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Hydrographic conditions and distribution of silver hake (Merluccius bilinearis Mitchill) on Georges Bank and off Nova Scotia in 1964

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Introduction

Compared to previous years, 1964 was noted for a number of peculiarities in the distribution of silver hake in areas off Nova Scotia and on Georges Bank. Observations in these areas carried out by the West Atlantic Research Laboratory of AtlantNIRO provide an insight into the nature and causes of these peculiarities.

Data collected from 1962-1964 by AtlantNIRO research vessels, as well as statistics provided by commercial fishery statistics, served as a basis for the present studies.

A conception of the hydrographic conditions in the areas investigated during different periods was derived from hydrographic surveys, the data from standard sections and from control stations, with the main attention being paid to water temperature as the most decisive factor. Ichthyological studies, as part of all hydrographic work, were also conducted on control catches from silver hake shoals. A comparison of hydrographic conditions and the biological state of hake in different parts of its habitat was made, as well as hake distribution over particular seasons.

Certain difficulties were encountered in producing a comparative analysis of 1963-1964 hydrographical data. Yet, the results of this analysis show that hydrographic conditions during these years have not been identical.

Georges Bank

During all seasons of 1964, the effect of warm Atlantic water on Georges Bank was less pronounced than during respective seasons of 1963. This is seen from Tables 1 and 2 and from temperature distribution graphs obtained from different stations, sections and surveys conducted during practically the same periods of 1963 and 1964. The most indicative among other data are the distribution of water temperatures on the section across the Fundy Channel (Fig. 1), off-bottom temperatures on the southeastern slope in June 1963 and 1964 (Fig. 2) and monthly temperature fluctuations during these years on the southern and northern slopes (Fig. 3).

A general pattern of silver hake distribution in different seasons based on observations made in 1962-1963 is given in a paper by V. Sauskan entitled: "Results of Soviet Studies on Silver Hake Distribution on Georges Bank and off Nova Scotia in 1962-1963 (ICNAF Document No. 61, 1964).

During April and June 1962-1963 in an area southeast of Georges Bank concentrations of spawning and maturing silver hake composed of first-time spawning 3 to 4-year-olds 29-30 cm long were found at depths of 85-200 m along the bank slope within the frontal zone between Atlantic and Labrador waters. Maximum shoal densities here were reported in June 1962 and 1963 with most females shedding their first portion of eggs. Then in July and August the fish migrated and remained for a time on feeding grounds on the northern

slope and on the shallows of Georges and Browns Banks.

On the northern part of Georges Bank, in an area exposed to the action of Labrador and coastal waters with a high content of food organisms during the summer months, shoals of silver hake were observed at depths of 40-110 m with off-bottom temperatures around 6°-10°C. The density of these shoals was somewhat lower than on the southeastern slope.

By the end of 1963 and at the beginning 1964, shoals of immature fish and "recruits" were observed in Georges Basin in the southern part of the Gulf of Maine at depths of 200 and more m (Fig. 4).

Fig. 5 shows the distribution of hake shoals and Fig. 6 gives monthly estimates of their biological state on Georges Bank and off the coast of Nova Scotia in 1964.

Table 1. Water temperature in May 1963, 1964 on the southeastern slopes of Georges Bank.

1963				1964				
Date	Position	Depth	t°C	Date	Position	Depth	t°C	△ t
23	40°56'	100	14.0	29	40°55'	100	6.5	7.5
	66°38'8	200	11.0		66°33'8	200	6.5	4.5
23	40°50'1	100	11.8	29	40°49'5	100	3.6	8.2
	66°49'2				66°52'5			
24	40°33'3	100	11.4	22	40°33'	100	4.2	7.2
	67°21'				67°28'			
23	41°05'5	100	13.6	29	41°10'	100	4.1	9.5
	66°24'5	200	11.7		66°17'	200	4.5	7.2
9	40°39'	100	11.1	6	40°30'	100	2.6	8.5
	67°02'2	200	9.7		67°12'5	200	2.9	6.7
9	40°32'	100	9.0	9	40°28'5	100	3.7	5.3
	67°43'5				67°50'			

Table 2. Water temperature west of Georges Bank in April 1963 and 1964.

1963				1964				
Date	Position	Depth	t°C	Date	Position	Depth	t°C	△ t
18	40°03'5	100	9.3	14	40°02'	100	4.9	4.4
	70°13'1	150	9.8		70°22'5	150	7.1	2.7
		200	9.2			200	7.0	2.2
18	40°07'8	100	10.1	13	40°10'	100	4.3	5.8
	70°37'8				70°37'9			
17	40°04'5	100	11.8	15	40°03'7	100	4.7	7.3
	71°06'	200	8.1		71°09'9	200	6.2	1.9

A most characteristic feature of hake distribution on Georges Bank in 1964 is that its shift to the southern slopes of the Bank in March and April occurred almost simultaneously in two areas - near the Walker, Hydrographer and Veatch Canyons in the south and in the eastern part of Lydonia Canyon.

In March and April samples from control and commercial catches showed a predominance of maturing fish. In May there was further gonad development, and by the end of May and in June and July, catches contained males and females with flowing gonad products.

Thus, the rate of gonad development was found to be basically the same as in 1962 and 1963. Yet owing to unfavourable hydrographic conditions at the usual spawning grounds during May and June 1964 (Table 1) and, contrary to previous years, no mass spawning was noted. Repeated attempts, based on an

analogy with previous years, to use these spawning grounds for commercial fishery at the end of May and during June were invariably unsuccessful. On the other hand, it is remarkable that dense concentrations of hake were reported in this area as early as March. These concentrations, as mentioned, were located simultaneously in two areas - eastern and western.

In the eastern part (east of Lydonia Canyon), silver hake were in a small area at depths of 140-230 m with bottom water temperature 7°-8°C (Fig. 2 and 7); in a position east of 67°W, conditions for hake were totally unsuitable. Warm water, as seen from the results of a hydrographic section, did not reach the slope. Hydrographic conditions west of this concentration and along both sides of Lydonia Canyon were somewhat unstable owing to the inflow of a pulsating current of warm Atlantic water which caused frequent shifts of the hake in this area.

In the western part (Walker, Hydrographer, Veatch) similar conditions were found to be related to the accumulation of hake. It is characteristic that owing to unfavourable conditions (Fig. 7) no hake was found between the eastern and western 'shoals' on the continental slope bordered by Oceanographer and Walker Canyons. During March and April 1963 no hake shoals were observed along the southern and southeastern slopes. A careful hydrographic survey of this area in April showed relatively high water temperatures in all parts of the slope which were, most probably, unfavourable at this time for shoaling. Hake was noted in these regions only in May, with male and female gonads near the spawning stage (spawning hake as compared with maturing one). In March and April 1964, concentrations of hake were observed on many parts of the southern slope. They were undoubtedly associated with lower bottom temperatures than those in 1963 which created favourable conditions for hake with maturing gonads.

A comparison of hake distribution at the end of May 1962, 1963 and 1964 with the hydrographic conditions shows that the most dense concentrations of spawning silver hake on the southeastern slope occurred in 1962 and 1963 in areas with bottom temperature 10°-12°C. In cooler water (even with 9°C off bottom) hake was found in small quantities (Fig. 2). Early in May and late in June 1964, concentrations of hake were not great in this area. It appeared that off-bottom temperatures did not rise above 8°-9°C and were as low as 4°C at smaller and greater depths (Fig. 8). Hake that had reached the spawning stage by the end of May were scattered over an extensive area and did not form any bottom concentrations as in 1962 and 1963. Evidently conditions were such that hake did not form dense spawning concentrations during late spring and early in the summer of 1964. It is interesting to note in this connection that, according to the catch data from certain areas, such as the northern slope of Georges Bank, spawning hake were observed in greater numbers in the summer of 1964 than in 1962 and 1963.

As stated above, shoals of young hake were observed in the winter of 1963-1964 in the southern part of the Gulf of Maine at depths of 200 or more meters. Shoals of young hake 21-27 cm long, the so-called 'recruits', were also observed in this area at the beginning of the winter of 1964-1965, though now distributed in midwater.

Studies conducted over 5 days showed that hake remained in midwater without sinking to off-bottom depths. This is obviously due to a general temperature drop in 1964 which also affected this area. As early as August 1964, as a result of this process the temperature in the lower strata of the deep parts of the southern part of the Gulf of Maine was 2°C lower than in August 1963.

This, also, might be the reason for a complete absence of off-bottom shoals of hake fry north of Georges Bank in the summer of 1964-1965.

Nova Scotia Shelf

Data covering a period from 1962-1964 show that hydrographic conditions on the Nova Scotian Shelf have been widely different in the three years. Figures

3 and 9 present these differences in the deeps known as Scotian Bay and also on the outer slopes of the Shelf. To cite an instance, off-bottom water temperatures on the inland slope of Sable Island were 1°-3°C lower in 1964 than during the corresponding period of 1963.

Hake shoals are observed to dispose in three areas on Nova Scotian Shelf. During the winter months immature and young mature fish usually inhabit regions in Scotian Bay affected by an inflow of warm slope water with bottom temperatures about 4°-6.5°C. In spring silver hake pass through the deeps onto the continental slope and shoals there between Lahave Bank and the Deep of Hali. During this period the fish keep to the bottom in temperatures of 6°-8°C. Towards the end of the summer, with water on Sable Island shallows warming gradually to 12°C, hake appear there in increasing quantities, and this is where most of the spawning takes place. Later, due to a drop in temperature during winter months, hake leave the bank.

A general pattern of hake distribution on the Nova Scotian Shelf in 1964 is shown in Fig. 5. The distinctive feature of hake distribution in 1964, as compared with 1962 and 1963, is that no hake shoals were found on the continental slope just south of Sable Island and that it moved further west beyond Lahave Bank along the continental slope. Also, no shoals of hake fry were observed in the northeastern part of Scotian Deep in the winter of 1963-1964 and in the entire deep in the winter of 1964-1965. This is obviously a consequence of a reduced inflow of slope water to the bank which started already at the close of 1963. In the spring of 1964, however, with an abrupt rise of bottom temperature (Fig. 3), hake 'recruits' were found on the continental slope of the shallows west of Sable Island.

Biological data in the spring of 1964 were similar to those of previous years.

Hake spawning took place during June and August 1964 on the shallows off Sable Island and in the Scotian Deep. Initial spawning occurred in deep in June and July, further spawning occurred in August on the shallow of Sable Island. From the experience of 1963, mass spawning of the second portion was expected to take place in September; however, owing to circumstances beyond the control of the research party, no observations were made to verify this.

Conclusions

1. Silver hake distribution over the Nova Scotian Shelf and Georges Bank is governed, to a large extent, by hydrographic conditions whose annual changes bring about substantial changes in their distribution pattern.

2. Throughout 1964 the influence of warm Atlantic water on Georges Bank and off Nova Scotian Shelf was much less than during corresponding periods in 1963, which resulted in a temperature drop (particularly in off-bottom layers) within 1°-2°-5°C on Georges Bank and 1°-3°C on the Nova Scotian Shelf.

3. Depending upon their particular biological state, silver hake requires definite hydrographic conditions which are largely affected, directly or indirectly, by water temperatures. Obviously owing to lower temperatures in 1964, the hydrographic conditions prevailing on the southern slopes of Georges Bank in early spring 1964 were more favourable for maturing hake and less favourable for spawning than in 1963.

4. In 1963 silver hake spawning occurred within a limited area on the southern slope of Georges Bank between Corsair and Lydonia Canyons, but in 1964 spawning occurred over nearly the entire territory of the southern slopes as far as Veatch Canyon. Specimens with flowing gonads were also observed over the norther slopes.

5. No bottom hake shoals were observed in the southern part of the Gulf of Maine and in the Scotian Deep - the usual hake grounds - owing to a general temperature drop in these regions in the winter of 1964-1965.

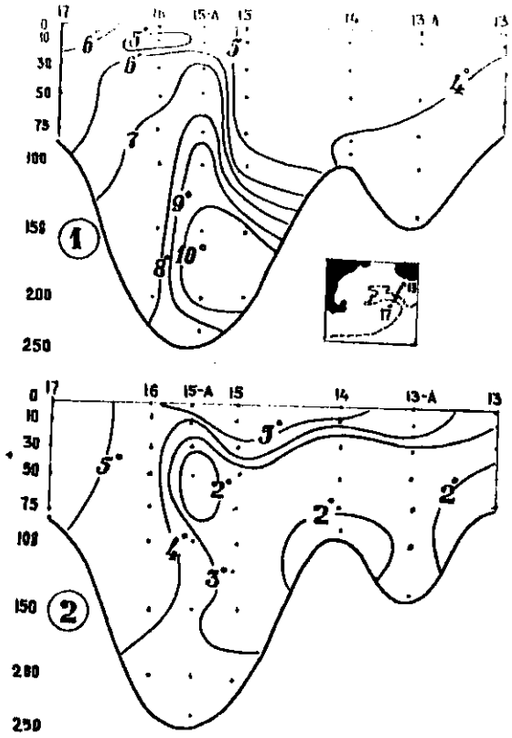

Fig. 1. Water temperature distribution in the passage between Browns and Georges Banks.
1. 20 May 1963.
2. 20 May 1964.

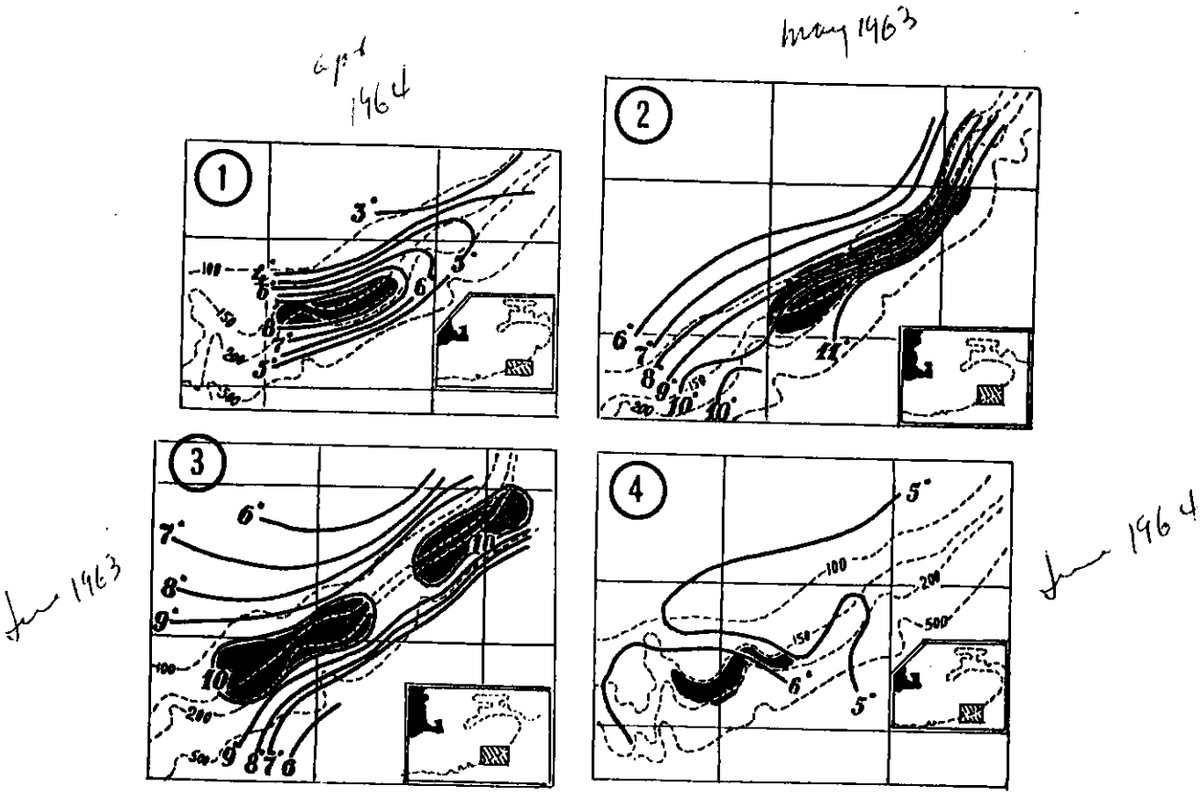

Fig. 2. Water temperature distribution off the bottom and silver hake concentrations on the southeastern edge of Georges Bank.
1. The end of March-beginning of April 1964.
2. The end of May 1963. 3. June 1963.
4. June 1964.

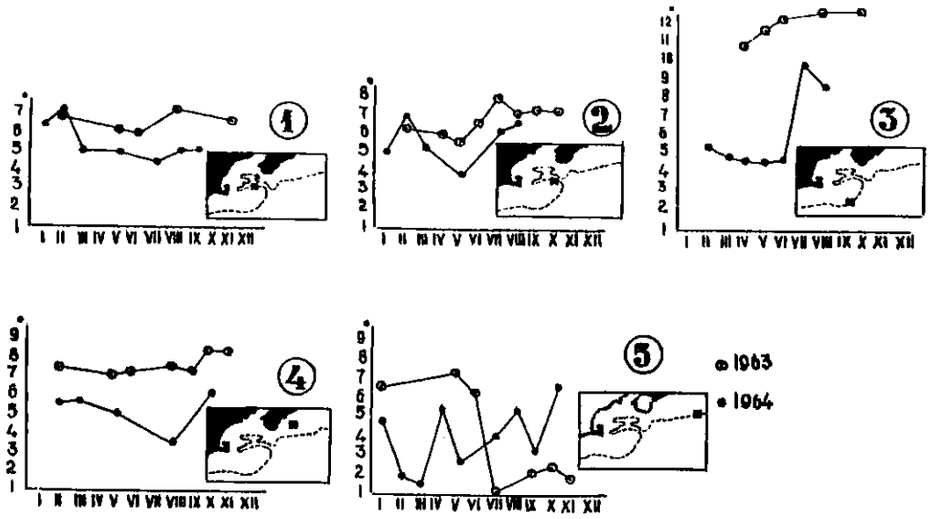

Fig. 3. Water temperature from month to month in the depth of 200 m in 1963 and 1964.
1. and 2. The northern slope of Georges Bank.
3. The southern slope of Georges Bank.
4. The Scotian Bay. 5. To the south of Sable Island.

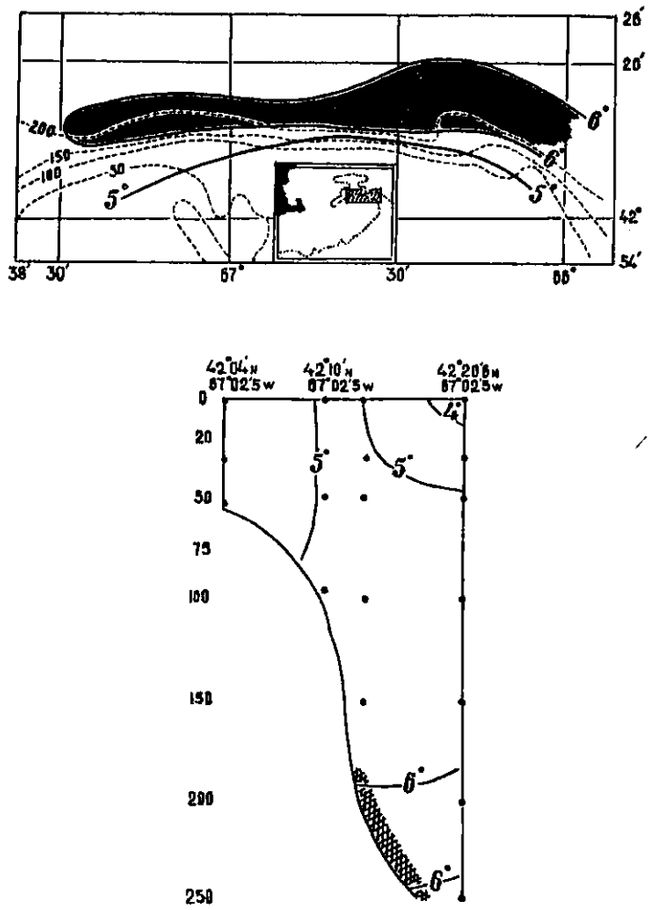

Fig. 4. Water temperature distribution and silver hake concentrations off the northern slopes of Georges Bank in the winter of 1963-1964.
1. Temperature and hake at 200 m and off the bottom in depths greater than 200 m.
2. Vertical distribution.

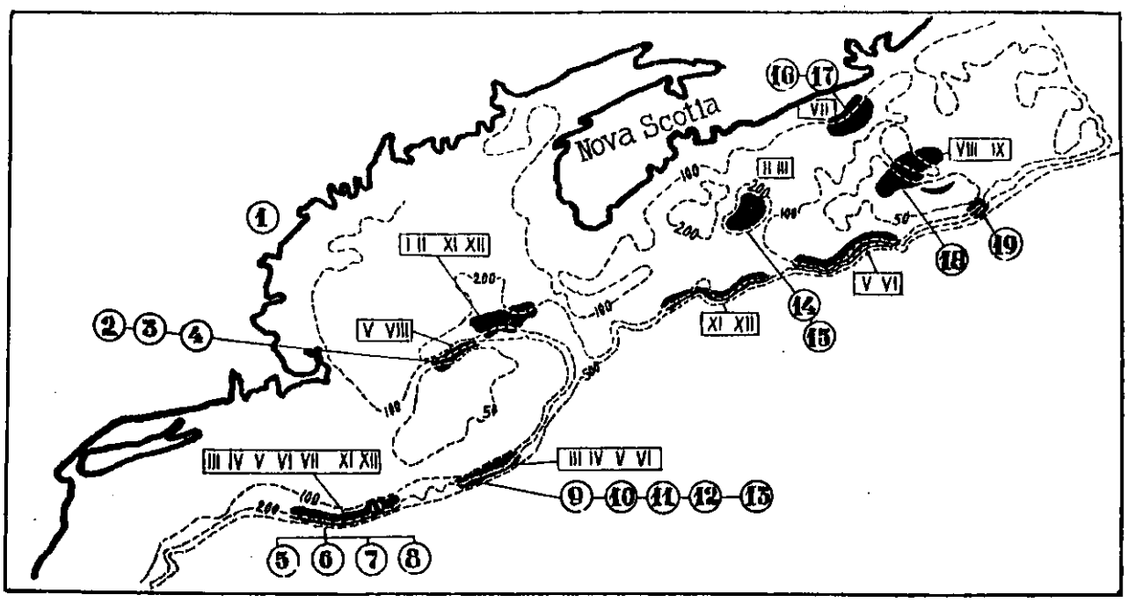

Fig. 5. Scheme of the distribution of silver hake concentrations on Georges Bank and the Nova Scotian Shelf (Number of biological analyses are in the circles; see Fig. 6) in the different months of 1964.

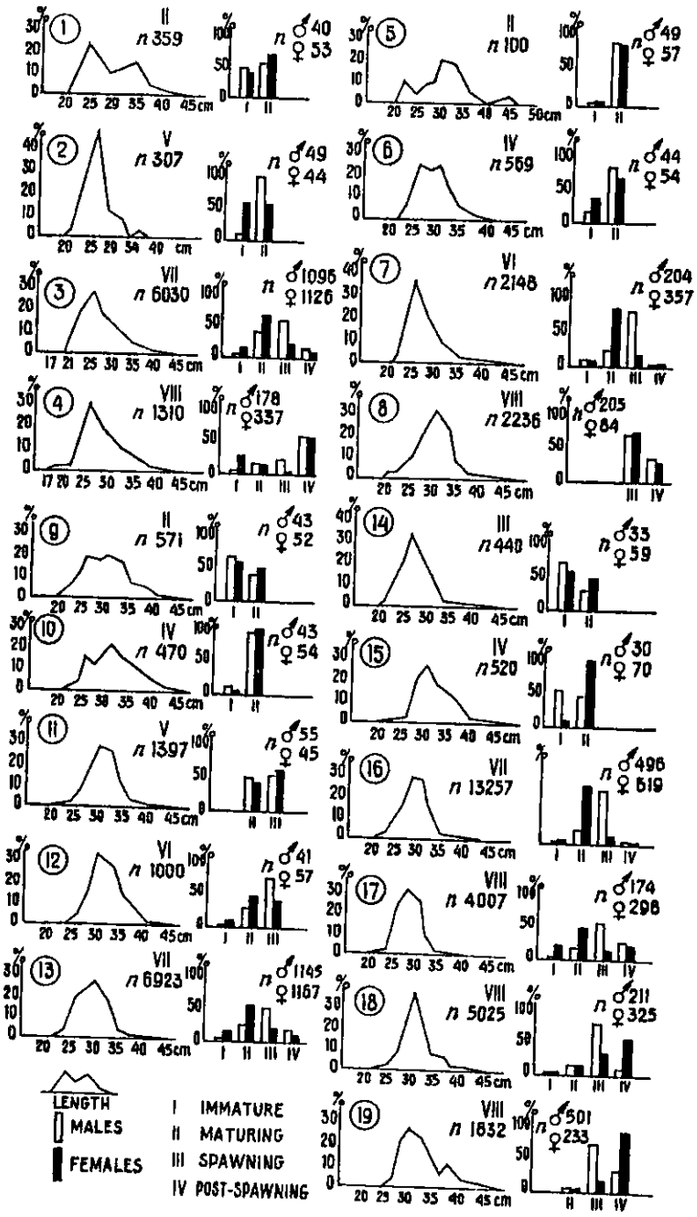

Fig. 6. Data on the biological condition of the silver hake on Georges Bank and the Nova Scotian Shelf in the different months of 1964. (Sampling locations are indicated by the proper number in Fig. 5).

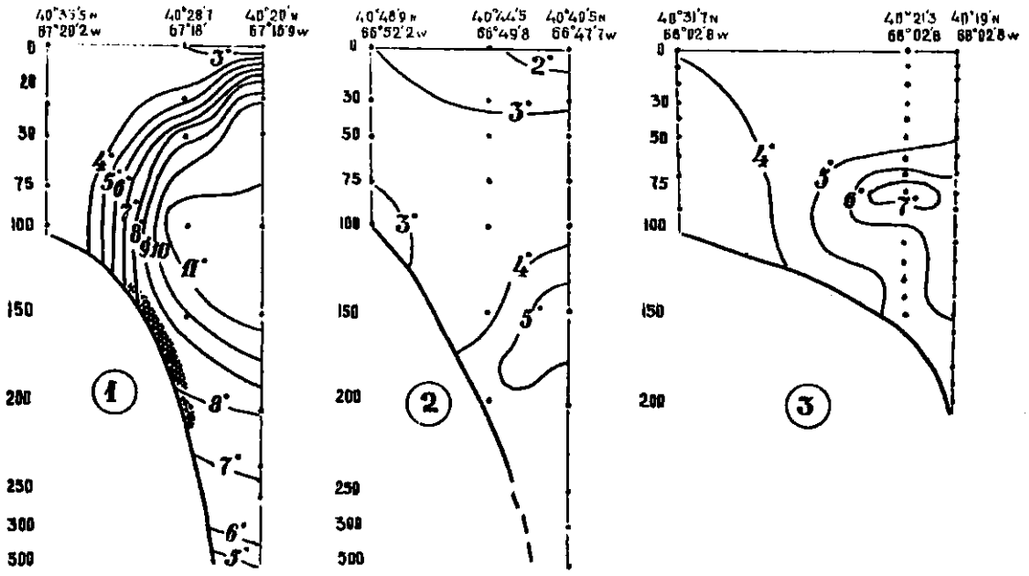

Fig. 7. Water temperature distribution on the southeastern slope of Georges Bank in April of 1964.
1. The area of silver hake concentration to the east of Lydonia Canyon.
2. To the east of silver hake concentration.
3. To the west of silver hake concentration (between the Walker and Oceanographer Canyons).

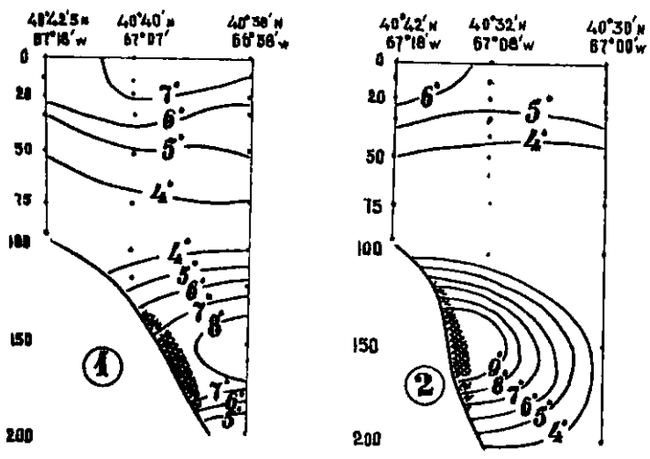

Fig. 8. Water temperature distribution in silver hake concentration area to the west of Lydonia Canyon in May 1964.

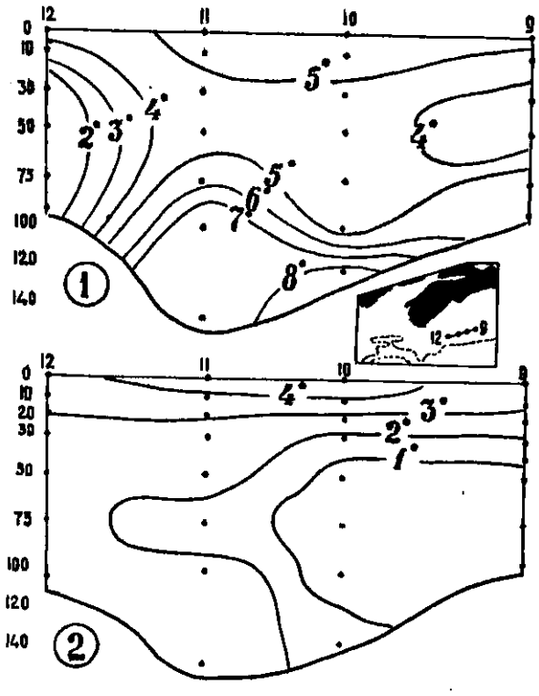

Fig. 9. Water temperature distribution in t channel between the Lahave and Emerald Banks.
1. 18 May 1963.
2. 3 May 1964.