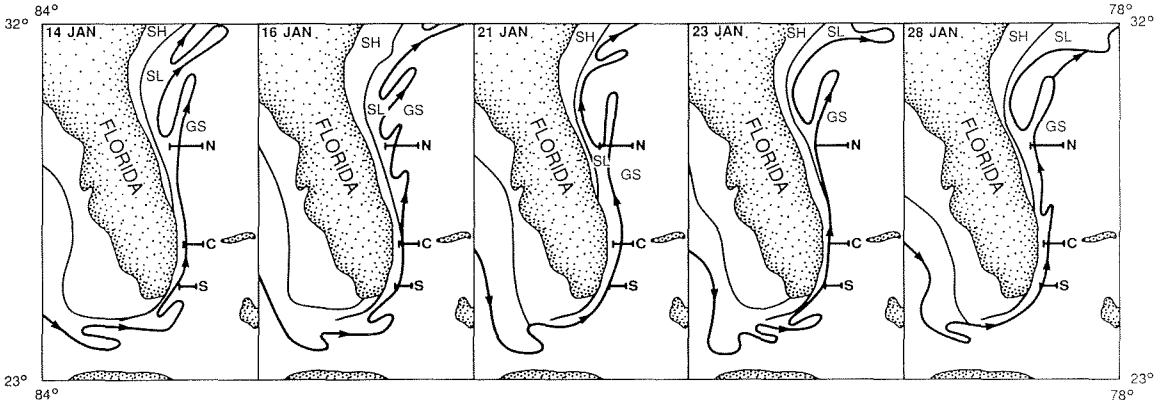

Fig. 23. Maps showing surface location of Slope/Gulf Stream front (solid line) on 5 occasions in the 14-28 January 1986 period. Lines **N**, **C** and **S** are also indicated. The location of the front was extracted from NOAA/NOS satellite-derived oceanographic analysis maps.

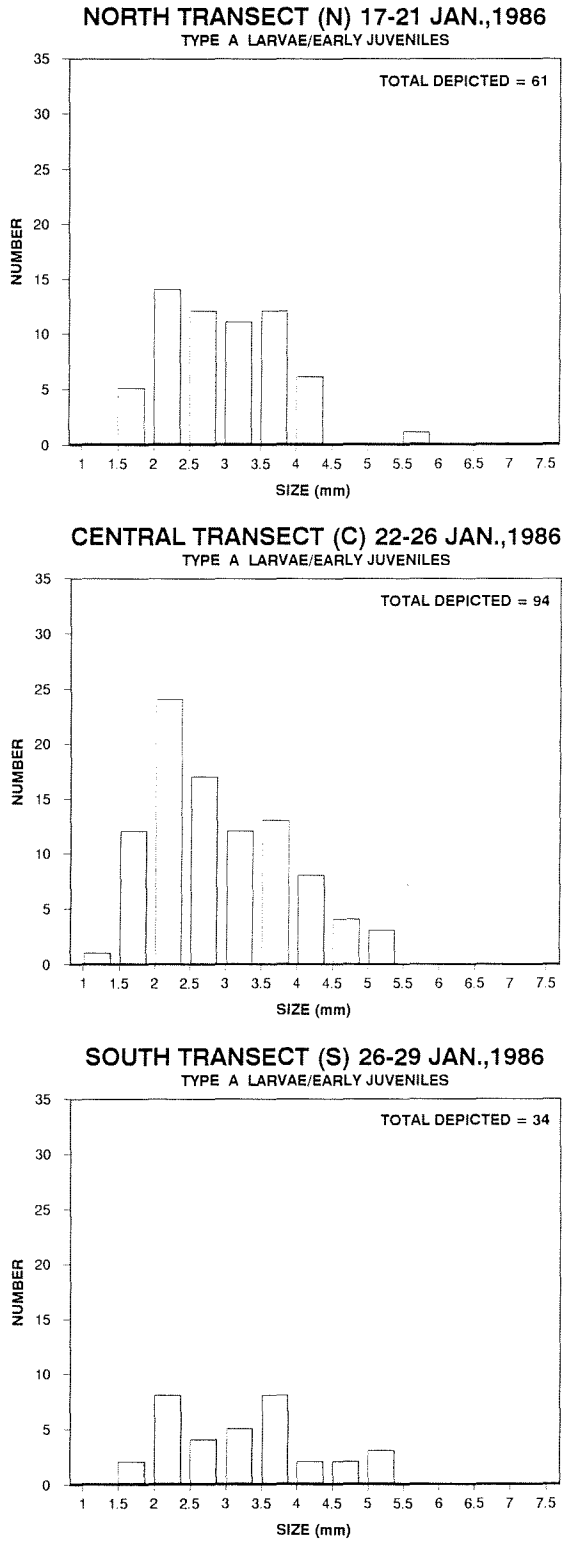

Fig. 24. Diagrams showing size distribution for Type **A** larvae/early juveniles from lines **N**, **C** and **S**.

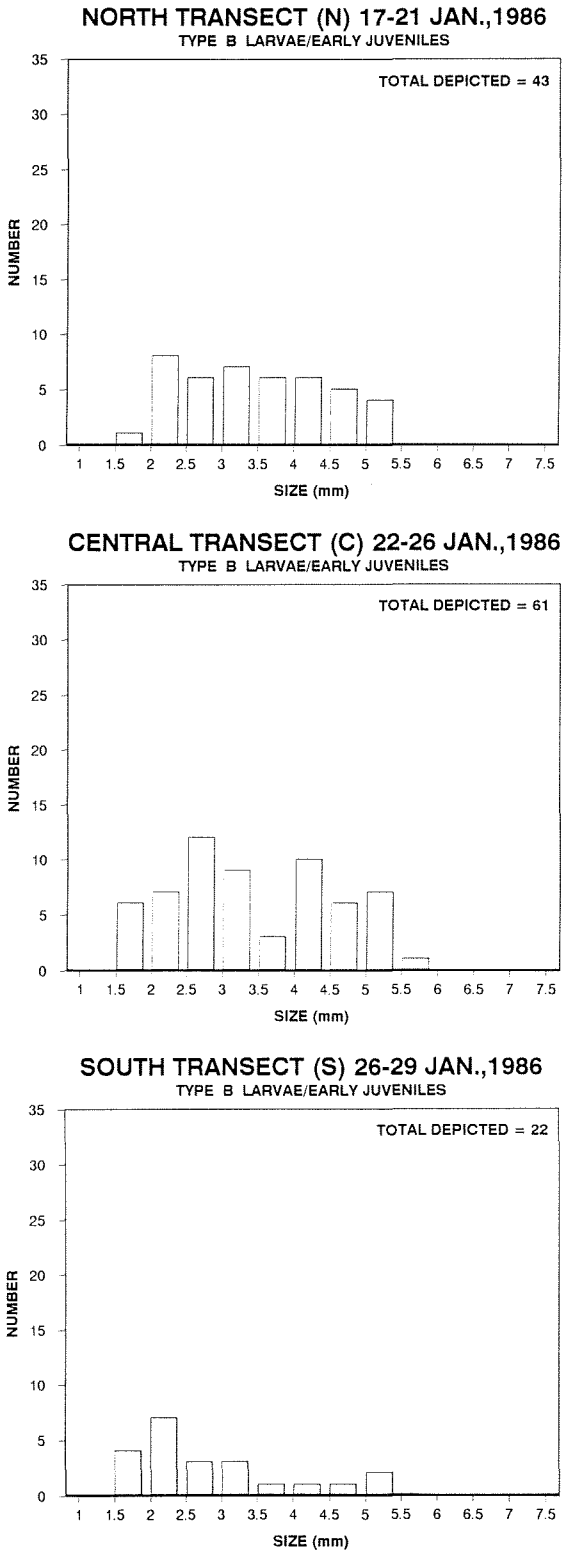

Fig. 25. Diagrams showing size distribution for Type **B** larvae/early juveniles from lines **N**, **C** and **S**.

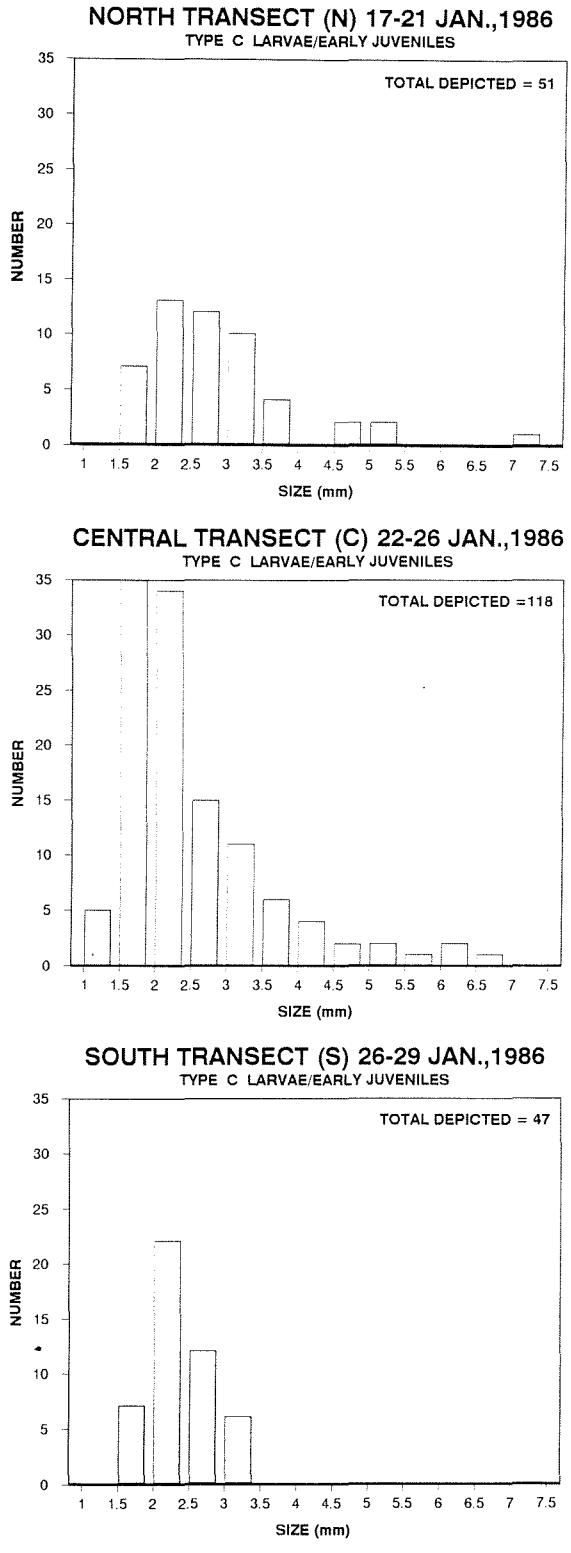

Fig. 26. Diagrams showing size distribution for Type C larvae/early juveniles from lines N, C and S.