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MORPHOMETRY OF THE SAGITTAL OTOLITH FROM *Atherinella brasiliensis* (QUOY & GAIMARD, 1824) (ACTINOPTERYGII - ATHERINOPSIDAE), AT THE COAST OF PARANÁ.

Bárbara M. de CARVALHO[1]
Marco F. M. CORRÊA[2]

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ABSTRACT

In this work was done the description of the morphological and morphometric of the otolith sagitta of the *Atherinella brasiliensis* together with the linear regressions between biometrics fish and otoliths. Were 145 specimens analyzed with total length of 7.01 cm and with a standard deviation of ± 4.28 cm. All sagitta otoliths of *A. brasiliensis* showed sulcus acusticus heterosulcoid shape and type ostial. With the growth of the specimens occurred changes in the shape and margins of the otoliths, in specimens having above 8 cm total length of the fish observed a dorsal depression. The appearance of this depression in the dorsal otolith this species is an indication of the stress caused by the first maturation of the species.

Key words: Brazilian silverside, teleósteos and regression.

RESUMO

No presente trabalho foi realizada a descrição morfológica e morfométrica do otólito sagitta da *Atherinella brasiliensis* juntamente com as regressões lineares entre a biometria dos peixes e dos otólitos. Foram analisados 145 exemplares com comprimento total médio de 7,01 cm com desvio padrão de ±4,28 cm. Todos os otólitos sagitta da *A. brasiliensis* apresentaram sulco acústico de formato heterossulcóide e do tipo ostial. Ao longo do crescimento dos exemplares ocorreram mudanças na forma e nas margens dos otólitos, tendo nos exemplares acima de 8 cm de comprimento total do peixe observou - se uma depressão dorsal. O aparecimento dessa depressão dorsal no otólito desta espécie é um indicio do estresse causado pela primeira maturação gonadal da espécie.

Palavra chave: teleósteos, peixe-rei e regressão.

INTRODUCTION

Otoliths are endogenous calcareous concretions, usually aragonite, and are localized in the inner ear of bony fishes (POPPER et al., 2005). They are immersed in endolymph and maintained in position by the otolithic membrane inside the labyrinthine compartment. Otoliths allow the stability and hearing capacity of the individuals because their density is three times larger than the rest of the fish body (POPPER et al., 2005). Teleostean fishes have 3 pairs of otoliths, which are called *sagitta, lapillus* and *asteriscus*, according to their form and position.

They are considered important structures in ichthyology, as the reading of their rings can be used to estimate fish age (NIELSEN & JOHNSON, 1983; FRANCIS & CAMPANA, 2004), the composition of the calcium carbonate can show the environmental parameters in which the fish developed (e.g. pollution) (CAMPANA, 1999; GHOSH et al., 2007; ELSDON et al., 2008;), and morphometry may demonstrate differences between populations indicating influences of different environmental parameters (VOLPEDO & ECHEVERRIA, 2003). Otoliths are also important in the trophic ecology of fish predators because they are resistant to digestion (SANTOS et al., 2002a; SANTOS et al. 2002b; COLABUONO; VOOREN, 2007; MEYNIER et al., 2008). *Atherinella brasiliensis* (Quoy; Gaimard, 1824) is a widely distributed species being present from Venezuela to Argentina (AUGUSTIN, 2012), in the Paraná coast this species is very abundant according to several studies (FALCÃO et al., 2006, SPACH et al., 2006 CONTENTE et al., 2011). *Atherinella brasiliensis* is considered an important link between

Authors is e-mails: bmaicarvalho@gmail.com, mfmcorrea@hotmail.com *Corresponding author: Bárbara M. de CARVALH:O bmaicarvalho@gmail.com [1] Programa de Pós – Graduação de Sistema Costeiro e Oceânicos, UFPR. [2] Centro de Estudos do Mar. . Avenida Beira Mar, s/n. Caixa Postal: 61 CEP: 83255-971. Pontal do Sul, Pontal do Paraná – PR – Brasil.

estuarine trophic levels because it feeds on benthic and planktonic organisms can transfer this energy to the next trophic levels (CONTENTE et al., 2010).

The objective this study of this study is to describe the morphology and morphometry of the sagittal otoliths of juveniles and adults of *Atherinella brasiliensis* and to make a comparison between these variables with descriptive studies of otolith *sagitta* other species of South American silversides.

MATERIAL AND METHODS

All specimens were captured in the estuarine and coastal region of Paraná state (Brazil) (25°20'-25°50'S and 48°50'-48°10'W) between 2003 and 2004. The specimens were captured using a *fyke* net, gill nets and beach nets, and identified following MENEZES and FIGUEIREDO (2000). Each specimen was measured for total length (TL;cm) using an ichthyometer, and weighted (W;g).

Sagittal otoliths were removed from the palate region through an incision made in the optical capsule (SECOR et al., 1991). The shape, margin type and its structures were observed in stereoscope microscope.

The following measurements were obtained: otolith length (Lo) the largest horizontal distance between the posterior and front margin of the otolith, otolith height (Ho) the largest vertical distance between the ventral and dorsal margins, ventral (Hv) and dorsal (Hd) heights the largest lengths between the respective margins and the *sulcus acusticus*, *ostium* length (Los) the straight line of the upper margin of the neck up to its frontal extremity, caudal length (Lc) measured at the front margin of the neck up to its posterior extremity, the largest widths of the cauda (LWc) and *ostium* (LWos) measured in a straight line between the dorsal and ventral margins of the cauda and the *sulcus acusticus*, respectively. The length of the *sulcus acusticus* (Lsa) was measured in a straight line between the front margin of the *ostium* and the posterior margin of the cauda (Figure 1).

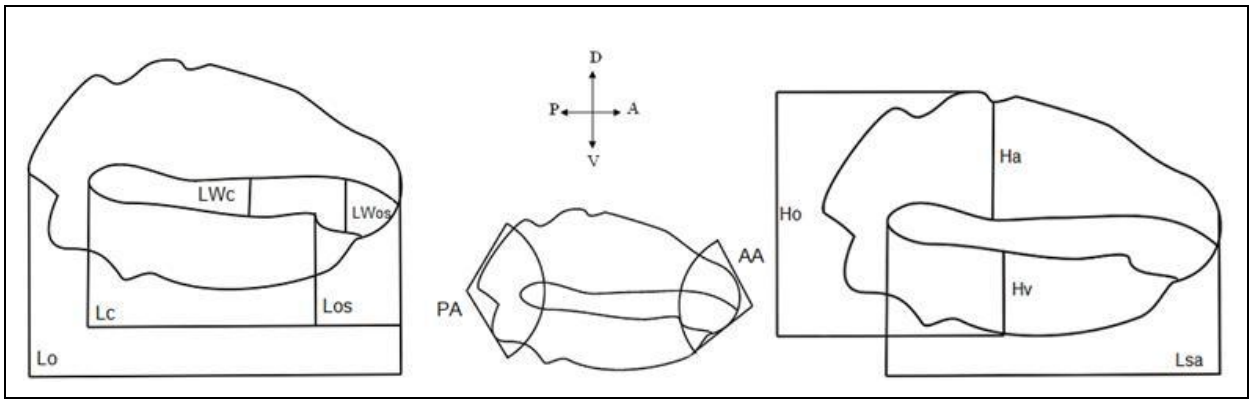

Figure 1 - Schematic drawing of the morphological structures analyzed in the left sagittal otolith of *Atherinella brasiliensis* where: Lo otolith length, Ho otolith height, Hd dorsal height, Hv ventral heigth, Los ostio lenght, Lc cauda's lenght, LWc maximum width of the cauda, LWos maximum width of the *ostium*, Lsa *sulcus acusticu*s length, AA angle of the anterior region of the otolith, PA posterior angle of the posterior region of the otolith, P region posterior, A region anterior, D region dorsal and V region ventral.

RESULTS

The total of 145 specimens between 1.4 and 15 cm in length was analyzed. Mean and standard deviation TL and Wt were 7.11 (±4.28) cm and 5.30 (±6.91) g, respectively. The *sulcus acusticus* was type ostial, shape heterosulcoid, concave, position median and faced the inner cavity. The cauda was usually curved and the *ostium* was deltoid for all lengths (Figure 2).Shape and the margins of the otoliths changed with the ontogenetic development (Table 1). They were circular up to 2 cm and changed to an elliptical form from 2 to 4 cm. After 4 cm they were predominantly oblong. The shape of the margins ranged from smooth, sinuous and lobed

up to 4 cm, when they become irregular. A postero-dorsal depression was also observed, always parallel to the *sulcus acusticus* in fishes with total length above 8 cm.

Table 1 - Morphological characteristics of the sagittal otolith of *A. brasiliensis*. "N" is the sampling size per size class.

TL (cm)	N	Otolith's shape	Otolith's margins	*Sulcus acusticus* type	*Sulcus acusticus* shape
0 - 2	9	Circular	Entire	Ostial	Heterosulcoid
2 |- 4	49	Oval	Entire	Ostial	Heterosulcoid
4 |- 6	13	Oblong	Sinuate and lobed	Ostial	Heterosulcoid
>6	74	Oblong	Irregular	Ostial	Heterosulcoid

The results of morphometry of the otoliths (all measurements in cm, means and ± standard deviation) were: Lo = 0.20 (± 0.12); Ho = 0.13 (± 0.07); Hd = 0.057 (±0.036); Hv = 0.05 (±0,03); Los = 0.042 (±0.03); Lc = 0.12 (±0.074); LWc = 0.020 (±0.011); LWos = 0.031 (±0,02); Lsa = 0.16 (± 0.104); Angles: Aa=100.1 (±9.12)º and Ap=106.1 (±11.7)º. Relations were performed between measurements of otoliths and length of the fish is shown in Table 2 for class size.

Table 2 - Class size of total length (TL) with means and standard deviations of the relations of the: length of the fish and otolith's length (TL/Lo), otolith's length and height (Lo/Ho), dorsal height and ventral height (Hd/Hv) and otolith length and ostial length (Lo/Los).

Relations / Class size	TL/Lo	Lo/Ho	Hd/Hv	Lo/Los
0 – 2 cm	36.82(± 2.53)	1.35(± 0.14)	0.89(± 0.10)	1.12(±3.54)
2 – 4 cm	36.94 (±4.87)	1.50 (±0.10)	0.96 (±0.17)	6.13 (± 1.40)
4 – 6 cm	32.73(±3.63)	1.48(±0.18)	0.96(±0.21)	5.71 (±1.31)
6 – 8 cm	30.70(±3.76)	1.43(±0.18)	0.98(±0.10)	6.13(±2.34)
8 – 10 cm	33.54(±4.56)	1.52(±0.09)	1.14(±0.11)	4.64(±0.62)
10 – 12 cm	34.22(±2.75)	1.62(±0.09)	1.13(±0.17)	4.30(±0.58)
12 – 14 cm	37.62(±2.67)	1.69(±0.10)	1.29(±0.15)	4.60(±0.76)
14 – 16 cm	39.69(±1.60)	1.71(±0.07)	1.22(±0.15)	4.11(±0.18)

The linear regression analysis was performed and was significant for Lo / LT ($r^2 = 0.98$; $p = 0.000$; $y = 0.16 + 33.4 * Lo$), Ho / LT ($r^2 = 0.98$; $p = 0.000$; $y = -0,15 + 55.7 * Ho$), Weight / Lo ($r^2 = 0.96$; $p = 0.000$; $y = 836.7 * Lo^{3.8}$).

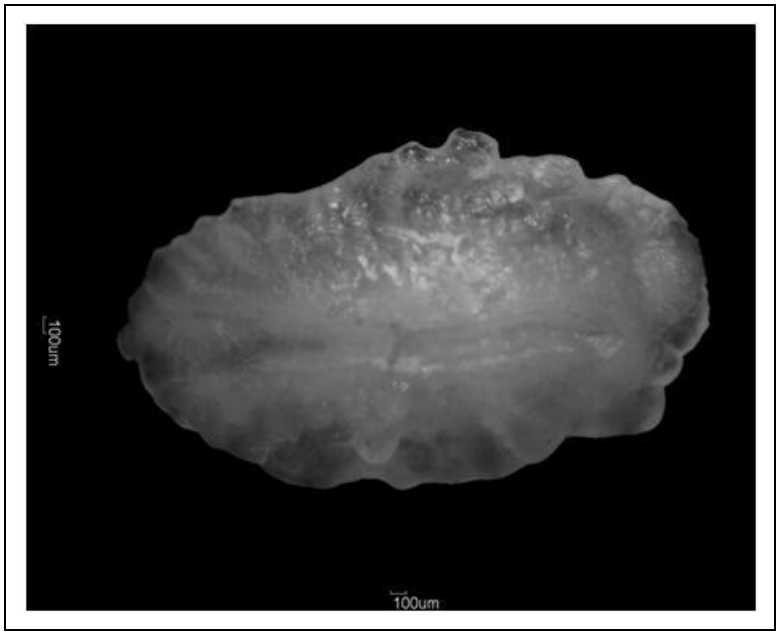

Figure 2 - Photo of the Sagitta otoliths of a 14.5 cm specimen of *Atherinella brasilienis*

DISCUSSION

In this work the sagitta otolith of the *A. brasiliensis* is considered small as also described in SMALLE (et al., 1995) to other species of the family Atherinopsidae. The comparison between *A. brasiliensis*, *Odontesthes argentinensis* and *Odontesthes bonariensis* shows that there is a pattern in shape, margins and type of sulcus acusticus within the of Atherinopsidae family (TOMBARI et al., 2005). The morphological characterizations of the otolith sagitta of the *A. brasiliensis* ranged along the ontogenetic development of the species with the emergence of a depression in the dorsal-posterior samples that class size of the 6-8 cm.

This class coincides with the length at first maturity of this species (FAVARO et al., 2003). Suggesting that depression is associated with physiological stress caused by gonadal maturation and is conservative after size 8 cm. Depressions in otolith sagitta of the family Atherinopsidae associated with first maturity were recorded for the species as described on *O. argentinensis* by TOMBARI (et al., 2005).

Differences in otolith dimensions between *Odontesthes* spp. *and Atherinella brasiliensis* are probably due to the larger specimens collected for the former (Table 3), which only overlap between classes larger than 8 cm. Also, the species *O. argentinensis* and *O. bonariensis* reach up to 32 cm in total length what results in larger otoliths. This distinction between their otolith morphometry facilitates the identification of these species in stomach contents of ichthyophagous animals.

Table 3. Morphometric comparasion between species *A. brasiliensis*, *O. argentinensi* e *O. bonariensis* and data species *O. argentinensi* and *O. bonariensis* removed from TOMBARI (et al.,2005)

Morphometry	Lo	Ho	Los	Lc	LWc	LWos
***A. brasiliensis* (cm)**	0.200 (± 0.12)	0.13 (± 0.07)	0.042(± 0.03)	0.120 (± 0.07)	0.020 (± 0.01)	0.031 (± 0.02)
***O. argentinensis* (mm)**	3.415 (±1.13)	2.108 (± 0.67)	0.786 (±0.25)	2.212 (±0.80)	0.293 (±0.10)	0.496(±0.16)
***O. bonariensis* (mm)**	3.584 (±0.96)	2.236(±0.45)	0.907 (±0.32)	2.188(±0.56)	0.302(±0.04)	0.380(±0.13)

CONCLUSION

This work concludes that the otolith *sagitta* of *Atherinella brasiliensis* can be considered small, and the shape of the otolith variable range until the fish 6 cm, the type and shape of the *sulcus acusticus* is heterosulcoid and ostial respectively. Finally, the depression of dorsal otolith Atherinella brasiliensis is directly correlated with the gonadal maturation of this species, this structure can assist in identifying the life stage of this species in studies of trophic ecology of ichthyophagous animals.

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