Copy

Northwest Atlantic Fisheries Organization

Serial No. N069 NAFO SCR Doc. 80/II/38

SPECIAL MEETING OF SCIENTIFIC COUNCIL - FEBRUARY 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

by

T. Amaratunga, T. Rowell, and M. Roberge
Department of Fisheries and Oceans Canada
Invertebrates and Marine Plants Division
Halifax, Nova Scotia, Canada

INTRODUCTION

A joint Canada/USSR research program on the short-finned squid Illex illecebrosus was undertaken by scientists from the Invertebrates and Marine Plants Division of the Department of Fisheries and Oceans, DFO Biological Station, Newfoundland, and AtlanNIRO, USSR.

The principal objectives of the joint study were to locate spawning grounds of Illex illecebrosus and to collect data important to the understanding of its life cycle. The survey was designed to collect data in relation to spawning areas, important spatial and temporal as well as biological aspects from the collection of mature females, larvae, and juveniles. The two cruises, each with two legs, which were initially proposed were changed due to the late arrival of the vessel. Six cruises were undertaken on the Soviet RV Belogorsk as follows:

Cruise 7901 - February 16 to March 6, 1979 - along the shelf break of the Scotian Shelf.

Cruise 7902 - March 7 to March 26, 1979 - from the Scotian Shelf to the Gulf Stream.

Cruise 7903 - March 26 to April 17, 1979 - from the Scotian Shelf to the Gulf Stream.

Cruise 7904 - April 18 to May 10, 1979 - from the Grand Banks to the Gulf Stream.

Cruise 7905 - May 10 to May 22, 1979 - from the Scotian Shelf to the Gulf Stream.

Cruise 7906 - May 25 to June 4, 1979 - Scotian Shelf.

OPERATIONS

Details of operations of each cruise were as follows:

Cruise 7901

The objectives of the survey included the search for mature female Illex illecebrosus and their spawning grounds and the study of diurnal and geographic distribution along the Shelf break, using bottom trawl gear.

All stations were located within one of ten transects (Table 1 and Figure 1). Survey operations commenced at Transect 1, and Transects 1 to 7 were occupied in sequence, followed by Transects 10, 9, and 8 respectively. On each station, temperature profiles were taken using BT or XBT casts. To locate larvae, an ICNAF-type oblique bongo tow was performed on all stations. The depth of tow was adjusted to approximately 25 m off bottom for shallower stations, with a maximum depth for deeper stations of 210 m. On completion of the bongo tow, a bottom trawl of 30 minutes' (depths 100, 200, and 300 m) or 60 minutes' (depths greater than 300 m) duration was made. It was originally planned to sample from the 100 m depth to at least 1000 m, however, the vessel had insufficient trawl warp to fish much deeper than 700 m. In order to sample plankton in the near-bottom region, simultaneous to the trawling operation, metre nets of 333 μ mesh were attached by single bridles to each of the trawl warps approximately 50 m ahead of the trawl doors.

A total of 27 sets were made: 9 in 100 m; 10 in 20 m; 6 in 300 m; 1 in 400 m; and 1 in 700 m. No sets were made at 500 or 600 m. For the depths of 100 and 200 m, the trawl times were well distributed throughout the four time blocks established to determine diurnal influences on squid and

plankton catches (0001-0600, 0601-1200, 1201-1800, 1801-2400). Depths greater than 300 m had extremely rough bottom and only two locations were found where bottom trawls could be used.

Cruise 7902

The objectives of the survey included the location of larvae and juveniles and a study of their diurnal and geographic distribution using plankton gear.

Survey operations commenced at Station 1 (Figure 2) and continued to Station 23 in sequence. Plankton tows were distributed throughout six time blocks established to determine diurnal influences on squid, particularly Illex, and plankton catches (0001-0400, 0401-0800, 0801-1200, 1201-1600, 1601-2000, 2001-2400).

On each station, an ICNAF oblique bongo tow at 200 m and a stepped oblique bongo tow from 10 to 0 m were conducted, using a 505 μ mesh. A series of five 15-minute Engle Midwater Trawls (EMT) were conducted at depths of 50, 100, 200, 300, and 500 m on stations located 50 miles apart. No EMT's were made on Station 18. Hydrographic work including dissolved oxygen, salinity, and temperature was also conducted on these stations. On stations 30 miles apart, XBT casts were made to determine temperature profiles.

A total of 23 stations were completed, including 16 stations with hydrology, bongo tows, and EMT's and 7 stations with XBT's and bongo tows. Oblique and bongo tow times were well distributed throughout five of the six time blocks. No bongo tows were made in the time block 0401-0800. EMT's were conducted in each time block with the greater number being made in the 0001-0400 and 1201-1600 time blocks.

Cruise 7903

The objective of the survey was to locate larvae and juveniles and study their diurnal and geographic distribution using plankton gear.

Survey operations commenced at Station 24 (Figure 2) and 30 stations were completed in sequence. Oblique and step bongo tows were conducted using a bongo net with a 505 μ mesh. A series of five 15-minute EMT's were performed at depths of 50, 100, 200, 300, and 500 m. XBT casts were made midway between those stations separated by a distance of 60 miles. Hydrographic analysis was performed using nansen reversing bottles to record salinity/temperature profiles. At Stations 26, 27, and 28 (15 minutes separation), no bongo tows were conducted and only one or two EMT's were carried out. Station 31 yielded high catches of Illex illecebrosus so a 24-hour monitoring program, using only the EMT, was employed to obtain information on diurnal migration. During this period, five 15-minute EMT replicates (50, 100, 200, 300, and 500 m as replicates) were performed. Two additional EMT's (50 and 100 m) were executed at Station 32 after the regular sampling procedure had been completed. In Transect 7, Stations 35-41 were only 30 minutes apart; and in Transect 8, Stations 48, 49, and 50 were only 30 minutes apart. These stations were placed close together in order to study geographic variations. In Transect 9, Station 52 differed in that no plankton tows were performed.

Cruise 7904

The objective of the survey was to establish the presence of larvae and juveniles in Subarea 3 using plankton gear.

Beginning at Station 55 (Figure 2), 15 fishing stations were occupied sequentially. The majority of stations were sampled at 100 and 200 m depths for 0.5 hours, using the EMT during the hours of darkness (approximately 1900-0400 - Halifax local time). Four of these stations were fished at five depths (50, 100, 200, 300, and 500 m). No further details were available for this report.

Cruise 7905

The objective of the survey was to locate larvae and juveniles along the Scotian Shelf break using bottom trawls, and seaward using plankton gear.

A new track was established for this cruise to accommodate both plans (Figure 3). The survey commenced at bottom trawl Station 28 (Table 1) and carried out sets during daylight hours. The vessel then moved seaward to perform EMT's (Table 2) at night and returned to the Shelf break for sampling during daytime. Thus, a zig-zag course was set. The seaward movement of the vessel for the EMT survey alternated between one and two days.

Four bottom trawls were done per day during the daylight hours, with one trawl in each of the following depth ranges: 100-149 m, 150-199 m, 200-249 m, and 250-299 m. The first set came on deck at about 0500 hours and the final bottom trawl of the day was on board by about 1630 hours. A total of 19 sets were done sequentially (Table 1).

In the EMT survey, two sites were sampled per night with two sets at each site, at depths of 100 and 200 m, respectively. Beginning at Station 74, 35 EMT's were carried out sequentially (Table 2).

Hydrographic stations were carried out at approximately 40-mile intervals along the entire cruise track. Each station consisted of temperature and salinity profiles.

During the final two nights of the cruise, five-minute EMT's were made in an attempt to capture live squid. A number of Illex were transferred to two tanks on board. The squid appeared to do well initially, but they rapidly became weak and none survived to reach Halifax.

Cruise 7906

The objective of this survey was to study diurnal feeding patterns of Illex illecebrosus at various locations along the edge of the Scotian Shelf using bottom trawl gear.

Survey operations commenced at Station 47 in the Emerald Basin area (Figure 4). Only one squid was caught in three sets so the Belogorsk steamed to the edge of the Scotian Shelf, south of Emerald Bank. Stations were chosen with the intent of finding large schools of squid, and depth-stratified sets were made in selected areas; viz., Emerald Basin, south of Emerald Bank, Sable Island Bank, and Banquereau Bank (Figure 4). When sufficient numbers were encountered in a set, a 24-hour survey was conducted at that location and depth with a set every two hours. One day more than anticipated was available at the end of the cruise. Three sets along the edge of Banquereau Bank were conducted during this day.

Hydrographic stations were conducted at each normal bottom trawl station and at the beginning, middle, and end of the 24-hour stations. Each station consisted of surface and bottom temperature recordings by an MBT and salinity profiles collected by nansen bottles.

A total of 53 sets were completed sequentially during the survey, 39 from the 24-hour bottom trawl survey stations and 14 normal bottom trawl sets (Table 1). All sets were between 100 and 300 m.

OBSERVATIONS AND DISCUSSION

The survey constituted a comprehensive search for I. illecebrosus spawning stock, and larvae and juveniles, over a wide area in SA 3&4 (Figures 1, 2, 3, and 4), using many types of gear. Since different gear types produced different results, they are treated independently in this report.

Engle Midwater Trawl Survey

Samples obtained from the bongo net survey have not been analyzed yet. However, few obvious I. illecebrosus were picked out on board the vessel and these are reported in this section of the report.

The total area covered in the EMT survey bounded from the southwestern edge of the Scotian Shelf along the Shelf break

to the Carson Canyon area of the Grand Banks and extended 150-350 miles seaward (Figure 2) from the Shelf break. Thus, this survey extended from the Continental Shelf well into the Gulf Stream. This area was mainly covered during cruises 7902, 7903, and 7904 between March 7 and May 10, 1979, while Cruise 7905 (May 10-22) occupied 19 different stations closer to the Shelf break. (Cruise 7904 data are not included in this report.) Most stations constituted replicate sets at different depths or on a 24-hour cycle, hence the total of 297 sets was made in the stations shown in Figure 2. Tables 3a and b show stations at which I. illecebrosus larvae and juveniles were caught. Catches ranged from 1 to 407 in number. The four sets that resulted in 200 or more I. illecebrosus had net depths of 50, 2 x 100, and 300 m, while sets that resulted in 100 or more animals were all at 200 m or less.

Sometimes the hydrographic stations differed from the EMT stations; however, Table 3 shows temperatures and salinities at depths I. illecebrosus was caught. Temperatures ranged from 4.81°C to 18.69°C. The largest catch of 407 animals had the highest recorded temperature of 18.68°C. Sets with 200 or more I. illecebrosus had temperatures ranging from 11.16-18.69°C as did sets with 100 or more. Salinity ranged from 33.840 to 36.579‰. Sets with 200 or more animals had salinities ranging from 35.433 to 36.551‰ and sets with 100 or more from 35.342 to 36.551‰.

Figure 5 shows hydrographic stations and a temperature and salinity profile for each transect is depicted in accompanying Figures (5-1 to 5-8 and 5-9 to 5-12 respectively). These figures also depict I. illecebrosus catches. Data from each cruise are summarized by cross tabulations of temperature versus depth (Table 4) and time of day versus depth (Table 5). Figure 6 shows a three-dimensional plot of average squid numbers against depth and temperature. The average numbers increased with decrease in depth; however, a peak is noted at 13°C at depth greater than 40 m. Cruise 7902 had insufficient

numbers to see diurnal patterns. Cruise 7903 showed best catches between 20 and 24 hours at all depths, and the poorest catches were between 12 and 16 hours.

The EMT survey produced an unprecedented collection of I. illecebrosus larvae and juveniles. While it is unusual to catch larvae and juveniles, this survey accounts for a very large collection (40 larvae and 5,081 juveniles) (Table 3) of these stages of the species. The survey also resulted in an unusual collection of other cephalopod species. Preliminary identifications, usually to family level, made aboard the vessel listed all specimens caught. Samples were then divided between Canada and USSR. The Canadian samples, which amounted to 46% of the total number, were further identified and listed in Table 6. The list shows that very unusual species were collected; however, the identifications were preliminary and need to be regarded as so.

Bottom Trawl Survey

The bottom trawl survey was concentrated along the Scotian Shelf break at depths ranging from 100 to 700 m. The area was covered by Cruises 7901, 7905, and 7906. While cruises 7901 and 7905 conducted random, depth stratified trawls within designated areas, Cruise 7906 searched for squid concentrations to conduct 24-hour diurnal studies. Summary of catch statistics by depth (Table 7) shows Cruise 7901 caught only 87.5 kg of I. illecebrosus, with best catches between 150 and 250 m. Two months later, however, catches were considerably higher with best catches at 200-250 m. During the latter part of May, squid concentrations were found at 100-150 m and diurnal studies were carried out at these depths.

Between February 16 and March 6, in Cruise 7901, the bottom trawl survey caught 228 males and 330 females. The significant feature was that 88% of the males and 95% of the females were in Stage 3 (Table 8). It was presumed that these

were animals from the spawning stock of 1978 (Amaratunga, 1980). Although the period probably represented the latter part of the spawning season (Amaratunga, 1980), the very late stages of maturity were not located. There was also the possibility that the few immature animals caught were early arrivals from the 1979 stock. Further analyses were necessary to determine this.

Cruise 7905 showed that immigration of 1979 stock to the Scotian Shelf had begun. Except for two Stage 4 females caught, animals were in Stage 1 maturity stage, and averaged close to 130 mm.

I. illecebrosus catches in the diurnal studies of Cruise 7906 are tabulated (Table 9) on a 2-hour time scale. Catches in the Sable Island Bank and Emerald Bank area increased between 0430 (local time) and 0630 hours, and 1430 and 1830 hours, while the Banquereau Bank area had high catches between 0430 and 1030 hours, and 1830 hours.

Metre net samples have not been analyzed yet.

In summary, the survey resulted in a unique collection of I. illecebrosus larvae and juveniles. As seen in Figure 5, the EMT captures were from the Gulf Stream, probably in the Gulf Stream/Shelf water mix (however, plankton samples and hydrographic data have not been analyzed yet to confirm this). Mean mantle lengths of the juveniles analyzed to date ranged from 16 mm to 74.5 mm. Mean sizes increased from about 20 mm at the beginning of March to about 65 mm by mid May and fitted well with the growth curves developed for the year (Amaratunga, 1980). Adults captured in February also related well to the growth curve (Amaratunga, 1980); however, the transition from 65 mm juveniles in the Gulf Stream to 130 mm juveniles on the Shelf was not observed. Although Cruise 7905 specifically attempted to trace immigration, this was not totally achieved.

ACKNOWLEDGEMENTS

We wish to extend our sincere thanks to Y. Grinkov, Y. Froerman, P. Fedulov, V. Kholukov, N. Drozdov, I. Sheremet, and G. Moskalev, the USSR scientists with whom the program was developed and cooperatively conducted. In view of the time constraints, this report was prepared as a summery of the data collected, with very little consultation with our USSR colleagues.

Our thanks are also extended to all others who assisted in making the cruises a success.

REFERENCES

Amaratunga, T. 1980. Growth and maturation patterns of short-finned squid Illex illecebrosus on the Scotian Shelf. ICNAF Res. Doc. 80/00/00.

Table 1. Date and location of bottom trawl stations surveyed in Cruises 7901-05-06.

Cruise no.	Transect	Station no.	Date	Location (at start)	
				Latitude	Longitude
7901	1	1	19/02/79	42°13'	65°33'
		2	19/02/79	42°21'	65°37'
		3	19/02/79	42°08'	65°25'
		4	19/02/79	42°08'	65°28'
		5	20/02/79	42°10'	65°23'
	2	6	20/02/79	43°08'	63°35'
		7	21/02/79	42°49'	63°40'
		8	21/02/79	42°48'	63°34'
		9	21/02/79	42°48'	63°37'
	3	10	22/02/79	42°55'	62°55'
		11	22/02/79	42°50'	62°50'
		12	22/02/79	42°48'	62°56'
	4	13	23/02/79	43°07'	62°21'
		14	23/02/79	42°56'	62°17'
		15	24/02/79	42°56'	62°14'
		16	24/02/79	42°52'	62°10'
	5	17	25/02/79	43°10'	61°30'
		18	25/02/79	43°07'	61°30'
	6	19	26/02/79	43°16'	61°01'
		20	26/02/79	43°18'	61°02'
		21	26/02/79	43°24'	60°57'

Table 1 Continued...

Cruise no.	Transect	Station no.	Date	Location (at start)	
				Latitude	Longitude
	7	22	26/02/79	43°32'	60°21'
		23	26/02/79	43°27'	60°18'
	8	27	04/02/79	43°39'	59°37'
	9	26	03/03/79	43°59'	58°42'
	10	24	02/03/79	44°23'	57°37'
		25	03/03/79	44°22'	57°36'
7902		28	12/05/79	42°21'	65°16'
		29	12/05/79	42°28'	64°46'
		30	12/05/79	42°28'	64°46'
		31	13/05/79	42°49'	64°03'
		32	13/05/79	42°45'	64°11'
		33	13/05/79	42°44'	64°10'
		34	13/05/79	42°44'	64°11'
		35	16/05/79	43°08'	62°35'
		36	16/05/79	42°52'	62°40'
		37	16/05/79	42°57'	62°31'
		38	16/05/79	42°51'	62°38'
		39	17/05/79	43°12'	61°24'
		40	17/05/79	43°05'	61°36'
		41	17/05/79	43°04'	61°37'
		42	17/05/79	43°03'	61°37'
		43	20/05/79	43°32'	60°20'
		44	20/05/79	43°26'	60°19'
		45	20/05/79	43°25'	60°20'
		46	20/05/79	43°25'	60°17'
7906		47	26/05/79	43°46'	61°51'
		48	26/05/79	43°38'	63°05'
		49	26/05/70	43°16'	63°14'
		50	27/05/79	42°59'	62°15'
		51	27/05/79	42°58'	62°13'
		52	27/05/79	42°58'	62°10'
		53-65*	27-28/05/79	42°59'	62°15'
		66	29/05/79	43°22'	60°49'
		67	29/05/79	43°20'	60°49'
		68	29/05/79	43°33'	60°10'
		69	29/05/79	43°31'	60°09'
		70-82*	30-31/05/79	43°32'	60°10'
		83	31/05/79	44°07'	58°28'
		84-96*	01-02/06/79	44°07'	58°28'
		97	02/06/79	44°18'	58°00
		98	02/06/79	44°18'	57°50
		99	02/06/79	44°21'	57°33

*24-hour bottom trawl stations.

Table 2. Date, temperature, depth, and coordinates of EMT stations surveyed during Cruise 7905.

Station	Operations*	Date	Temperature (°C)	Depth	Coordinates	
					Latitude	Longitude
74	EMT, H	12/05/79	7.3	1080	42°11'	64°28'
75	EMT, H	13/05/79	5.8	1360	42°29'	64°18'
76	EMT	13/05/79	6.8	1065	42°15'	63°51'
77	EMT, H	14/05/79	6.4	1400	41°58'	63°33'
78	EMT, H	14/05/79	18.8	2325	40°33'	62°18'
79	EMT, H	15/05/79	15.4	2450	40°53'	62°20'
80	EMT, H	15/05/79	9.9	1000	42°27'	62°37'
81	EMT, H	16/05/79	8.4	1480	42°40'	62°40'
82	EMT, H	16/05/79	8.9	1600	42°36'	62°11'
83	EMT, H	17/05/79	6.5	520	42°55'	61°41'
84	EMT, H	17/05/79	10.3	1100	42°46'	61°17'
85	EMT, H	18/05/79	10.8	1850	42°22'	60°58'
86	EMT, H	18/05/79	15.0	2750	40°39'	59°35'
87	EMT, H	19/05/79	11.8	5100	41°06'	59°42'
88	EMT	19/05/79	10.0	2400	42°59'	60°03'
89	EMT, H	20/05/79	9.6	3000	42°47'	60°03'
90	EMT, H	21/05/79	9.8	3600	42°39'	60°01'
91	EMT	21/05/79	9.8	1300	43°17'	60°10'

*H = hydrography
EMT = Engle Midwater Trawl

Table 3a. Number of *Illex* junveniles (≤ 10 cm), depth, temperature, and salinity at each station where squid were caught.

Cruise no.	Transect	Station	Number *Illex*	Depth (m)	Temp. (°C)	Salinity ‰
7902	I	1	79	50	-	-
			1	0-200	-	-
		3	1	300	-	-
			1	500	-	-
	II	5	14	100	17.57	36.482
			39	200	17.10	36.290
			179	300	16.62	36.385
			14	500	9.42	35.907
		7	122	50	15.21	35.969
			5	100	15.00	35.983
			21	200	14.22	35.766
			28	300	11.90	35.519
		11	9	50	6.68	33.840
			13	100	8.44	34.020
			3	200	11.90	35.362
			1	300	8.56	35.139
			2	500	6.16	34.990
		13	2	200	11.00	35.334
	III	14	1	50	8.92	33.925
		15	28	50	7.06	36.007
			82	100	14.36	35.850
			103	200	13.75	35.831
			243	300	11.16	35.433
			53	500	7.70	35.094

Table 3a Continued...

Cruise no.	Transect	Station	Number Illex	Depth (m)	Temp. (°C)	Salinity ‰
	IV	16	28	100	13.92	35.514
			7	200	12.81	35.613
			7	300	10.20	35.273
			3	500	6.45	35.039
		20	2	100	11.43	35.182
7903	V	25	184	50	16.08	36.135
			254	100	15.61	36.122
			63	200	14.56	36.053
			49	300	12.44	35.677
			67	500	8.86	35.260
		26	129	100	-	-
			3	200	-	-
		27	2	100	-	-
		28	46	100	-	-
		29	3	50	18.12	36.525
			1	100	18.16	-
			2	200	17.88	36.519
			14	300	17.70	36.495
			1	500	15.92	36.149
	VI	30	5	50	18.28	36.545
		31	279	50	18.69	35.555
			407	100	18.68	36.551
			85	200	17.96	36.579
			57	300	17.66	36.476
			122	500	15.76	36.118
		32	189	50	17.08	36.392
			106	100	15.64	36.064
			2	200	14.10	35.796
			83	300	13.67	35.762
		33	38	50	15.60	36.129
			27	100	14.83	-
			64	200	13.78	35.836
			17	300	12.79	35.642
			16	500	8.35	35.106
		34	66	50	11.77	35.247
			10	100	12.99	-
			22	200	13.60	35.804
			18	300	12.13	35.561
			24	500	6.86	34.921
	VII	37	10	50	14.38	35.931
			62	100	13.62	35.770
		39	103	100	13.80	35.827
			54	200	13.80	35.833
			75	300	13.83	35.840
			64	500	9.04	35.175
		41	2	50	15.68	36.169
			46	100	14.32	35.865
			8	300	13.44	35.905
			2	500	9.00	35.136
		42	72	50	15.24	36.091
			184	100	15.24	36.091
			73	200	14.06	35.846
			71	300	14.12	35.905
			64	500	8.33	35.050
		43	20	50	16.86	36.361
			6	100	16.26	36.263
			18	200	14.84	35.985
			10	300	11.81	-

Table 3a Continued...

Cruise no.	Transect	Station	Number *Illex*	Depth (m)	Temp. (°C)	Salinity ‰
	VIII	46	1	50	12.91	35.573
		47	54	50	13.62	35.744
			193	100	13.40	35.695
			145	200	11.84	35.342
	VIII		35	300	11.69	35.482
			50	500	7.12	35.033
		48	1	50	10.00	35.090
			2	500	6.12	35.031
		49	3	50	8.84	34.400
			3	100	11.30	35.216
			1	200	11.12	35.405
			1	500	5.20	34.904
	IX	53	1	500	4.81	34.809
7905		78	5	100	-	-
		79	6	100	-	-
			7	200	9.13	35.014
		85	4	200	9.72	35.108
		86	48	100	-	-
			23	200	8.78	35.079
		87	1	100	-	-
Total			5081			

Table 3b. Number of *Illex* larvae, depth, temperature, and salinity at each station where squid were caught.

Cruise no.	Transect	Station	Number *Illex*	Depth (m)	Temp. (°C)	Salinity ‰
7902	I	1	1	0-10	-	-
		2	6	0-10	-	-
			6	0-200	-	-
	II	6	17	0-10	-	-
			1	0-200	-	-
		8	1	0-10	-	-
	III	15	3	0-200	13.75	35.831
7903	V	25	1	0-10	-	-
		29	1	0-10	18.14	36.551
			1	0-200	17.88	36.519
	VI	33	1	0-10	15.62	36.137
	VII	40	1	0-10	-	-
Total			40			

Table 4a. Number of Illex juveniles caught in each temperature regime at each depth (March 10-25, 1979).

Temperature (°C)	Depth (m)					
	50	100	200	300	500	Total
5.1-10.0	38	13	-	1	72	124
10.1-15.0	-	117	141	278	-	536
15.1-20.0	122	14	39	179	-	354
Total*	160	144	180	458	72	1014

*Certain stations did not have temp. recordings; therefore, not all squid were recorded.

Table 4b. Number of Illex juveniles caught in each temperature regime at each depth (March 28-April 13, 1979).

Temperature (°C)	Depth (m)					
	50	100	200	300	500	Total
0.0-5.0	-	-	-	-	1	1
5.1-10.0	4	-	-	-	298	302
10.1-15.0	131	444	442	366	-	1383
15.1-20.0	1149	781	38	20	43	2031
Total*	1284	1225	480	386	342	3717

*Certain stations did not have temp. recordings; therefore, not all squid were recorded.

Table 4c. Number of Illex juveniles (≤ 10 cm) caught in each temperature regime at each depth (May 12-21, 1979).

Temp. (°C) \ Depth (m)	50	100	200	Total
0-5.0	-	-	-	-
5.1-10.0	-	-	-	-
10.1-15.0	-	55	34	89
15.1-20.0	-	5	-	5
Total	-	60	34	94

Table 5 a. Number of Illex larvae and juveniles caught in each time block for each tow type (March 10-25, 1979).

Time \ Depth (m)	Bongo			EMT					
	0-200	0-10	ε	50	100	200	300	500	ε
00:01-04:00	3	18	21	37	95	106	1	0	239
04:01-08:00	-	-	-	-	-	-	244	58	302
08:01-12:00	0	-	0	0	0	0	0	-	0
12:01-16:00	1	-	1	123	5	21	28	-	177
16:01-20:00	6	6	12	0	42	46	179	0	267
20:01-24:00	1	1	2	79	2	-	7	17	105
Total	11	25	36	239	144	173	459	75	1090

Table 5 b. Number of Illex larvae and juveniles caught in each time block for each tow type (March 28-April 13, 1979).

Time \ Depth (m)	Bongo			EMT					
	0-200	0-10	ε	50	100	200	300	500	ε
00:01-04:00	-	1	1	126	314	83	68	132	723
04:01-08:00	-	1	1	70	207	5	1	1	284
08:01-12:00	1	1	2	23	127	65	26	20	261
12:01-16:00	-	-	-	11	1	37	30	14	93
16:01-20:00	-	-	-	69	111	58	86	7	331
20:01-24:00	-	1	1	628	819	284	226	248	2205
Total	1	4	5	927	1579	532	437	422	3897

Table 5c. Number of Illex juveniles (< 10 cm) caught in each time block using the EMT (May 12-21, 1979).

Time	Depth (m)			Total
	50	100	200	
00:01-04:00	-	-	23	23
04:01-08:00	-	7	11	18
08:01-12:00	-	-	-	-
12:01-16:00	-	-	-	-
16:01-20:00	-	-	-	-
20:01-24:00	-	53	-	53
Total	-	60	34	94

Table 6 Provisional list of cephalopod species identified from the Canadian samples.

Family	Species
Alloposidae:	Alloposus mollis
Ctenopterygidae:	Ctenopteryx sicula
Cranchiidae:	Teuthowenia megalops Cranchia scrabra Heliococranchia sp. Leachia sp.
Octopoteuthidae:	Octopoteuthis sp.
Mastigoteuthidae:	Mastigoteuthis hjorti Mastigoteuthis sp.
Onychoteuthidae:	Onykia carriboea Onychoteuthis banksi Moroteuthis equatorialis
Histioteuthidae:	Histioteuthis reversa Histioteuthis dofleini Histioteuthis bonnellii Histioteuthis corona corona Histioteuthis sp.
Lycoteuthidae:	Selenoteuthis scintillans
Enoploteuthidae:	Abraliopsis pfefferi Abraliopsis sp. Abralia redfieldi Pterygioteuthis giardi Abralia sp. Ancistrochirus sp. Pyroteuthis margaritifera Pterygioteuthis gemmata
Gonatidae:	Gonatis fabricii
Chiroteuthidae:	Chiroteuthis lacertosa
Brachioteuthidae:	Brachioteuthis sp.
Ommastrephidae:	Illex sp.
Sepiolidae:	Rossia sp.

Table 7. Total catch and catch rate of Illex caught in each depth strata using the bottom trawl in Cruise 7901-05-06.

Date	Depth	Total weight (kg)	No. of trawls	$\overline{Wt}$/trawl (kg)
Feb. 19-Mar. 5 (7901)	50-99	0.0	1	0.00
	100-149	0.5	7	0.07
	150-199	13.8	2	6.90
	200-249	44.7	8	5.59
	250-299	0.0	1	0.00
	300-449	24.4	5	4.88
	450-599	4.1	1	4.10
	600-749	0.0	1	0.00
Total		87.5	26	
May 12-20 (7905)	50-99	-	-	-
	100-149	397.7	6	66.28
	150-199	96.9	4	24.23
	200-249	586.7	4	146.68
	250-299	211.4	5	42.28
Total		1292.7	19	
May 26-June 3 (7906)	50-99	-	-	-
	100-149	5397.4	45	119.9
	150-199	192.9	5	38.6
	200-249	10.7	1	10.7
	250-299	0.3	2	0.2
Total		5601.3	53	

TABLE 8. Distribution of Illex by transect and maturity stages in Cruise 7901.

Transect no.	No. Illex	Male maturity stages				No. Illex	Female maturity stages					Total
		1	2	3	4		1	2	3	4	5	
1	89		4	85		114		4	105	5		203
2	10	1	1	8		8		2	6			18
3	30	1	1	28		51	1	1	49			81
4	65		10	55		111		2	108	1		176
5	4	1		3		4			4			8
6	6		2	4		6			6			12
7	14		6	8		22		2	20			36
8	4			4		4			4			8
9	6	1		5		10			10			16
10	0					0						0
Total	228	4	24	200		330	1	11	312	6		558

TABLE 9. Squid catches (kg) in the 24-hour bottom trawl surveys during Cruise 7906.

Time (GMT)	Station 1*	Station 2**	Station 3***
00:30	11.8	16.0	4.4
02:30	13.5	12.5	18.0
04:30	15.9	39.8	27.5
06:30	10.3	33.2	6.9
08:30	149.9	96.2	454.8
10:30	228.8	29.6	10.2
12:30	6.8	1.7	294.4
14:30	2.7	3.2	238.4
16:30	9.9	4.1	39.6
18:30	66.2	62.5	34.4
20:30	427.1	393.2	65.5
22:30	48.9	287.6	326.2
Total	991.8	950.0	1520.3

*South of Emerald Bank
**Sable Island Bank
***Banquereau Bank

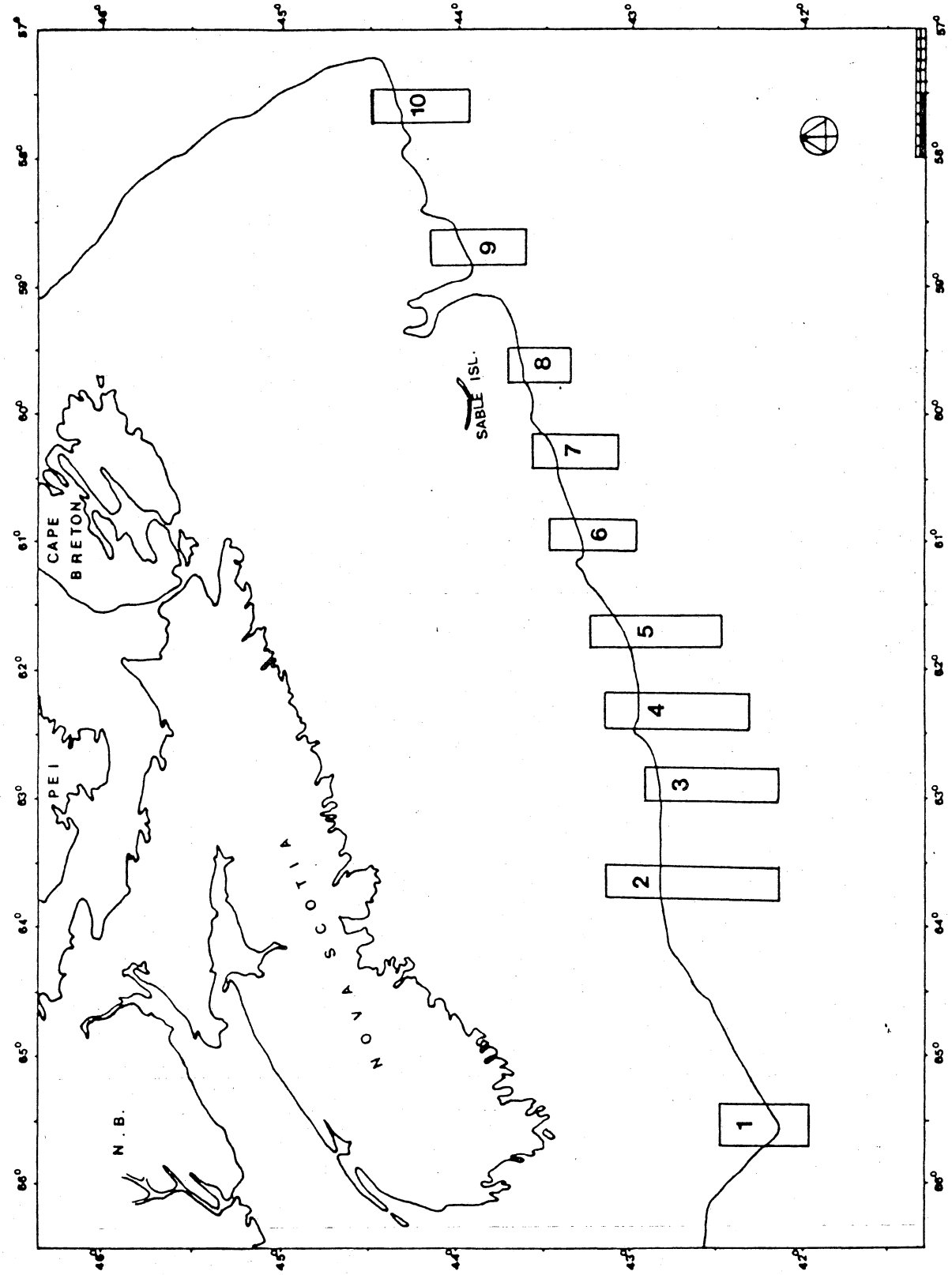


Figure 1. Transects surveyed in Cruise 7901, February 16 to March 6, 1979.

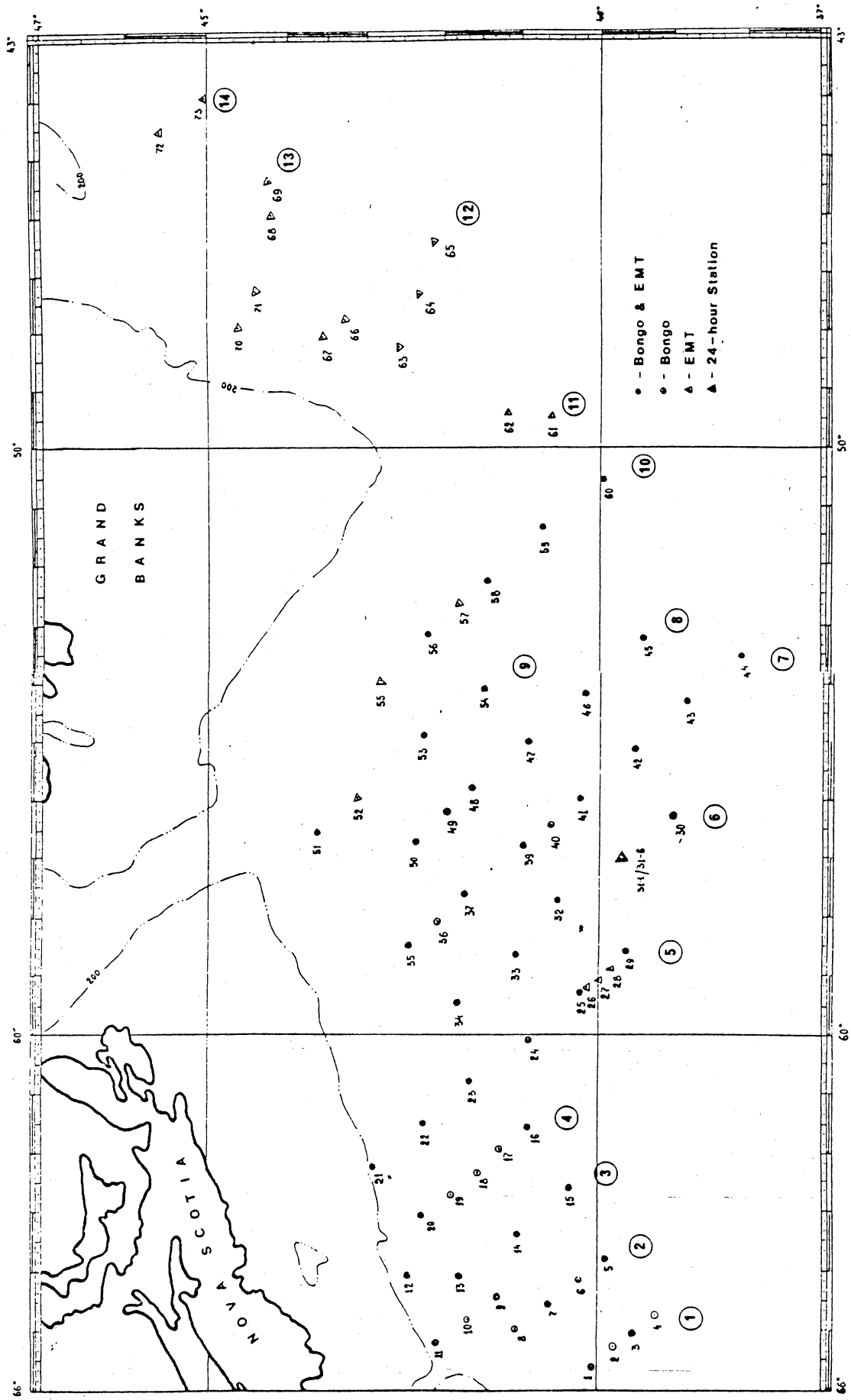


Figure 2. Stations sampled during Cruise 7902-03-04, March 10 to April 5, 1979.

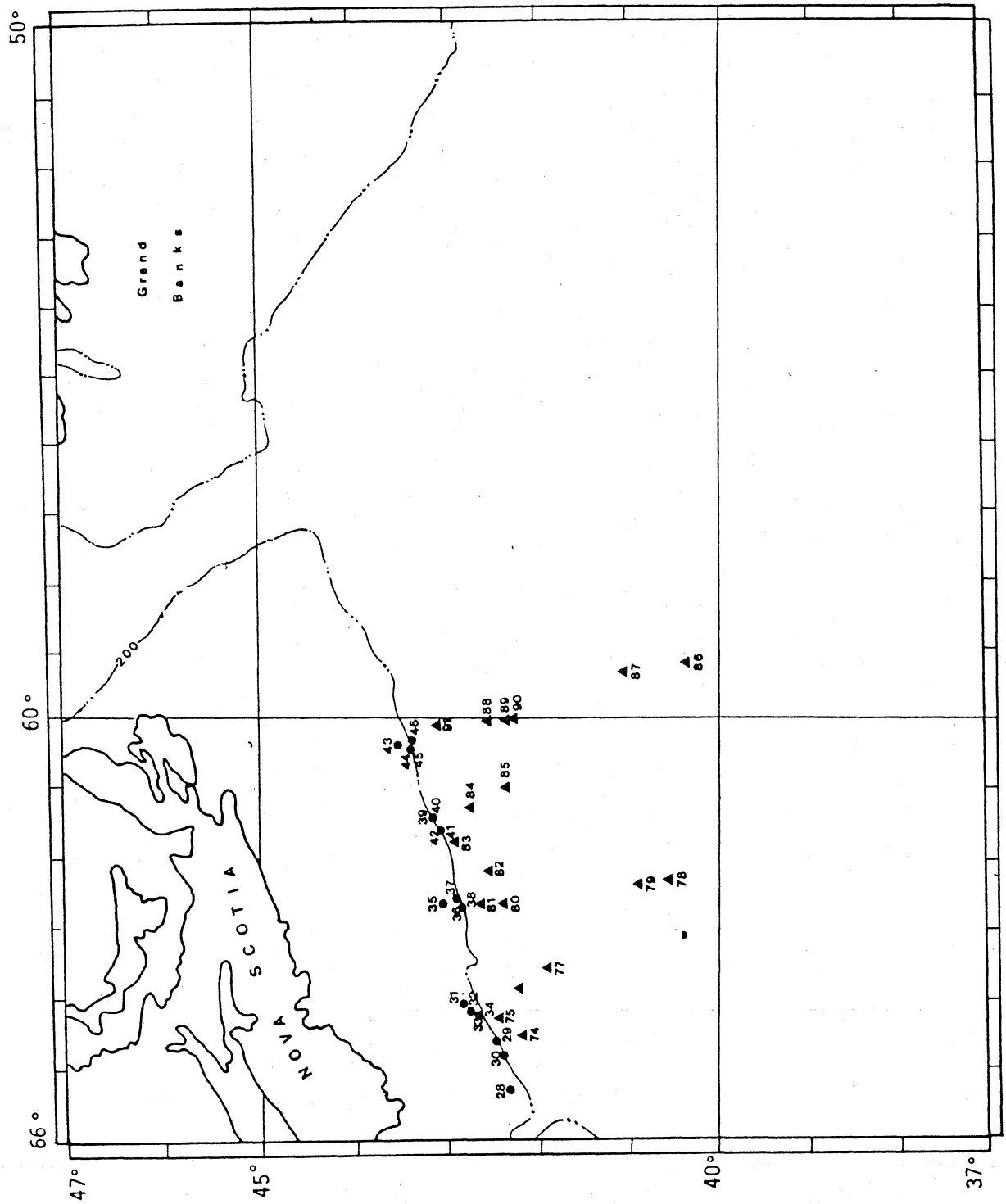


Figure 3. Stations sampled during Cruise 79 05, May 10 to May 22, 1979.
● - EMT
▲ - Bottom Trawl

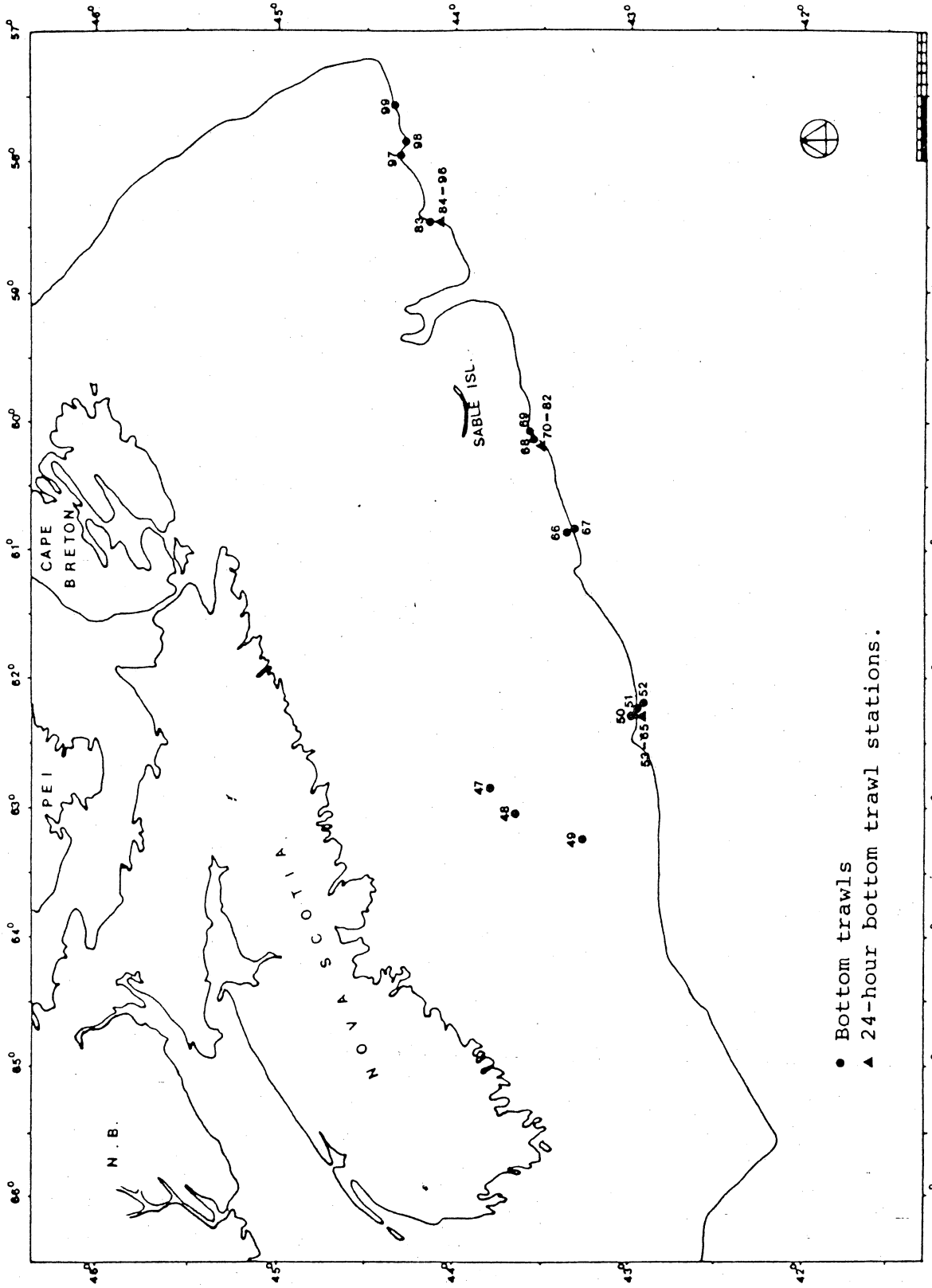


Figure 4. Stations sampled during Cruise 79 06, May 26 to June 2, 1979.

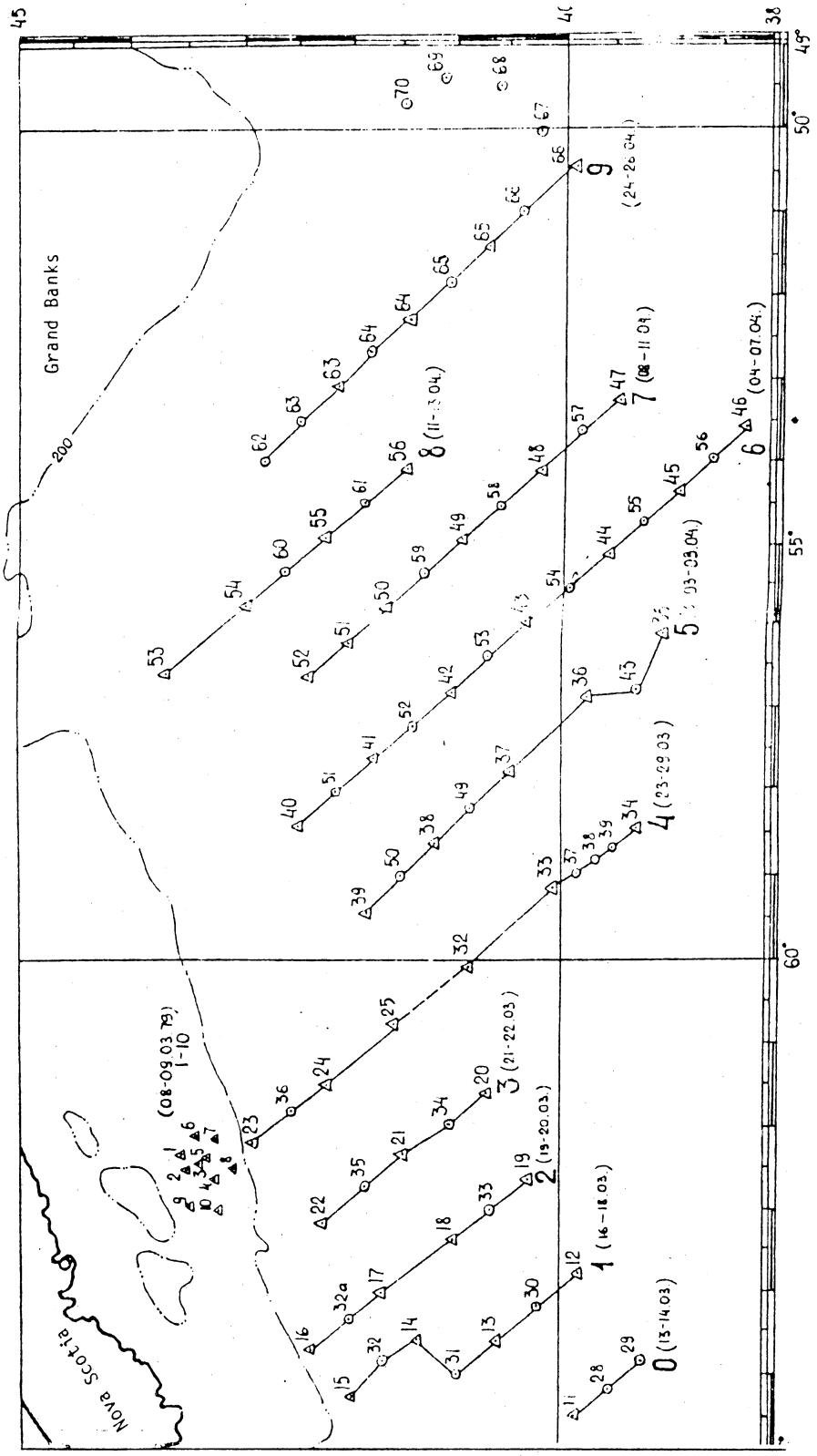


Figure 5. Hydrological stations and transects surveyed from March 8 to April 27, 1979.
▲ nansen bottle
⊙ XBT

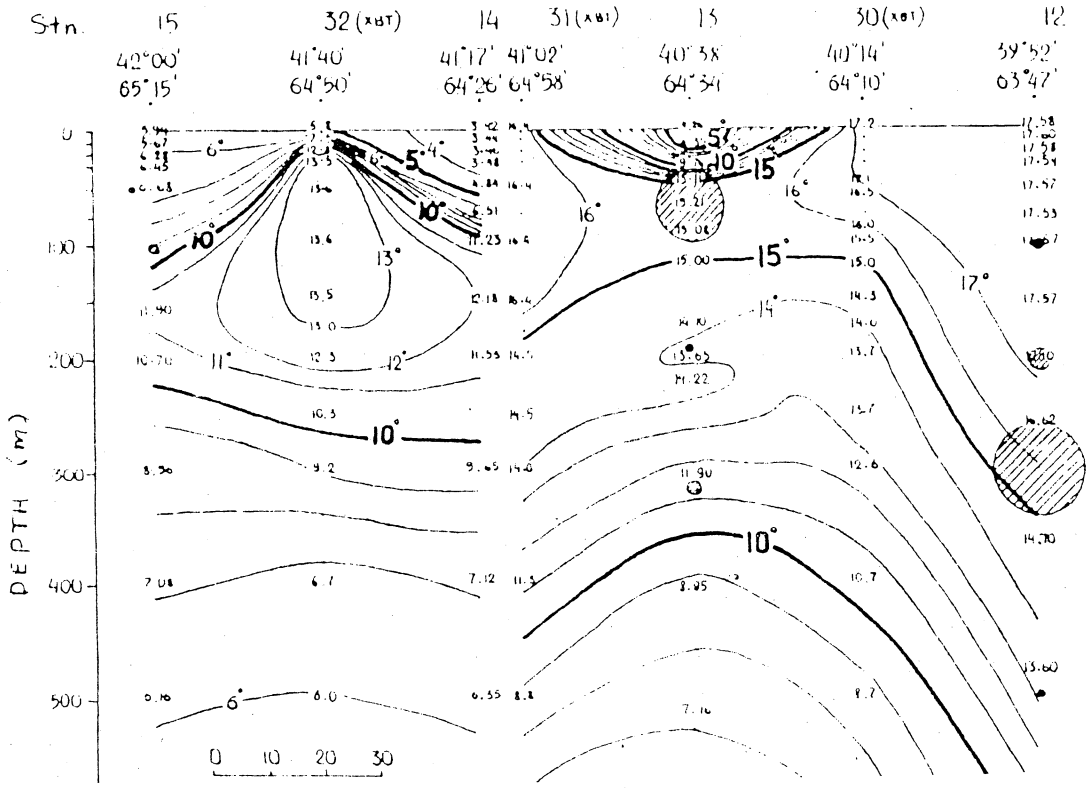


Figure 5-1. Vertical water temperature profile of Transect 1 (March 16-18, 1979)

⊘ = 50 Illex

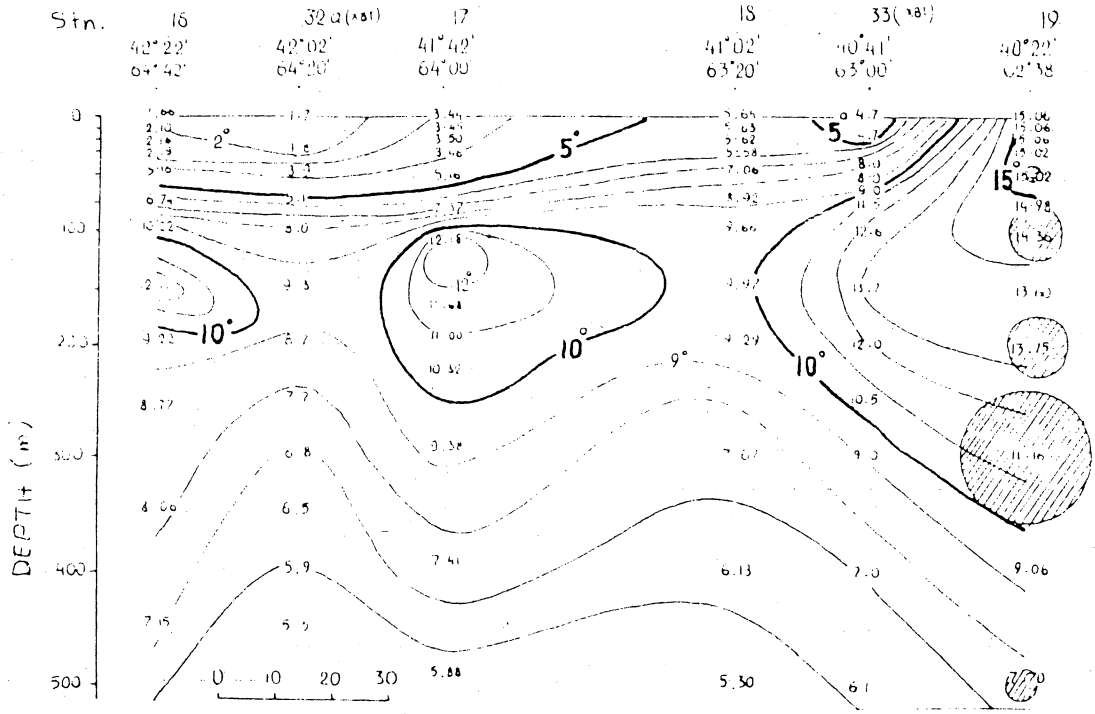


Fig. 5-2. Vertical water temperature profile of Transect 2 (March 19-20, 1979).

Diameter of circles represent magnitude of catch.

◯ = 50 Illex

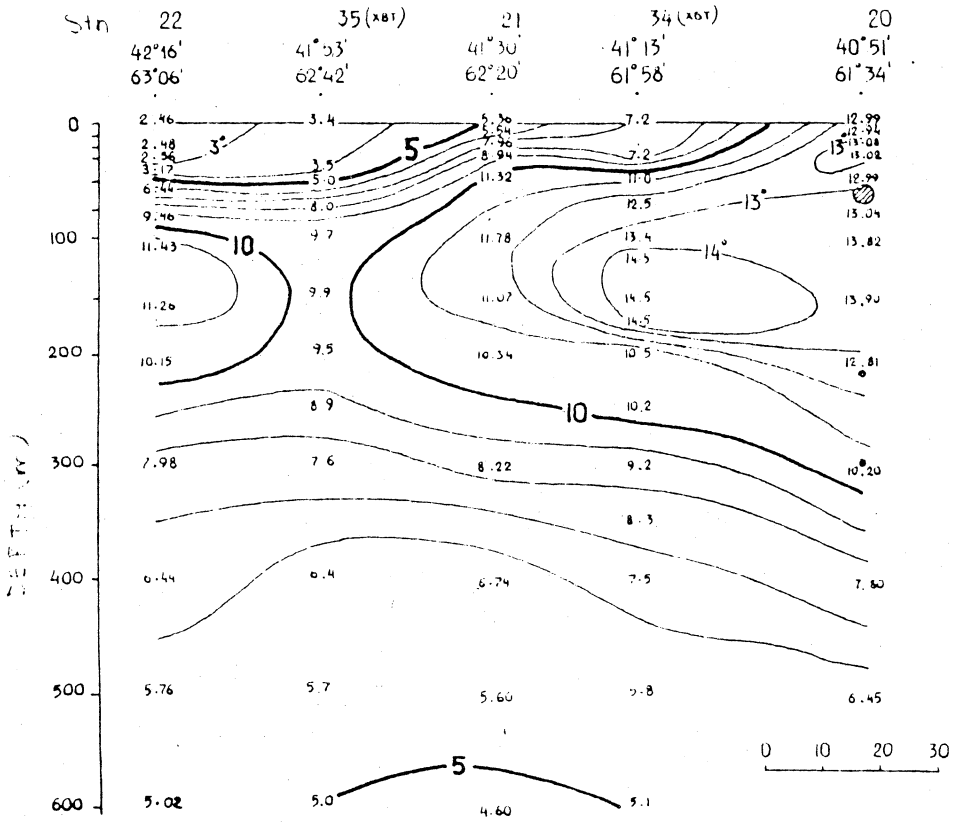


Fig. 5-3. Vertical water temperature profile of Transect 3 (March 21-22, 1979). Diameter of circles represent magnitude of catch.

◯ = 50 Illex

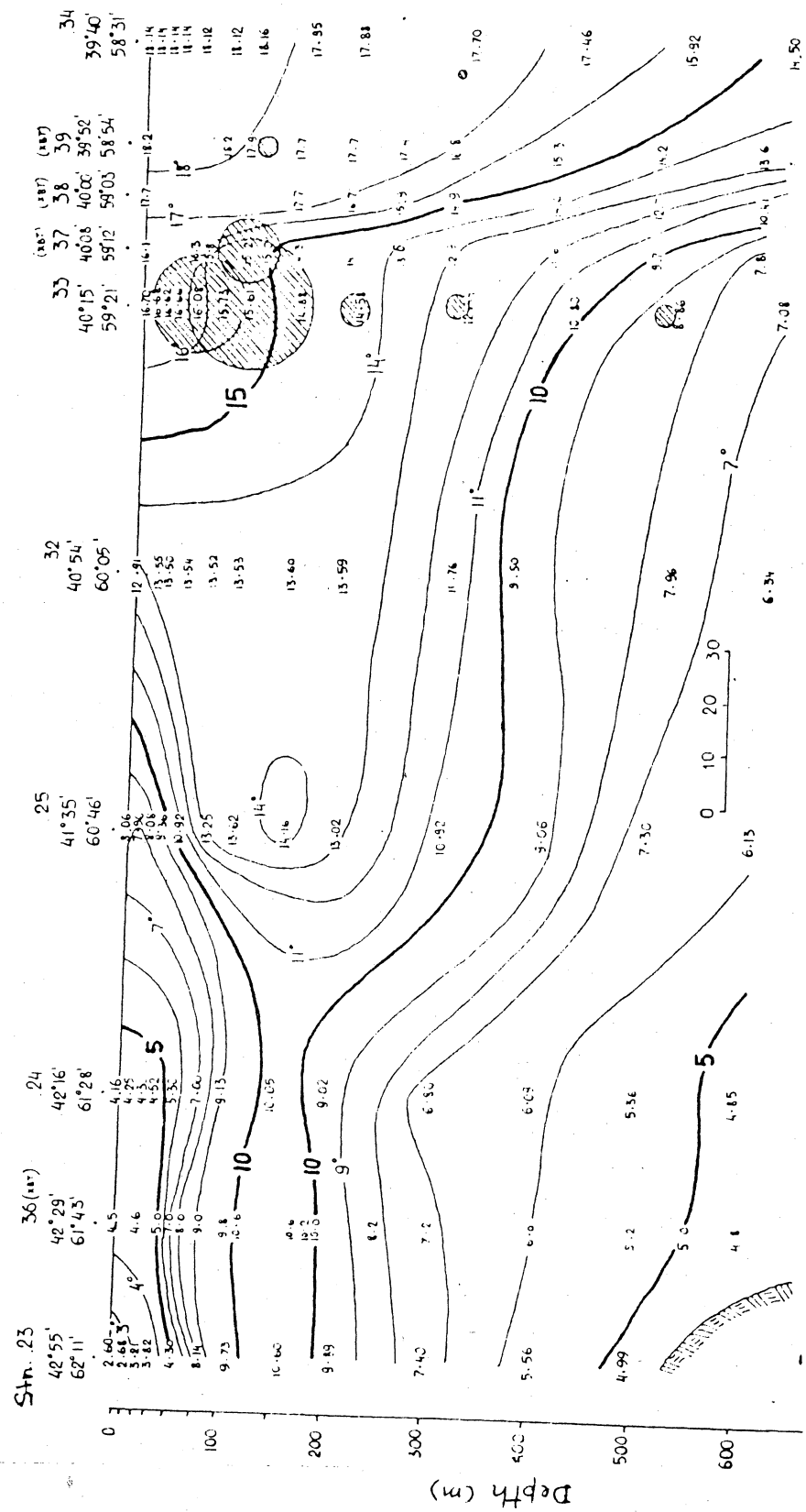


Fig. 5-4. Vertical water temperature profile of Transect 4 (March 23-29, 1979).
Diameter of circles represent magnitude of catch.
⓪ = 50 Illex

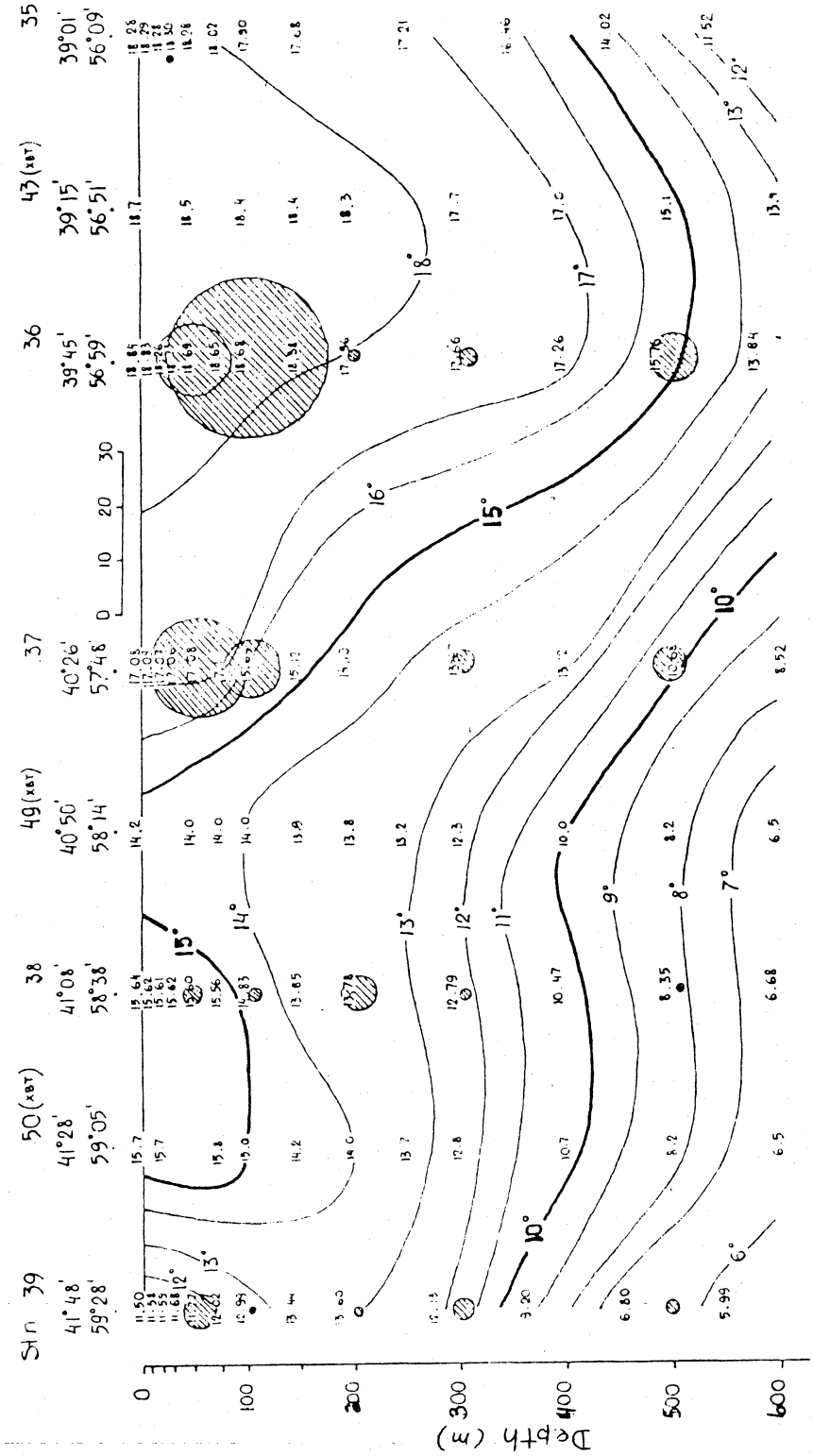


Fig. 5-5. Vertical water temperature profile of Transect 5 (March 31-April 3, 1979). Diameter of circles represent magnitude of catch.

◯ = 50 Illex

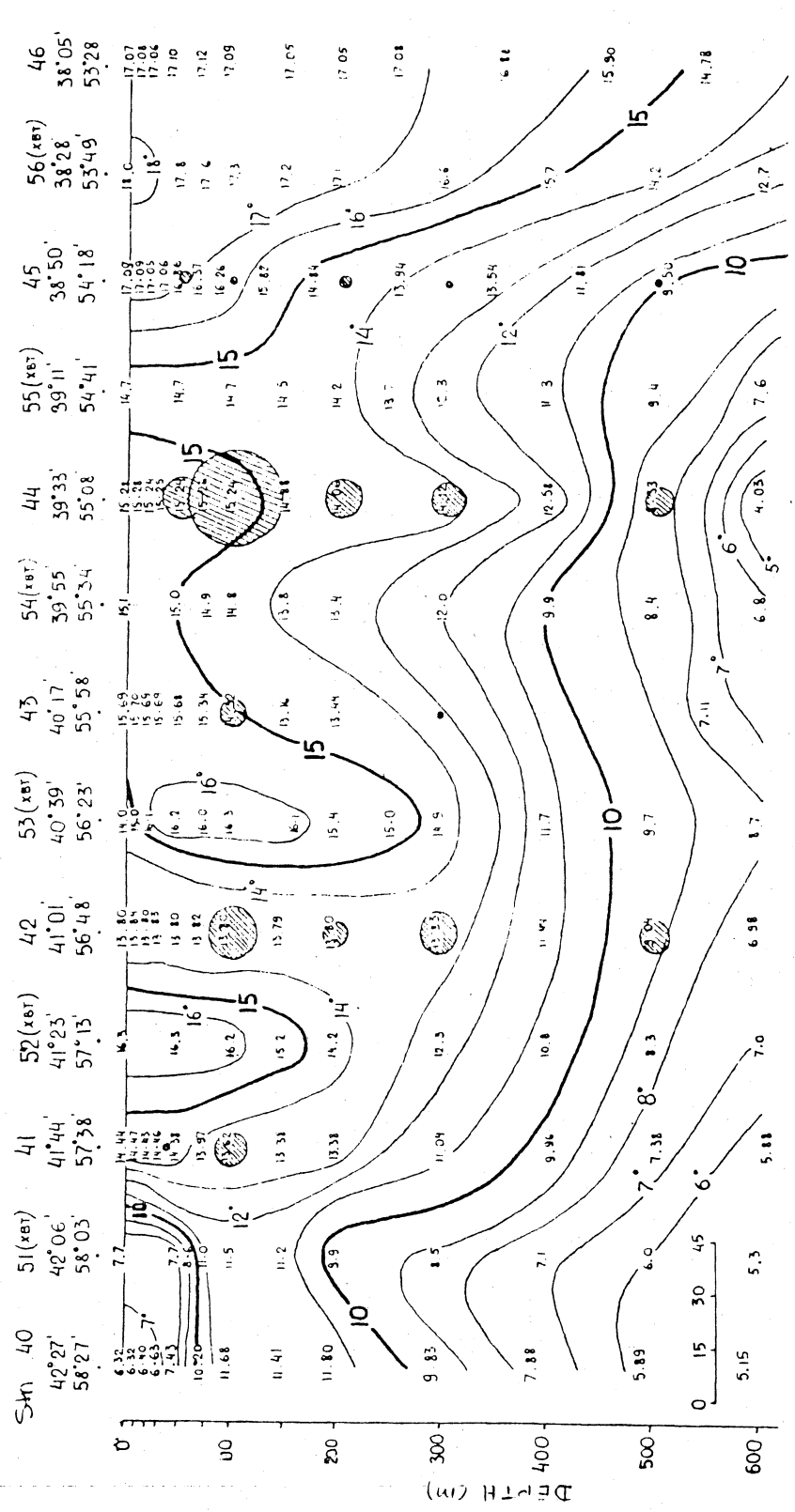


Fig. 5-6. Vertical water temperature profile of Transect 6 (April 4-7, 1979).
Diameter of circles represent magnitude of catch.
(2) = 50 Illex

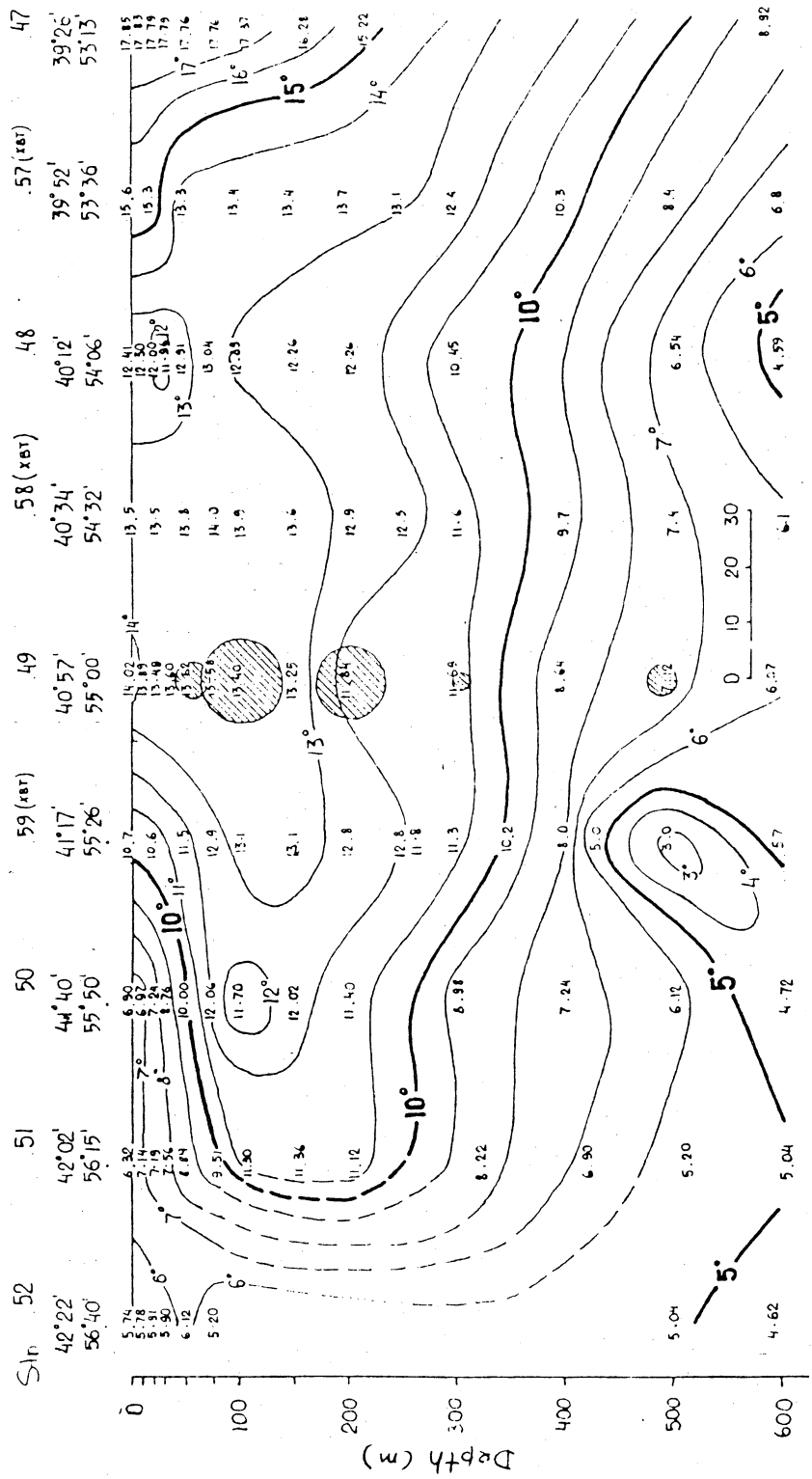


Fig. 5-7. Vertical water temperature profile of Transect 7 (April 8-11, 1979). Diameter of circles represent magnitude of catch.

○ = 50 Illex

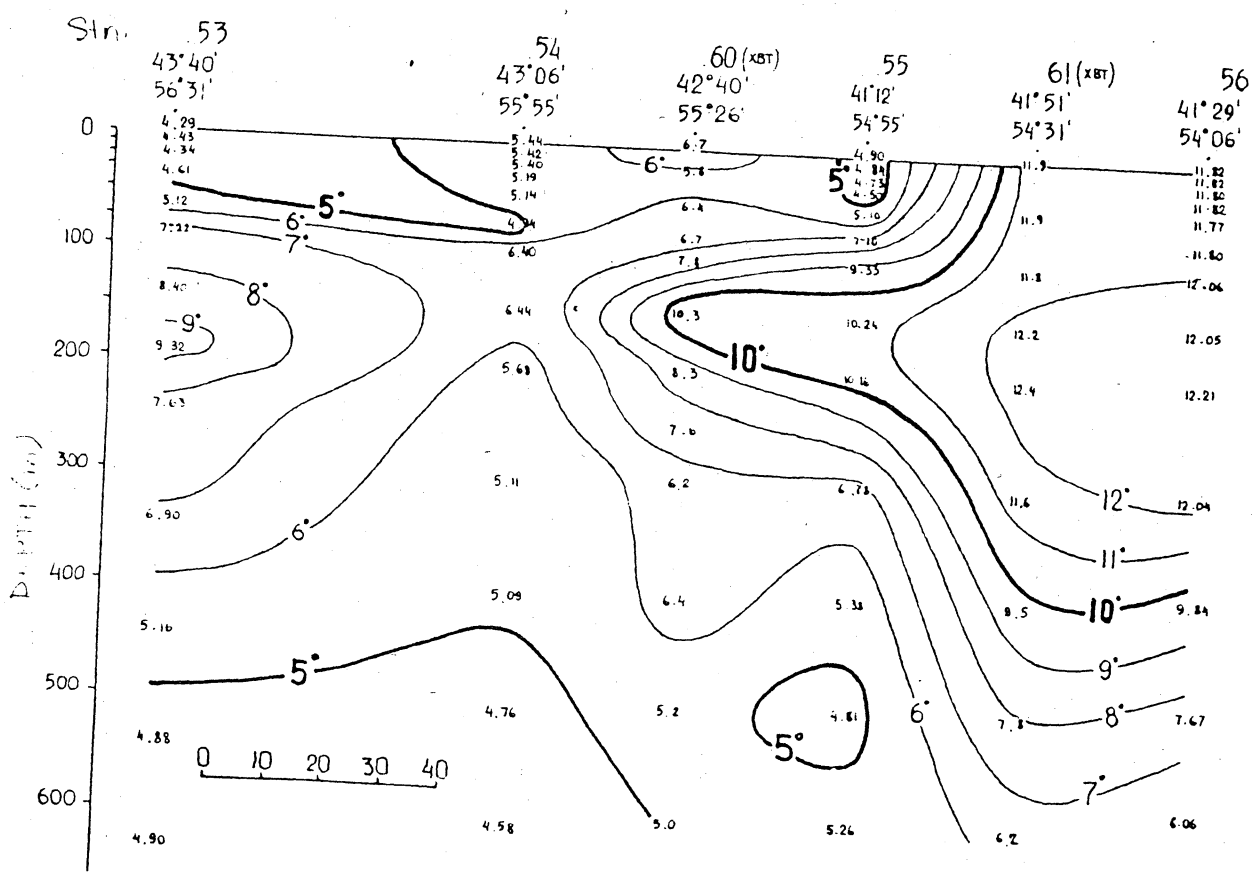
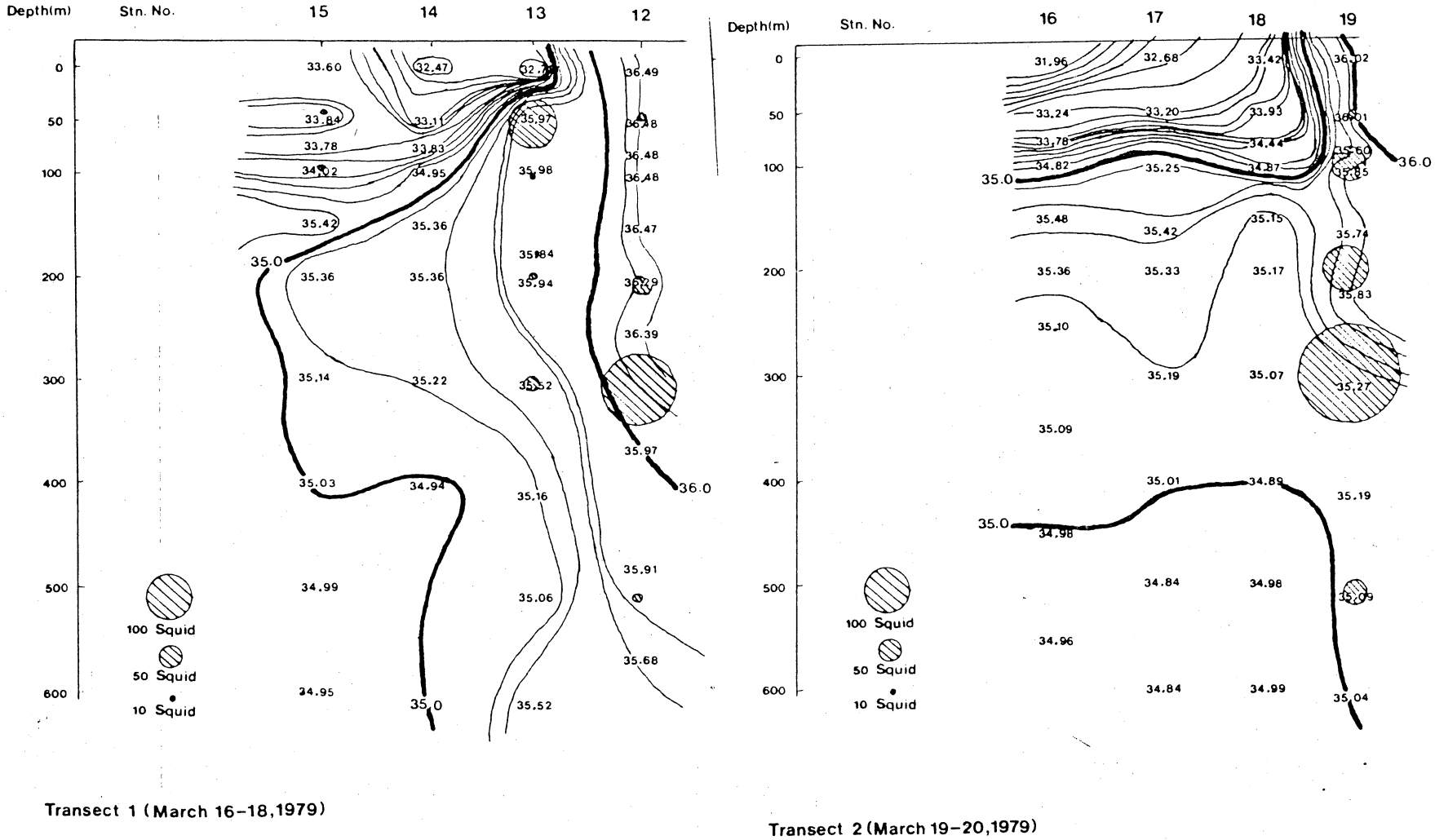


Fig. 5-8. Vertical water temperature profile of Transect 8 (April 11-13, 1979). Diameter of circles represent magnitude of catch.

○ = 50 Illex



Transect 1 (March 16–18,1979)

Transect 2 (March 19–20,1979)

Fig. 5-9. Vertical salinity profiles of Transects 1 and 2.

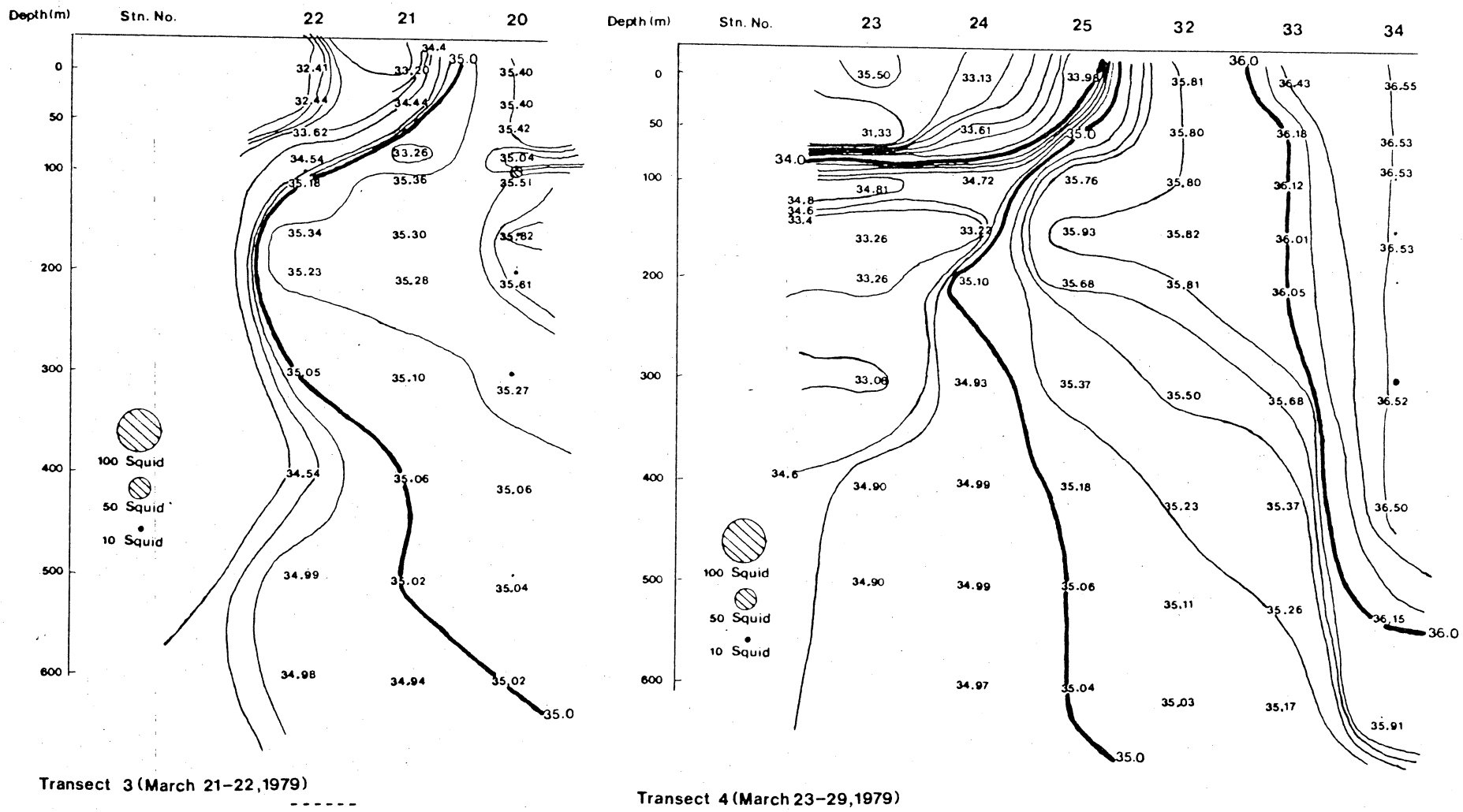


Fig. 5-10. Vertical salinity profiles of Transects 3 and 4.

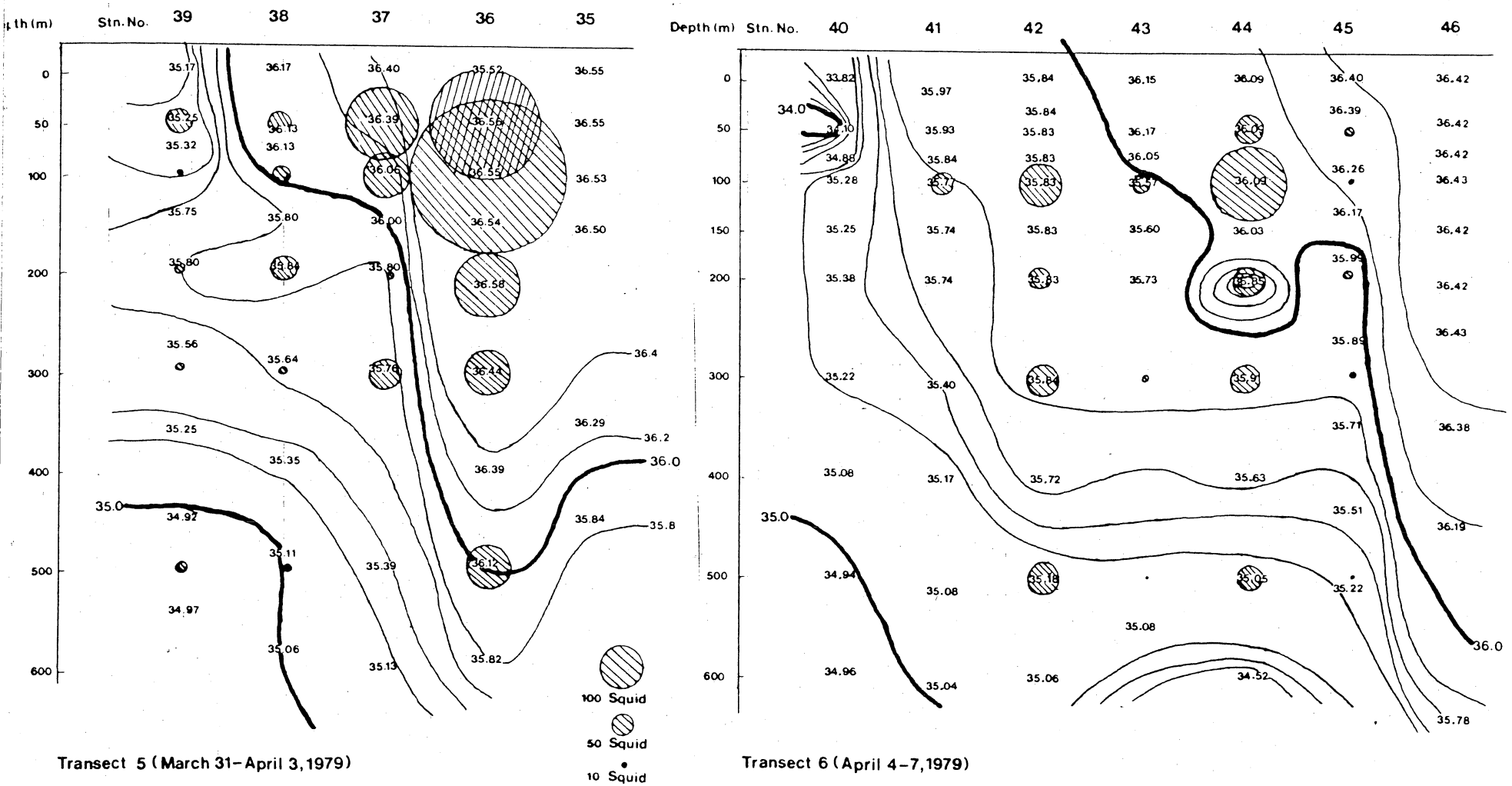
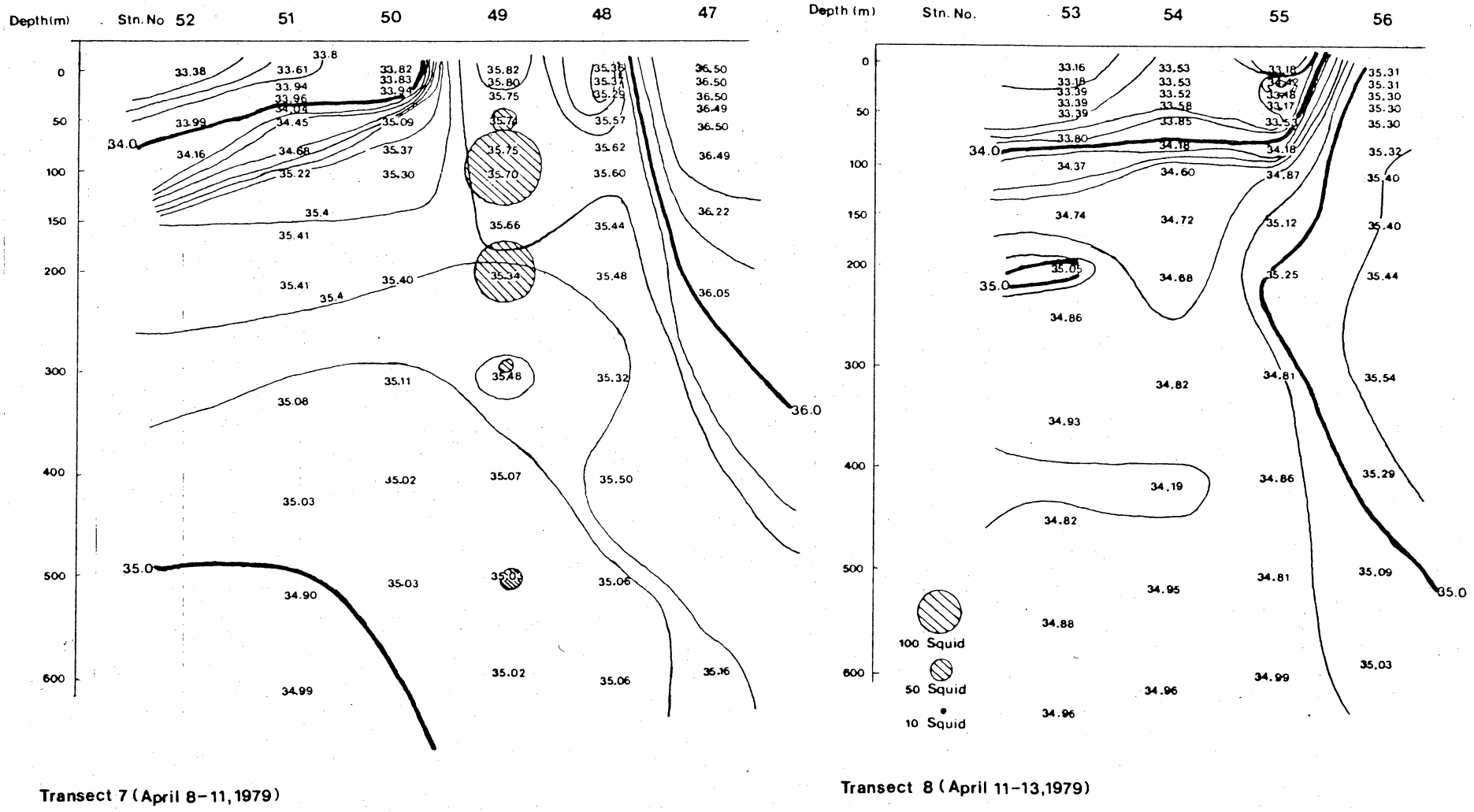


Fig. 5-11. Vertical salinity profiles of Transects 5 and 6.



Transect 7 (April 8-11, 1979)

Transect 8 (April 11-13, 1979)

Fig. 5-12. Vertical salinity profiles of Transects 7 and 8.

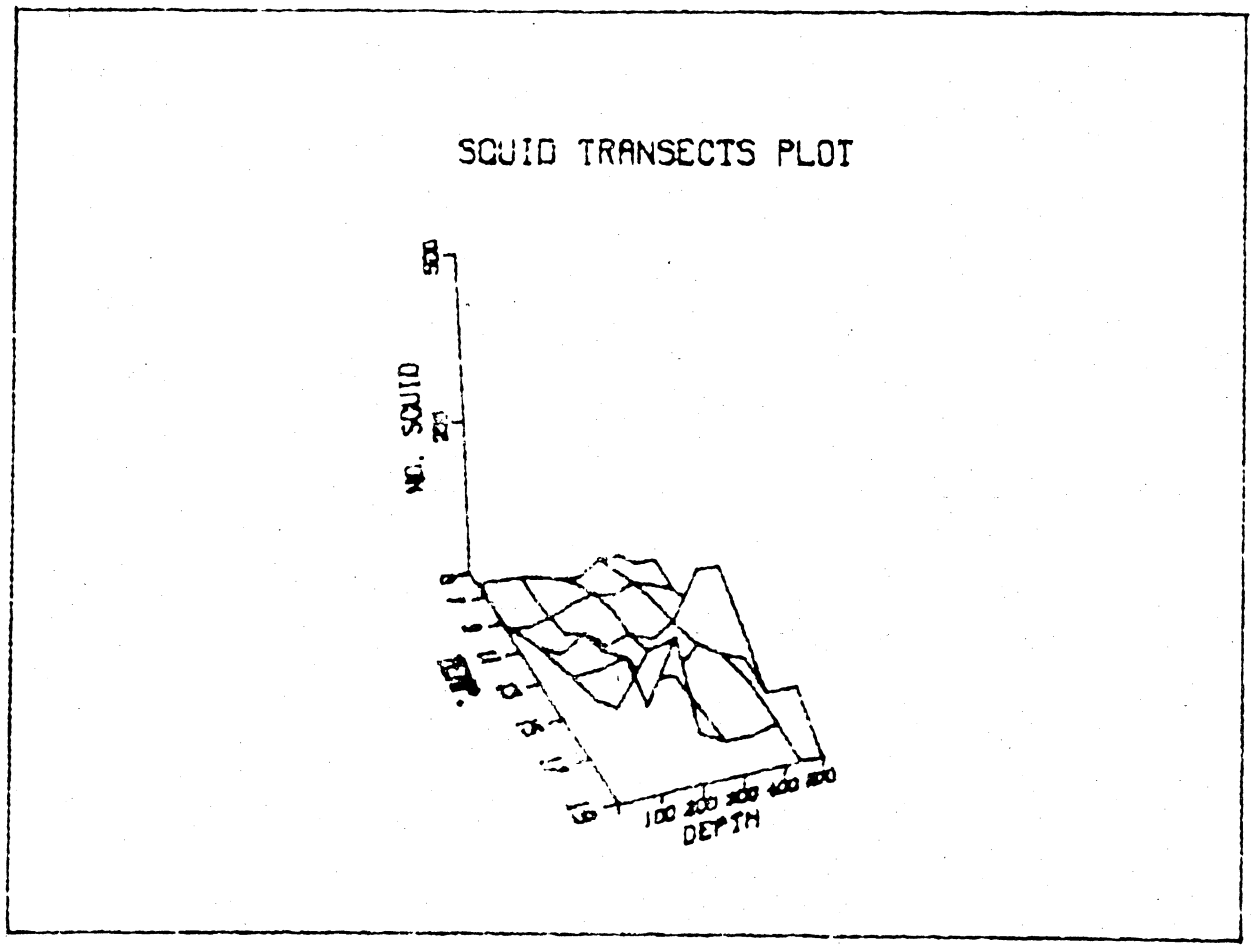


Figure 6. Three-dimensional plot of average numbers of squid caught against depth and temperature.