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MORPHOLOGICAL AND BIOLOGICAL CHARACTERISTICS OF
THE NOVA-SCOTIA SHELF HERRING (BANQUEREAU AND
AND GEORGES BANKS)

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In 1960-61 the Baltic Research Institute of Marine Fisheries and Oceanography, along with general herring investigations, started explorations in the North-west Atlantic on the Nova-Scotia Shelf-Banquereau and Georges Bank. Table 1 shows the amount of work carried out.

Since the studies of Clupeidae on the Nova-Scotia Shelf Banks proceeded only for a year, the material available permits to draw but preliminary conclusions.

It is known however that no research into herring in the above-mentioned areas, situated far from the coasts of North America, has been carried out. The work of Canadian and American scientists and the detailed investigations by Dr. Tibbo (1), in particular, refer to herring found in coastal waters.

We have found that herring concentrations on Banquereau and Georges Banks refer to the sub-species Clupea harengus harengus, typical of the whole North Atlantic, but they are characterized by morphological peculiarities of their own, which makes it possible to regard them as a special race. Each of the two banks is inhabited by a local herring stock of its own.

Table 2 shows morphological characteristics of these herring as compared with Atlanto-Scandian stock.

The data given in the table indicate that the major morphological characteristics of Banquereau and Georges Banks herring are identical and that they may be treated as a unit. The only differences that should be mentioned are vertebral numbers in the dorsal (D) fin and the anal fin base length.

As to their morphological characteristics, however, there is no doubt that Banquereau and Georges Banks herring differ from the Atlanto-Scandian stock (table 2), which seems to be attributed to the effect of different ecological conditions, the Atlanto-Scandian stock being a typically oceanic stock, whereas the herring of Banquereau and Georges Banks refer to Bank herring with different biological characteristics. The vertebral counts in the Bank herring are lower. They occupy an intermediate place between the Atlanto-Scandian herring and herring of some other areas of the North-west Atlantic, viz.

	- Vertebrae counts	

Nova-Scotia herring	55.52	According to Tibbo (1)
The Gulf of St.Lawrence herring (southern part)	55.64	"
(northern part)	55.29	"

Newfoundland herring	55.64	According to Tibbo (1)
Banquereau Bank herring	56.65	Our data
Georges Bank herring	56.73	"
Atlanto-Scandian stock	57.16	"

The dorsal and anal fins in the Banquereau Bank herring are situated nearer to the head than is the case with Atlanto-Scandian herring, which is typical of herring whose radius of feeding and spawning migrations is not great.

The difference in the ray counts in the dorsal and anal fins of Bank herring is greater than that in Atlanto-Scandian stock, where an increase in the anal fin ray number (A) is parallel to a decrease in the dorsal fin ray number (D), that is - rays in A - 18.29, in D 18.25.

If the dorsal fin is situated more to the front the ray number in the anal fin decreases and in the dorsal fin-increases.

The dorsal and anal fins base length varies in accordance with the ray number.

The mean length of the Banquereau Bank herring is greater as compared to that of the Georges Bank herring, but both these groups are considerably smaller than the Atlanto-Scandian herring. The difference in the mean length and weight of the Bank herring is accounted for by different age groups composing the stock. (Table 3,4).

Table 3, 3a and 4, 4a present data on the age length composition of the Banquereau and Georges Banks herring.

As is seen from table 3 the length of Georges Bank herring in October changes. It seems to result from the fact that individual herring shoals are replaced by new ones coming from the Gulf of Maine. The tables indicate that the difference in the age and length composition of the two local stocks is rather great. Georges Bank herring is dominated by younger stages (4-5 year-olds), whereas Banquereau Bank stock is comprised of various age groups represented by nearly equal numbers.

The mass onset of maturity is observed in the 4th year, which is seen from the position of the scale spawning rings and the state of maturity of gonads.

The fecundity of Georges Bank herring is from 47 to 118.2 thousand eggs. They are characterized by a single stage spawning.

Bank herring grow more speedily in the first two or three years of their life. The growth rate decreases with the onset of maturity.

The growth rate of Georges Bank herring is nearly like that of Banquereau Bank herring, the former, up to age of 3, resemble the North Sea herring.

Banquereau Bank herring grow faster than Atlanto-Scandian herring and much faster than the North Sea herring. Their growth rate is higher in comparison with Georges Bank herring (Fig. 1).

Very indistinct annual rings on the scale of the Bank herring distinguish them from the Atlanto-Scandian stock. This

seems to be accounted for by the peculiarities in the feeding of the Bank herring, characterized by various intensity throughout the year.

In the scales of the Bank herring narrow rings deposited in the early stages of life may be distinguished; it is probable that immature herring feed in the coastal waters off Nova Scotia or Newfoundland (Banquereau Bank herring) and in the Gulf of Maine (Georges Bank herring), where small-sized herring, so-called "sardine", are fished.

When analysing the biological characteristics of Georges and Banquereau Banks herring it should be pointed out that there are apparently three biological groups here;

On Georges Bank: 1. Spring-spawning herring;

2. Summer-spawning herring;

On Banquereau Bank: 3. These herring are believed to spawn in late autumn.

The division of herring into the three groups is based on the differences in the age and length composition, in the time and place of formation of commercial concentrations, in the maturity rate and feeding migrations.

The seasonal distribution of herring of these different groups on the Banks is given below:

In spring 1960 spring-spawning herring of 16-34 cm, with specimens of 27-30 cm predominating, occurred on Georges Bank (immature herring with the length of 21-23 cm made up 23.02%).

The age varied from 2 to 7 years, with specimens from 3 to 5 years prevailing. In May herring were in maturity stage II and VII-II, with clear signs of being spent. They fed intensively but the nutrition factor was rather low. Comparatively low quantities of these herring were observed. At the same time mass surface concentrations of herring were found near Georges Bank.

In winter 1960 herring of 24-32 cm (mainly 26-28 cm) were fished on Georges Bank, their age varied from 3 to 9 years (the 7 year-olds prevailing). They fed in the Bank waters and their nutrition factor was somewhat higher than in spring. They were in maturity stage II. The shoals were small, scattered, not dense and moved rather actively. No doubt these herring belonged to another group that had completed spawning in autumn.

They were observed to gradually leave the Bank.

In spring 1961 no spring-spawning herring were observed on Georges Bank, instead great concentrations of summer-spawners were found.

The length varied from 17 to 34 cm, with specimens of 25-26 cm, age - 4 years. Larger herring occurred in smaller numbers than in 1960. In May they were in maturity stage II, and II-III, the fat content was 12%, specimens of 24-26 cm dominated the catches. Later from June to September the quantity of herring with the length of 24 cm decreased, which may be attributed to the pre-spawning changes in the stock composition.

Herring of 25-26 cm, at the age of 4-5 years, dominated the catches during August-September.

In the period May-August herring gonads were quite mature and the spawning started directly on Georges Bank.

Post-spawners were first observed in the first days of September. Feeding intensity increased gradually in early June, the fat content amounted to 14%.

From May through September herring concentrations remained very dense. In September owing to the beginning of spawning the behaviour of herring somewhat changed. They kept close to the bottom where rather dense concentrations were formed.

Separate schools of herring remained on the Bank throughout the winter. But the concentrations had become more sparse. The smallest quantities of herring were observed on the Bank during January-March. In winter 1960-61 the herring observed on Banquereau Bank measured 17-39 cm, the age ranged from 3 to 19 years, with herring of various length groups being rather evenly distributed, the 6-7 years old slightly predominating. From January to April herring were observed to feed in spite of rather low water temperatures, 64-89% of the caught herring were in maturity stage II.

In late April herring left Banquereau Bank. The direction of the migration was not recorded.

On the basis of the biological characteristics of the three groups of Nova Scotia Shelf herring, a preliminary scheme of their migrations can be drawn.

Having completed spawning the spring-spawning herring feed for a short period of time on Georges Bank and then quit the place.

From May summer-spawning herring appear on this Bank. They spawn here in September-October and leave the Bank little by little. Individual shoals occur on Georges Bank even in December.

The relation of these herring to the Gulf of Maine herring has not been found out yet. It is believed that the Gulf of Maine serves as a feeding ground for the young (1-2 year-olds). It is known that spawning on the Bank and in the Gulf of Maine takes place simultaneously, since herring larvae were observed in both the areas within the same period of time.

Banquereau Bank herring spawn in late autumn or in winter (October-December).

They appear on the Bank as late as December and inhabit its waters until March. It has not been cleared up whether Banquero Bank serves as a spawning ground for these herring or whether they perform spawning runs to the coasts of Newfoundland or Nova Scotia.

Thus, herring concentrations, formed a different times, stay on Georges Bank throughout the year, with spring-spawning herring being replaced by autumn-spawners.

From May to April herring concentrations are most abundant. In January-March very small quantities of herring were observed.

In December-January large amounts of herring appear on Banquereau Bank, they stay here till March.

A detailed description of the biological peculiarities and the final chart of the migratory pattern of Nova Scotia Shelf herring living in offshore waters will be given when there is enough material obtained as a result of long-term observations.

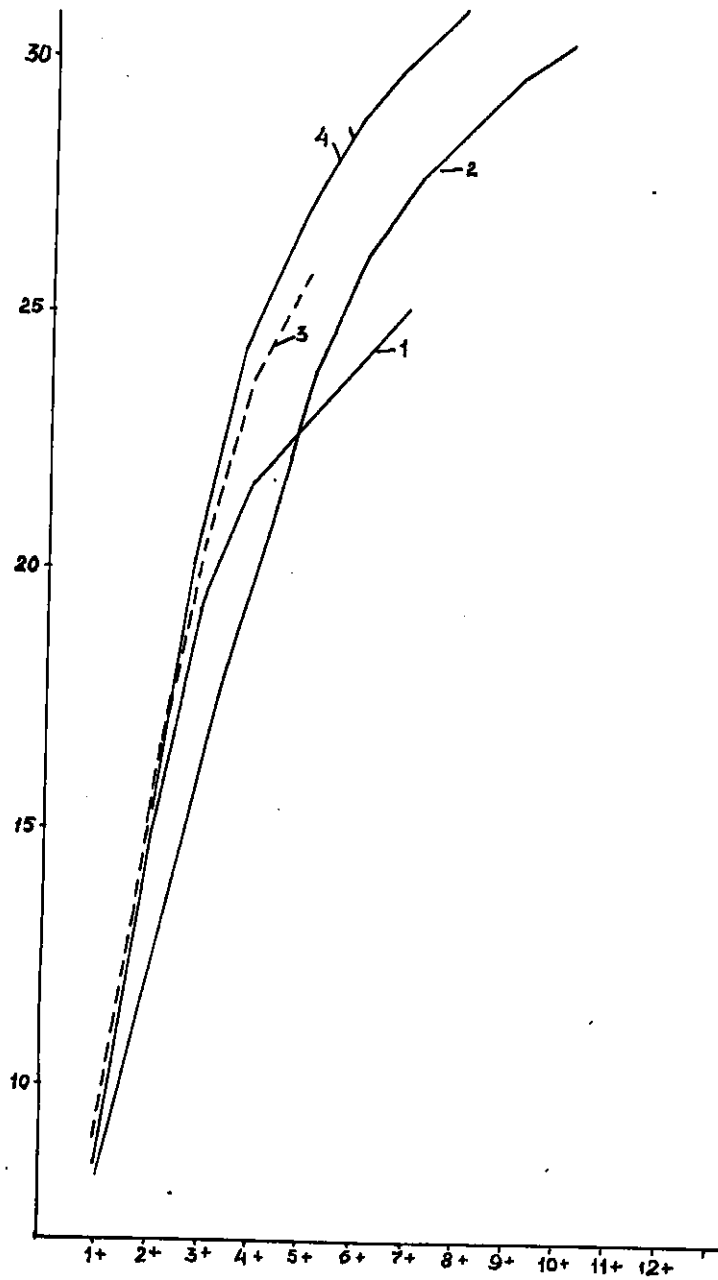


Fig.1

Herring growth rate: 1. On Dogger Bank
2. Atlanto-Scandian stock
3. On Georges Bank
4. On Banquereau Bank

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Table I

Ichthyological work carried out in the Nova Scotia Shelf waters
in 1960-1961

The number of herring, measured	64,661
The number of herring for age determination	2,604
The number of herring for race analysis	609

Table 2

Morphological characteristics of Banquereau Bank herring, Georges Bank herring and Atlanto-Scandian herring.

	Banquereau	Georges	Atl.-Scand.	Banq. and Georg.	Banq. and Atl.-Scand.	Georg. and Atl.-Scand.
Length of fish, cm.	29.63	25.19	31.44			
Weight, gr.	220.60	164.00	360.80			
Weight of gutted fish	196.40	144.70	306.20			
Vertebrae number	56.65	56.73	57.15	0.74	7.33	3.56
Keel scale number	13.27	13.20	13.68	1.0	4.93	4.58
Ray number in A	17.54	17.48	18.29	0.70	8.59	7.10
Ray number in D % of the body length	19.14	18.31	18.75	9.20	3.88	3.55
Anal fin base length	11.37	11.71	11.51	7.90	5.57	4.25
Dorsal fin base length	12.45	12.34	11.80	2.56	24.52	12.38
Ante-anal distance	71.04	70.54	74.07	2.04	22.90	15.13
Ante-dorsal distance	48.83	48.70	50.34	0.59	14.11	7.38

Length and weight are averaged. The length was measured from the snout tip to the end of median caudal fin rays. The number of fin spines and rays is given as a single value. The number of herring analysed: from Banq. Bank - 500 specimens, from George Bank - 100, and 100 of Atlanto-Scandian herring.

Table 3

Length composition of Georges Bank herring (per cent.)

	Length, cm														% Number of specimens	
	18	10	20	21	22	23	24	25	26	27	28	29	30	31		
May	1.0	2.0	3.0	3.0	2.0	3.0	17.0	38.0	22.0	6.0	2.0	1.0	-	-	100	3,020
June	-	-	2.0	4.0	6.0	6.0	14.0	35.0	25.0	7.0	1.0	-	-	-	100	8,484
July	-	-	-	-	2.0	6.0	8.0	28.0	38.0	14.0	3.0	1.0	-	-	100	8,934
August	-	-	-	-	-	2.0	6.0	20.0	42.0	22.0	7.0	1.0	-	-	100	8,955
September	-	-	1.0	2.0	4.0	6.0	6.0	21.0	33.0	18.0	6.0	2.0	1.0	-	100	18,457
October	-	0.4	2.1	6.2	11.2	18.0	11.2	13.1	20.0	11.0	4.1	1.7	0.7	0.3	100	8,941
November	0.1	-	0.1	0.1	0.6	1.1	5.8	22.2	42.7	18.2	5.4	2.3	1.1	0.3	100	2,082
December	-	-	-	0.1	1.1	3.8	5.4	14.0	34.8	27.3	8.9	3.1	1.4	0.5	100.4	5,536
February																
Total																61,409

Table 3a

Age composition of Georges Bank herring (an average per year)

Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
%	0.3	12.0	50.1	25.0	4.2	2.4	1.2	0.8	-	-	-	-	-	-	-	-	-	100

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Table 4
Length composition of Banquereau Bank herring (December-February)

cm	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
%	-	0.1	-	-	0.3	0.9	2.2	3.0	4.2	3.5	4.1	6.4	9.3	9.5	8.2
	32	33	34	35	36	37	38	39							
	10.3	13.0	10.0	77.4	3.7	2.2	1.5	0.2	100	3252					

Age composition of Banquereau Bank herring

Age	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
%	-	2.0	4.9	14.4	16.7	17.2	7.2	6.1	13.0	6.1	4.9	3.7	1.2	2	-	0.1	0.1	0.4	100	1596

Table 4a