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The Young Silver Hake Growth in the Scotian Area, 1977-1988

by

A. I. Sherstjukov

Atlantic Scientific Research Institute of Marine Fisheries and Oceanography (AtlantNIRO)
5, Dm. Donskoy Str., Kaliningrad 236000, USSR

ABSTRACT

Power relation of absolute values of 0-group daily growth increment and its average length, and a positive linear relation of absolute values of daily weight increment and the average length of 0-group were revealed based on the data of the joint Soviet-Canadian ichthyoplankton and young fish trawling surveys, for August-November 1977-1988.

INTRODUCTION

As a result of announcement of the Economic Zone by Canada (1977) and restriction of the silver hake fishery on the narrow part of the continental slope between 59° and 65°W (1979)forecosting the massive hake movement for spawning to the north of the small mesh gear line has become indispensable. Prelimingry estimation of massive silver hake spawning times was based on the data of ichthyoplankton surveys curried out during the joint Soviet-Canadian research in August-September 1977-1982. As appeared, this species is characterized by long spawning period lasting from July to October (Moskov et al., 1978, 1982). Ichthyoplankton surveys have not been carried out since 1982. The data of the silver hake biological analysis available from the Soviet commercial vessels for the 1983 to 88 period are limited, as very often the fleet left the Canadian zone early in July after having taken out the quota, so they are not adequate to determine the times of massive hake spawning in 1983-88. This problem might have been solved with the use of the data on the 0-group growth rate at

the stages of larva and fry. But such data are not available because no special collection of otoliths for aging the 0-group silver hake was undertaken. Nevertheless it is possible to determine tentative times of beginning of massive hake spawning and thus to analyse retrospectively the causes of hake migrations for spawning in shallow areas of Sable Island based on the inderect index of growth rate versus 0-group mean length variation in time. The results of the analysis can be taken into account in forecasting possible spawning migrations of the silver hake.

MATERIALS AND METHODS

The materials were mainly collected during the cruises of the Soviet vessels of the SRTM to the Scotian shelf in August-November 1977-1988 (Tables 1,2). In addition, the data obtained from the cruise of the Canadian research vessel "Lady Hammond" made in January 1981 (Koeller et al., 1985) were used. During the ichthyoplankton surveys carried out over the 1977 to 82 period for sampling the hake larvae the large model of Bongo sampler with 0.6 m opening diameter and 0.333 mm mesh size was used. Ichthyoplankton sampling and sample treatment methods were described in details earlier (Noskov et al., 1982). Initially the trawling inventory surveys of the young hake (October-November 1978-80) were carried out with the 13.6 m fry trawl, but since 1981 the international trawl IYG PT was been used (Noskov and Sherstyukov, 1984). The surveys were carried out each year at the same time period, after all newly born larvae had undergone the metamorphosis and became accessible to the fry trawl. The methods of fishing and trawl catch treatment were also discussed earlier (Noskov and Sherstyukov, 1984b). Indirect indices such as mean length (weight) variations during particular time interval give the idea of the growth rate of the 0-group silver hake. Mean daily absolute growth increments were calculated to evaluate the larva and fry growth rate by the following expression:

$$\Delta Y = \frac{Yn - Yo}{t_n - t_o},$$

where ΔY - mean absolute growth increment in a time unit;

Y_n - mean length (weight) by the end of time interval;

Y_o - mean length (weight) at the beginning of time interval (at hatching) is 3.0 mm for hake (Colton and Marak, 1968);

t_n - end of time interval;

t_o - beginning of time interval identical to the end of embryonal period which continued about 4 days for hake (Nichols and Breder, 1927, Coombs and Mitchell, 1982).

The specific growth rate was estimated from the formula (Mina and Klevezall, 1976):

$$C = \frac{\ln Y_n - \ln Y_o}{t_n - t_o} .$$

Variations in the ratio of adult hake maturity stages by 5-day interval were analysed to determine the starting times of massive spawning in 1977-81, and thus the beginning of the embryonal period.

During some years, the inventory trawling surveys were followed by the repeated hauls in the areas of massive hake aggregations. The gained data were used to estimate daily length and weight increments of hake fry using the above formula where $Y_n - Y_o$ is the difference between the 0-group mean lengths from the inventory and reiterated surveys, and $t_n - t_o$ is the time interval between these surveys.

The materials were then treated by common statistical methods.

RESULTS

Quantitative indices, such as variation of mean length and weight of larva and fry in time, which characterize the daily rate of the 0-group hake linear and weight growth in the Scotian area are presented in Tables 1,2 and in Figs. 1,2. Absolute daily linear increment in newly hatched larvae (3.0-6.4 mm lenght) was 0.14-0.28 mm/day while by the start of metamorphosis (23-24 mm length it reached 0.44-0.50 mm/day (table 1) and persisted at about that level (0.36-0.68 mm/day) till the 28-67 mm length (Table 2). The same trend was observed for weight increments.

One of possible forms of linear and nonlinear dependences relative to the above mentioned data was analysed by the method of regression. The best approximation for empirical data on the absolute linear increment of the young hake with different lengths

was received by the power equation (Fig. 3A): $y = 0.15 \cdot x^{0.31}$, where y - absolute daily linear increment in 0-group (mm/day);

x - average length of 0-group (mm).

The above relation is very useful for determining the tentative date of massive spawning based on estimates of absolute length increments during the entire 0-group feeding period after batching. For example, in 1985, the mean fry length was 61 mm from the data of the inventory survey (Sigaev et al., 1988). By substituting this value into the above power equation the absolute daily increment of 0.54 mm/day was found, and for the larva (3-22 mm length, on average 12 mm) it was only 0.32 mm/day. The difference between the hake fry mean length (61 mm) in the catches taken by the IYG PT trawl and the length of developed fry (23 mm) was 38 mm. It implies that 70 days passed since the metamorphosis with the absolute daily increment of 0.54 mm/day. Accordingly, the difference between the length values from hatching (mean length 3.0 mm) to metamorphosis is 20 mm and the feeding period is 62 days. Thus a total of 132 days elapsed from hatching to the inventory fry survey in 1985, i.e. the massive spawning is supposed to begin in the first days of July. The analysis of changes of the ratio of the adult silver hake maturity stages in the Scotian area (from observers data), by 5-day period in 1985 showed that the indices of ovary maturation were the highest on 1-5 July, so this period should evidently be considered as the beginning of massive spawning. In separate years, the dates of massive spawning can shift to later time, as it was the case in 1987 (Sigaev et al., 1988). Thus in 1987, the young hake mean length in fry trawl catches was as small as 33 mm as a result of underfishing the 10-22 mm length specimens. As this value is considerably lower than the usual one (50-60 mm) it is unreliable and the use of the above power equation for determining the massive hake spawning dates is not recommended in this case.

Positive linear dependence of the values of absolute daily weight increment for the 0-group on its mean length was deduced (Fig. 3B) ($r = 0.87 \pm 0.05$): $y = 0.41 \cdot x - 3.13$, where y - absolute daily weight increment for 0-group (mg/day); x - mean length of 0-group (mm).

SUMMARY

The presented nonlinear (power) relation of the value of absolute daily linear increment for the O-group Scotian silver hake and its mean length is of practical importance as it provides the opportunity of back - calculating the tentative date of beginning of massive spawning which helps to identify the causes of hake spawning migrations to the north of the small mesh gear line.

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Table 1

Growth rate indices for the Scotian O-group silver hake at the stage of larva

Vessel	Observation period	Interval between observations (days)	Number of measured specimens	Mean length (mm)	Absolute daily linear increment (mm/day)	Specific rate of growth	Body weight for mean size (mg)	Absolute daily weight increment (mg/day)	Specific rate of weight increment
SRTM-8024	15.09.77	14		3.0	0.24	0.05	0.28	0.15	0.17
Foton	29.09.77		964	6.4			2.33		
SRTM-8004	30.07.78	12		3.0	0.14	0.04	0.41	0.04	0.01
Vykhma	11.08.78		151	4.7			0.94		
SRTM-8004	25.08.78	9		3.0	0.28	0.07	0.41	0.17	0.17
Vykhma	3.09.78		158	5.5			1.94		
SRTM-8004	11.08.78	55	151	4.7	0.44	0.03	0.94	3.02	0.09
Vykhma	5.10.78		5704	29			167.00		
SRTM-8002	28.08.79	45	909	6.2	0.48	0.03	2.12	2.95	0.11
Vyandra	12.10.79		1889	28			135.00		
SRTM-8080	15.07.81	50		3.0	0.50	0.04	0.20	2.60	0.13
Ekliptika	3.09.81		80	28			130.00		

Table 2

Growth rate indices for the Scotian O-group silver hake at the stage of fry

Vessel	Period of observation	Interval between observations (days)	Number of measured specimen	Mean length (mm)	Absolute daily linear increment (mm/day)	Specific rate of linear growth	Body weight for mean size (mg)	Absolute daily weight increment (mg/day)	Specific rate of weight increme
SRTM-8072	2-7.10.80		928	34			280		
60 Let VLKSM	24-29.10.80	22	625	42	0.36	0.01	450	7.73	0.09
60 Let VLKSM	28.09.-18.10.80		2964	32			240		
Lady Hammond	5-16.01.81	95	550	66	0.36	0.01	1660	14.95	0.02
SRTM-8080	26.08,-12.09.81		80	28			130		
Ekliptika	1-10.11.81	62	6309	58	0.48	0.01	950	13.22	0.03
SRTM-8095	18-21.10.85		2765	58			1500		
Tava	23-26.11.85	37	1983	73	0.41	0.01	2560	28.65	0.01
SRTM-8102	1-5.11.87		2220	30			190		
Maltsevo	19-23.11.87	18	1802	40	0.56	0.02	420	12.78	0.04
SRTM-8101	26-31.10.88		799	50					
Saulkrasty	22-23.11.88	25	609	67	0.68	0.01	-	-	-

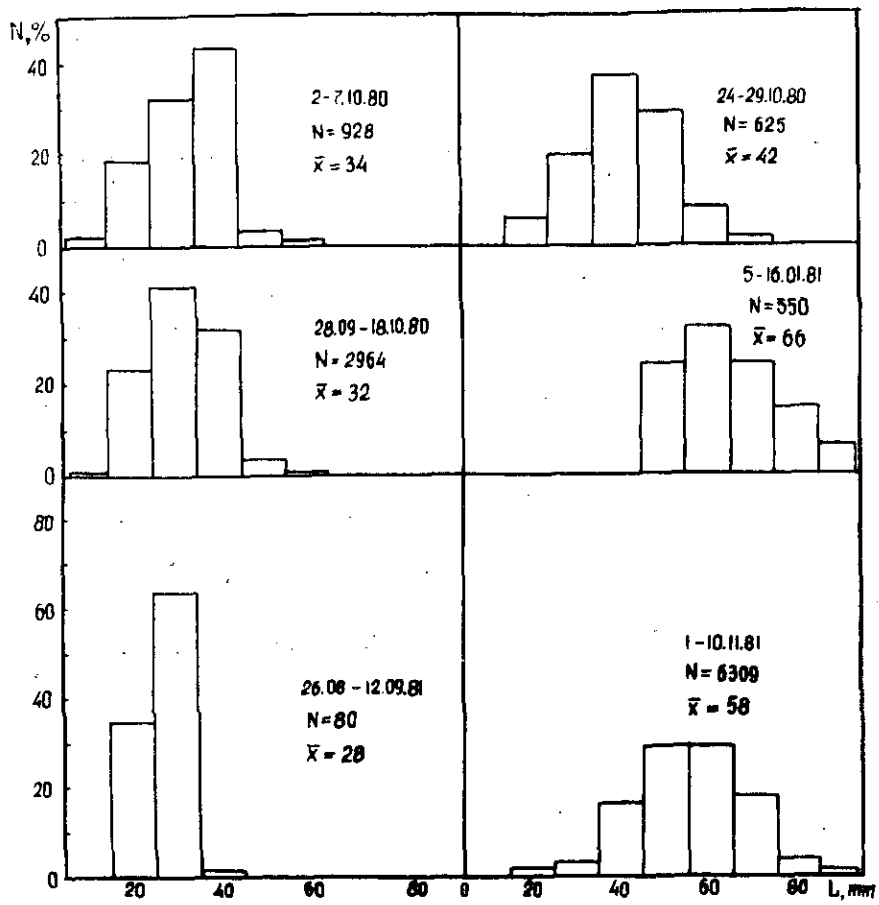

Fig. 1. Size composition of the Scotian O-group silver hake catches during the inventory and reiterated trawling surveys in 1980-81.

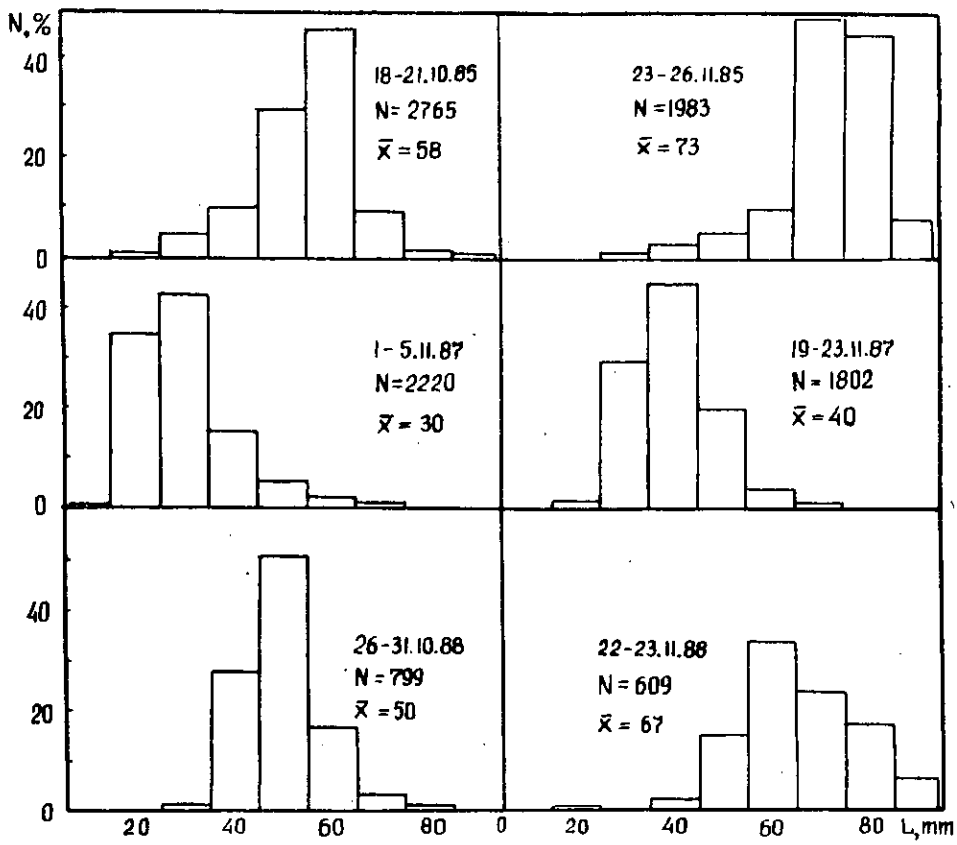

Fig. 2. Size composition of the Scotian O-group silver hake catches during the inventory and reiterated trawling surveys in 1985, 1987 and 1988.

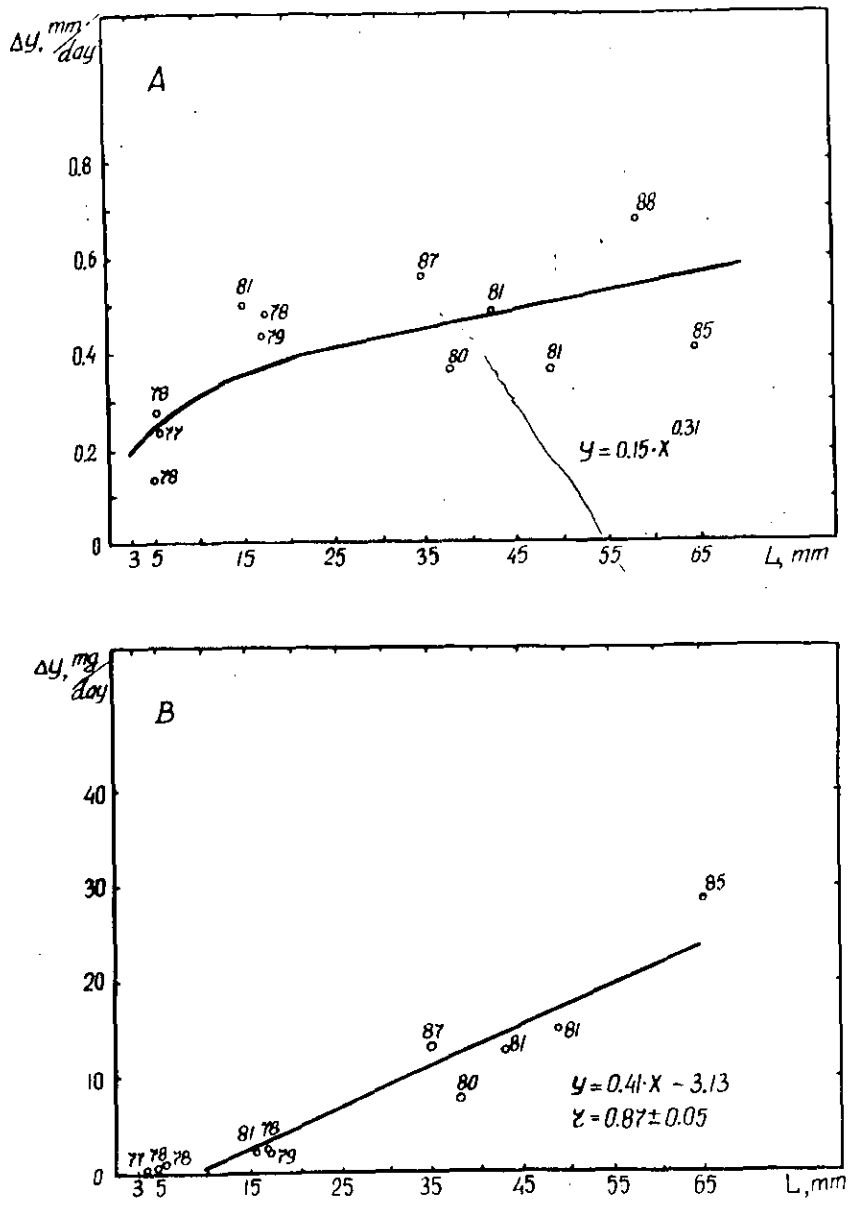

Fig. 3.A. Relation of absolute daily linear increment of the 0-group silver hake (Δy) and its mean length values (L).

B. Relation of absolute daily weight increment of the 0-group silver hake (Δy) and its mean length values (L). Numerals show the year when absolute linear and weight increment values were calculated for the 0-group silver hake.