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Otolith microstructure of the Russian sturgeon, *Acipenser gueldenstadti*

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Otolith microstructure of the Russian sturgeon, *Acipenser gueldenstadti* was examined in adult samples collected in the Caspian Sea. The microstructure of the otolith was the same among specimens. The anterior side of the sagitta grew in two directions elongating both the long and short arms, and the long arm sections exhibited 14–21 distinct translucent and opaque zones. Otolith increments in this species can be used for age determination.

Considerable interest in the various species of sturgeon (Acipenseridae) has been generated in response to the dramatic decline in their population (Birstein, 1993). The Russian sturgeon (*Acipenser gueldenstadti*) is a semi-anadromous fish that is found in the Black, Azov and Caspian Seas, and that migrates to the adjacent rivers for spawning (Doroshov, 1985), and is one of the most important fish commercially supporting the worldwide sturgeon fishery. To clarify the basic biological information such as age, growth rate, migration patterns and habits of reproduction would provide data for fisheries management, thereby allowing effective and sustainable use of sturgeon resources.

Recent progress in otolith analytical techniques have revealed significant details of life history, including age, growth rate and migration patterns, of a great number of teleost fish. However, otolith microstructure and ageing, and rate of otolith annulus formation have not been obtained in sturgeons, although Greeley (1937) enumerated ridges on the external surface of otoliths without examination of internal sections in the Atlantic sturgeon. Otolithic material does not resorb, which is useful in accurately determining age, especially for long-lived fish such as sturgeons.

The objectives of this preliminary study were to examine the internal microstructure of otoliths of the Russian sturgeon, *A. gueldenstadti*. The results provide a basis for discussion of the ageing technique using otoliths for this species.

Adult *A. gueldenstadti* were collected by gill nets in the North Caspian Sea (Russia), between 1 and 3 October 2000. Sagittal otoliths were extracted from each fish after measurement of the total length (range: 101–126 cm). The otoliths were embedded in epoxy resin (Struers, Epofix) and mounted on glass slides. A total of ten otoliths were used for the present study. They were ground to expose the core in the frontal plane, using a grinding machine equipped with a diamond cup-wheel (Struers, Discoplan-TS), and further polished with 6 μm and 1 μm diamond paste on an automated polishing wheel (Struers, Planopol-V). They were then cleaned in an ultrasonic bath and rinsed with deionized water pending subsequent examinations. Otolith samples were examined at 40–400× under a light microscope.

The microstructure of the otolith was fundamentally the same among specimens (Figure 1A). The Russian sturgeon sagittae possessed multiple primordia and multiple cores (Figure 1B), both located at the posterior side of the translucent zone. This indicates that the otoliths grew quickly on the anterior side. The multicore structure was very similar to that of salmonid fish (Marshall & Parker, 1982; Mugiya, 1987), and according to these reports, the outside ring (Figure 1B) might be a hatch check. The diameter of the hatch check was 298 ± 28.0 μm (mean ± SD) (range: 259–331 μm). The anterior side of the sagitta grew in two directions elongating both the long and short arms. The long arm sections exhibited distinct translucent and opaque zones (Figure 1A) with 14–21 growth zones. Thus, the otolith seems to have potential as a convenient tool to reconstruct individual life history traits not only for the Russian sturgeon, but also for many other teleost fish. Nevertheless, no one has yet validated a growth zone as an indicator of annual growth in this species. In order to interpret age precisely, such a validation study will need to be carried out.

It is noteworthy that the ventral part of a long arm section in the otolith has 17 to 28 accessory growth centres (AGCs) (Figure 1C). The body of an AGC is round in shape, with a core at the centre. Thus, the AGCs seemed to attach secondarily at the ventral part of a long arm section of the otolith. The diameter of AGCs ranged from 52 to 167 μm with various sizes within one long arm section. Inside each AGC, growth increments comprising a series were observed around the core. The number of increments in a single AGC ranged from 28 to 112. Such AGCs are also reported to form in certain other fish species such as walleye pollack, flounder and conger eel (Campana, 1984; Nishimura & Yamada, 1984; Lee & Byun, 1996) accompanying the onset of metamorphosis from larva to juvenile, although no report shows this phenomenon during the adult stage. The cause behind the formation of this structure is not yet completely understood. Sturgeons are classified as bony fish (Osteichthyes) although their internal skeletons are almost wholly composed of cartilaginous tissue similar to those of cartilaginous fish (Chondrichthyes). In the latter, the otoliths consist of various sizes of statoconia (Carlström, 1963). It has been suggested that the structural variability of otolith formation follows evolutionary regularities (Lychakov, 1988). Furthermore, in the process of evolution the thin undifferentiated otoconial layer is transformed into a conglomerate otoconia upon formation of a single amorphous otolith in the philogenetically older fish (Lychakov, 1988). Thus, AGCs with a statoconia-like shape might be formed in various numbers and sizes in the sturgeon during the process of otolith formation. However, further studies on the formation mechanism of AGCs, as well as on deposition timing and periodicity of growth increments in the AGC, are necessary for a

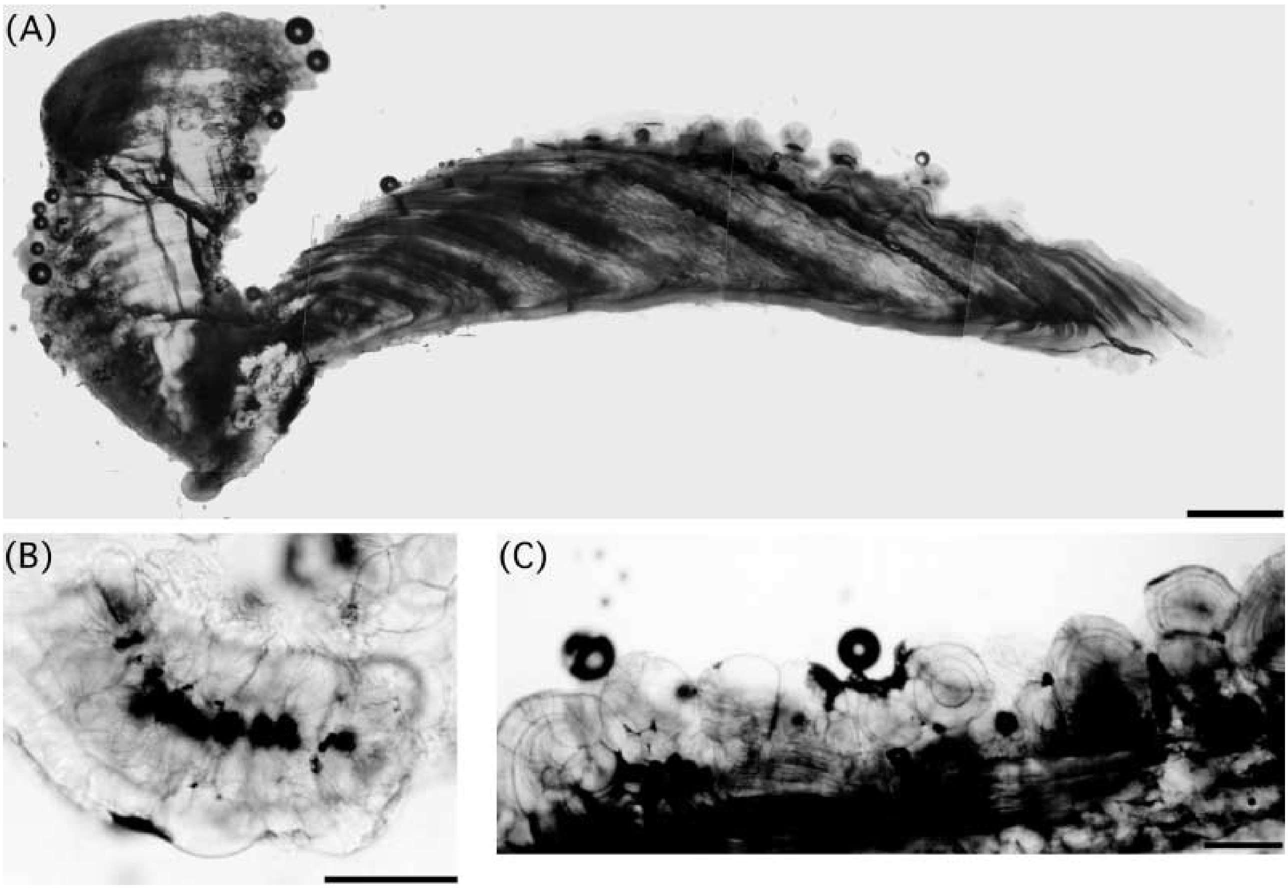

Figure 1. *Acipenser gueldenstadti*. Otolith microstructure of an adult sturgeon (TL: 112 cm) collected in the North Caspian Sea (Russia) on 2 October 2000. (A) Whole structure of the frontal otolith section with translucent and opaque zones; (B) cores and surrounding region; (C) accessory growth centres (AGCs) at the ventral part of a long arm section. Scale bars: A, 500 μm; B&C, 100 μm.

complete understanding of otolith microstructural growth in sturgeons.

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