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The Fecundity of Canadian Atlantic Herring

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Rapidly increasing demands on herring stocks in the Canadian ICNAF area have brought about a concern for the ability of these stocks to withstand this pressure. Involved in determining this is an estimate of recruitment of which one vital factor is fecundity.

Many estimates of fecundity for herring have been made by European workers but very few for the western Atlantic. Hence, any calculations made by North American workers have, of necessity, utilized either values published by European workers, those of Bigelow and Schroeder (1953), or values which have been determined on a small and localized scale. Katz and Erickson (1950) emphasize that the values for fecundity in their study apply only to the area investigated. It is therefore illogical to assume that estimates of fecundity for European stocks and restricted localities are valid for Canadian Atlantic stocks. For this reason, a program to study the fecundity of herring stocks in the southern Gulf of St. Lawrence (Div. 4T) was begun in the spring of 1967.

An additional benefit of fecundity studies, as pointed out by Baxter (1959, 1963) in reviewing the literature, is that differences in fecundity may be used for separating stocks of herring. This separation may be on the basis of seasonal spawning (Farran, 1938; Hickling, 1940), or on locality (Kändler and Dutt, 1958; Baxter, 1959, 1963).

Materials and Methods

A small sample of spring-spawning herring was taken on 30 May, 2 and 5 June 1967. The sample totalled 51 females. These fish were measured for total length prior to the removal of the ovaries. Each pair of ovaries was placed in a separate plastic bag containing Gilson's fluid (without HgCl). The bags were sealed and then punctured. Care was taken to ensure that the perforations were smaller in diameter than the ova. The plastic bags were collectively stored in a large container with Gilson's fluid.

The ova were washed and separated from the remaining ovarian tissue and then air dried. During the drying process, the ova were rolled gently by hand to promote separation and to facilitate drying.

A Decca Mastercount was used to count the ova. Because of the speed (1000 ova per minute) and the accuracy (± 0.5%), entire samples were counted. This eliminated the grosser errors and time consumption of the volumetric and gravimetric methods.

True numbers of ova were determined by calculating the mean of three counts for each batch. An accuracy test was applied for each count. This was done by counting a known test sample of 2000 ova. The per cent error was used in adjusting the counts to a real value.

Results

The smallest female in the sample measured 297 mm and produced 32.7 thousand ova. The largest female measured 347 mm and produced 59.5 thousand ova. The minimum number of ova was 23.9 thousand in a female measuring 321 mm. The maximum number was 82.6 thousand in a female measuring 333 mm. As yet, an analysis of age-length data has not been completed. However, preliminary findings indicate a range in age of 5 to 9 years. The greatest proportion of the sample were 7 and 8 years old.

Figure 1 shows a plot of the entire sample by individual fish. A relationship of the form $F = CL^n$ was assumed and, after a log transformation, the method of least squares yielded the equation $F = 0.0006515\ L^{2.36}$. The entire sample was classified into five 1-cm classes (Fig. 2 and Table I). New values for the equation were calculated to provide the equation $F = 0.10479\ L^{1.80}$. This regression was significant at the .001 level (Coeff. Corr. = .99).

Table I indicates that, within a restricted range of sizes, the rate of increase in fecundity is steady in fish up to 34.0 cm. At this length, the rate of increase falls off markedly. The predicted values based on the system of orthogonal polynomials indicate a change in rate and, in fact, predict more closely the values attained in the 34.5 cm class.

Utilizing the method of Katz and Erickson (1950) in relating the fecundity of successive size classes to the first size class, the change in rate is also noted in the Δ value for the 34.5 cm class.

Discussion

The sample is restricted both in number and length range. The restriction in numbers is due to several factors, most of which can be eliminated. The restriction in size is a result of gill-net selectivity, and this can be alleviated by utilizing purse-seine catches.

Real values for the herring in this preliminary study are much greater than those quoted by Bigelow and Schroeder (1953). It is generally accepted that spring-spawning fish are less fecund than those spawning in the fall. It would seem logical to assume that the spawning time of the fish which contributed the values (20 to 40 thousand) stated by these authors was the spring. However, they also state that there is little if any spring spawning occurring in the Gulf of Maine. Other assumptions as to the nature of these fish are that they were young and small, or that they may be values from some less fecund European stock.

The value of n (2.36) for the sample studied is low when compared to existing values for European fish. This may be explained on a number of points. The two most salient are: (a) the sample encompasses a group of fish which is becoming senile (rate of fecundity decreasing rapidly), and (b) this is one of the differences between the European and North American herring.

Farran (1938), Katz and Erickson (1950) and Gerking (1959) point out that, in the general equation $F = CL^n$, n decreases in value with larger and older fish. This is substantiated in part by the low value of n in this study and by the large decrease in value of Δ in Table I.

Thus it would seem from this investigation that the general concepts pertaining to fecundity hold true for the Gulf of St. Lawrence. However, the values found in these data appear to be quite different from both those of the European stocks and those of Bigelow and Schroeder (1953).

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Table I. Fecundity of spring-spawning herring from the Bay of Chaleur, Gulf of St. Lawrence, according to size class (May-June 1967).

Size class Total length cm	n	Mean value ova x 1000	Predicted value ova x 1000	Predicted value orthogonal polynomial ova x 1000	Ratio to basic group	Δ ratio
30.5	5	48.3	49.6	48.3	1.00:1	-
31.5	11	52.3	52.2	52.1	1.08:1	.08
32.5	20	55.2	55.2	55.5	1.14:1	.06
33.5	11	58.5	58.3	58.3	1.21:1	.07
34.5	4	60.2	61.4	60.2	1.24:1	.03

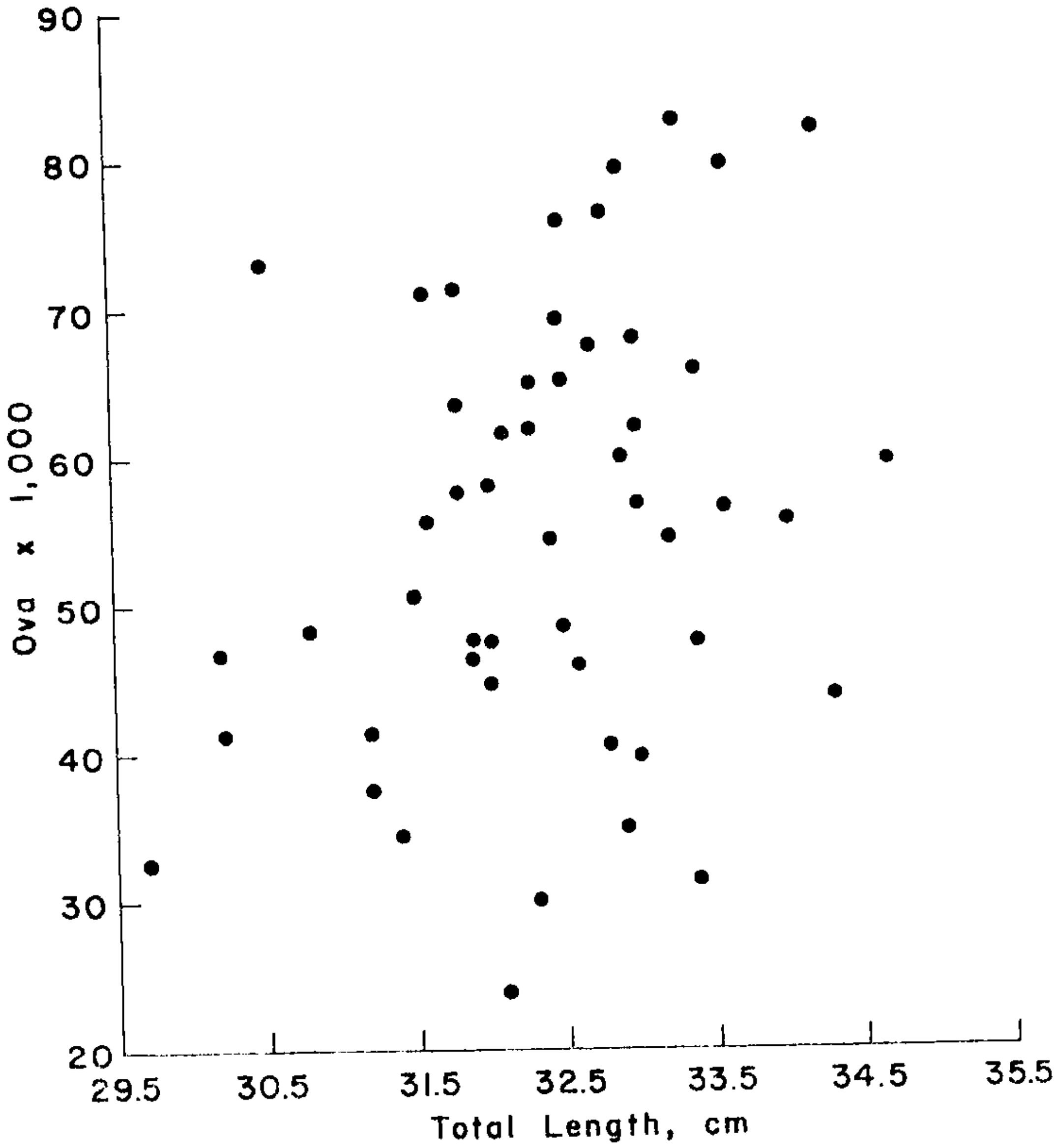

Fig. 1. Relationship between fecundity and length in spring-spawning herring from Bay of Chaleur, 1967.

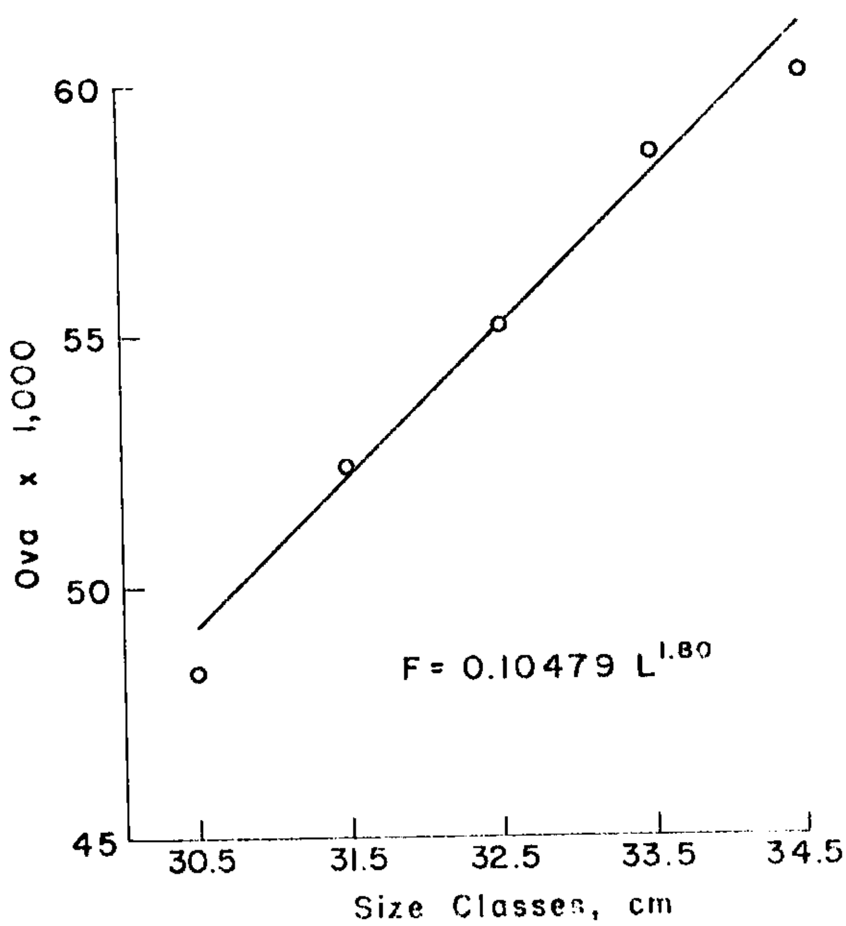

Fig. 2. Relationship between length and fecundity in spring-spawning herring of the Gulf of St. Lawrence.