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Aging Round Whitefish (*Prosopium cylindraceum*) of the Leaf River, Ungava, Quebec, by Otoliths

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Ages assigned to 503 round whitefish (*Prosopium cylindraceum* (Pallas)) from the Leaf River on the basis of otoliths differed notably from those assigned on the basis of scales only for fish above age 8. The hyaline zones in otoliths corresponded to the scale annuli, and the growth increments in otoliths at various dates as percentages of the totals during the collection period were similar to those for scales. Otolith radius increased linearly with fork length, as did otolith weight with fish age.

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L'âge otolithaire de 503 ménomini ronds (*Prosopium cylindraceum* (Pallas)) provenant de la rivière aux Feuilles ne diffère notablement de l'âge scalaire que chez les poissons âgés de plus de 8 ans. Les zones hyalines de l'otolithe correspondent aux annuli de l'écaille. L'augmentation de taille des otolithes à diverses dates, exprimée en pourcentage de la croissance totale durant toute la période d'échantillonnage, est la même que celle des écailles. Le rayon de l'otolithe augmente linéairement par rapport à la longueur à la fourche. Il en est de même du poids de l'otolithe par rapport à l'âge du poisson.

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THIS report compares ages read from scales and otoliths of round whitefish, *Prosopium cylindraceum* (Pallas), from the Leaf River, Ungava, and presents indirect evidence for the validity of using otoliths to age this species. Scales are an accepted method of aging round whitefish (Bailey 1963; Mraz 1964; MacKay and Power 1968; Normandeau 1969). To my knowledge, no information is available in the literature on the use of otoliths to age any coregonid species. However, otolith–scale comparisons have been made for several salmonids (Nordeng 1961; Grande 1964; Bilton and Jenkinson 1968).

Both scales and otoliths were collected from 508 round whitefish from the Leaf River between June 28 and September 8, 1968. Most fish were caught in 0.5–2.5- inch stretch mesh monofilament gillnets, and the remainder by beach seine. Fork lengths ranged from 110 to 365 mm.

Scale interpretation — From 5 to 10 scales were removed from the left side of each fish, immediately posterior to the termination of the dorsal fin and 2–3 rows above the lateral line. They were mounted on plastic slides (Power 1964) and later examined, without further preparation, at magnifications to 80×. All scale samples were independently read twice by the author (with an agreement of 91.6%), then a third reading was made of only those samples in which ages disagreed, and a final age was assigned on the basis of majority agreement. Each sample of scales contained at least one scale suitable for aging, and no samples were rejected as being completely unreadable. The Petersen method (Graham 1929) of constructing a length-frequency histogram was used to assist in recognition of the annuli of fish to age 3, as the number of histogram peaks corresponded to the number of scale and otolith annuli. The large scale size and distinct separation of annuli (Fig. 1) permitted easy aging of fish up to age 9, but in older fish more difficulty was experienced because of crowding of the outer annuli.

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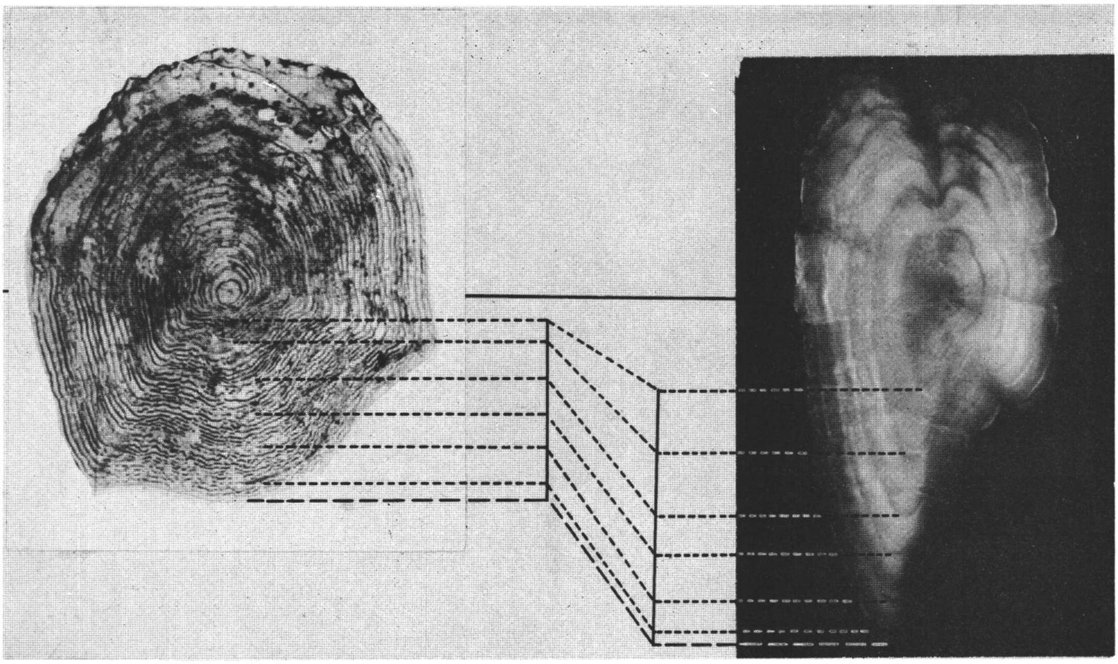

FIG. 1. Annuli of a scale and an otolith from a mature female round whitefish, 260 mm long, age 6+, from the Leaf River. There are equal numbers of zones in scale and otolith, and corresponding variations in summer zone width.

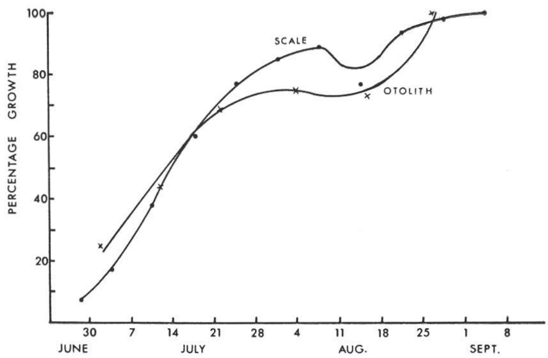

FIG. 2. Mean growth increments as percentages of the total growth between June 28 and September 6 of 45 scale and 37 otolith samples from round whitefish, age 6+, from the Leaf River.

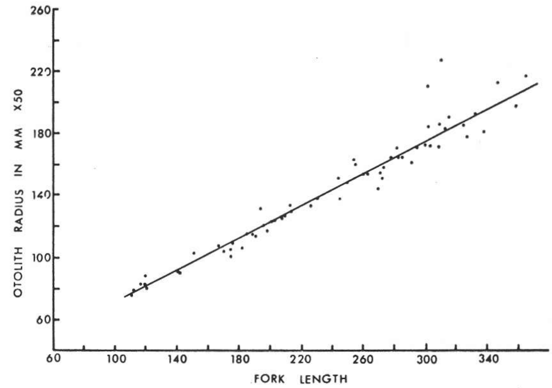

FIG. 3. Relation between otolith radius (*focus–rostrum*) and fork length (*mm*) of 62 round whitefish from the Leaf River. The line was fitted by eye.

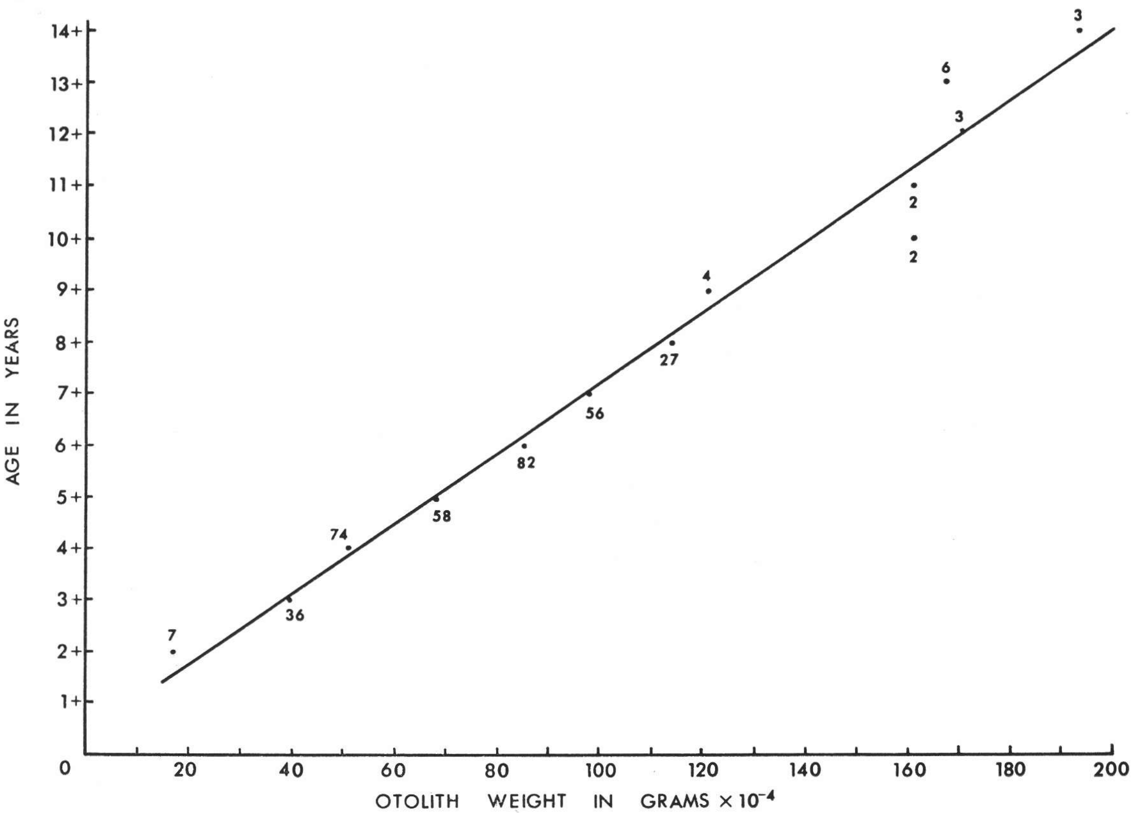

FIG. 4. Relation between mean otolith weight and age of 360 round whitefish from the Leaf River. The sample size accompanies each plotted value. The line was fitted by eye.

Otolith interpretation — For 150 of the fish, cleaned otolith pairs were preserved in glass vials containing a 50% solution of glycerol and water. The method was abandoned as unnecessary and all other otoliths were stored dry. All dry otoliths were weighed to the nearest 10^{-4} g before further use. Following Nordeng (1961), 67 pairs of otoliths were cast in methyl methacrylate to permit easy handling while grinding to expose the otolith zone structure. Before viewing under a stereomicroscope, the ground surface was cleared with creosote. This method was time-consuming and unnecessary. The remaining uncast otoliths were easily read after being soaked in the water-glycerol solution for 24 hr, placed on a matte black background covered with creosote, and illuminated from above with a high intensity lamp. The numbers of otoliths read by the two methods were:

	Uncast	Cast	Total
Readable	439	64	503
Unreadable	2	3	5
Total	441	67	508

The alternating opaque and hyaline zones in otoliths were most easily read on a line from the nucleus to the tip of the rostrum (Fig. 1). The hyaline zone was taken to represent material deposited during the period of slow winter growth, and to be comparable to the annuli on the scales. Age determinations from otoliths were made independently of those from scales. Otoliths were read only once.

Otoliths were readily interpreted because of their relatively large size (1.5–7.0 mm) and distinct zonation (Fig. 1). Narrow, less distinct accessory zones occurred occasionally between major hyaline zones, but created little difficulty in interpretation. The increased blurring of divisions between the outer zones, and the crowding of zones, made it difficult to age older fish. The first one or two hyaline zones also were difficult to distinguish on occasion because of the thickening of the otolith body with age. A small number of otoliths displayed a distinct, narrow hyaline zone between the focus and the first pronounced hyaline zone (Fig. 1). Nordeng (1961) suggested that in Arctic char otoliths, such a zone is formed on transition to free feeding after the absorption of the larval yolk sac. This may be true for the round whitefish.

Otolith usefulness — Estimates of age using scales and otoliths showed a 96.8% agreement (Table 1). Beyond age 8, the percentage of disagreements increased markedly, with the otolith readings generally higher than the scale readings. The difference usually was one year, but occasionally two.

Measurements of scales and otoliths were made at a magnification of 50 ×, and those for samples of age-6 fish were used to estimate mean growth increments as percentages of the total growth of scales and otoliths during the collection period. The collection period (June 28–September 8) represented the major part of the growing season (Jessop MS 1968).

TABLE 1. Percentages of agreement in ages of 503 round whitefish as determined from scales and otoliths.

Age	Total read	Percent agreement
2	8	100.0
3	53	94.3
4	94	98.9
5	74	100.0
6	144	98.6
7	77	98.7
8	29	93.1
9	5	80.0
10	3	100.0
11	5	60.0
12	4	50.0
13	4	100.0
14	3	33.3
Total	503	96.8

The initiation of growth and rate of growth in scales and otoliths were similar. The proportionate seasonal growth increments (Fig. 2) indicate that these otoliths can be used, as the scales are (Bailey 1963), for studying growth rates. By early July, all fish of age-5 or less showed some summer growth on both scales and otoliths, while a small percentage of fish of age-group 6 and older showed no discernible growth in either. As for the age-6 fish, a decrease in the growth rate in early August was evident in similar graphs constructed for four other age-groups.

A linear relation was found between otolith radius and fork length, (Fig. 3) and between mean dry weight of otoliths and fish age (Fig. 4) in representative samples of 62 and 360 fish, respectively.

Any difficulty in obtaining and utilizing otoliths, as opposed to scales, for aging might be offset by the considerations that malformed or unreadable otoliths are few, and that otoliths might offer a more complete record of the early growth of the fish than do scales. Koo (1962) has noted that otoliths of some salmonids are already formed when fry leave the gravel. Presumably this is true of Leaf River round whitefish, while the scales in the area of scale sampling are formed at a fry length of 45–50 mm (Jessop MS 1968). The otolith may be of value in the calculation of growth histories for this species.

Discussion — The close agreement between scale and otolith age determinations indicates that otoliths provide a valid alternative to scales for aging round whitefish from the Leaf River, and are possibly more accurate for aging older fish. That ages on the basis of scales and otoliths differed notably only in the older age-groups has been observed in several species (Kohler and Clark 1958; Nordeng 1961; Messieh and Tibbo 1970).

The large size of the scales and otoliths, and the slow growth rate of this species in the subarctic (MacKay and Power 1968), undoubtedly contributed to the ease of reading these structures. Nordeng (1961) found a relation between the clarity of the hyaline zone and growth rate in the Arctic char, so that the slower the growth the more distinct the zones. Crowding of the outer annuli was less severe in otoliths than in scales, although Messieh and Tibbo (1970) noted the opposite in herring scales and otoliths.

The opaque zone was formed during the period of maximum otolith growth, a finding reported by Nordeng (1961) and Koo (1962) for several salmonids. A plot of age versus otolith weight produced a linear relation similar to that obtained by Trout (1954) for Barents Sea cod. The evidence presented indicates that there is a relation between otolith ring growth and body growth, and that one opaque and one hyaline zone are added yearly to the otolith of round whitefish from the Leaf River. Trout (1954), Irie (1960), and others have observed such relations in several fish species.

The decreased growth rate of fish in August (Fig. 2) may have been related to a sudden decrease in water temperature that occurred between the 1st and 3rd weeks of the month. The limited sample sizes taken on the dates involved might also be a factor.

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