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AGE ASSESSMENT OF WHITE BASS FROM OTOLITHS, DORSAL SPINES, AND SCALES

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ABSTRACT

Otoliths, dorsal spines, and scales of 85 white bass collected in 1987 from a pre-spawning group were used for age assessment. Agreement between spine and otolith ages were 78.3%, between scale and otolith ages was 68.2%. Unlike spine ages, percent agreement of scale ages with otolith ages decreased from small to large fish.

Length-frequency analysis in conjunction with ages assessed by the three calcified structures showed that dorsal spines and scales underestimated white bass ages compared to the otoliths. Clarity of the otolith annuli, even of the older fish, makes them a reliable source for white bass age assessment.

INTRODUCTION

Age data are useful in fish growth and longevity studies and in making management decisions. In the past 50 years, fish scales have been the main source for age determination of freshwater fishes, but this method might not reveal the true age of slow-growing or older fishes (Carlander, 1987; Erickson, 1983). Indistinctness or compactness of annuli at the outer edges of scales makes them unreadable. Resorption of scales to provide calcium to fish during periods of deficiency and ovarian development adds to the difficulty of scale age assessment (Garrod and Newell, 1958; Simkiss, 1974). Age estimates using otoliths and bones, which have a higher priority for calcium utilization and have easily recognizable annuli, have been found more reliable than the scales, even in older fish (Simkiss, 1974; Beamish, 1979; Erickson, 1983; Sikstrom, 1983; Casselman, 1983). In contrast to the scales, otoliths continue to grow as the fish gets older (Beamish and McFarlane, 1987).

To our knowledge, scales are the only calcified structures to have been used in the age assessment of white bass *(Morone chrysops)* (Jenkins and Elkin, 1957; Forney and Taylor, 1963; Priegel, 1971; Yellayi and Kilambi, 1975), but as early as 1941, Frey and Vike (1941) reported the failure of annulus formation on white bass scales. The efficacy of various calcified structures in aging white bass was not determined. Therefore, the purpose of our study was to evaluate the feasibility of reliable age determination of white bass using calcified structures other than scales.

MATERIALS AND METHODS

A total of 85 white bass was collected in March 1987 from the 11,400 ha Beaver Reservoir, Arkansas, by electroshocking and gillnetting. Total length (mm), weight (g), and sex were recorded for each fish. Scale samples obtained from an area near the tip of the appressed left pectoral fin just below the lateral line were cleaned, mounted between two glass slides and photographed by microfiche reader-printer. The annuli were counted from the photographs.

The second dorsal spine removed from the base and the excised otoliths (sagittae) were stored in alcohol and a 1:1 mixture of alcohol and glycerine, respectively. They were sectioned after epoxy embedding using a low speed circular saw. Two spine sections were discarded due to bad sectioning. The spine and otolith sections mounted on glass slides in Permount were examined for annuli under a Ken-a-Vision microprojector and photographed under a phase contract microscope. An annulus was assumed at the outer margins of the three calcified structures used in this study, even when it was not recognizable, as the white bass were collected from a pre-spawning population. Sexes were pooled for age analysis. Initially, the age determinations were made independently by the authors. The calcified structures were reexamined by both of us in cases of disagreement, to assign final ages.

RESULTS AND DISCUSSION

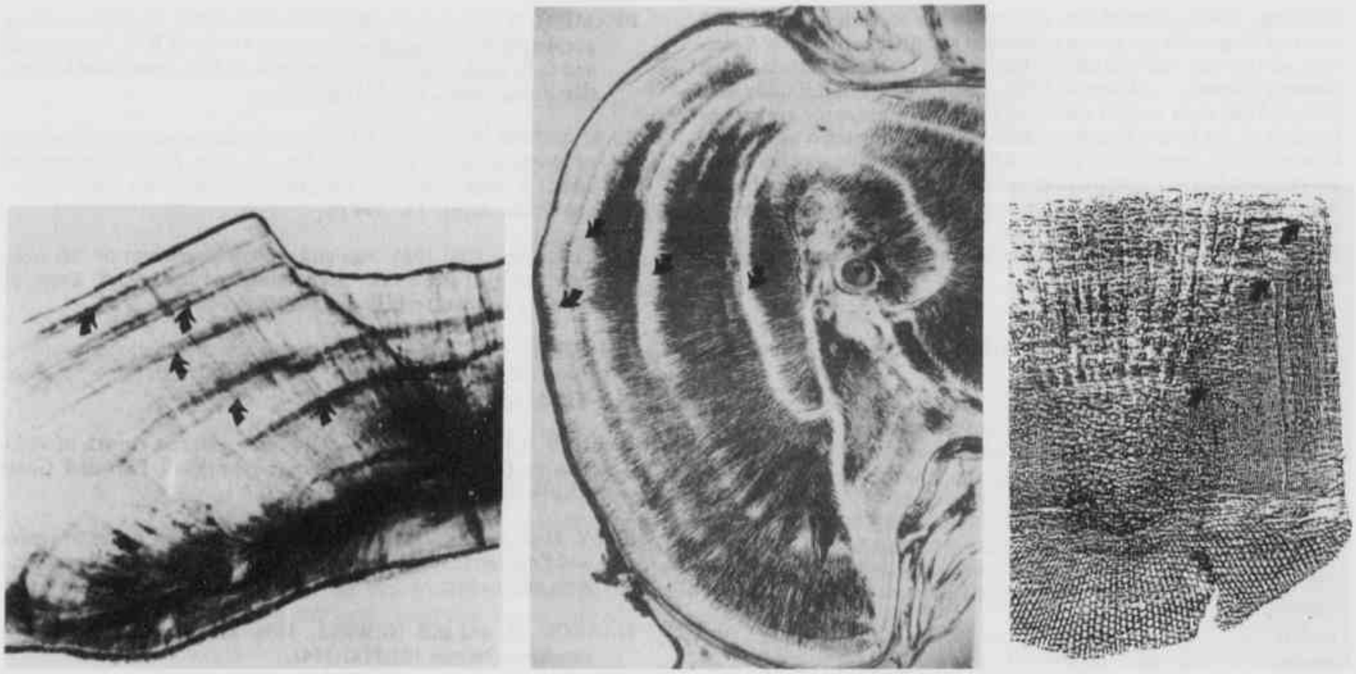
The otolith annuli, even of the older white bass, were distinct and easy to enumerate (Fig. 1). Hence, otolith ages were used as the basis for comparison with spine and scale ages (Table 1). The otoliths and spines yielded six age groups, while five age groups were discernible from the scales.

Agreement between the spine and otolith ages was 78.3%. Excluding the age group VI because of small sample size, spine ages did not exhibit any trend in percent agreement with increased otolith ages (Table 1). For the age group II, the age overestimation by spines of some fish was by one year and for age groups III through VI, the spine ages were less than the otolith ages by one year for some of the white bass. The spine ages for the rest of the white bass were in agreement with the otolith ages. The underestimation of age by some dorsal spines was probably because of difficulty in locating the first annulus due to the vacularized core obliterating it (Prince *et al.*, 1986).

Agreement between scale and otolith ages was 68.2%. In comparison with otolith ages, percent agreement of scale ages decreased and age underestimation increased with increased otolith ages (Table 1). Some scale ages were one year less than the otolith ages for age groups III, IV, and V. The ages of the two fish in age group VI were underestimated by one and two years by the scale method. Some scale ages were more than otolith ages for groups II, III and IV with no trend. The discrepancies in scale age estimates occurred for all the otolith ages and were probably due to failure of formation, indistinctness and presence of supernumerary scale annuli. Frey and Vike (1941) reported that the annuli failed to form on the scales of the Kegonosa and Waubesa white bass populations when the fish did not grow because of food scarcity. We found the annuli on some scales hard to discern and enumerate, unlike the annuli on the otoliths.

The numbers of spine and scale ages were regressed on otolith ages by the least square method (Steel and Torrie, 1980). Details of the statistics are given in Table 2. Although correlation coefficients (r) were significant, the regression coefficients (b) were significantly less than the unit slope ($b = 1$) and the Y-intercepts (a) were significantly different from zero. Therefore, we concluded that the spines and scales underestimated white bass ages in comparison with otolith ages. The variances about regression line (S^2_{yx}) indicated greater variability for scale ages than the spine ages compared to the otolith ages (Table 2). The otolith, spine, and scale annuli of the 404 mm white bass showed underestimation of age by the spine and scale methods (Fig. 1). The maximum scale age of four years recorded for the Beaver Reservoir white ass by Yellayi and Kilambi (1975) was probably an underestimate assuming the otolith ages represent the actual age.

The length distribution of the 85 white bass of this study was disjunct with 44 fish in the 215-270 mm, 35 fish in the 304-376 mm, and six fish in the 400-439 mm size groups, respectively (Table 3). Analysis of the length-frequency distribution by the probability paper method



A B C

Figure 1. Otolith and dorsal spine sections, and body scale of 404 mm white bass.
A. Otolith (40x)
B. Dorsal Spine (41x)
C. Body Scale (10x)

Table 1. Agreement and disagreement of spine and scale ages with otolith ages of white bass.

Otolith age	Number of fish	Percent Agreement	Underestimate	Overestimate
		Spine age		
II	28	89.3		10.7
III	22	72.7	27.3	
IV	26	73.1	26.9	
V	5	80.0	20.0	
VI	2	50.0	50.0	
		Scale age		
II	30	96.7		3.3
III	22	54.6	31.8	13.6
IV	26	61.5	34.6	3.9
V	5	20.0	80.0	
VI	2		100.0	

Table 2. Sample size (n), Correlation coefficient (r), regression coefficient (b), Y-intercept (a), standard errors of b and a (S.E.b and S.E.a), and variance about regression (S^2_{yx}) of least square regression analysis with t-tests for b = 1 and a = 0.

Statistics	Regression of Spine ages on otolith ages	Scale ages on otolith ages
n	83	85
r	0.91***	0.85***
b	0.86**	0.75**
S.E.b	0.0445	0.0514
a	0.31*	0.59***
S.E.a	0.1484	0.1701
S^2_{yx}	0.1776	0.2437

Significance level, p:*≤0.05; **≤0.005; ***≤0.001

(Harding, 1949) indicated two age groups for the fish in the 215-270 mm size range with age group separation at 240 mm. In Beaver Reservoir, all two-year-old and older white bass of both sexes attain sexual maturity (Newton and Kilambi, 1969). The white bass of this study were collected just prior to their spawning migrations, hence the age groups I and II of the length-frequency analysis were designated as two and three year olds, respectively. The otolith, spine, and scale annulus counts also showed this size group comprised of two- and three-year-old white bass (Table 3). Two year olds constituted 68.2% of this size group by the otolith method and 73.8% and 79.6% by the spine and scale methods, respectively, thus the latter two methods underestimated the age of white bass.

Table 3. Age group frequencies in relation to length of white bass.

	Number of fish in age groups													
Length group	Otolith					Spine					Scale			
(mm)	II	III	IV	V	VI	II	III	IV	V	VI	II	III	IV	V
215-224	3					3					3			
225-234	4					3					4			
235-244	10	2				9	3				12			
245-254	11	6				12	3				12	5		
255-264	1	5				3	3				2	4		
265-274	1	1				1	2				2			

The 340-376 mm group contained a single age group according to the probability technique. The annulus counts showed three and four year olds contributing 33.3% and 63.8%, respectively to the size group (Table 3). The relative composition of the four-year-old white bass by the otolith, spine, and scale ages was 74.3, 57.1, and 60.0%, respectively.

The spine and the scales underestimated white bass age, compared with the otolith age. The failure of the probability analysis in discerning more than a single age group was probably due to slow growth with length overlap of the constituent age groups.

The white bass in the 400-439 mm size was composed of five and six year olds by the otolith and spine aging; the scale analysis showed four and five year olds, thus underestimating the ages of the older fish (Table 3). The single age group designation by the probability technique was due to very small sample size.

Our study found variation in the otolith, spine, and scale assessed ages of white bass. The spines and scales underestimated the ages when compared with the otolith ages. It cannot be ascertained which of these three calcified structures depicted the true ages of white bass without validation through mark-recapture or by the study using known-age fish. However, otolith annuli were more distinct and easy to enumerate, even of the older fish, than the spine and scale annuli. We, therefore, assume that the otoliths provide a reliable source for aging white bass.

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