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Striped Bass Scale Analysis by Scanning Electron Microscopy for Delineation of Annuli

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STRIPED BASS *(MORONE SAXATILIS)* SCALE ANALYSIS BY SCANNING ELECTRON MICROSCOPY FOR DELINEATION OF ANNULI

Ever since Scofield (1931) demonstrated the utility of striped bass *(Morone saxatilis)* scales for age determination, striped bass have been aged mainly by the scales. Recently, Heidinger and Clodfelter (1987) and Kilambi and Prabhakaran (1987) showed that the scale method underestimated striped bass age in comparison to otolith and dorsal spine methods, respectively. Detection of scale annuli is difficult, especially of older fish, due to their compacted nature at the scale margin. Conventional methods (light [optical] microscopy and scale projection techniques) may not yield desired resolving power to depict the annuli. Due to greater resolving power and depth of focus, the scanning electron microscopy (SEM) was used to study the ultrastructure of the sculptural design, growth pattern, and annual formation of external ridges on scales and otoliths (DeLamater and Courtenany, 1974; Liew, 1974; Radtke and Hurley, 1983; Wilson and Dean, 1983; Morales-Nin, 1987). Body scales that underestimated the ages of Beaver Reservoir striped bass (T. L. 658 and 979 mm) in comparison to dorsal spine sections were examined by the SEM for the sculptural pattern of circuli and delineation of annuli.

The striped bass scales from below the lateral line at the tip of the left pectoral fin were obtained in August 1986 (Kilambi and Prabhakaran, 1987). The scales were cleaned of adhesive tissue by soaking them in water, dipping them for about a minute in a 5% HCl solution and then rinsing them in water. A pie-shaped section of the scale passing through the focus was made and dehydrated through a series of alcohol to 100%. After blotting free of solvent, the specimen was mounted on a metal stud using double stick tape. The scales were examined by the SEM and photographed.

The SEM examination of the scale from the 979 mm striped bass revealed that the circuli were semicircular in shape extending between the radii becoming flat close to the annulus and resumed semicircularity with increasing concavity away from the annulus (Fig. 1). The annulus was further delineated as an opaque zone extending dorso-ventrally (Fig. 1). Nine scale annuli were counted from the SEM photographs and the same number of annuli were observed on the microfiche photograph. Ten annuli were recorded from the dorsal spine section of this fish examined under the phase-contrast microscope (Kilambi and Prabhakaran, 1987). Examination of the SEM photographs of the scale from the 658 mm striped bass showed the configuration of the circuli and annuli similar to that of the 979 mm fish and the focus area of the scale was translucent (Fig. 2). Using the criteria described above, three scale annuli were observed, same as the number of annuli denumerable from the microfiche photograph. However, the dorsal spine section of this fish revealed six annuli (Fig. 3).

The SEM provided greater resolution of the circuli and annuli compared to the conventional scale projection technique. However, the number of scale annuli observed on the scales of the two striped bass used in this study by the SEM and the microfiche photographs were identical. The ages of the striped bass estimated from the body scales were lower than the spine ages. The results of this study are in agreement with the findings of Kilambi and Prabhakaran (1987), that the scales underestimated the ages of the Beaver Reservoir striped bass compared to the dorsal spine ages.

We thank Ms. Betty Martin of the Plant Pathology Department, University of Arkansas, for her valuable help in operating the scanning electron microscope.

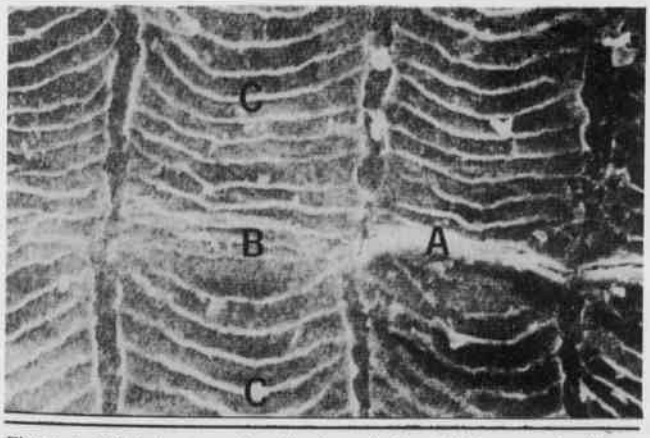
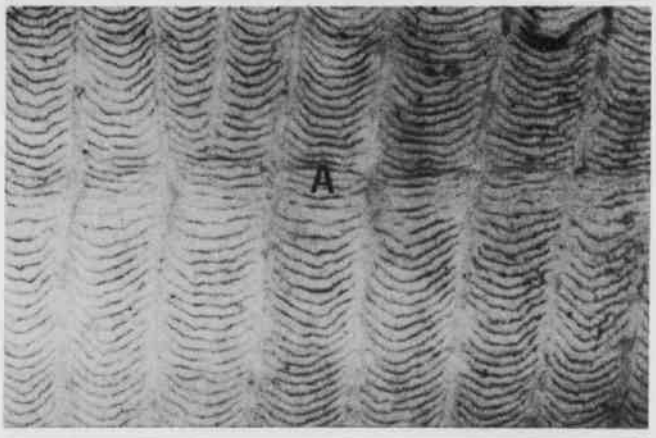


Figure 1. SEM photograph of body scale from 979 mm striped bass (x450). (Above)
A. Annulus
B. Flat circuli in annulus
C. Concave circuli away from annulus



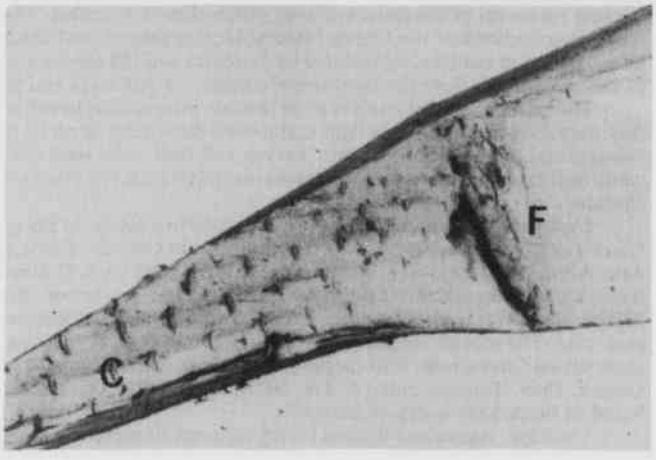


Figure 2. SEM photographs of body scale from 656 mm striped bass (x150). (Upper and Lower Right)
A. Annulus
C. Ctenii
F. Focus

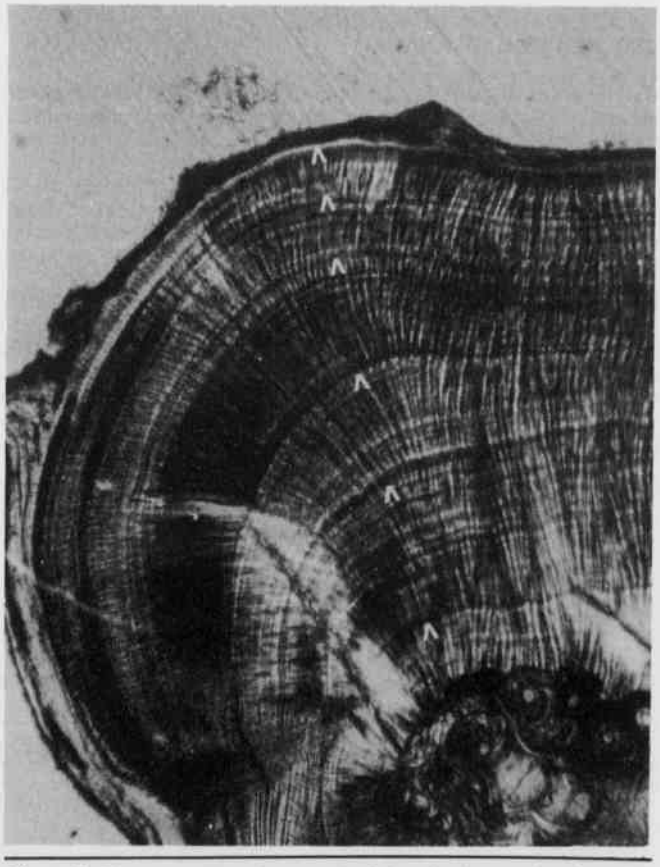


Figure 3. Phase-contrast micrograph of dorsal spine section from 658 mm striped bass showing six annuli (x40).

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SELECTED FAMILIES OF TRICHOPTERA IN ARKANSAS

Unzicker, Aggus and Warren (A Preliminary List of the Arkansas Trichoptera, J. Georgia Entomolog. Soc. 5(3):167-174, 1970) provides the best statement of the distribution of caddis flies in Arkansas. The records listed in this report came from three sources, literature search, the synoptic collections of the Illinois Natural History Survey, and the pre-impoundment study of the aquatic insect fauna of the Beaver Reservoir Basin. Fourteen families, represented by 39 genera and 102 species were reported. However, as a consequence of the pre-impoundment study, most of the records are from the northwestern corner of Arkansas and give a very limited seasonal and geographical distribution.

The purpose of this study was to provide information based on observations from a wider geographical and seasonal range. Adult caddis flies were collected by a black light maintained three miles north of Batesville in a residential area, another portable black light used near aquatic habitats and the use of sweep nets. Larvae and their cases were collected by hand or through the use of dip and drift nets. Identifcations were confirmed by comparison with specimens borrowed from the Illinois Natural History Survey. Specimens were housed in the collections at Arkansas College.

Unzicker, Aggus and Warren (1970) reported two species of Phryganeidae from a single site on Cove Creek south of Prairie Grove in Washington County. *Agrypnia vestita* (Walker) was collected in October. Farris and Harp (Aquatic Macroinvertebrates of Wapanoca Wildlife Refuge, Proc. Ark. Acad. Sci. 34:115-117, 1982) reported the species from Crittenden County, but did not provide a date. The species was collected north of Batesville in Independence County in June, July and September. Ross (The Caddis Flies or Trichoptera of Illinois, Bull. Ill. Nat. Hist. Survey 23[1]:1-326, 1944) reported that the adults of this species were collected from May to August and that more than one generation might be produced each year. The second species reported by Unzicker et al. (1970) was *Ptilostomis ocellifera* (Walker) with records during June and July from the same site on Cove Creek. This species has also been collected north of Batesville in June of 1986. Wiggins (Larvae of the North American Caddisfly Genera, Univ. Toronto Press, p. 336, 1977) reported that this species is univoltine in Canada. A third species, *Phryanea sayi* Milne has been collected at black light north of Batesville.

Unzicker, Aggus and Warren (1970) reported *Rhyacophila kiamichi* Ross from Crawford, Washington and Hot Springs counties with collec-