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The *R.V. Lady Hammond* Larval-juvenile Survey, February 1982 in Subarea 4

by

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Introduction

As a result of a larval/juvenile survey in early 1977 (Amaratunga et al., 1980), in September, 1980, NAFO Scientific Council identified the need to conduct a comprehensive research program focused on squid Illex illecebrosus spawning stock and larval. The NAFO coordinated program in 1981 resulted in valuable descriptions of spatial and temporal distribution of larval and juvenile Illex. The 1982 program expanded the area of geographical coverage to include Subareas 5 and 6 extending to Cape Hatteras and a more intensive study of the water masses in the immediate vicinity of the Gulf Stream was intended (NAFO SCS Doc 81/VI/20). The R.V. Lady Hammond (Canada), one of four vessels committed to the program, was assigned to conduct intensive surveys within a small geographical area, in the vicinity of 63°W, in the region of the Slope Water-Gulf Stream-Sargasso Sea water masses and their interfaces. The objective of this study was to determine the abundance, distribution, and transport of Illex with emphasis on hydrographic and water-mass definition.

Materials and Methods

The survey cruise consisted of two legs: Leg 1 from February 2 to 12; and Leg 2 from February 12 to 25, 1982.

A relatively small geographical area between 59°W and 63°W and the region between the Scotian Shelf and Sargasso Sea (Fig. 1)

was chosen as the survey area. Exploratory, "coarse," transects were defined extending from the edge of the Scotian Shelf (approximately 42°30'N) southward through the Gulf Stream to 38°N with stations placed at approximately 30 mile intervals. The first such transect was located at 63°W and subsequent parallel transects were located eastward at 1° intervals (approximately 60 miles).

Operations along the coarse transects were interrupted when a high concentration of Illex was encountered, and then an "intensive" survey was carried out on a 10 mile square grid around that station. Intensive surveys were conducted at four such areas in the survey (Fig. 1).

At each coarse survey station four 15 min. midwater trawls (at 50, 100, 300 and 500 m) were attempted using a 510 Pelagic Trawl (Fig. 2). Also two oblique bongo tows at 50 m and 200 m were attempted with a 60 cm net with 333/μ mesh during Leg 1 and 505/μ mesh during Leg 2. Hydrographic operations consisted of an XBT cast and Kneudson bottle sampling at 0, 10, 20, 30, 50, 75, 100, 150, 200 and 250 m. Reversing thermometer temperatures were recorded and the water samples were analysed for dissolved oxygen content, salinity, chlorophyll, and nutrients.

At each intensive survey station the full complement of hydrographic and bongo operations was carried out, and only one 300 m oblique midwater trawl was conducted.

All midwater trawl samples were sorted at sea for cephalopods. Cephalopods were identified later in the laboratory and morphometric analysis (Amaratunga and Budden, 1982) was carried out on Illex samples.

Results and Discussions

The coarse survey consisted of four north/south transects at 63°W' 62°W, 61°W and 60°W (Fig. 1). The objective of the intensive survey was to determine water mass structure in the areas of large squid concentrations. However, total interpretation of the water profile data is not completed; hence

unless otherwise stated, the intensive survey data are considered here along with the coarse survey data. Table 1 summarizes all station operations.

Midwater trawl net samples were sorted but all cephalopods have not been completely identified yet. It is probable that a few small-sized I. illecebrosus may be among them. Preliminary identifications have resulted in a total of 2,458 Illex ranging from 6.1 to 46.4 mm mantle length (ML). Table 1 gives the number of Illex caught in each midwater trawl. It is important to note that one set; Set Number 46 at 300 m (46-03) resulted in 1,058 Illex and this represented 43% of the total number of Illex caught in the cruise. This was an unusually large catch which tended to bias the interpretations of the general cruise data. When Illex catches were examined in relation to time of day and depth, it appeared that the greatest number were caught between 12:01-18:00 h at 300 m (Table 2). However when Set 46-03 was excluded, the more true pattern showed the greatest catches were between 18:01-00:00 h, followed by 00:01-06:00. Similarly catch rates (mean number of Illex per tow) after the exclusion of Set 46-03 were highest between 18:01-00:00 h followed by the 00:01-06:00 time segment. Catches and catch rates remained greatest at 300 m in all time segments except 18:01-00:00 h when they were apparently more dispersed in the water column.

The overall cruise catches and catch rates are relatively uniform throughout the water column (Table 2). Therefore Illex catches at all depths were summed to depict geographical distribution (Fig. 3). Figure 3 also depicts the corresponding sea surface temperatures, while the position of the Gulf Stream and eddy represented in Figure 1 were estimated from sea surface temperature charts. A wide range of water temperatures (3.2°-21.8°C) were sampled, and Illex catches were greatest within an intermediate temperature range of 10.1-16.0°C (Table 3). In waters where surface temperatures were between 10.1° and 16.0°C, 2,374 or 96.6% of Illex were caught, while 91.8% were caught within a 4° range of 12.1-16.0°C. Mean mantle

lengths of Illex decreased as water temperatures increased (Table 4).

Geographically, Illex distribution was within a band of intermediate water temperature between the warm Gulf Stream and the cold slope water masses (Fig. 3). During the survey a well-defined warm core eddy, still attached to the Gulf Stream, was observed (Fig. 1). Largest catches were associated with this eddy and the water between the eddy and the Gulf Stream. Interestingly very few Illex were caught in the slope water, and except for one specimen in Station 41, no Illex were caught in the Gulf Stream.

The geographical distribution, when considered temporally, also shows interesting patterns. Transects were occupied sequentially: Transects 1 and 2 during the period Feb. 2-12, and Transects 3 and 4 between Feb. 14-25. If we were to neglect the potential influence of temperature and water mass structure, squid were then being encounted farther north and closer to the Shelf as time progressed (Fig. 3). This probable Shelfward movement of rapidly growing juveniles is further supported by an apparent increasing mantle size gradient northward (Table 5). Table 6 shows the mean ML at stations completed along each transect. The north-south mean size differential is 16.9 mm in a maximum period of 25 days, or a maximum mean daily growth rate of 0.67 mm. Amaratunga (1980), in a three-year study (1977-1979), estimated possible growth rates ranging from 0.95 mm to 1.63 mm per day for animals up to 130 mm ML.

Temperature and salinity profiles for survey transects are presented in Figures 4(a-d) and 5(a-d), showing catches at depth.

References

Amaratunga, T. 1980. Growth and maturation of the short-finned squid (Illex illecebrosus) on the Scotian Shelf. NAFO SCR Doc. 80/II/30.

Amaratunga, T., T.W. Rowell, and M. Roberge. 1980. Summary of joint Canada/USSR research program on short-finned squid (Illex illecebrosus), 16 February to 4 June 1979: spawning stock and larval survey. NAFO SCR Doc. 80/II/38.

Amaratunga, T. and F.G. Budden. 1982. Allometry of the squid Illex illecebrosus. NAFO SCR Doc. 82/VI/28.

NAFO SCS Doc. 81/VI/20.

Table 1. Summary of station locations, operations, and Illex catches during cruise 8202 (Feb. 2-12, Feb. 14-25)

STATION NO.	LOCATION		MIDWATER TRAWLS (#'s of ILLEX CAUGHT)				OBLIQUE BONGO		XBT CAST	HYDROGRAPHIC SAMPLING			
	LATITUDE	LONGITUDE	50 m	100 m	300 m	500 m	50 m	200 m		TEMPERATURE	SALINITY	DISSOLVED OXYGEN	CHLOROPHYLL/ NUTRIENTS
1	42°38'	62°59'	0	0	0	0	X	X	X	X	X	X	
2	42°09'	63°02'	0	0	0	2	X	X	X	X	X	X	X
3	41°33'	63°00'	0	7	2	1	X	X	X	X	X	X	X
4	40°59'	62°59'	0	0	0	0	X	X	X	X	X	X	X
5	40°32'	63°02'	1	5	1	3	X	X	X	X	X	X	X
6	40°03'	63°01'	34	13	11	5	X	X	X	X	X	X	X
7	39°29'	62°59'	33	4	33	5	X	X	X	X	X	X	X
8	39°01'	63°04'	4	0	0	0	X	X	X	X	X	X	X
9	38°30'	63°01'	0	0	0	0	X	X	X	X	X	X	X
10	37°59'	63°00'	0	0	0	-	-	-	-	-	-	-	-
11	38°04'	62°01'	0	0	-	-	X	X	X	-	-	-	-
12	38°34'	61°57'	0	0	0	0	X	X	X	X	X	X	X
13	39°00'	62°02°	82	41	75	51	X	X	X	X	X	X	X
14	39°01'	62°13'	-	-	28	-	X	X	X	X	X		X
15	39°02'	61°48'	-	-	11	-	X	X	X	X	X		X
16	39°31'	62°02'	2	0	3	-	X	X	X	X	X	X	X
17	40°33'	61°55'	0	0	]	2	X	X	X	X	X	X	X
18	41°00'	62°00'	0	2	22	4	X	X	X	X	X	X	X
19	41°31'	62°01'	0	0	0	1	X	X	X	X	X	X	X
20	42°00'	62°00'	0	0	0	0	X	X	-	X	X	X	X
21	42°30'	62°00'	0	0	0	0	X	X	-	X	X	X	X
22	42°30'	61°00'	0	0	0	-	-	-	X	-	-	-	-

Table 1. (continued)

STATION NO.	LOCATION LATITUDE	LONGITUDE	MIDWATER TRAWLS (#'s of ILLEX CAUGHT) 50 m	100 m	300 m	500 m	OBLIQUE BONGO 50 m	200 m	XBT CAST	HYDROGRAPHIC SAMPLING TEMPERATURE	SALINITY	DISSOLVED OXYGEN	CHLOROPHYLL/ NUTRIENTS
23	42°03'	60°59'	0	2	1	0	X	X	X	X	X	X	X
24	41°30'	60°58'	0	14	26	21	X	X	X	X	X	X	X
25	41°02'	61°05'	3	0	0	0	X	X	X	X	X	X	X
26	40°31'	61°06'	9	1	3	22	X	X	X	X	X	X	X
27	39°54'	61°05'	37	81	45	25	X	X	X	X	X	X	X
28	39°30'	61°00'	12	8	7	3	X	X	X	X	X	X	X
29	40°01'	60°48'	-	-	14	-	X	X	X	X	X	X	X
30	40°14'	60°48'	-	-	14	-	X	X	X	X	X	X	X
31	40°11'	61°01'	-	-	15	-	X	X	X	X	X	X	X
32	40°14'	61°16'	-	-	12	-	X	X	X	X	X	X	X
33	40°00'	61°13'	-	-	25	-	X	X	X	X	X	X	X
34	39°50'	61°13'	-	-	20	-	X	X	X	X	X	X	X
35	39°57'	61°00'	-	-	4	-	X	X	X	X	X	X	X
36	39°46'	60°49'	-	-	2	-	X	X	X	X	X	X	X
37	39°01'	60°58'	0	69	32	17	X	X	X	X	X	X	X
38	39°14'	60°45'	-	-	4	-	X	X	X	X	X	X	X
39	38°52°	60°44'	-	-	33	-	X	X	X	X	X	X	X
40	38°54'	61°10'	-	-	10	-	X	X	X	X	X	X	X
41	38°31'	60°55'	1	0	0	0	X	X	X	X	X	X	X
42	37°55'	60°58'	0	0	0	0	X	X	X	X	X	X	X
43	38°01'	60°05'	0	0	0	-	X	X	X	X	X	X	X
44	38°32'	59°58'	0	0	-	-	X	X	X	X	X	X	X

Table 1. (continued)

STATION NO.	LOCATION		MIDWATER TRAWLS (#'s of ILLEX CAUGHT)				OBLIQUE BONGO		HYDROGRAPHIC SAMPLING				
	LATITUDE	LONGITUDE	50 m	100 m	300 m	500 m	50 m	200 m	XBT CAST	TEMPERATURE	SALINITY	DISSOLVED OXYGEN	CHLOROPHYLL/ NUTRIENTS
45	39°06'	60°05'	0	5	7	-	X	X	X	X	X	X	X
46	39°33'	60°08'	12	0	1058	-	X	X	X	X	X	X	X
47	39°32'	59°48'	-	-	14	-	X	X	X	X	-	X	X
48	39°20'	59°52'	-	-	3	-	X	X	X	X	-	X	X
49	39°21'	60°02'	-	-	8	-	X	X	X	X	-	X	X
50	39°21'	60°17'	-	-	11	-	X	X	X	X	-	X	X
51	39°30'	60°18'	-	-	0	-	-	-	X	X	-	X	X
52	39°40'	60°12'	-	-	1	-	-	-	X	X	-	X	X
53	39°39'	59°58'	-	-	0	-	-	-	X	X	-	X	X
54	39°40'	59°50'	-	-	0	-	-	-	X	X	-	X	X
55	39°60'	60°02'	11	0	13	0	-	-	X	X	-	X	X
56	40°26'	60°02'	12	21	7	-	-	-	X	X	-	X	X
57	40°58'	60°04'	46	15	18	7	-	-	X	X	-	X	X
58	41°30'	60°04'	0	0	0	0	-	-	X	X	-	X	X
59	42°02'	60°00'	0	39	23	46	-	-	X	X	-	X	X

Table 2. Mean numbers of Illex per tow and absolute numbers of squid by time and depth.

DEPTH	TIME (LOCAL AST) 00:01-06:00	06:01-12:00	12:01-18:00	18:01-00:00	TOTAL
50	13.00 (117)	4.17 (50)	3.67 (33)	12.38 (99)	7.87 (299)
100	12.89 (116)	1.55 (17)	0.71 (5)	17.18 (189)	8.61 (327)
300	13.47 (202)	5.21 (73)	4.33 (52) [92.50(1110)]*	14.50 (232)	
500	5.50 (33)	2.80 (14)	1.00 (8)	16.00 (160)	7.41 (215)
TOTAL	12.00	3.67 (154)	2.80 (98) [32.11(1156)]*	15.11 (680)	15.17 (2458)

*Values obtained when catches from Set 46-03 (1,058 Illex caught) are included.

Table 3. Numbers of Illex caught and mean number per tow by temperature regimes.

SURFACE TEMPERATURE (°C)	NO. OF STATIONS	NO. OF ILLEX	MEAN NO ILLEX/TOW
2.1-4	1	0	0
4.1-6	2	1	0.50
6.1-8	4	12	3.00
8.1-10	0	0	0
10.1-12	2	118	59.00
12.1-14	15	407(1465)	27.13(97.67)
14.1-16	21	791	37.67
16.1-18	7	66	9.43
18.1-20	4	1	0.33
20.1-22	1	4	4.00

Numbers in brackets represent values obtained when catches from set 46-03(1058 Illex caught) are included.

Table 4. Mean dorsal mantle length (DML) of Illex caught in various temperature regimes.

	Temperature (°C)								
	4.1-6	6.1-8	8.1-10	10.1-12	12.1-14	14.1-16	16.1-18	18.1-20	20.1-22
Mean DML(MM)	46.35	23.10	-	36.32	28.09	19.89	20.45	18.95	10.24
Number Squid measured	1	11	0	118	505	777	55	1	4

Table 5. Mean DML of Illex caught in 1 degree intervals of latitude.

	Geographical Location				
	North of 42°N	41°01' 42°00'	40°01' 41°00'	39°01' 40°00'	South of 39°N
Mean DML(MM)	36.91	27.53	21.76	24.31	20.09
Number Squid measured	113	72	334	670	293

TABLE 6. Mean Length of *Illex* at Stations in Transects Completed During Cruise 8202.

Transect Number							
1 (63°W)		2 (62°W)		3 (61°W)		4 (60°W)	
Station No.	Mean DML	Station No.	Mean DML	Station No.	Mean DML	Station No.	Mean DML
2	25.35	19	46.35	23	23.87	59	37.49
3	22.60	18	15.71	24	28.13	57	22.39
5	23.71	17	15.65	25	16.65	56	22.73
6	25.14	16	12.86	26	19.72	55	18.63
7	16.28	13	18.37	27	20.60	46	34.49
8	10.24	-	-	28	15.65	45	16.88
				37	31.16		
				41	18.95		

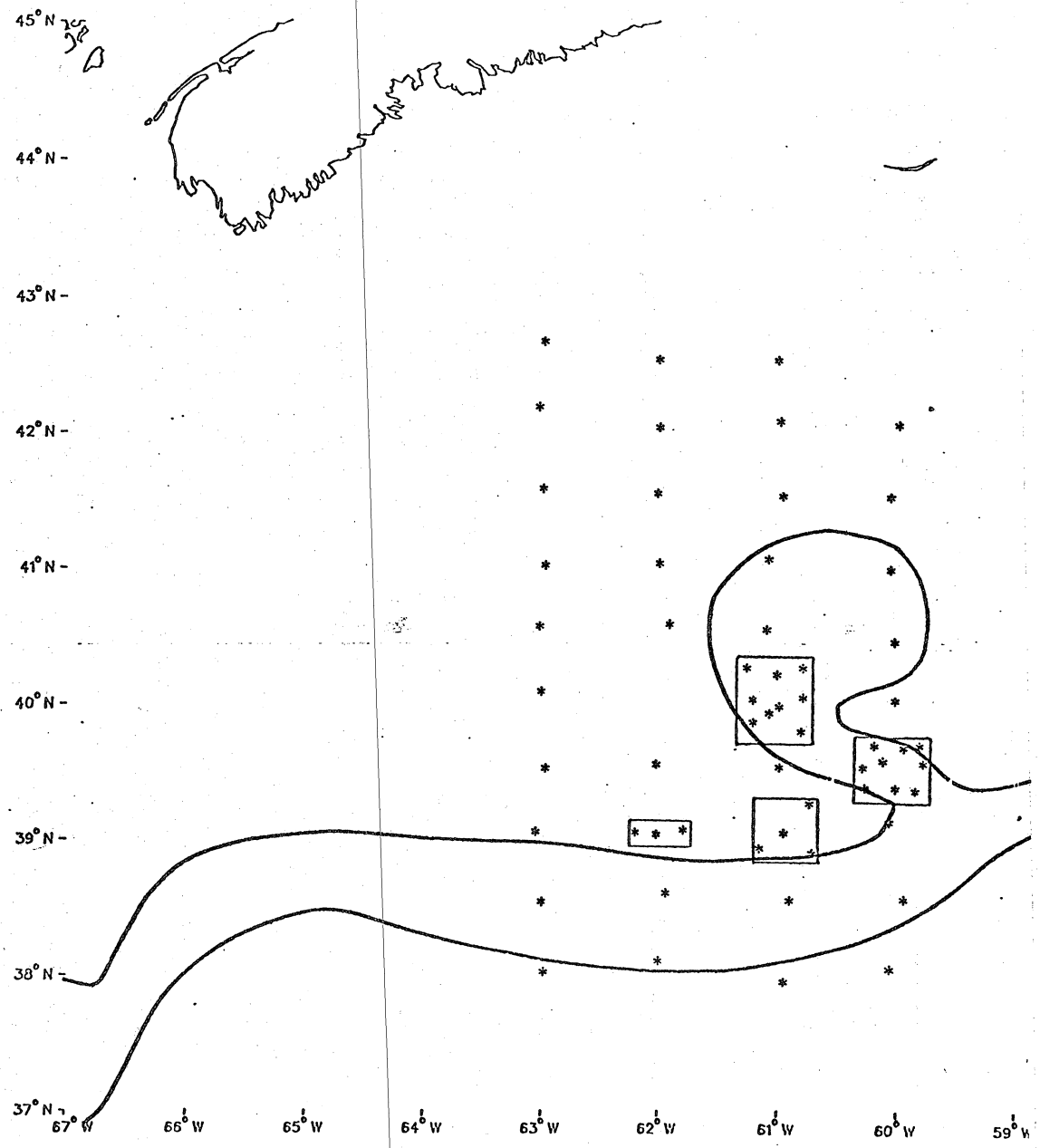

Figure 1. Station plot of Cruise 8202, including areas of intensive survey and position of Gulf Stream during survey.

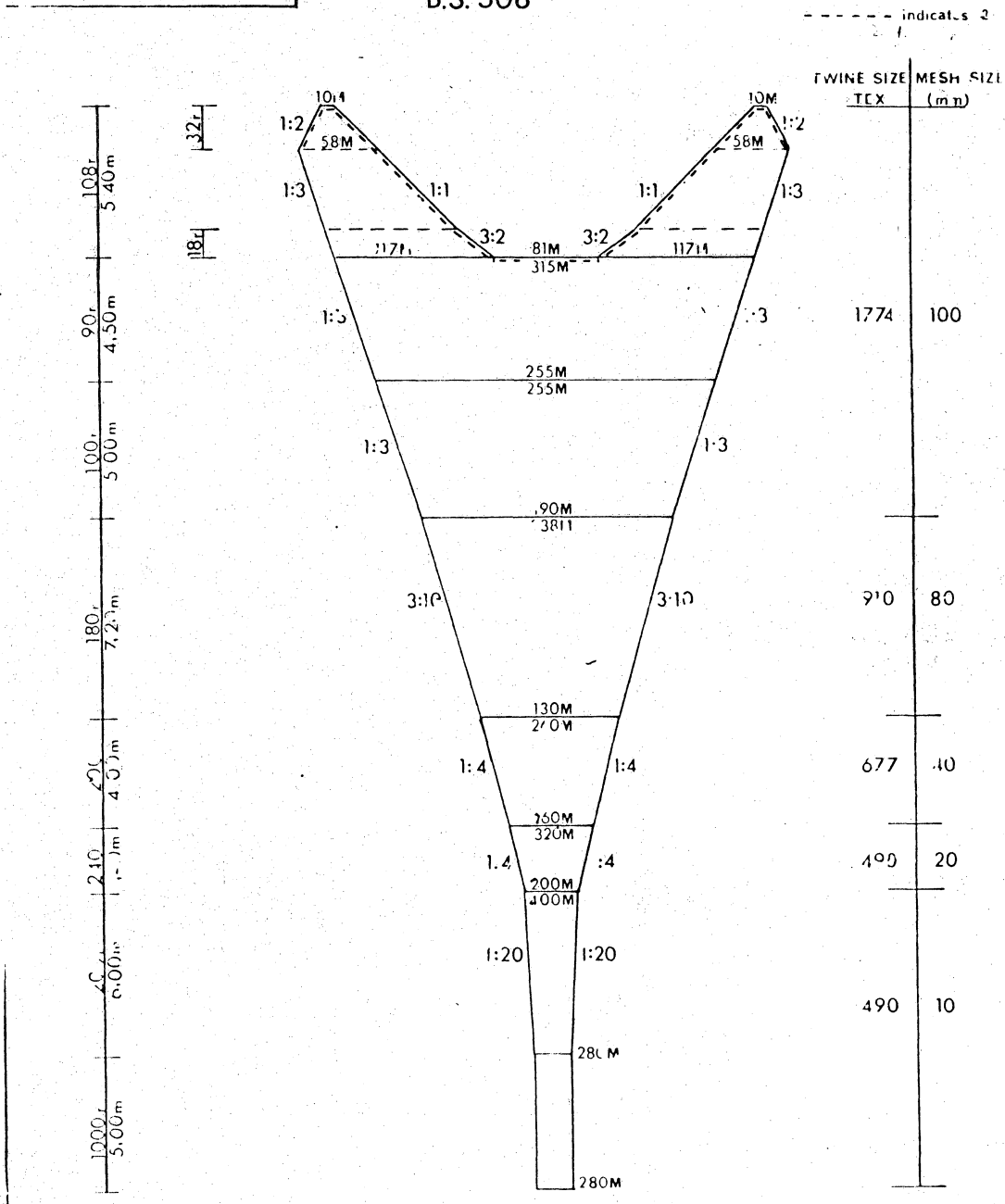

Fig. 2. Schematic of 510 Pelagic trawl used during cruise 8202.

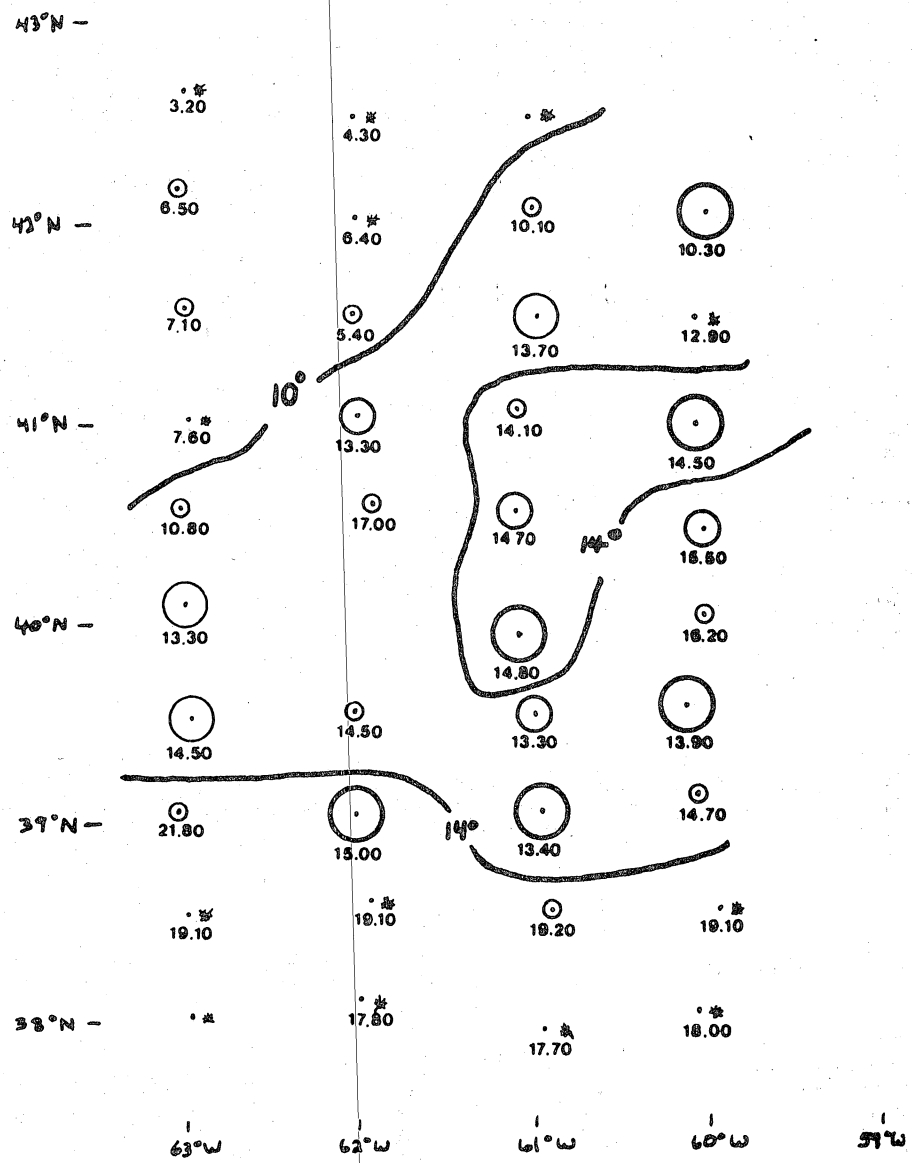

Fig. 3. Sea-surface temperatures and Illex catches at stations completed during cruise 8202.

ILLEX CATCHES

* 0

○ 1-25

◯ 26-50

◯ 51-75

◯ >75

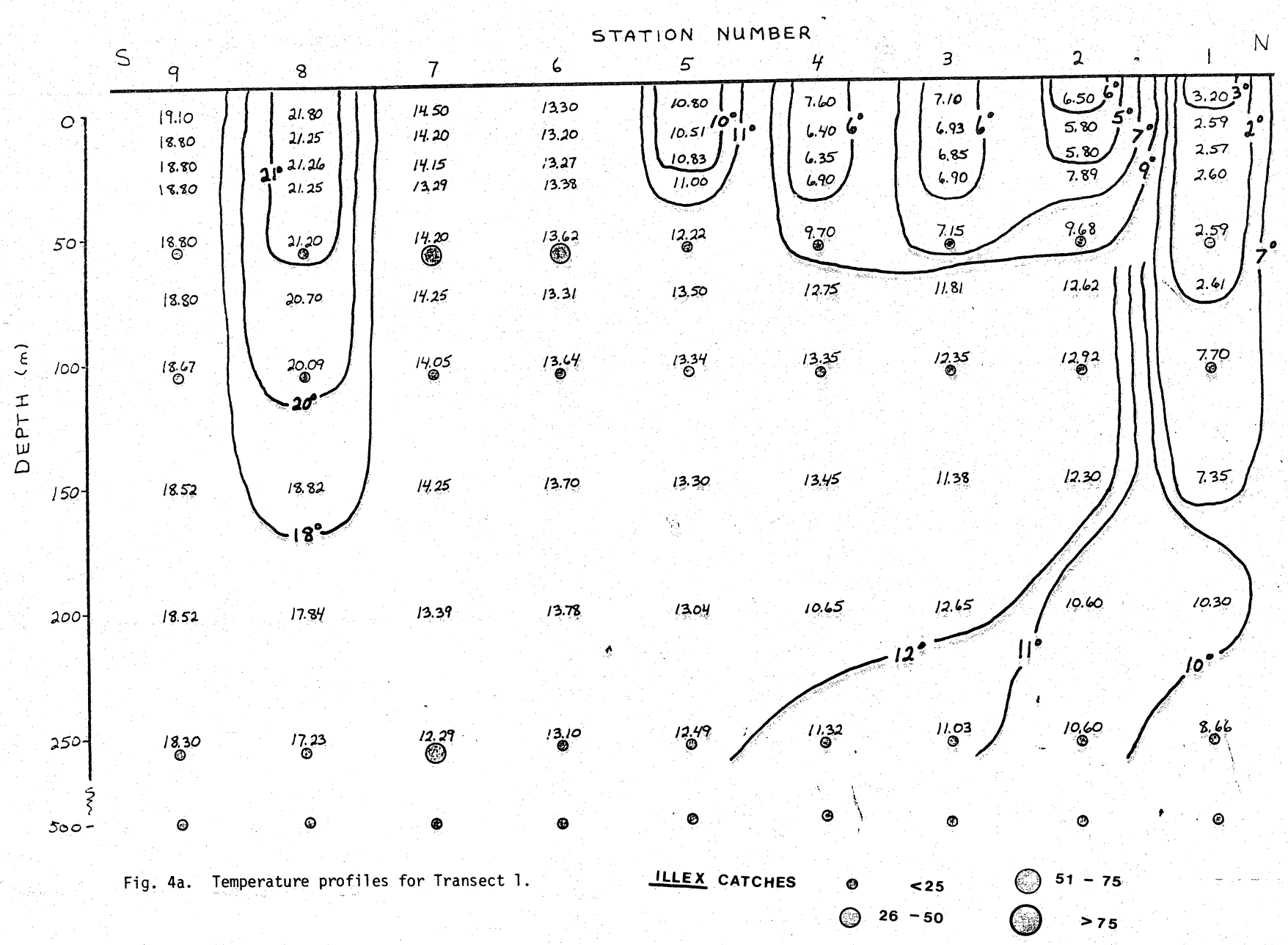

Fig. 4a. Temperature profiles for Transect 1.

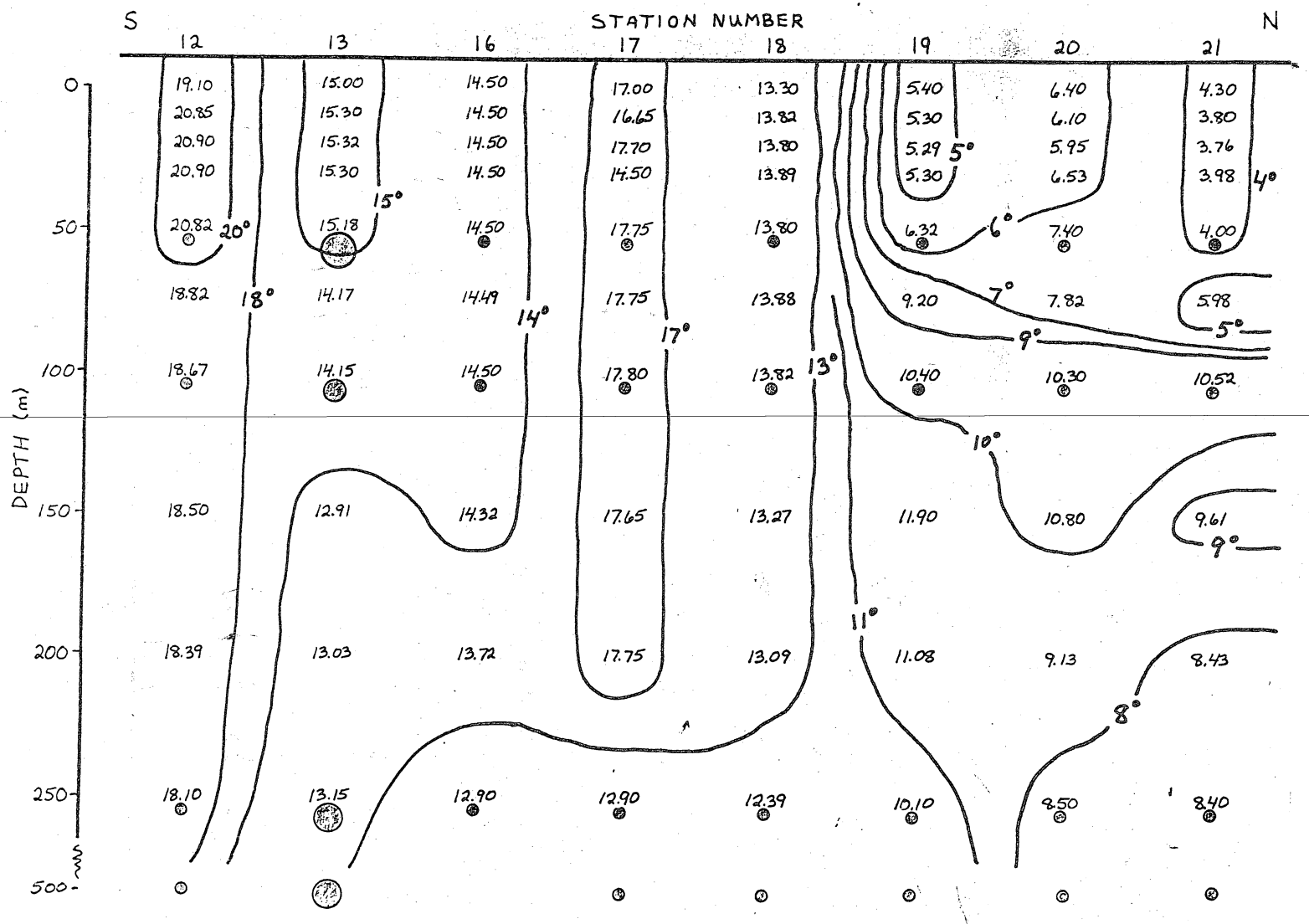

Fig. 4b. Temperature profiles for Transect 2.

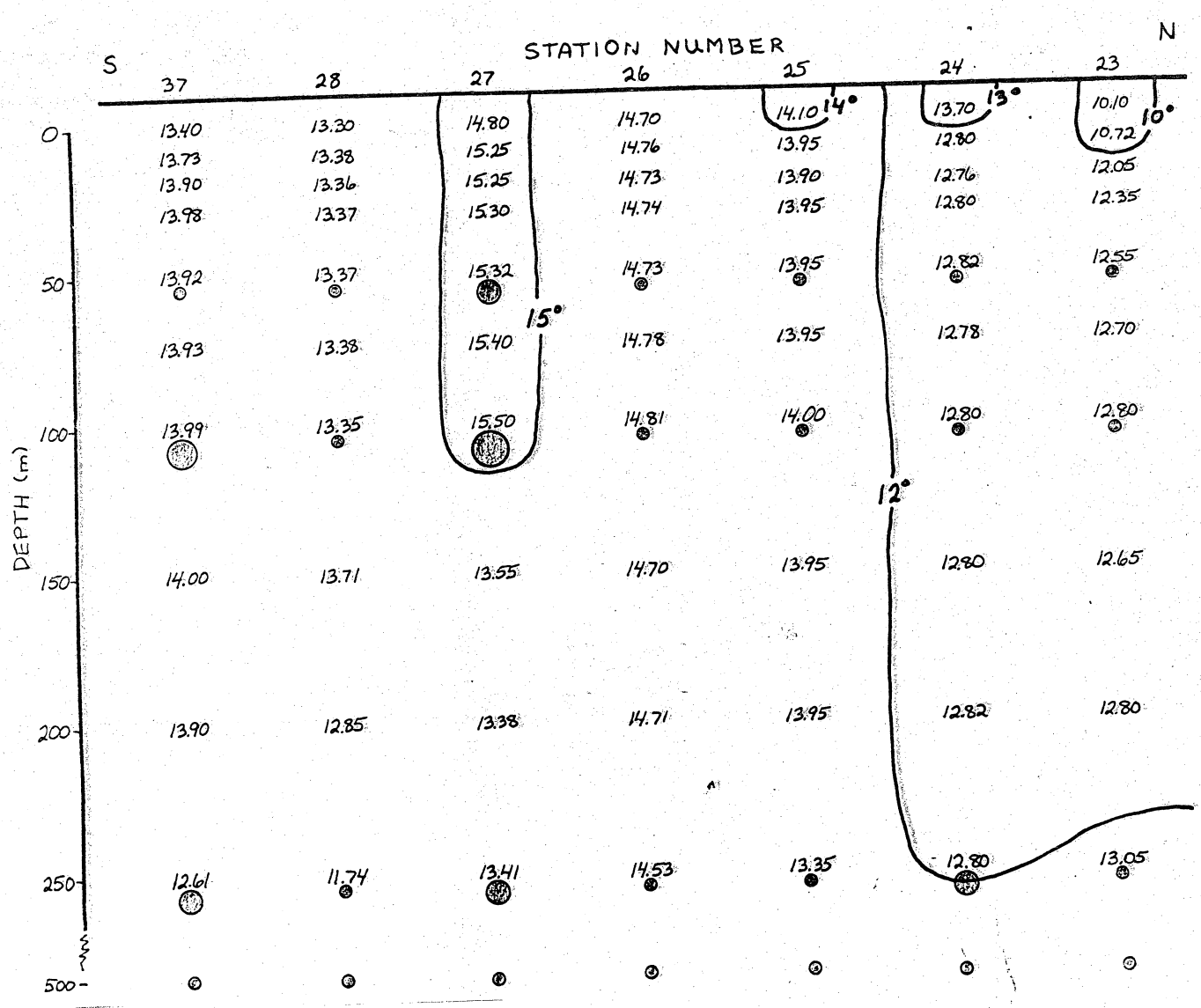

Fig. 4c. Temperature profiles for Transect 3.

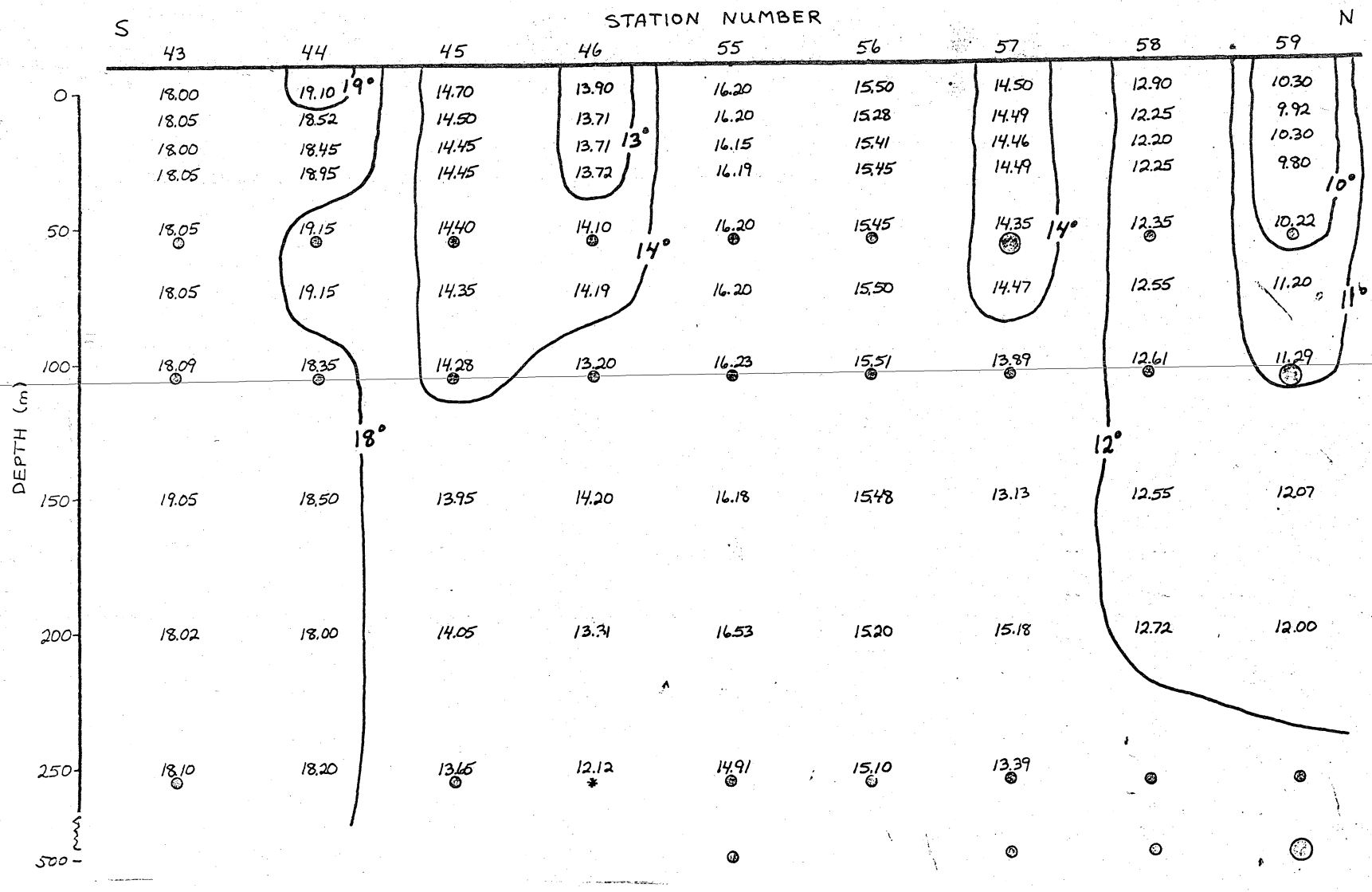

Fig. 4d. Temperature profiles for Transect 4.

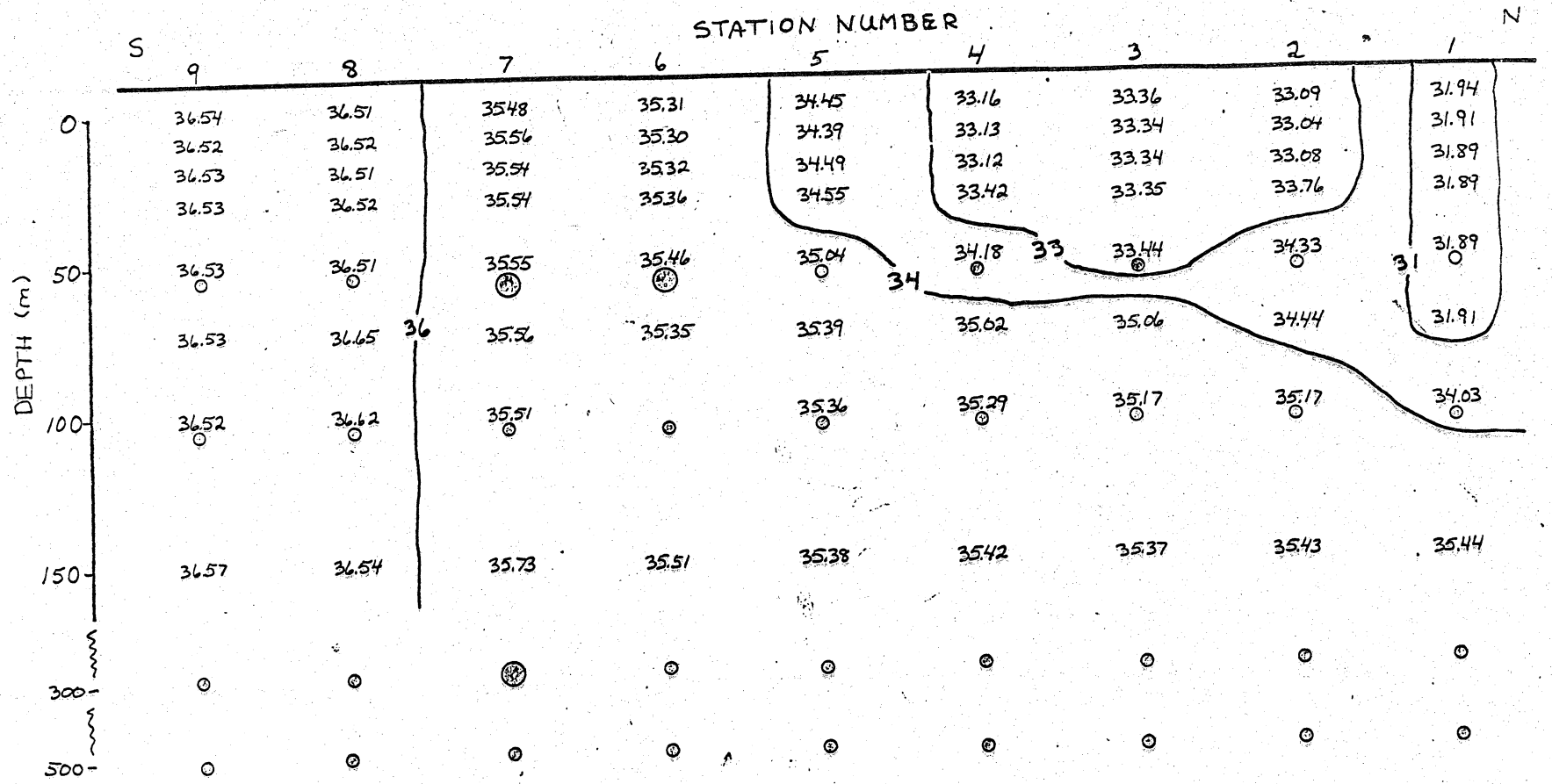

Fig. 5a. Salinity profiles for transect 1.

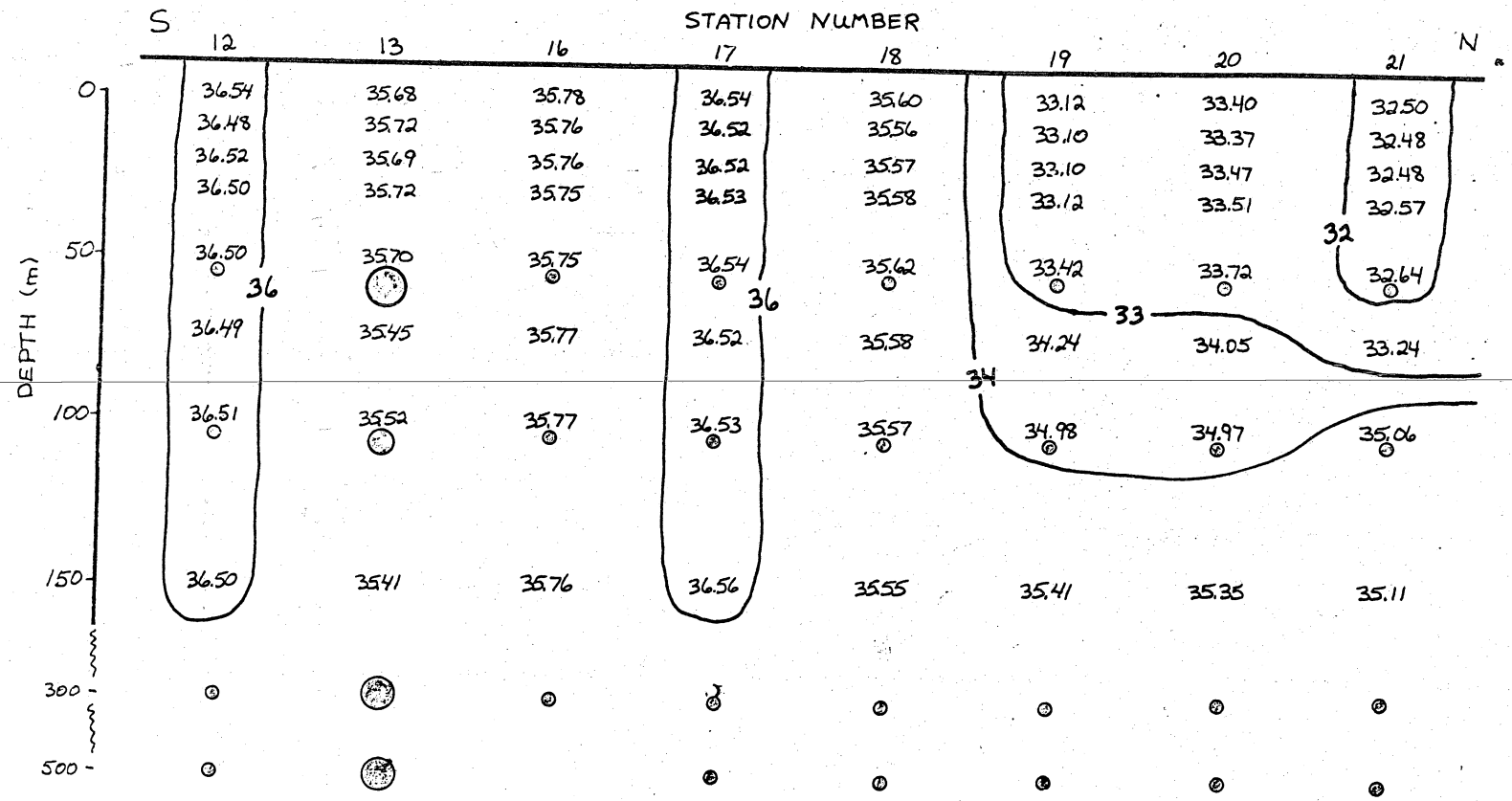

Fig. 5b. Salinity profiles for transect 2.

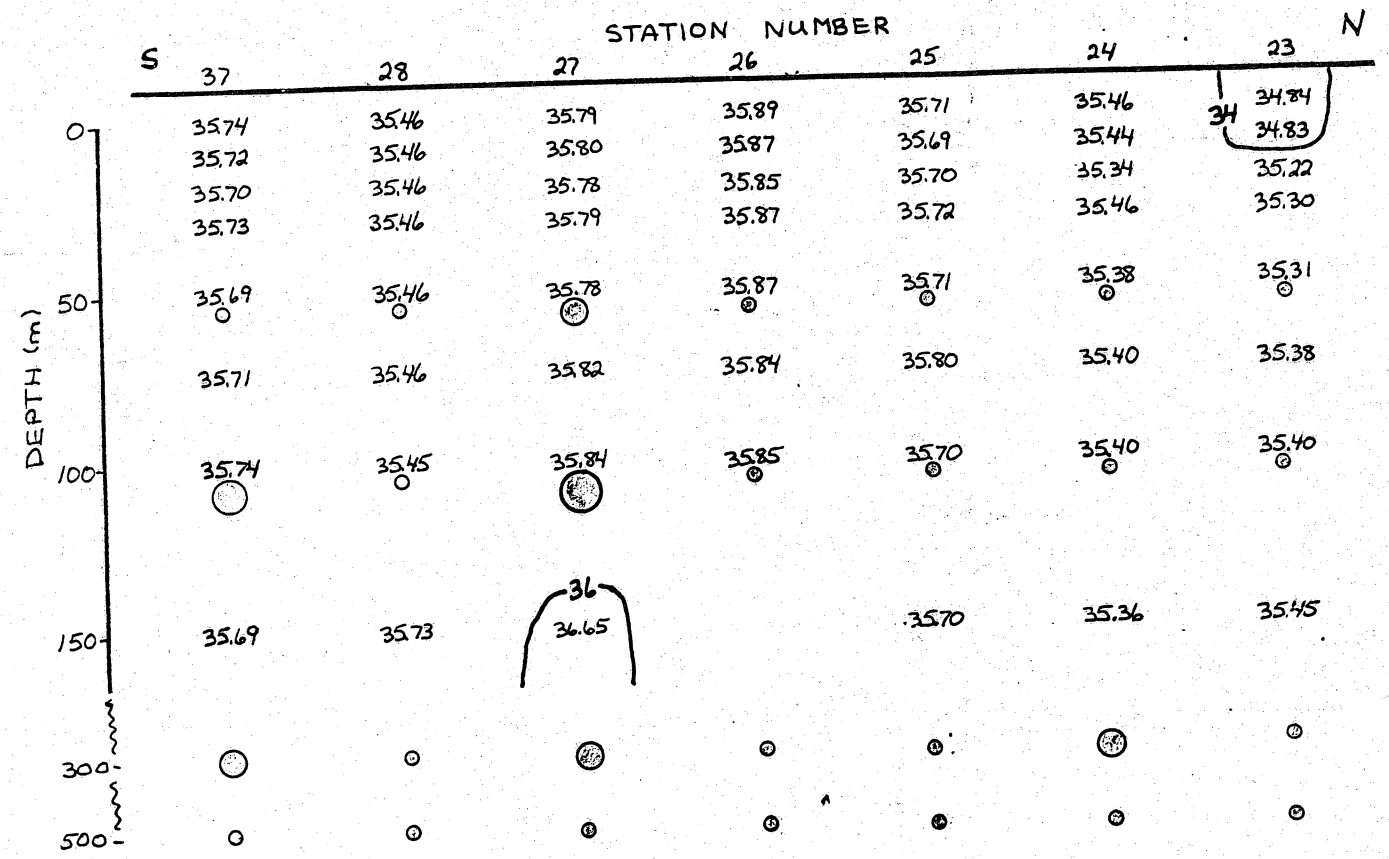

Fig. 5c. Salinity profiles for transect 3.

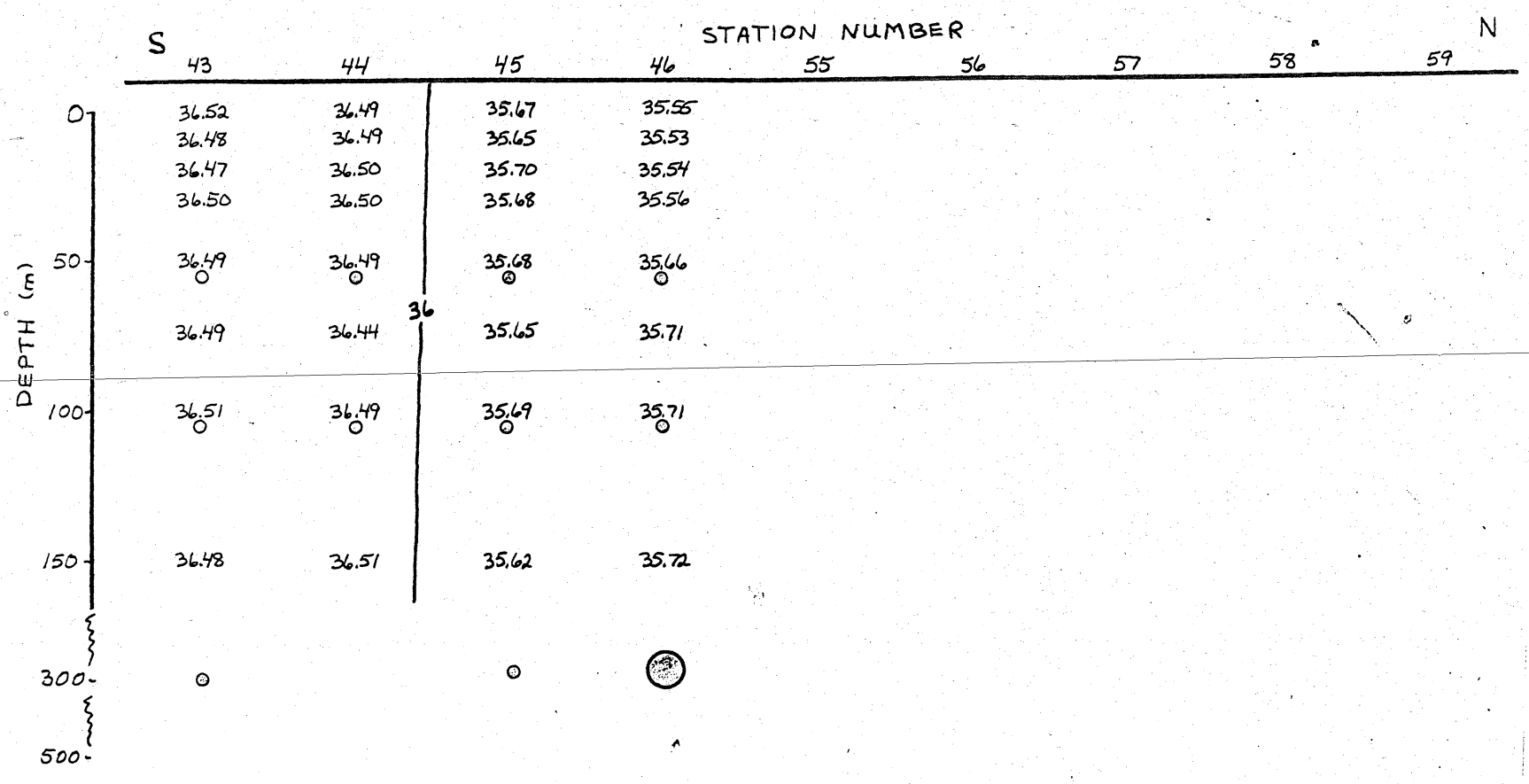

Fig. 5d. Salinity profiles for transect 4.