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International Commission for the Northwest Atlantic Fisheries



1970

RESTRICTED

Serial No.2431
(B.g.7)

ICNAF Res.Doc.70/82

ANNUAL MEETING - JUNE 1970

Vertebral numbers of the Bay of Fundy herring
and the origin of New Brunswick sardines.

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The Bay of Fundy supports two major herring fisheries, one on the New Brunswick side which is based largely on two-year-old "sardines", and one near the southwest coast of Nova Scotia exploiting both juveniles and adults (Res.Doc.70/78).

Data on vertebral numbers for Nova Scotia adults have been presented and discussed by Anthony & Boyar (1968) but none has been published for juvenile or sardine herring from either fishery. Sampling at the St. Andrews Biological Station in 1969 for vertebral numbers of herring from both fisheries has given enough information to pose questions of interest and importance concerning the origins of and relationships between the two Fundy herring groups and a preliminary account is now presented.

Herring were X-rayed using a Faxitron 805 "soft" ray unit and counts were made on the negative films which are available as permanent records at St. Andrews.

The urostyle is not included in the count; individuals showing vertebral anomalies were excluded from the analysis of the data.

Monthly distributions and mean vertebral numbers for the 1967 "sardine" year class in the 1969 samples are listed in Tables 1a and 1b for the two areas. Text Table 2 gives the data on which a Z-test was based to determine the significance between the grand mean vertebral count shown in Tables 1a and 1b.

	n	Mean	St. Dev.	
New Brunswick	4917	55.3557	0.6208	Z = 4.9242
Nova Scotia	592	55.4864	0.6579	

Table 2. Z-test for the significance of the difference in mean vertebral count between the New Brunswick and Nova Scotia 1967 year-class.

The difference is highly significant statistically and there is little doubt that the 1967 sardine year-class in the Bay of Fundy is made up of two major components at least. It is conceivable that these represent the segregation of progeny from a single parental stock, but although this possibility is being examined, it appears to be unlikely and much more probable that the two sardine groups have different parental origins.

This hypothesis tends to be supported by vertebral numbers available for other year-classes, presented in text Table 3, together with the information for the 1967 year-class itself.

Year-class	New Brunswick		Nova Scotia	
	n	Mean VS	n	Mean VS
1967	4417	55.356	592	55.486
1966	800	55.383	144	55.479
1961-65			408	55.463
1960			964	55.514
1959	1036	55.346		
1958	1916	55.391	650	55.554
1957	1300	55.450		
1956	2389	55.337		

Table 3. Comparison of mean vertebral numbers for Nova Scotia and New Brunswick herring year-classes.

(The 1966 year-class for both areas was sampled in 1969; the Nova Scotia adult year-classes (1961-65) for the 1969 samples are combined. The Nova Scotia 1960 and 1958 year-classes were sampled as adults by Anthony & Boyar (1968). The 1956-59 New Brunswick data are from "sardine" samples examined in the years 1958 to 1961 at St. Andrews. These latter data are provisional, but are unlikely to be modified to any significant degree).

Higher mean vertebral numbers are found at Nova Scotia for each of the three year-classes for which comparison can be made. The mean vertebral number for the 1957 New Brunswick year-class is considerably higher than those of all of the other year-classes but, despite this, the data in Table 3 suggest strongly that persistent differences exist and that the possibility that two different stocks are involved in Bay of Fundy fisheries is real.

The origin of the Bay of Fundy New Brunswick sardines was discussed by Tibbo (1968) who concluded that, while the Nova Scotia spawners was currently considered to be the major contributors, the problem was still not solved, and that the Georges Bank spawners could not be excluded as possible parental stock.

The data presented here both makes it less likely that the Nova Scotia spawners are regular, major contributors to the New Brunswick sardine population and more likely that the Georges Bank spawners are, for the low mean vertebral numbers of most of the New Brunswick sardine year-classes, are similar to values given by Anthony & Boyar (1968) for Georges Bank herring. The evidence is by no means conclusive but does suggest that possible mechanisms whereby Georges Bank progeny could enter and remain in the western side of the Bay of Fundy (and as distinct from the eastern side) should be investigated.

In earlier discussion on the origin of "sardine" herring in the Bay of Fundy, emphasis has been laid on the question of the larval dispersal that "non-tidal" drift would tend to generate. A counter-clockwise current system in the Bay of Fundy whereby water, entering along the eastern (Nova Scotia side, passes across the Bay at about half-way in and leaves the Bay along the western (New Brunswick) side, is well

documented although seasonal and year-to-year variation may be considerable, as may be the extent to which the circulation is "closed" (Bumpus & Lauzier, 1965). Perhaps more consideration can now be given to the possibility that the sardine concentrations in New Brunswick waters result from active upstream movement of larger post-larval herring from the southwest. If herring at this stage of the life-history are both negatively rheotactic and "shore-seeking" then their accumulation along the western shore as far as Saint John, the "cross-over" point, and which represents also the inner limit of the New Brunswick sardine fishery, might then be explained. More detailed information on the distribution and movements of the one-year-old herring, the "brit" stage would be desirable.

References

- Anthony, Vaughn C., and H. C. Boyar. 1968. Comparison of meristic characters of adult Atlantic herring from the Gulf of Maine and adjacent waters. ICNAF Res. Bull. 5: 91-98.
- Bumpus, D.F., and L.M. Lauzier. 1965. Surface circulation on the continental shelf -- off eastern North America between Newfoundland and Florida. Ser. Atlas Mar. Environment, Folio 7 - AMER. GEO.
- Tibbo, S.W. 1968. On the origin of herring stocks in the Bay of Fundy - A review. ICES Res. Doc. No. C.M. 1968/31.

Month	Number of Vertebrae						Total	Mean
	53	54	55	56	57	58		
January	-	12	178	114	7	-	311	55.373
February	1	33	332	247	12	-	625	55.378
March	-	21	201	110	7	-	339	55.304
April	2	29	316	209	11	2	569	55.359
May	-	34	375	244	11	1	665	55.353
June	-	13	156	96	8	-	273	55.363
July	-	31	304	203	7	-	545	55.341
August	1	34	253	140	5	1	434	55.270
September	-	29	410	284	17	-	740	55.391
October	-	21	197	143	10	1	372	55.390
November	-	4	18	21	1	0	44	55.432
TOTAL	4	261	2740	1811	96	5	4917	55.356

Table 1a. Monthly distribution of vertebral numbers for the New Brunswick 1967 herring year-class.

Month	Number of Vertebrae						Total	Mean
	53	54	55	56	57	58		
March	-	6	70	69	1	-	146	55.445
April	-	6	74	65	6	-	151	55.470
May	-	10	79	95	11	-	195	55.549
June	2	3	47	45	2	1	100	55.450
TOTAL	2	25	270	274	20	1	592	55.486

Table 1b. Monthly distribution of vertebral numbers for the Nova Scotia 1967 herring year-class.