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A morphological description of the sagittal otoliths of two mormyrids, *Marcusenius macrolepidotus* and *Petrocephalus catostoma* (Family: Mormyridae)

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The morphology of the sagittal otoliths of two South African mormyrid fish, *Marcusenius macrolepidotus* and *Petrocephalus catostoma*, were studied to determine possible morphological significance. The sagittae of *M. macrolepidotus* and *P. catostoma* are kidney-shaped and oblong, respectively. The ventral margin is slightly indented in the former and slightly flattened in the latter. The sulcus acusticus of both species is archaesusulcoid but mesial in *M. macrolepidotus* and ostio-caudal in *P. catostoma*. The crista inferior in *M. macrolepidotus* is ridge-like and well defined posteriorly and anteriorly, whereas in *P. catostoma* it is clearly defined posteriorly and disappears anteriorly. The otoliths of both species do not have a rostrum, antirostrum or an excisura. The differences in sagittal morphology between the two mormyrid species are distinct.

Key words: morphology, sagittal otoliths, SEM, freshwater fish identification.

INTRODUCTION

Three otoliths are found in the capsula auditiva on either side of the neurocranium of teleost fish. According to their structure these otoliths are termed sagitta, astericus and lapillus. Sagittae are often used for taxonomic purposes, since these have many more recurring features for comparative descriptions than either the lapillus or the astericus (Secor *et al.* 1991).

Although marine fish otoliths have been studied to a greater extent, Shepherd (1914) was the first freshwater fish biologist to describe otoliths of a few freshwater species, including some mormyrids. It was, however, only in 1965 that the first major work regarding freshwater fish otoliths appeared, with a description of the asterici of Hungarian Cypriniformes (Hecht 1979). Since the otoliths of many fishes are species-specific, their presence in the gut contents of piscivorous predators has enabled researchers to identify prey species. Otoliths have been extensively used in the understanding of marine food webs, particularly at the upper trophic levels (Smale *et al.* 1995).

The family Mormyridae includes 18 genera and 200 species distributed throughout tropical Africa.

Of the genera *Marcusenius* and *Petrocephalus*, only one species of each is found in South Africa. These are *M. macrolepidotus* and *P. catostoma* (Skelton 1993). The aim of this study was to determine whether there are differences in the morphology of the sagittae of the two South African mormyrids.

MATERIALS & METHODS

Specimens for this study were obtained from Lake Tzaneen (23°55'S, 30°10'E), a man-made lake situated below the confluence of the Great Letaba and the Ramadiepa Rivers (Olifants River System), just upstream of Tzaneen, Northern Province, South Africa. The lake has a catchment area of 666 km² and is used to store water and regulate the flow of the Great Letaba River for irrigation.

Fish were caught using multi-filament gill nets. All the specimens were measured for total length (TL), fork length (FL) and standard length (SL), and weighed to the nearest milligram. Sagittae were removed from 55 *Marcusenius macrolepidotus* (132–310 mm TL) and 23 *Petrocephalus catostoma* (101–122 mm TL). Juvenile *P. catostoma* were not selectively caught by the gill nets. Otoliths were prepared for scanning electron microscopy according to Smale *et al.* (1995) and photographed.

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Otolith length (OL) was measured using a digital Vernier calliper. The terminology used for morphological description follows that of Smale *et al.* (1995).

RESULTS

Marcusenius macrolepidotus (Peters, 1852)

Sagittal otolith description (Fig. 1a,b,c): kidney-shaped (slender), moderately thick, medially laterally concave. Lateral surface features include a ventrally located notch. The dorsal margin is slightly rounded and is irregularly sculptured. The ventral margin is slightly indented and has an irregular sculpture. The posterior margin is rounded and is irregularly sculptured. The sulcus acusticus is mesial and archaesusloid. The colliculum is undifferentiated and homomorphic. There is no collum or pseudocolliculum. The crista superior is ridge-like, broad and rounded posteriorly and interrupted anteriorly. The crista inferior is ridge-like, well defined posteriorly and anteriorly, disappearing under the sulcus. The otolith does not have a rostrum, antirostrum or an excisura.

Petrocephalus catostoma (Gunther, 1866)

Sagittal otolith description (Fig. 2a,b): oblong, moderately thick, medially laterally concave. Lateral surface features include a notch. The dorsal margin is rounded and irregularly sculptured. The ventral margin is slightly flattened and irregularly sculptured. The posterior margin is rounded and irregularly sculptured.

The sulcus acusticus is ostio-caudal and archaesusloid. The colliculum is undifferentiated and homomorphic. There is no collum. The crista superior is well developed, broad and rounded anteriorly and posteriorly. The crista inferior is clearly defined posteriorly and disappears anteriorly. The otolith does not form a rostrum, antirostrum or an excisura.

DISCUSSION

Morphological differences between the sagittae of *Marcusenius macrolepidotus* and *Petrocephalus catostoma* lie in the shape of the otolith, kidney-shaped versus oblong, respectively. Furthermore, the sulcus acusticus in *M. macrolepidotus* is mesial (the sulcus does not open onto any margins of the otolith other than the mesial surface), whereas in *P. catostoma* it is ostio-caudal (sulcus opens widely on both the anterior and posterior

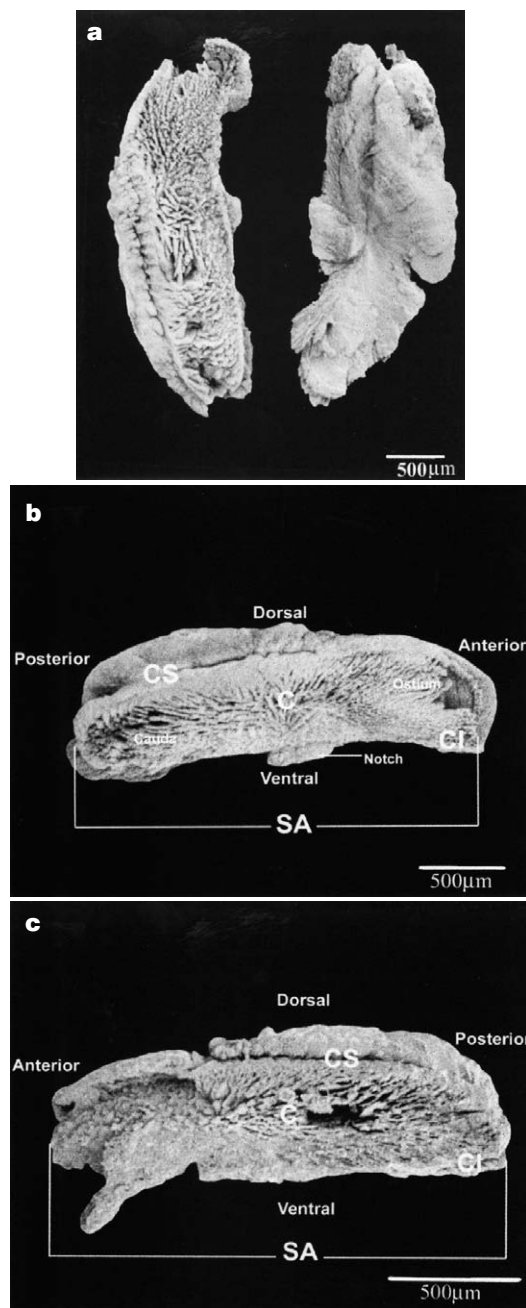


Fig. 1. a, Electron micrograph showing the mesial and lateral surfaces of the sagittal otoliths of an adult (TL = 280 mm) *Marcusenius macrolepidotus*; b, electron micrograph showing the mesial surface of a left sagittal otolith of an adult (TL = 210 mm) *M. macrolepidotus*, illustrating the following features: SA, sulcus acusticus; CS, crista superior; Cl, crista inferior; C, colliculum; c, electron micrograph showing the mesial surface of a right sagittal otolith of a juvenile (TL = 125 mm) *M. macrolepidotus*.

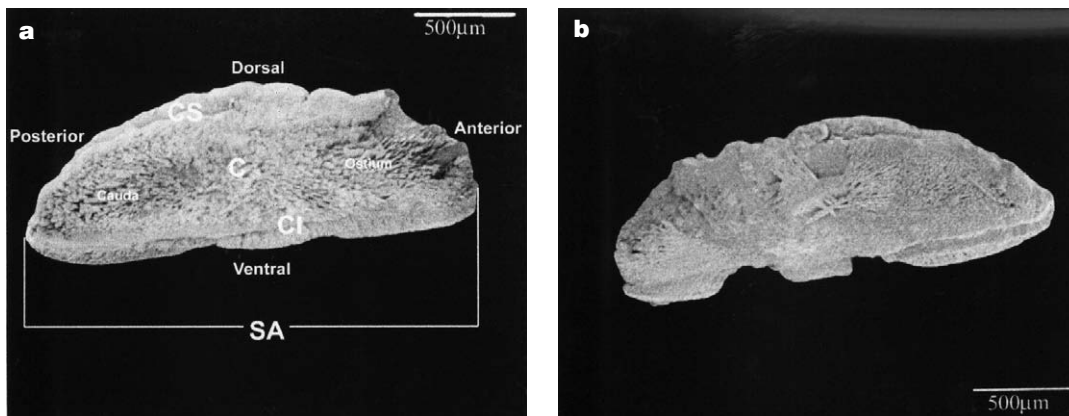


Fig. 2. a, An electron micrograph showing the mesial surface of a left sagittal otolith of an adult (TL = 124 mm) *Petrocephalus catostoma*, illustrating the following features: SA, sulcus acusticus; CS, crista superior; CI, crista inferior; C, colliculum; **b,** electron micrograph showing the mesial surface of a right sagittal otolith of an adult (TL = 118 mm) *P. catostoma*.

margins) (Smale *et al.* 1995). *P. catostoma* has a broken crista inferior and *M. macrolepidotus* has a well-defined posterior crista inferior, but this becomes less distinct anteriorly. While otolith morphology changes to an extent with fish length (Fig. 1a,c), the general shape of the otoliths of both adults and juveniles of both species remains the same. Differences in sagittal morphology can be used to identify prey species from the stomach content of predators. This application has already been used successfully for marine fish (Smale *et al.* 1995).

The positive correlation between otolith length and fish length (Figs 3, 4) and the specific shape of the otoliths of these two species should enable researchers to identify either of the two species from the stomach contents of predators.

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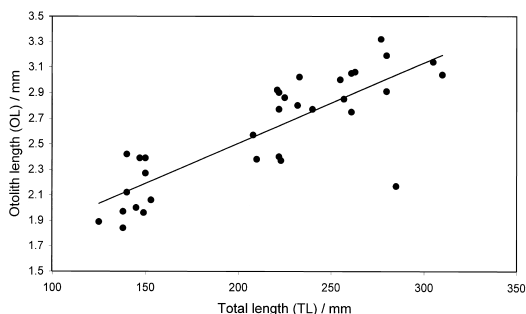


Fig. 3. Correlation between total length (TL) and otolith length (OL) in *Marcusenius macrolepidotus* from Lake Tzaneen, Northern Province, South Africa. ($n = 33$, $r^2 = 0.83$).

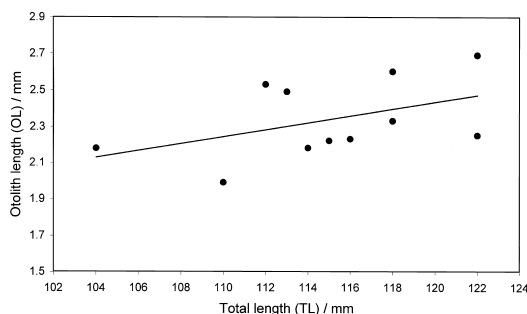


Fig. 4. Correlation between total length (TL) and otolith length (OL) in *Petrocephalus catostoma* from Lake Tzaneen, Northern Province, South Africa. ($n = 11$, $r^2 = 0.47$).

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