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Morphometric Analysis of Sagittal Otolith in Relation to Total Fish Length of A Cyprinid Fish, *Puntius conchonius* (Hamilton, 1822)

Verma Bhawana* and Jain Seema

Laboratory of Fish Taxonomy, Department of Zoology, Raghunath Girls' Postgraduate College, C.C.S. University, Meerut, Uttar Pradesh, India

**Corresponding Author*

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Abstract: The present study was conducted to find a correlation between dimensions (length and width) and weight of otolith with total fish length and weight in the 30 samples of a Cyprinid fish *Puntius conchonius* (Hamilton, 1822). Fish samples were caught from Ganga river near and around Meerut region, India. Identification of each specimen of fish samples was done. Morphometric analyses were done as total length (TL) and weight (TW) were measured in cm and g, respectively. After otolith extraction Nikon S Element Software was used to measure the dimensions (length and width) of otoliths. Weight of otoliths were measured with Kab-200 precision scale (± 0.0001 g). Ranges of total fish length and weight were between 4.3-6.5 cm and 1.4-3.44 g, respectively. Range of length, breadth and weight of otoliths of each specimens were between 0.52-0.71 mm, 0.44-0.67 mm and 0.001-0.002 mg, respectively. To analyze the relationship between otolith dimensions and fish morphometry, linear regression model was applied and it showed strong correlation. Present study suggested positive relationship between total fish length with otolith length and otolith width. In this fish species there is no remarkable differences between right and left otolith (t-test, P>0.05). Morphometric analysis of otoliths of this species could be a useful tool for fish stock identification and management. It could be used by fish taxonomists to back calculate the age and growth of fish. Otoliths also reveal the migratory pattern, water pollutants and feeding habits of fish.

Keywords: *Puntius conchonius,* Otolith morphometry, Linear regression, Nikon S Element software

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Introduction

The fish *Puntius conchonius* belongs to family Cyprinidae. It is an economically important, ornamental small Cyprinid fish. It is commonly known as "Rosy barb" or "Lalpothi". It is a beautiful and attractive fish species in the barb group, which usually inhabit running and standing water of ponds, chaurs, ditches, tanks, river with muddy bottom and plants. Body is uniform silvery. During breeding season body shows pink red coloration. Characteristic black blotch on caudal

peduncle at edges of caudal fin is present. Being omnivorous in nature its feed includes plant matter, insects, worms, planktons and small fishes. Breeding occurs during the months of June and July at moderate temperature like 25-26° C. Maximum length could be 5 cm. It is distributed throughout India, Pakistan, Nepal, Bangladesh, Sri Lanka, Burma, and Thailand (Jayaram, 1981).

In the inner ear cavity of Teleosts there are three paired calcified structures (Sagitta, Lapillus and Asteriscus) known as "Ear stones" or "Otoliths" (Campana *et al*., 1985). Sagitta was used for the morphological study. Compositions of otoliths are mainly calcium carbonate and otolin protein (Campana, 1999; Campana *et al*., 2001). Most important functions of otoliths are equilibrium and sound perception. These are usually used for age and growth determination (Templeman *et al*., 1956; Botha, 1971; Beamish, 1979; Mathur *et al*., 2014; Nimesh, 2018, 2019; Nimesh *et al*., 2021). A study revealed that these are highly species-specific in shape and size and have characteristic features (Platt and Popper, 1981). This uniqueness of otoliths makes them an important systematic tool for bony fishes (Akkiran, 1985).

In the present study to establish a relationship between fish size and otolith dimensions (length and breadth) with the help of regression model; otolith length, breadth and weight as well as fish length and weight were measured. There is no previous study on relationship between otolith dimensions and fish size of *Puntius conchonius.*

Materials and Methods

Specimens of fish *Puntius conchonius* (Fig.1) were collected from Ganga river, India in and around Meerut region by local fisherman during the period March 2022- July 2024. Fishes were brought to the laboratory on an ice layer. Identification of each fish sample was done as described by Day (1878) and Jayaram (1981). Morphometric measurements of fish samples were done. Total fish length and weight were measured in cm and g, respectively. Length was measured via 1 mm precision fish length measuring scale as total length (TL) and weight was measured to the nearest gram as total weight (TW).

Otolihs were removed from the fish samples by giving a horizontal cut in the cranium between both the eyes. Exposed otoliths were kept separately as left and right. Cleaning was done with 10% KOH solution followed by distilled water. Cleaned otoliths were left for a few minutes to let them dry. Dried otoliths were stored in clean and transparent eppendorf tubes and labeled with date of collection, generic and specific name and identification number for further observations.

Length and breadth of paired otoliths were measured with the help of NIS Element D5.10.00 64-bit imaging software. Light microscopic photographs of otoliths (Fig. 2) were taken via Nikon ELWD 0.3/ 0D75.

Statistical Analysis

Least squares linear model was applied to determine the relationship between otolith dimensions (length and breadth) with fish length and otolith weight with fish weight. The calculated parameters were otolith length (OL) and otolith breadth (OB) with total fish length (TL) and otolith weight (OW) with fish weight (FW).

Results and Discussion

This study contained 30 samples of fish *Puntius conchonius* as study material. Range of total fish length and weight were between 4.3-6.5 cm. and 1.4-3.44 g, respectively. Range of length, breadth and weight of otoliths of each fish samples were between 0.52-0.71 mm, 0.44-0.67 mm and 0.001-0.006 mg, respectively (Table 1).

The relationship between total length of fish with otolith length and breadth were as-

$y=0.0584x+ 0.3427$ ($R^2= 0.2498$)

$y= 0.0436x + 0.3001$ ($R^2= 0.1243$) (Fig. 3a, b)

The relationship between the weight of fish with otolith weight was as-

$y= 0.0005x + 0.0008$($R^2= 0.2132$) (Fig. 3c)

Fig.1: *Puntius conchonius* (Hamilton, 1822).

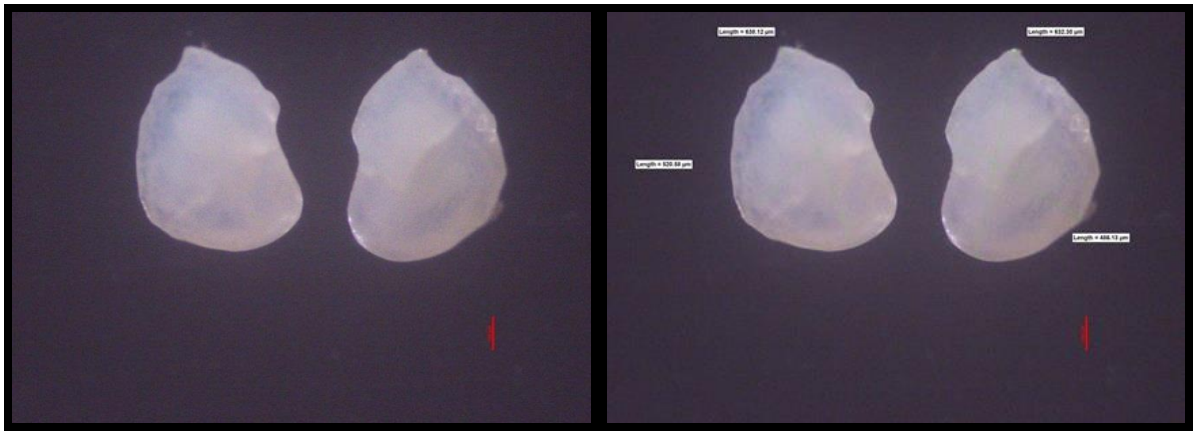
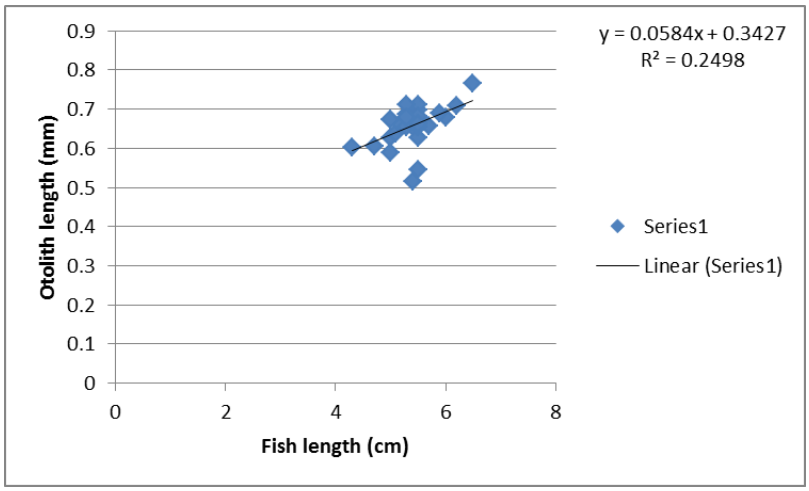


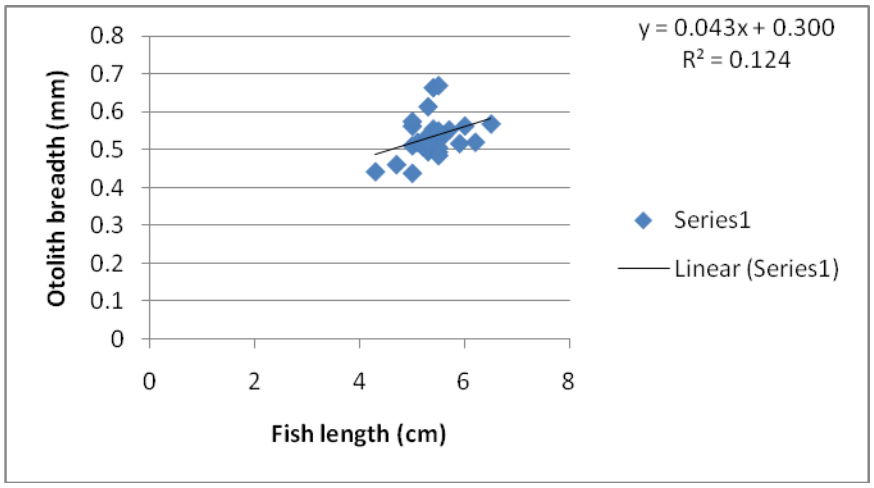
Fig. 2: Morphometric measurements of left and right sagittal otoliths of *Puntius conchonius* using NIS Element D5.10.00, 64-bit imaging software.

Table 1: The values of measured parameters of *Puntius conchonius*

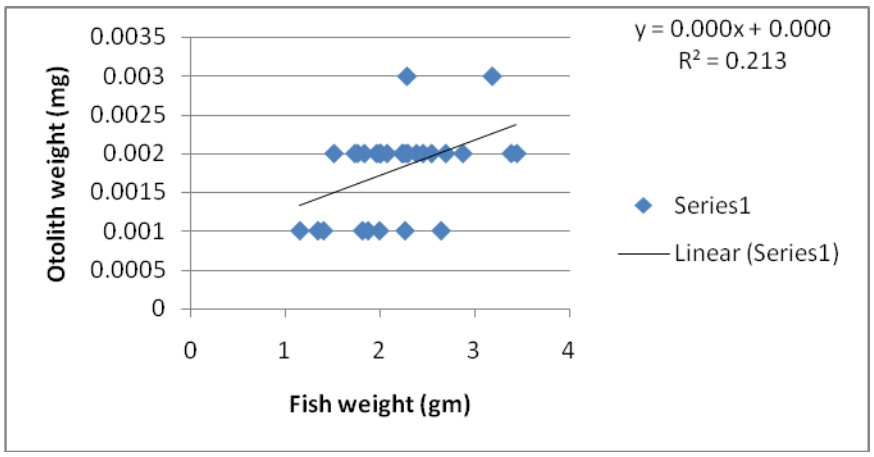
Parameter	**Number**	**Mini.**	**Max.**	**Mean**	**SD**
Fish length (cm)	30	4.3	6.5	5.39	0.42
Fish weight (g)	30	1.4	3.44	2.18	0.55
Otolith length (mm)	60	0.52	0.71	0.65	0.04
Otolith width (mm)	60	0.44	0.67	0.53	0.05
Otolith mass (mg)	60	0.001	0.002	0.001	0.00055



(a)



(b)



(c)

Fig. 3: Showing linear relationship between (a) Fish Length- Otolith Length, (b) Fish Length- Otolith Breadth, and (c) Fish Weight- Otolith Weight in *Puntius conchonius.*

This study shows a strong relationship between Otolith length with total fish length obtained (R^2= 0.2498) and a moderate relationship between otolith breadth with total fish length (R^2= 0.1243) and total fish weight with otolith weight (R^2= 0.2132).

Otoliths of *Puntius conchonius* showed no significant differences between right and left Sagitta (p>0.005), hence this observation reflects that paired otoliths are mirror images of each other. This study was supported by other many studies (Jawad *et al*., 2011, 2012; Dehghani *et al*., 2016; Zengin *et al*., 2017; Saygin *et al*., 2017; Sumiarsih *et al*., 2018). A similar character was also found in *Amblypharyngodon mola* between right and left otolith size from Ganga river (Nimesh *et al*., 2018). Similar observations have also been reported by Kumar *et al.* (2012); Mathur *et al*. (2014); Singh (2015); Nimesh (2019); Nazir and Khan (2019); Rani *et al*. (2019) and Nimesh *et al*. (2021). It suggests that otolith morphometry could be used as a taxonomic tool to back calculate the age of fish, fish biology, habitat reconstruction etc.

Hunt (1979) and Harvey *et al*. (2000) observed that otolith morphometry could be used to determine fish size, weight and length and relationship can be estimated. Similar observation was also found by Javed *et al.* (2011) about relationship between otolith length and total length in specimens of the fish Bengal snappers (*Lutjanus bengalensis*) according to linear model (R^2 = 0.853). A positive relationship between fish length and otolith growth in *Sardinella sindensis* was also observed by Dehghani *et al*. (2016). A relationship between fish length, otolith size and otolith weight was observed in fishes *Sperata aor* (Bagridae) and *Labeo bata* (Cyprinidae) by Nazir and Khan (2019).

This is the first study about the relationship between fish length with otolith dimensions in specimens of fish *Puntius conchonius* collected from Ganga river near Meerut region, Uttar Pradesh, India. This study provides an important tool for estimation of fish growth and to calculate the length of fish samples according to otolith dimensions.

Conclusion

This study strongly suggests that otolith size depends on fish size, as otolith size increases with the increase of fish size. We observed a linear correlation between otolith length with total fish length, similarly between otolith breadth with total fish length and otolith mass with fish weight. Morphometric relationship analysis between these parameters of *Puntius conchonius* shows that otolith length and otolith breadth can be used to determine the fish length.

Ethical Statement

The authors confirm that all ethical issues have been dealt with the research ethics guidelines provided by the Department of Zoology, Raghunath Girls' Postgraduate College, C.C.S. University, Meerut, Uttar Pradesh, India.

Author Contributions

Each author has contributed equally to the study's planning, analysis, writing, and editing. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflicts of interest.

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