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Variation of Some Meristic Characters in Alewives, *Alosa pseudoharengus*, from Three Rivers in the Southern Gulf of St. Lawrence

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ABSTRACT

Alexander, D.R. and M.M.Niles. 1989. Variation of some meristic characters in alewives, *Alosa pseudoharengus*, from three rivers in the Southern Gulf of St. Lawrence. Can. Tech. Rep. Fish. Aquat. Sci. No.1688. iv + 6p.

Meristic characters were compared from alewives, *Alosa pseudoharengus* (Wilson), from the Miramichi River, New Brunswick, and from the South River and the Margaree River, Nova Scotia. Characters examined from 100 specimens from each of the three rivers included : dorsal, pectoral and anal fin ray counts and vertebral counts. Comparison within rivers showed no significant difference between sexes for any location or for any character. Differences between age classes were significant for anal fin rays at the South River. Comparison between rivers showed that meristic counts were generally lower for alewives from the Miramichi River than for the other two rivers. However, only dorsal fin ray counts were significantly different between all three locations. Pectoral fin ray counts were significantly higher for the Margaree than for the other two rivers. In addition, anal fin ray counts were significantly lower for the Miramichi River. Results suggest that the Miramichi and the Margaree stocks are distinct from one another. However, the South River stock seems to overlap with the two other stocks.

RÉSUMÉ

Alexander, D.R. and M.M.Niles. 1989. Variation of some meristic characters in alewives, *Alosa pseudoharengus*, from three rivers in the Southern Gulf of St. Lawrence. Can. Tech. Rep. Fish. Aquat. Sci. No.1688. iv+ 6p.

On a comparé les caractères méristiques des gaspareaux *Alosa pseudoharengus* (Wilson), provenant de la rivière Miramichi au Nouveau-Brunswick ainsi que des rivières South River et Margaree en Nouvelle-Écosse. Parmi les caractères examinés chez 100 specimens de chacune des trois rivières, notons les dénombrements des rayons de nageoires dorsales, pectorales et anales ainsi que les dénombrements des vertèbres. Les comparaisons effectuées à l'intérieur d'une même rivière n'ont révélé aucune différence significative entre les sexes, et ce quel que soit l'endroit, quelle que soit le caractère. Les différences entre les classes d'âge se sont avérées significatives que pour les rayons de nageoires anales dans la rivière South River. Les comparaisons entre les rivières ont démontré que les dénombrements des caractères méristiques étaient, règle générale, inférieure pour les gaspareaux de la rivière Miramichi par rapport aux gaspareaux des deux autres rivières. Toutefois, seuls les dénombrements relatifs aux rayons de nageoires dorsales différaient considérablement dans les trois rivières. Les dénombrements de rayons de nageoires pectorales étaient significativement plus élevés dans la rivière Margaree par rapport aux deux autres rivières. De plus, les dénombrements de rayons de nageoires anales étaient beascoup moins élevés dans la rivière Miramichi. Les résultats semblent indiquer que les stocks de la rivière Miramichi et de la rivière Margaree sont distincts l'un de l'autre tandis qu'il y aurait un certain mélange de stocks entre la South River et les deux autres rivières.

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INTRODUCTION

The natural range of the alewife (*Alosa pseudoharengus*, Wilson) covers the Atlantic coast of North America from Newfoundland to North Carolina (Berry, 1964; Scott and Scott, 1988). The species is anadromous, entering fresh water between March and July (Treinen, 1966). Spawning occurs in lakes, ponds, or slow moving rivers at temperatures between 12 and 16°C (Bigelow and Schroeder, 1953). Landlocked populations have established themselves in the Great Lakes (Miller,1956) and in other waters (Gross, 1953) where the life cycle is completed entirely in fresh water.

By introducing gravid adults into unpopulated ponds, Bigelow and Schroeder (1953), demonstrated that alewife spawning migrations could be established in three to four years. This is consistent with studies on alewives in the Gulf Region which indicate that virgin spawners are typically three or four years of age (Alexander and Vromans, 1988a, 1988b). An experimental transfer of 81 female and 69 male adult alewives and blueback herring (*Alosa aestivalis*) to an unpopulated lake on the South River, Nova Scotia in 1986 (unpublished) showed that juvenile production was at least 600,000 and could lead to the establishment of an anadromous population if fish home to natal waters. This homing hypothesis is supported by Thunberg (1971) who showed that alewives removed from their spawning grounds selected water from the same source when offered a choice including water from a neighbouring source. Confirmation of this homing tendency and additional information on the degree to which alewives home may be important to fisheries management.

Due to their low economic value, alewives have not been studied extensively. However, commercial fisheries on the Miramichi and the Margaree rivers are significant to the local economy. These fish are harvested during the annual spawning migration and efforts have been made to model those populations using sequential population analysis (Alexander and Vromans, 1988a, 1988b). That model is valid only if there is a high degree of homing.

Some experimental studies have shown a relationship between meristic character counts and environmental factors prevailing during the early development of certain fish (Hubbs, 1925; Parsons and Hodder, 1971). Meristic characters of alewives display this adaptive plasticity (Leim and Scott, 1966). In an early study on shad (*Alosa sapidissima*), Vladykov and Wallace (1938) concluded that variations in meristic counts suggested distinct stocks in different rivers. Carscadden and Leggett (1975) also studied shad and found that in 71% of the comparisons, significant differences occurred between populations of different rivers and also between populations of different tributaries on the Saint John River. Meristic studies on herring (*Clupea harengus harengus*) further support the homing of clupeids (Parsons, 1975; Messieh and Tibbo, 1971). For the alewife, the study by Messieh (1977) supports the homing theory in general but suggests a high degree of intermingling between tributaries compared to that reported for shad or for Atlantic salmon (*Salmo salar*) (Kerswill, 1971).

Further study of meristic characters of alewives is warranted. This study compares fish sampled from the Miramichi River in New Brunswick and from the Margaree River and South River in Nova Scotia (Fig. 1).

MATERIALS AND METHODS

Alewife specimens were obtained from samples collected by the Department of Fisheries and Oceans (DFO) Science Branch for stock assessment during 1985.

On the Miramichi River, specimens were collected from a DFO index trap operated at Millbank. Samples were collected between May 30 and July 11. On the Margaree River , specimens were obtained from a commercial tip trap near Margaree Forks. Samples were collected between May 14 and June 7. Specimens from the South River, Antigonish, were collected from a DFO fish counting fence (Chadwick et al., 1985). Samples were collected between May 27 and June 27.

One hundred specimens were sampled from each site, choosing only fish of ages 3 and 4.These were the most prevalent age classes. Fish ages were determined by reading scales according to the method described by Cating (1953) and Rothschild (1963). Initially, an effort was made to obtain 50 specimens for each age class by ageing immediately, but subsequent ageing required reclassification, resulting in an unequal number of fish in each group. Sex of fish was also recorded as determined by dissection, according to the method described by Nikolsky (1963).

After selection of samples, four meristic characters were examined: dorsal, left pectoral, and anal fin rays and vertebrae. These are the most geographically variable meristic characters (Messieh, 1977; MacCrimmon and Claytor, 1985). Meristic characters were counted by examining radiographs of the fish and fish parts . Vertebral counts excluded the hypural and basioccipital bones. Fin ray counts included all detectable rays from the base, thus including rudimentary rays.

STATISTICAL METHOD

1. Variation between sexes and between age classes

Within each area, meristic counts of fish were compared between age classes and between sexes. The F-statistic

was used to evaluate homogeneity of variances of these sub-groups. When sex or age class sub-groups presented homogeneous variances, the Student t-test was employed for comparison. When heteroscedasticity occurred, the sub-groups were compared using the Mann-Whitney non-parametric test. When no difference was shown between sexes or age classes, values were combined for further analysis.

2. Variation between locations

Comparisons of meristic counts between the three locations was conducted by single classification analysis of variance (ANOVA) modified for unequal sample sizes. The ANOVA test was applied only when the samples met homoscedastic criteria (F-max test). Samples not showing homogeneous variances were compared with the Kruskal-Wallis non-parametric test. When a significant difference was indicated by the ANOVA, Duncan's New Multiple Range test (Steel and Torrie, 1960) modified for unequal sample sizes (Kramer, 1956) was applied to determine where the differences arose.

RESULTS

1. Variation between sexes and between age classes

No significant differences ($P<0.05$) in meristic counts existed between sexes. Therefore, male and female data were combined for further analysis.

No significant differences ($P<0.05$) in meristic counts existed between age classes within an area with one exception. The exception was on South River where the number of anal fin rays was significantly greater at age 3 than at age 4. For this character, the two age classes were kept separate for all locations in subsequent comparisons. However, data from the two age classes were combined for the other characters in subsequent analysis.

2. Variation between locations

Dorsal, pectoral and anal fin ray counts from the three areas showed homogeneous variances. In contrast, vertebral counts showed heteroscedasticity between areas.

Analysis of variance for the homoscedastic characters showed significant differences ($P<0.05$) in dorsal fin rays, pectoral fin rays and anal fin rays. However the non-parametric Kruskal-Wallis test revealed no significant differences for vertebral counts (Table 1).

2.1 Dorsal fin rays

Duncan's New Multiple Range test indicates that alewives from the South River, the Margaree River and the Miramichi River are significantly different from each other ($P<0.05$) for dorsal fin ray counts(Table 2).

2.2 Pectoral fin rays

Duncan's New Multiple Range test reveals that the Margaree sample differs significantly in mean pectoral fin ray counts from the South River and Miramichi samples. Mean counts for the South River and the Miramichi River were not significantly different (Table 2).

2.3 Anal fin rays

Duncan's New Multiple Range test indicates that the mean anal fin ray counts of the Miramichi alewives differs significantly from those of alewives from the other two locations. However the South River and the Margaree River mean counts were not significantly different from each other. Both age sub-groups exhibit the same between-area differences (Table 2).

DISCUSSION

There were no within-area differences in meristic counts between male and female alewives. Nevertheless, within-area differences existed between age classes of the South River fish with respect to anal fin ray counts. These results are consistent with other meristic studies conducted for various other rivers (McHugh, 1954; Anthony and Boyar, 1968; Parsons, 1973). Despite the differences between age 3 and age 4 alewives found for anal fin ray counts in South River, each age class independently showed the same between-area differences. According to Carscadden and Leggett (1975), meristic count variations between age classes could be the result of annual environmental variations within a river. Other factors could also account for these variations.

The mean meristic counts of alewives from the Miramichi River are lower than those from the South River and the Margaree River for all four meristic characters compared. These differences are possibly the result of persistent annual differences in environmental conditions which may exist between rivers. For dorsal fin ray counts, multivariate comparisons indicated the existence of separate stocks in each of the three locations. Analysis of pectoral, and anal fin ray counts revealed significant differences between the Miramichi River samples and the Margaree River samples. However, the South River sample is not significantly different from either the Miramichi sample or the Margaree sample, for these fin ray counts. Vertebral counts did not differ significantly between the three locations. This is in contrast to the results of some meristic studies (McHugh, 1954; Messieh, 1977; Meng and Stocker, 1984) which found significant differences in vertebral counts between different locations.

Mais (1972) and Messieh (1977) suggested that the percent overlap between means of meristic counts is an estimate of the degree of intermingling between stocks. Messieh concluded that percent overlap between stocks of alewives

is higher than that reported for other anadromous fish, thus indicating a high degree of intermingling. The overlap of mean pectoral fin ray counts for alewives from the South River and the Miramichi River may indicate mixing of these two stocks. Similarly, the overlap of mean anal fin ray counts for alewives from the South River and the Margaree River may suggest the intermingling between those stocks. An alternate explanation however, is that the environmental conditions on the South River may be intermediate between those for the Miramichi and the Margaree. However, no environmental comparisons were made to evaluate this in the present study. Little or no ioverlap is indicated between the Miramichi and the Margaree stocks.

Generally, these results support the homing hypothesis for the alewife but suggest that some straying may also occur. A more thorough study of meristic characters possibly combined with morphometric and electrophoretic studies might lead to the development of discriminant functions leading to true stock separation. For the interim however, there is no reason to conclude that stocks stray on a regular basis and that sequential population analysis is not appropriate for stock assessment purposes.

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REFERENCES

Alexander, D.R. and A.H. Vromans. 1988a. Status of the Margaree River alewife (*Alosa pseudoharengus*) fishery 1987. CAFSAC Research Document 88/25. 25 pp.

Alexander, D.R. and A.H. Vromans. 1988b. Status of the Miramichi River fishery (1987) for alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*). CAFSAC Research Document 88/27. 30 pp.

Anthony, V.C. and H.C. Boyar. 1968. Comparison of meristic characters of adult Atlantic herring from the Gulf of Maine and adjacent waters. Int. Comm. Northwest Atl. Fish. Res. Bull. 5:91-98.

Berry, F.H. 1964. Review and emendation of: Family Clupeidae. Copeia, 4:720-730.

Bigelow, H.B. and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish. Wild. Serv., Fish. Bull. 53:1-557.

Carscadden, J.E. and W.C. Leggett. 1975. Meristic differences in spawning populations of American shad, *Alosa sapidissima*: evidence for homing to tributaries in the St. John River, New Brunswick. J. Fish. Res. Board Can. 32:653-660.

Cating, J.P. 1953. Determining age of Atlantic shad from their scales. U.S. Fish and Wild. Serv., Fish. Bull. 54:187-199.

Chadwick, E.M.P., D.R. Alexander, R.W. Gray, T.G. Lutzac, J.L. Peppar and R.G. Randall. 1985. 1983 Research on anadromous fishes, Gulf Region. Can. Tech. Rep. Fish. Aquat. Sci. No.1420: xi + 69p.

Gross, R.W. 1953. Some observations of the landlocked alewife, *Pomolobus pseudoharengus* (Wilson), in New Jersey. New Jersey Fisheries Survey Report, 2:157-164.

Hubbs, G.L. 1925. Racial and seasonal variation in the Pacific herring. Calif. Fish. Game, 8:1-23.

Kerswill, C.J. 1971. Relative rates of utilization by commercial and sport fisheries of Atlantic Salmon (*Salmo salar)* from the Miramichi River, New Brunswick. J. Fish. Res. Board Can. 28:351-363.

Kramer, C.Y. 1956. Extension of multiple range tests to group means with unequal numbers of replication. Biometrics, 12:307-310.

Leim, A.H. and W.B. Scott. 1966. Fishes of the Atlantic Coast of Canada. Fish. Res. Board Can. Bull. 155,485 p.

MacCrimmon, H.R. and R.R. Claytor. 1985. Meristic and morphometric identity of Baltic stocks of Atlantic salmon (*Salmo salar*). Can. J. Zoo. 63:2032-2037.

McHugh, J.L. 1954. Geographic variation in the Pacific herring. Copeia, 2:139-151.

Mais, K.F. 1972. A subpopulation study of the Pacific sardine. Calif. Fish. Game, 58:296-314.

Meng, H.J. and M. Stocker. 1984. An evaluation of morphometrics and meristics for stock separation of Pacific herring (*Clupea harengus pallasi*). Can. J. Fish. Aquat. Sci. 41:414-422.

Messieh, S.N. 1977. Population structure and biology of alewives (*Alosa pseudoharengus*) and blueback herring (*A. aestivalis*) in the Saint John River, New Brunswick. Env. Biol. Fish. 2:195-210.

Messieh, S.N. and S.N. Tibbo. 1971. Discreteness of Atlantic herring (*Clupea harengus harengus*) populations in spring and autumn fisheries in the southern Gulf of St. Lawrence. J. Fish. Res. Board Can. 28:1009-1014.

Miller, R.R. 1956. Origin and dispersal of the alewife, *Alosa pseudoharengus*, and the gizzard shad, *Dorosoma cepedianum*, in the Great Lakes. Trans. Am. Fish. Soc. 86:97-111.

Nikolsky, G.V. 1963. The ecology of fishes. Academic Press, New York, 352 pp.

Parsons. L.S. 1973. Meristic characteristics of Atlantic herring, *Clupea harengus harengus* L., stocks in Newfoundland and adjacent waters. Res. Bull. Int. Comm. Northw. Atlant. Fish. 10:37-52.

Parsons, L.S. 1975. Morphometric variation in Atlantic herring from Newfoundland and adjacent waters. Int. Comm. Northwest Atl. Fish. Res. Bull. 11:73-92.

Parsons, L. S. and V.M. Hodder. 1971. Meristic differences between spring and autumn-spawning Atlantic herring (*Clupea harengus harengus* Linnaeus) from southwestern Newfoundland. J.Fish. Res. Board Can. 28:553-558.

Rothschild, B.J. 1963. A critique of the scale method for determining the age of alewife, *Alosa pseudoharengus* (Wilson). Trans. Am. Fish. Soc. 92:402-413.

Scott, W.B. and M.G. Scott. 1988. Atlantic fishes of Canada. Can. Bull. Fish. Aquat. Sci. 219:731 p.

Steel, R.G.D. and J.H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill, Inc., New York. 481 p.

Thunberg, B.E. 1971. Olfaction in parent stream selection by the alewife (*Alosa pseudoharengus*). Anim. Behav. 19:217-225.

Treinen, C.W. 1966. Life history, ecology, and management of the alewife (*Pomolobus pseudoharengus*) Wilson. Fish. Res. Board Can. 23:1-8.

Vladykov, V.D. and D.H. Wallace. 1938. Remarks on populations of the shad (*Alosa sapidissima*) along the Atlantic coast region. Trans. Amer. Fish. Soc. 67:52-66.

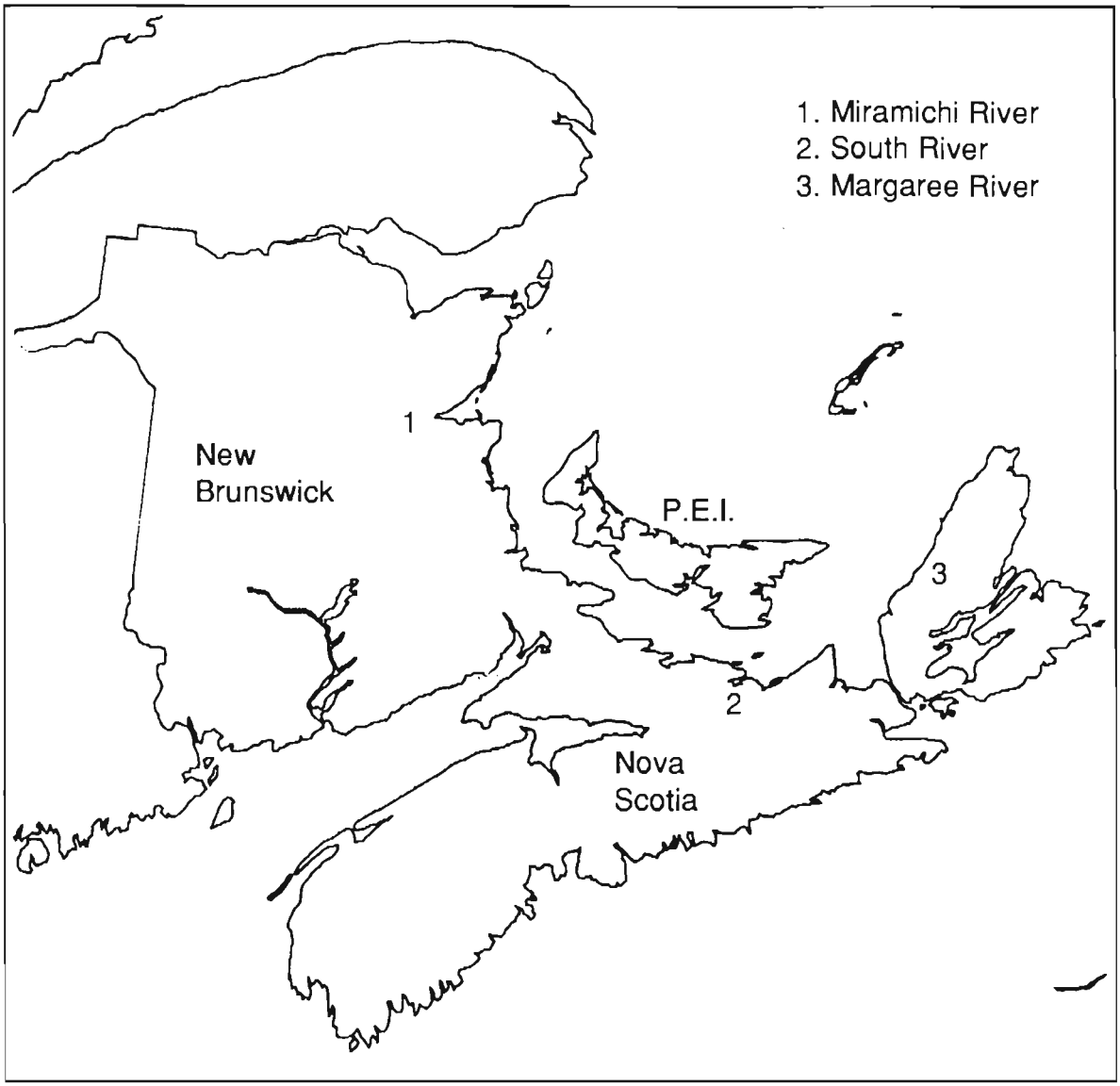

Figure 1. Location of sample collections for comparison of meristic characters of alewives (*Alosa pseudoharengus*) from three rivers in the Gulf Region.

Table 1. Anova results on meristic counts of alewives (*Alosa pseudoharengus*) from three rivers in the Southern Gulf of St. Lawrence.

Meristic character	South River $\bar{X} \pm s$	n	Miramichi River $\bar{X} \pm s$	n	Margaree River $\bar{X} \pm s$	n
Vertebrae (a)	48.79 ± 0.7	195	48.78 ± 1.09	110	49.00 ± 0.67	104
Dorsal fin ray*	17.68 ± 0.69	95	17.19 ± 0.89	106	17.46 ± 0.76	99
Pectoral fin ray*	15.50 ± 0.77	95	15.36 ± 0.91	106	15.90 ± 0.84	98
Anal fin ray(3)*	20.32 ± 1.06	47	19.14 ± 1.02	42	20.04 ± 0.94	27
Anal fin ray(4)*	19.87 ± 0.81	38	19.37 ± 0.96	60	19.77 ± 1.06	71

(a) Kruskal-Wallis statistic = 3.067

X=arithmetic mean; s=standard deviation; n=number of individuals; *= significantly different at the 5%level; 3 = 3 year old; 4 = 4 year old.

Table 2. Duncan's New Multiple Range test results applied to mean meristic counts of alewives (*Alosa pseudoharengus*) from three rivers in the Southern Gulf of St. Lawrence. Means having different letters are significantly different from each other at the 5% level.

Meristic character	Mean		Meristic characters	Mean	
Dorsal fin ray			**Anal fin ray (age 3)**		
Miramichi River	17.20	A	Miramichi River	19.14	A
Margaree River	17.46	B	Margaree River	20.04	B
South River	17.68	C	South River	20.32	B
Pectoral fin ray			**Anal fin ray (age 4)**		
Miramichi River	15.36	A	Miramichi River	19.37	A
South River	15.51	A	Margaree River	19.77	B
Margaree River	15.87	B	South River	19.87	B