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SELECTION OF SCALES FOR GROWTH ANALYSIS OF LARGEMOUTH BASS

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ABSTRACT

Scales from four regions of the body of largemouth bass were compared for efficacy in estimating fish length at the time of scale formation and at capture. The scales from above and below the lateral line in the pectoral and caudal peduncle regions yielded intercepts of 64.73, 52.36, 19.77 and 25.81 respectively for the total length-scale radius relationship. These intercept values represent the fish length at the time of scale formation. By the regression of estimated lengths at capture on empirical lengths it was found that the caudal peduncle scales were better suited in predicting fish length.

INTRODUCTION

Scales have been used extensively in growth dynamics studies of fishes. Scale reading remains somewhat subjective and requires experience. Errors are common (Carlander, 1974; Carlander, 1982; Heidinger, 1975; Le Cren, 1974; Prather, 1967). Quite often errors are not due to techniques but to procurement of scales from different body regions at different times during the life history of fish, resulting in different graphic records of growth and proportionality relationships (Bennett, 1948; Carlander, 1974; Carlander, 1982; Clugston, 1964; Hofstede, 1974; Le Cren, 1974; Ricker and Lagler, 1942; Whitney and Carlander, 1956).

The total length-body scale regression method of back calculating fish length yields inconsistent length estimates depending upon the body region from which scales are taken (Whitney and Carlander, 1956) and in some fish the estimated length at the last annulus may be larger than the length at capture (Carlander, 1981; Carlander, 1982). Evaluation by the regression method of small samples or even large samples with small size ranges of fish can introduce errors in growth computations (Whitney and Carlander, 1956). The intercept value of regression equations has been interpreted as the length of the fish when the scales first formed on the fish. Such being the case, scales from a body region where scales first appear may yield an intercept value closer to the actual fish size at the time of scale formation. Studies to evaluate this hypothesis and the efficacy of scales from four body regions of largemouth bass *(Micropterus salmoides)* estimating fish length at time of scale formation and at capture were conducted in 1981 and 1982.

METHODS

Eighty-eight largemouth bass (TL = 140-480 mm) were collected in 1981 and 1982 by electroshocking from Lake Elmdale, Washington County, Arkansas. Total length for each fish was measured to the nearest millimeter. Scales were taken from the left side of the fish from four body regions:

1. Above the lateral line at the tip of the appressed pectoral fin (Pectoral Upper),
2. Below the lateral line at the tip of the appressed pectoral fin (Pectoral Lower),
3. Above the lateral line in the middle of the caudal peduncle (Caudal Upper),
4. Below the lateral line in the middle of the caudal peduncle (Caudal Lower).

Six scales from each body region for each fish were selected at random and impressed on plastic slides. The scale radius, distance from focus to the anterio-lateral edge, was measured at 40X using a Eberbach Scale projector. Total length-scale radius relationship was expressed as $L = a + bR$, where, L = total length of fish (mm), R = scale radius (mm) and a and b = intercept and regression coefficients respectively.

Total lengths of bass at capture were estimated by the total length-scale radius relationships. The efficiency of estimating length was evaluated by the regression formula $\hat{L} = a + bL$, where $\hat{L}$ = estimated total length, L = observed total length, and a and b are constants. In this equation, perfect estimates of length with reference to observed length will have a unit regression coefficient (b = 1.0) and zero intercept (a = 0).

RESULTS

Comparison to total length-scale radius relationship between the sexes yielded no significant differences ($P < 0.01$) for the scales from the pectoral region below the lateral line and the two caudal regions. The scales from the pectoral area above the lateral line yielded no significant sex difference in the regression coefficients ($P < 0.05$) and the intercepts were significantly different at the 0.01 level, but not at the 0.005 level. The data for the sexes were pooled for each of the body regions and the statistics for the total length-scale radius relationship are listed in Table 1. Based on low standard error of estimates (S_{yx}) and correlation coefficients (r), scales from the caudal peduncle areas describe the total length-scale radius relationship better than the scales from the pectoral regions.

The total lengths of largemouth bass at capture were estimated using the respective total length-scale radius relationships. The estimated lengths were regressed on the empirical lengths at capture and the covariance analysis showed significant difference between the four body regions ($P < 0.01$). Further analysis indicated no significant differences at the 0.05 level either between the pectoral regions or between the caudal peduncle regions. Details of the statistics for the estimated length-empirical length regression are listed in Table 2. The regression coefficient (0.93) for the caudal peduncle was not significantly different from 1.00 ($P < 0.001$) while the coefficient was significantly lower for the pectoral region ($P > 0.001$). It is evident from the S_{yx}, b, and r values that the scales from the caudal peduncle gave the best estimates.

Table 1. Statistics of total length-scale radius ($L = a + bR$) relationship.

Body Region	a	b	S_{yx}	r
Pectoral Upper	64.73	1.39	21.76	0.91
Pectoral Lower	52.36	1.16	24.22	0.91
Caudal Upper	19.77	1.84	16.53	0.96
Caudal Lower	25.81	1.68	17.14	0.95

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Table 2. Statistics of estimated total length-observed total length ($\hat{L}$ = a + bL) relationship.

Body Region	a	b	S_{yx}	r
Pectoral (Combined)	52.18	0.79	18.73	0.94
Caudal (Combined)	15.36	0.93	17.86	0.96

DISCUSSION

Scales of largemouth bass have traditionally been selected from the pectoral region (Carlander, 1982; Bryant and Houser, 1971; Kilambi et al., 1978; Padfield, 1951; Prather, 1967). The intercept of the length-scale radius relationships has been interpreted frequently as the length of the fish at the time of scale formation.

Everhart (1949) reported that in the smallmouth bass, *Micropterus dolomieui* (and probably reflective of the genus *Micropterus*) the scales first appear on the caudal peduncle at an average total length of 20.2 ± 1.0 mm and scale formation then proceeds anteriorly. Carlander (1982) reported a mean intercept value of 20.9 mm from a sample of 32 largemouth bass and recommended 20.0 mm as a standard to be employed. Our study, based on scales from four body regions, yielded increased intercept values of the total length-scale radius relationship from caudal to pectoral regions indicating that in largemouth bass, scales form first on the caudal peduncle and then on the pectoral region. The intercept values of 19.77 and 25.81 mm for the scales from above and below the lateral line of the caudal peduncle, respectively, were similar to the fish length at the time of scale formation reported by Everhart (1949) and Carlander (1982).

Our study revealed that scales from the caudal peduncle are better suited than pectoral region scales for studies of largemouth bass growth. Information on the fish length at which scales first appear may be a primary requirement for identifying the body region for scale selection to predict growth relationships for any species of fish.

One of the primary criteria of utilizing fish scales in growth studies is that the estimated lengths represent the observed lengths. The statistical parameters (Table 2) and the tests in our study indicated that total lengths of largemouth bass at capture were best estimated by scales taken from the caudal peduncle.

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