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Distribution and Abundance of 0-group Silver Hake on the Scotian Shelf in Autumn 1988

by

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ABSTRACT

Data from the joint Soviet-Canadian inventory servey of the 0-group silver hake are presented. The research was conducted by the R/V SRTM-8101 SAULKRASTY on the Scotian Shelf from October 23 through November 27, 1988. Some peculiarities of horizontal and vertical distribution of the youngs-of-the-year were identified during the feeding period in 1988. The preliminary total abundance estimate showed the 1988 year-class strength to be at the 1981-1987 average level.

INTRODUCTION

The Scotian silver hake is of great importance for the international fisheries. Its stocks vary significantly depending on the strength of the year-classes recruiting to the fisheries. The strength of a year-class can be predicted two years in advance from the 0-group fish abundance. Inventory serveys to estimate the Scotian silver hake 0-group abundance have been carried out annually by the Soviet and Canadian scientists since 1978. The obtained data are used to estimate the stock size and to predict the silver hake catches. Most recent data on the 0-group silver hake distribution and abundance in 1988 are presented in this paper.

MATERIALS AND METHODS

The inventory trawling survey of the 0-group Scotian silver hake was carried out from October 23 to November 17, 1988, at 111 stations (Fig. 1). The survey was based on the standard stra-

tified random sampling scheme (Grosslein, 1969). Like in 1981-1987, the IYGPT trawl was used as a fishing gear (Noskov and Sherstyukov, 1984). The trawling duration was 30 min. at the towing speed of 3.5 knots. The trawlings were made at night at three depth levels: near bottom (2-4 m off the bottom), middle (in the mid-layer, as a rule) and subsurface (3-5 m under the surface). To shoot the trawl to a given level the cable echo depth recorder IGEK was used which was attached to the healine. All the data on the weight and length distribution of the catches were entered on the trawl logs. To obtain the quantitative value of the young 1988 year-class silver hake the data were processed using standard methods (Grosslein, 1969; Gasyukov, 1983).

During the survey of the 0-group silver hake, the water temperatures were measured at each station using the Japanese mechanical bathythermograph, MBT (measurement depth range 0-270 m) and the expendable bathythermograph, XBT (measurement depth range 0-450 m). Similar measurements were taken along the trasects (Fig. 1). Based on the observation data the horizontal temperature distribution charts and temperature profiles were drawn.

To determine the young silver hake linear daily growth in 1988 the trawlings in the areas of dense concentrations of the one size fish, namely 50-mm in length (southern slopes of the La-Have Bank, Fig.6) were reiterated after the inventory survey. To calculate the young fish absolute length increment per unit time the Mina and Klevezal (1976) formula was used:

$$\Delta Y = \frac{Y_n - Y_o}{t_n - t_o},$$

where ΔY - mean absolute increment per unit time;

Y_n - mean length at the end of time interval;

Y_o - mean length at the start of time interval;

t_n - end of time interval;

t_o - start of time interval.

From 23 to 26 November 1988, the vertical distribution of the 0-group silver hake was studied in the stratified waters of the La-Have Bank south-eastern slopes. The IYGPT fry trawl was again used as a fishing gear. Trawlings over two nights were made

at the following levels: subsurface, near bottom, in the thermocline layer, above and under it. Each trawling lasted 30 min, at the ship's towing speed of 3.5 knots.

RESULTS AND DISCUSSION

Water temperature distribution

It is a common knowledge that the vertical structure of the waters of the Nova Scotia Shelf is characterized by a three-layer pattern resulting from mixing of water masses of different origin (Smith et al., 1978).

The Scotian Shelf surface layer is influenced by the climatic factors, so its temperature field does not reflect the peculiarities of the major hydrodynamic events taking place in the area in various years. This was also characteristic of 1988.

The intermediate layer is mainly formed by the Labrador Current waters (3-5°C) intruding onto the shelf from the northeast. It is noted for a peculiar thermocline position. Usually the thermocline is confined to the depths of 40-55 m although sometimes it can be observed somewhat higher, as it took place in 1987, for instance (Sigaev et al., 1988). For this reason the 60m depth in the intermediate layer was chosen to determine the peculiarities of the temperature distribution in that layer (Fig. 2A). As compared to 1987, the temperature field there was characterized by increased influence of the Labrador water, especially in the areas west and south of the Sable Island (4-5°C in 1988 and 8-16°C in 1987). The intensity of the warm slope water influx onto the shelf was also lower than a year before which is confirmed by the temperature values of these waters along the shelf slope. So in 1988, they didn't exceed 9°C while in 1987 the temperatures reached 14-16°C.

The near bottom layer is formed by the warm Slope North Atlantic waters penetrating into the shelf deeps through the deep-water troughs west of the Sable Shoals. The mechanism of this process can be well seen in Fig. 3. The inter-year changes of the vertical location of this tongue core are noteworthy. So in 1987, the core was located at 130-150 m depths while in 1988 it was confined to the depths of 100-120 m. The intensity and depth of

penetration of the warm tongue in 1988 were significantly greater (Fig. 2B) than in 1987. Besides, the year of 1988 was also characterized by extensive tongues of cold Labrador water in the upper portion of the near bottom layer oriented to the continental slope in the areas of the Browns and La-Have Banks and the Sable Shoals. As a result, in 1988, the gradient temperature zones in the near bottom layer were observed both in the area of the main tongue of the warm slope water and along the entire slope.

Distribution and abundance of the 0-group silver hake

Like during the previous two years, the young hake catches from the largest part of the area did not exceed 50 sp./haul (Sigaev et al., 1988) (Fig.4). The young fish were actually absent from the areas north and south of the Sable Island and were found in insignificant number on the shoals of the Emerald, La Have and Browns Banks (1-20 sp./haul). Such a distriburion can be explained by the presence of cold Labrador waters in that area with the temperatures of 3-5°C (Fig. 2). Dense concentrations of the young hake (101 to 500 sp./haul) were recorded north of the Emerald Bank, that is, in the area with a characteristic warm tongue of the slope water. Most dense concentrations (501 to 1889 sp./haul) formed a narrow band along the continental slope between the western and Browns Banks, i.e. at the base of the warm slope water tongue, where distinct gradient zones with the temperature of 5-11°C were observed (Fig.2). The analyses of the young hake distribution relative to the site depth (Table 1) revealed that their maximum numbers (92% of the total catch) occurred above the deepwater part of the shelf (101-200m), where the mean catch per trawling was 257 sp.

Thus, by the survey period, almost all the young hake of the 1988 year-class (92% of the total catch) had already moved to deepor part of the shelf in the areas adjacent to the Emerald Deep and continental slope for winter stay.

The length of the youngs-of-the-year in the 1988 catches varied from 2 to 10 cm, 5.6 cm on the average (Fig. 5). The comparison of the length frequencies and mean values for 1988 with the data for the corresponding periods in 1983 and 1985 gives every reason to suggest that the dates of massive spawning in these

years coinsided, i.e. in 1988, it took place as usual early in August (Noskov et al., 1982) in the shallow waters west of the Sable Island. The analysis of changes of the ratio of the adult Scotian silver hake maturity stages(from the observers data) by 5-day period in 1988 showed that the ovary maturation indices were the highest on July 1-5 (the start of massive spawning). Besides the hydrographic transect along the continental slope occupied by the R/V STRLNYA on July 1-2, 1988 revealed a warm tongue of the slope water on the shelf close to the Emerald Bank and Sable Shoals. This process seems to have promoted the hake concentrations withdrawal for spawning, which resulted in a sharp worsening of the fishing conditions.

The quantitative values characterizing the daily growth rate of the young silver hake during the 1988 feeding period are presented in Table 2. The absolute daily linear increment in 1988 was significantly higher than in 1987 (0.56 mm/day) comprising 0.70 mm/day. This is indicative of more favourable feeding conditions for the 0-group silver hake in 1988. With the fact that the absolute daily linear increment in the hake larvae (with the length of 0.3-22.5 mm) is naturally lower than in the hake fry, and the embrional period lasts 2-5 days in this species (Nichols and Breder, 1927; Coombs and Mitchell, 1982) the tentative spawning date in 1988 can be determined. Mean length of the fish in the middle of the first half of November, on November 7 (Fig. 5), was 56 mm which means that only 76 days would have passed from the birth date till November 7 if the absolute linear increment were 0.70 mm/day; but as the increment was lower at the larval stage the appropriate period should be taken to be 1-2 weeks longer-up to 80-90 days. Thus the approximate date of birch was in the second ten day period of August and the spawning peak took place in the end of the first ten day period that month. These calculations support the idea that the peak of the massive silver hake spawning on the Scotian shelf in 1988 occurred in the beginning of August as usual.

During the period from August to September, the newly hatched hake larvae stay on the spawning beds till the fry stage in the anticyclonic water circulation system (Sigaev, 1978). With the fall-winter

cooling of shallow waters, the youngs-of-the-year move in the Scotian Current (Sutcliffe et al.,1976) to the southwest towards the continental slope and mix with the larger fish spawned in the beginning of the spawning season. The distribution of the young hake mean length of the 1988 year-class (Fig. 6) is the evidence for this mechanism.

The observations on vertical distribution of the young silver hake in November 1988 yielded the data presented in Fig. 7. In the first night (A), the catches of the young fish near the surface were 18 sp./haul (fluctuation range 9-21 sp./haul) on the average; in the thermocline layer, they were 105 (54-139) sp/haul and 337 (300-375) sp./haul near the bottom. In the second night (B) the catches were 326 sp./haul (256-396) above the thermocline layer, 414 sp./haul (294-535) under this layer and 362 sp./haul near the bottom. Thus, in one and the same site the young fish concentrated mainly near the bottom in the first night while during the second night they dispersed evenly throughout the water column as in 1980 (Koeller, 1981). But generally, the data obtained are of great interest and need a thorough analysis; this information also speaks for the need of a further research on the vertical distribution of the 0-group silver hake.

Preliminary calculations of the total abundance of the 1988 year-class young silver hake gave the value at the level of 1983, 1986 and reached 33 x 10^7 specimens, i.e. the 1988 year-class strength was at the mean annual 1981-1987 level (Table 3).

It is worth noting that in contrast to the previous years the fry trawl used in the 1988 survey of the Scotian Shelf quite often caught the adult hake in the areas of their usual concentrations (La Have and Emerald Basins) and didn't catch them over the continental slope (fig. 8) where the abundant concentrations of the 0-group silver hake had been observed. Such a separation of distribution ranges of the young and adult silver hake of the Scotian population during their feeding period seems to have contributed to setting favourable conditions for formation of the 1988 year-class 0-group abundance (reduced cannibalism).

CONCLUSION

As compared to 1987, in October-November 1988 the hydrological conditions on the Scotian Shelf were characterized by the increasing effect of the cold Labrador waters in the intermediate layer and warm slope waters in the near bottom layer, particularly along the continental slope between the Browns Bank and Sable Shoals, which has resulted in formation of an extensive narrow band of the gradient zones with the temperatures of 5-11°C. Maximum concentrations of the young fish ranging between 501 and 1889 sp./haul which accounted for the 92% of the total catch were observed in these areas during the inventory surveys. The size composition of the young hake (length range 2-10 cm; mean length 5.6 cm) in the 1988 catches was similar to that recorded in 1983 and 1985. As the massive spawning took place in the beginning of August, the fish were available for fishing and inventory surveys. The total abundance of the 0-group silver hake (33×10^7 specimens) estimated in October-November 1988 allows to predict two years in advance that the 1988 year-class will be of moderate strength.

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Table 1

Abundance of 0-group silver hake in fry trawl catches relative to depth, 1988

Depth, m	Total catch, numbers		Mean catch, haul, nos	Number of empty hauls		Number of hauls	
	n	%		n	%	n	%
0-100	280	2	9	13	42	31	28
101-200	15180	92	257	8	13	59	53
201-300	960	6	46	6	28	21	19
Total	16420	100	148	27	24	111	100

Table 2

Growth rate indices for young silver hake in 1988

Observation period	Interval between observations, days	Number of fish measured	Mean length, mm	Absolute linear daily increment, mm/day
26.10-		277	48	
22.11	27	268	67	0.70
31.10-		398	52	
23.11	23	102	68	0.70
31.10-		124	49	
23.11	23	241	68	0.83

Table 3

Abundance indices for 0-group silver hake in the Scotian Shelf area in 1981-1988

Year	Survey area, strata Nos.	Number of hauls	Area covered, sq.mi.	Mean number of fry per haul, $\bar{x}$	Total number of young fish, $x10^7$ sp.	Standard deviation S.D.	Variation factor $\frac{S.D.}{\bar{x}}$ (%)
1981	53-81	105	22699	501	114	71	14
1982	60-78	61	14516	9	1	1	16
1983	60-78	64	15520	233	36	5	10
1984	43-81	132	37343	29	11	4	15
1985	48-81	113	28679	248	68	46	19
1986	53-81	99	22699	146	33	30	21
1987	53-81	109	26502	79	21	27	34
1988	53-81	111	26502	125	33	23	19
Mean for 1981-1987	-	-	-	178	40	-	-

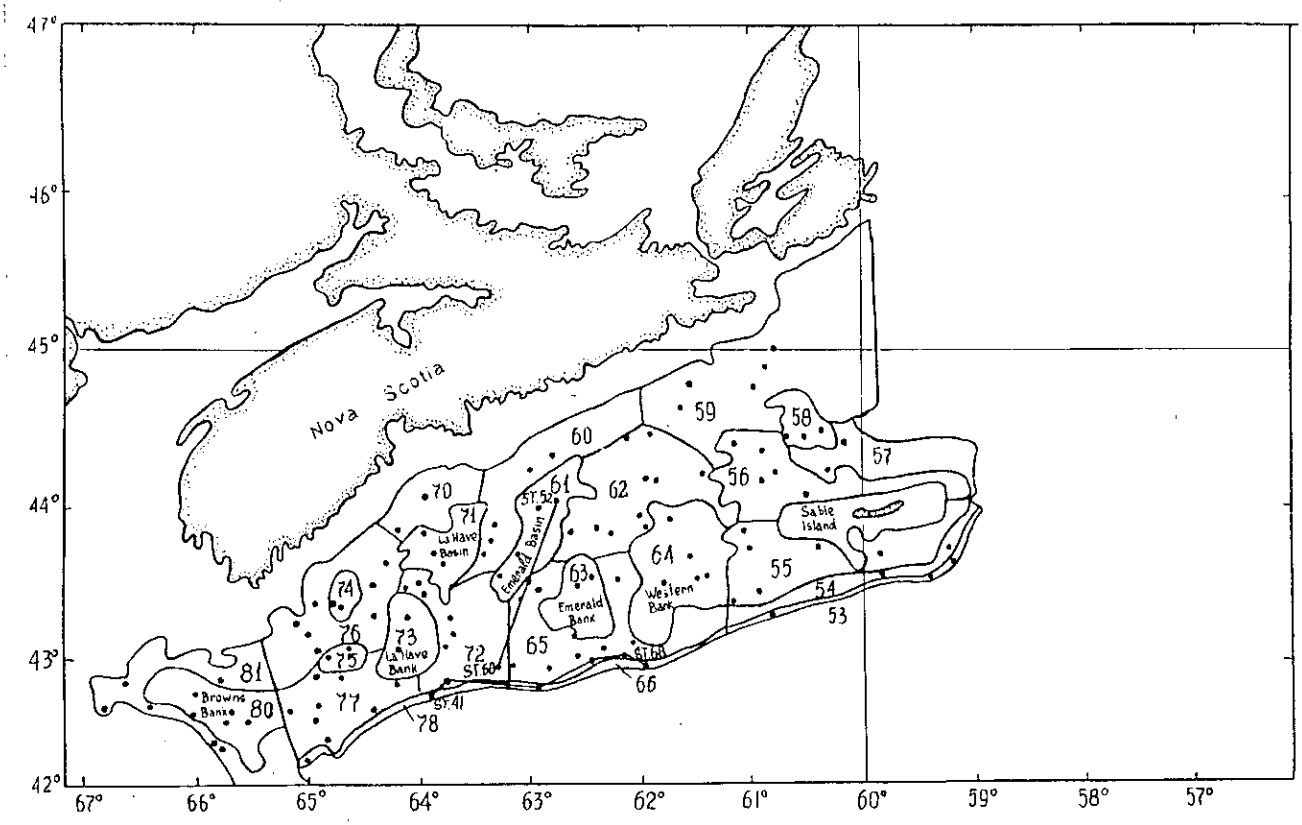

Fig. 1. Station grid for the fry trawling survey (23.10.-17.11.1988): Sts. 41-68-slope transect; Sts 60-52-shelf transect.

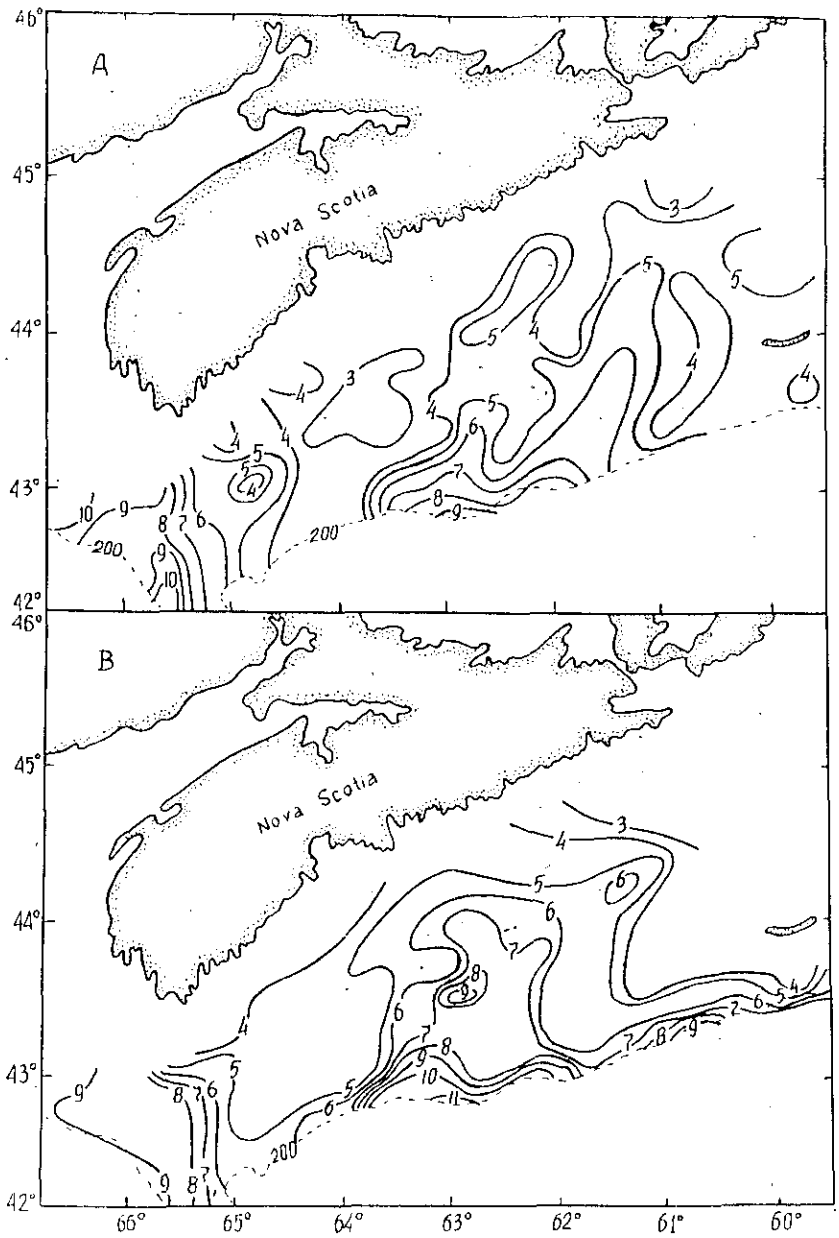

Fig. 2. Water temperature distribution at 60 m(A) and 100 m (B) depths.

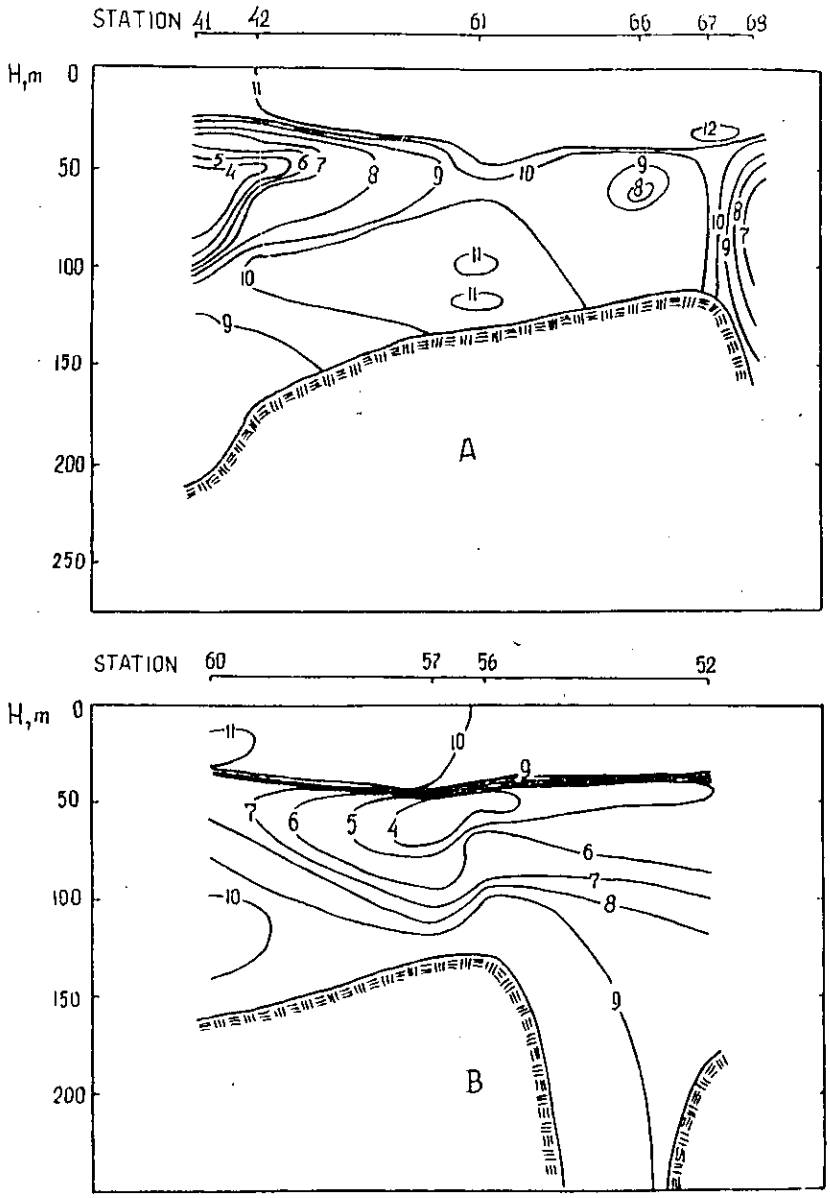

Fig. 3. Vertical water temperature profile along slope trasect (A) and shelf transect (B).

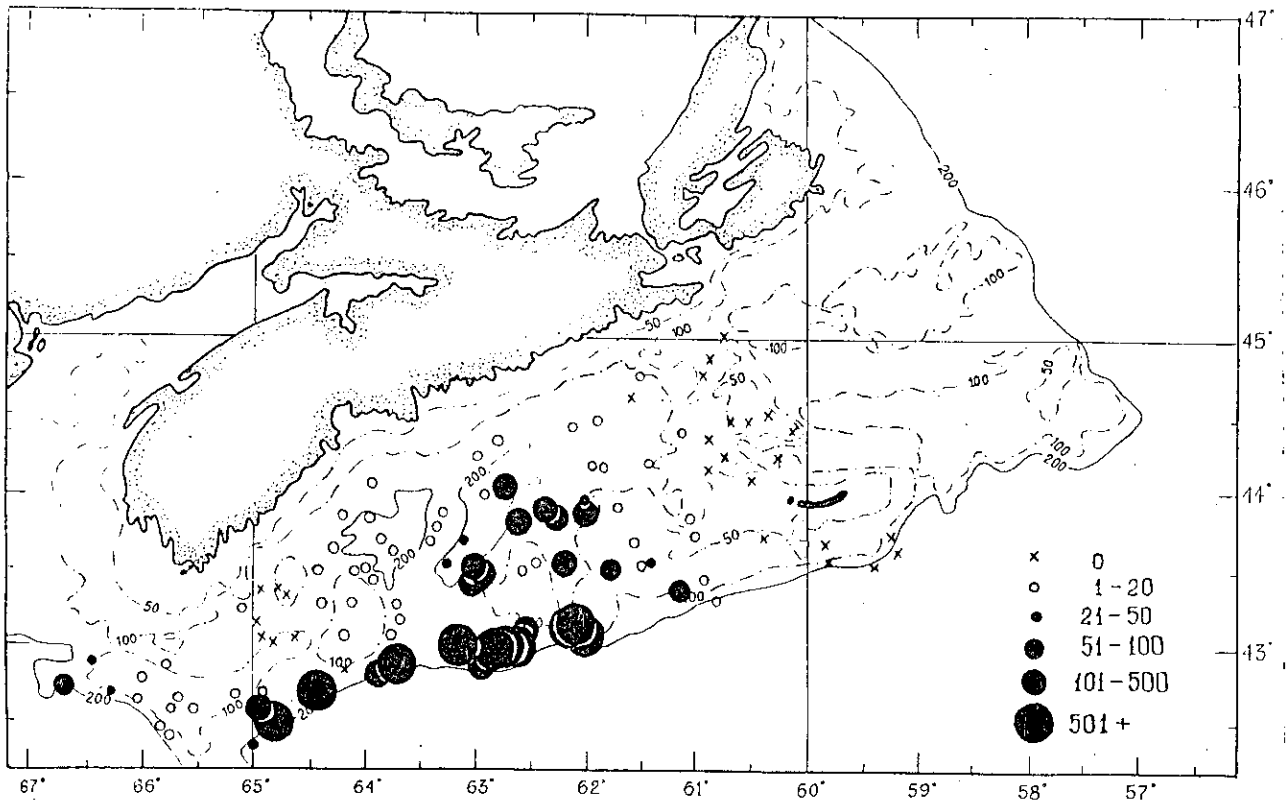

Fig. 4. Distribution of 0-group silver hake, sp./haul (23.10.-17.11.1988).

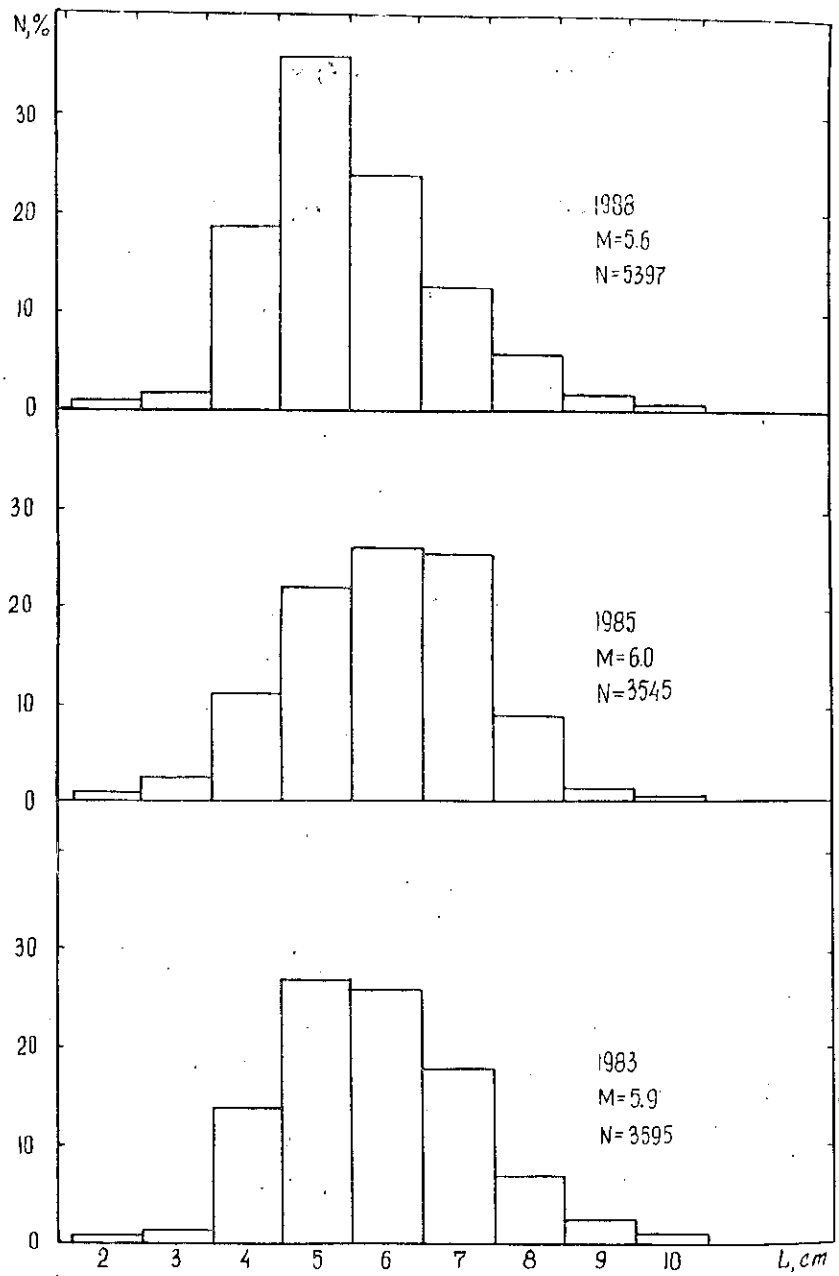

Fig. 5. Size composition of 0-group silver hake (first half of November) in 1983, 1985 and 1988.

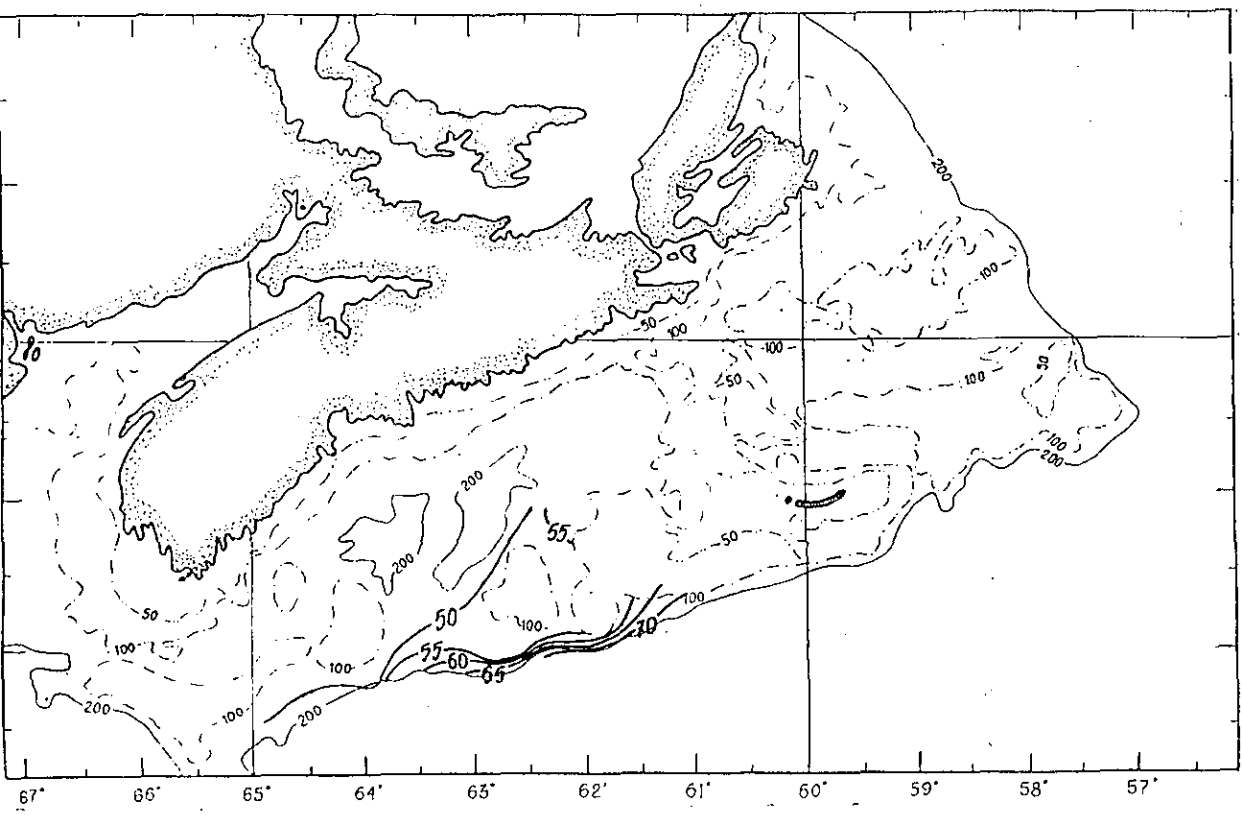

Fig. 6. Distribution of 0-group silver hake; mean length in mm (23.10-17.11.1988).

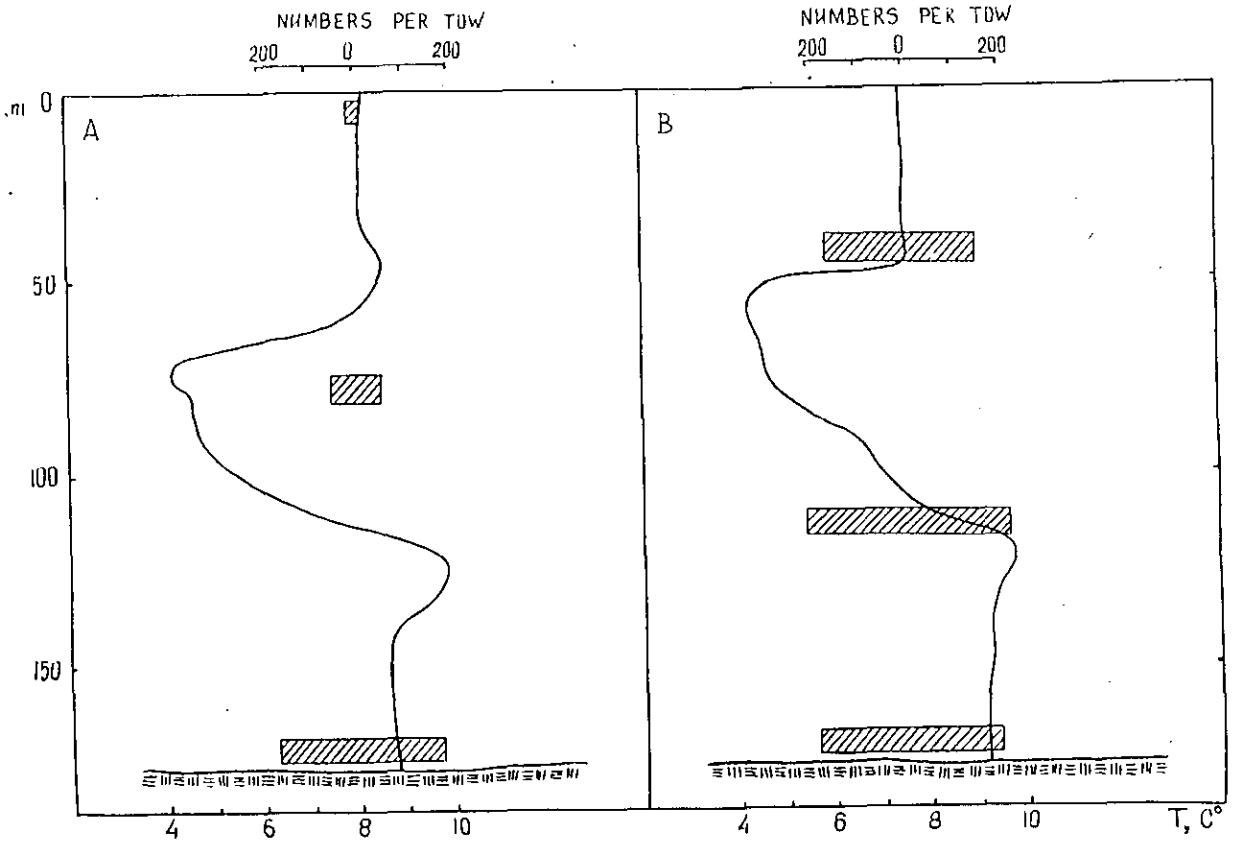

Fig. 7. Vertical distribution of 0-group silver hake in stratifi waters: A - 23.-24.11.1988; B - 24-25.11.1988).

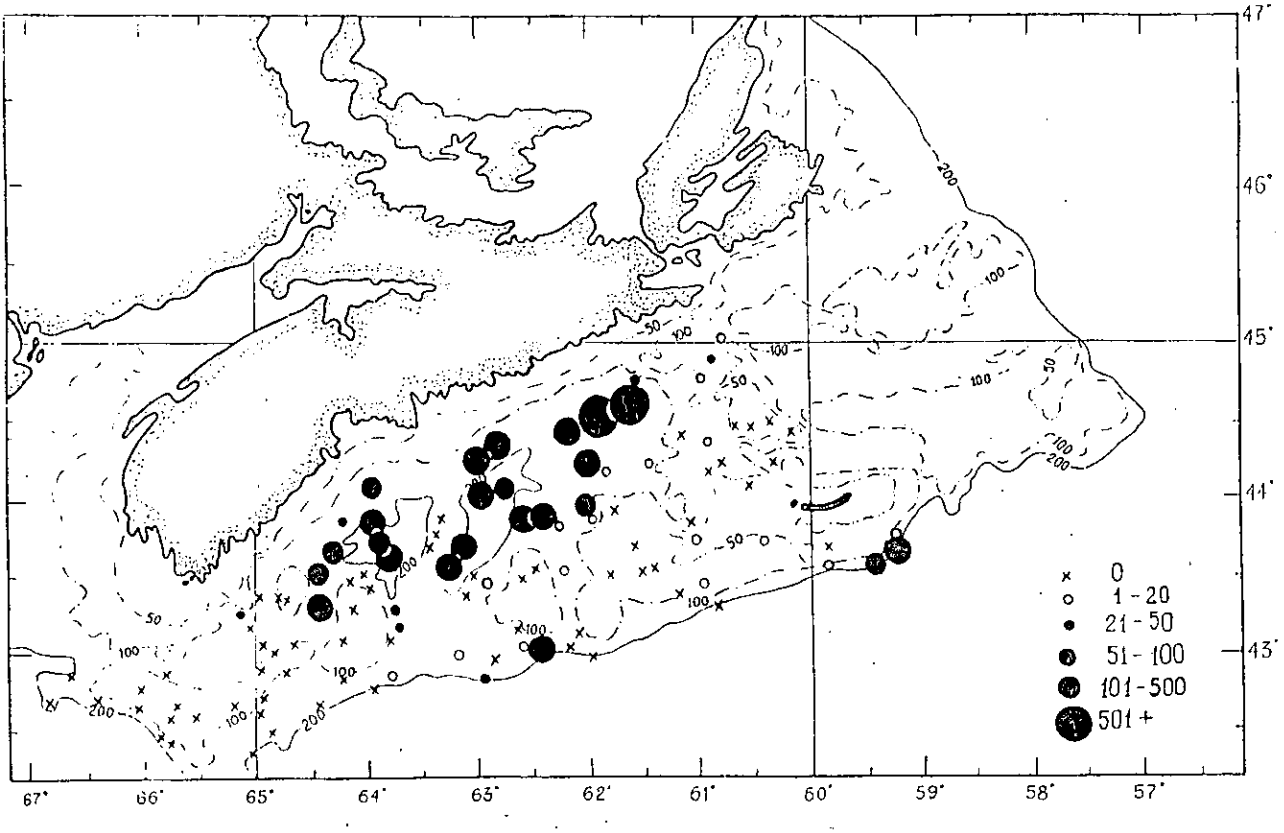

Fig. 8. Silver hake distribution, sp./haul (23.10-17.11.1988).