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Relationship between otolith morphometry and fish size of *Otolithoides pama* (Hamilton, 1822) from Hooghly-Matlah estuary, India

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The correlation between sagitta otolith morphometry (length, weight, and breadth) and weight of *Otolithoides pama* (Hamilton, 1822) occurring in the Hooghly-Matlah estuary of West Bengal was examined for one year (February 2017 to January 2018). The sagitta otoliths were extracted, cleaned, photographed, and measured. Otolith length, weight, and breadth were recorded for each pair of sagittae. The length and weight of the fish sample, as well as those of otoliths, ranged from 51 to 327 mm, 1.1 to 270 g, 2.0 to 13.9 mm, and 0.0085 to 0.756 g, respectively. A linear relationship existed between the length and weight of otolith with the length of fish. The relationship between total fish length (TL) and otolith length (OL) was recorded as TL = 0.038 (OL) + 0.123 (R^2 = 0.799), that of total fish length (TL) and otolith weight (OW) being TL = 0.025 (OW) - 0.221 (R^2 = 0.887), that of total fish length (TL) and otolith breadth being TL = 0.031 (OB) + 0.089 (R^2 = 0.781). The morphometric relationships indicated that length, weight, and breadth of otolith exhibited a high correlation with the total length of fish.

[**Keywords**: Hooghly-Matlah estuary, India, Otolith morphometry, *Otolithoides pama*, Sagitta, West Bengal]

Introduction

Sciaenids are considered as an important commercial fishery of India and West Bengal accounting for 4.56 % and 11.45 % of total marine catch, respectively from 2015-16(ref. 1). The commercially important species of sciaenids occurring along the Indian coast are *Otolithoides biauritus*, *Otolithes ruber*, *O. cuvieri*, *Protonibea diacanthus*, *Johnius macrorhynus*, *J. glaucus*, *J. elongatus*, *J. carutta*, *J. borneensis*, *J. dussumieri*, and *Pennahia anea.* In Hooghly-Matlah estuary of West Bengal[2], *Otolithoides pama* occupies the third rank in terms of abundance next to hilsa (*Tenualosa ilisha*) and Bombay duck (*Harpadon nehereus*). It is also emerging as a commercially important fishery in the Narmada estuary of Gujurat, India[3].

Otoliths are small calcified structures occurring inside the inner ear cavity of fish and they serve as balancing organs as well as help in hearing of fish. Its salient feature is a lack of resorption compared to other calcified structures (scales, bones) and thus grows throughout the life-time of fish continuously. It is very important in the determination of age and growth rate of fish. In most teleost fishes, otolith comprises three pairs of structures in the inner ear, the largest of which is the saccular otolith (sagitta)[4]. The growth of otolith is enhanced with the size of the species and usually follows an allometric increase in dimensions[5]. Otoliths are not only used to estimate the age of the fish but also to characterise stock-specific differences which are based on some relation between otolith and fish dimensions[6]. Models for estimation of fish age were prepared with the use of otolith morphometrics in recent studies[7-9]. A comparative length-weight relationship and otolith morphometry of sciaenid species from the west coast of India was studied earlier by some researchers[2,10].

The sciaenids have quite large otoliths compared to other teleosts, but there is meagre information about the relationship between otolith dimensions and the size of the fish species. Once, the correlation of otolith length with the total length of fish is found out, one can estimate the total length of a fish or vice versa[11-14]. The otoliths morphology is a distinctive feature that defines each fish species[15]. The main purpose of this work is to find out the relationships between the fish size and otolith dimensions from the Hooghly-Matlah estuary of West Bengal in India. There are many studies on stock assessment, reproduction, food and feeding habits, and fecundity as well as on exploitation rate of sciaenids in India[16-20]. The correlation between total length and otolith dimensions of *O. pama*, occurring in the

Hooghly-Matlah estuarine system is lacking. Hence, the present work was carried out to bridge the gap.

Materials and Methods

Collection of samples

Fish samples of *O. pama* were collected from three fish landing centers of the Hooghly-Matlah estuarine system *viz.* Godakhali, Diamond harbour, and Frasergang from February 2017 to January 2018 (Fig. 1). The fish samples were usually caught by bag and gill nets (15-60 mm mesh size). The samples were frozen in the field condition, brought to the laboratory, and thawed before further studies.

Identification and analysis of samples

All the samples were identified by using the standard taxonomical literature pertaining to species characters of FAO species identification sheets[21] and by standard texts[22-23]. Before the collection of otoliths, total length (TL) and weight (TW) of the specimen were measured to the nearest millimeter (0.1 mm) and gram (0.001 g), respectively. Then the largest otolith, sagitta from 184 specimens (74 male, 102 female, and 8 indeterminate) were extracted out of the optic capsule using fine forceps. The indeterminate groups mainly comprise juveniles where sex is not differentiated. The collected otoliths were cleaned and stored dry in glass vials. Maximum otolith length (OL) and breadth (OB) were measured using a digital caliper with a resolution of 0.01 mm (Fig. 2). Otoliths were weighed using an analytical balance with a resolution of 0.001 g. Both the left and right otoliths were taken out carefully to study the significant difference between them by using *t*-test. A non-linear equation in the form of $W = aL^{b}$ [ref. 24] was followed to establish the relationship of TL and TW with those of otolith length (OL), otolith weight (OW) and otolith breadth (OB). The equation is log-transformed for linear form with LogW = a + b logL. The significance of the exponent (b) was tested with the fisher '*t*' test. The morphometric relationships among compared features were found out with the use of a linear regression model that best fits the data distribution[25].

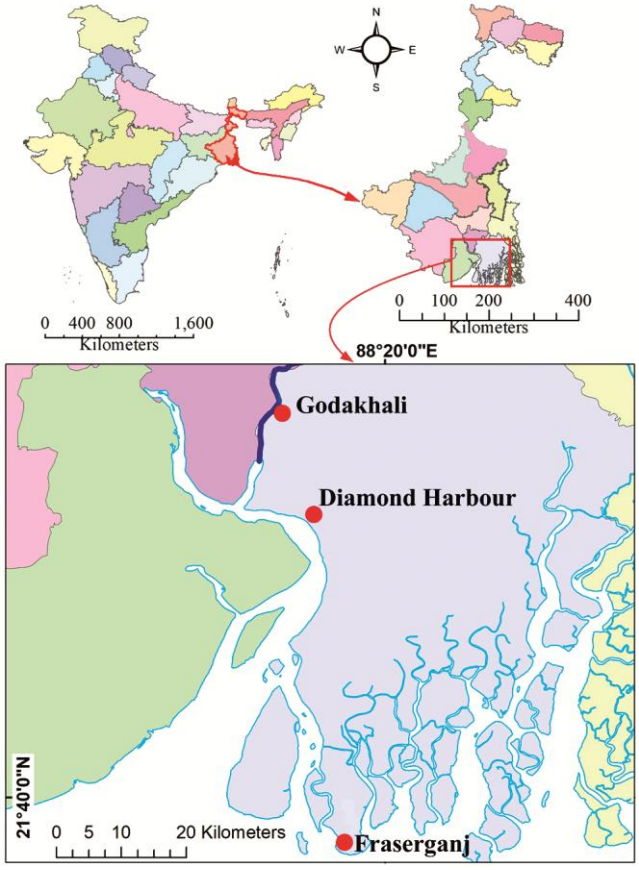

Fig. 1 — Study site under Hooghly-Matlah estuary of West Bengal

Results and Discussion

The length and weight correlation of otolith in *O. pama* is presented in Figure 3. Different parameters

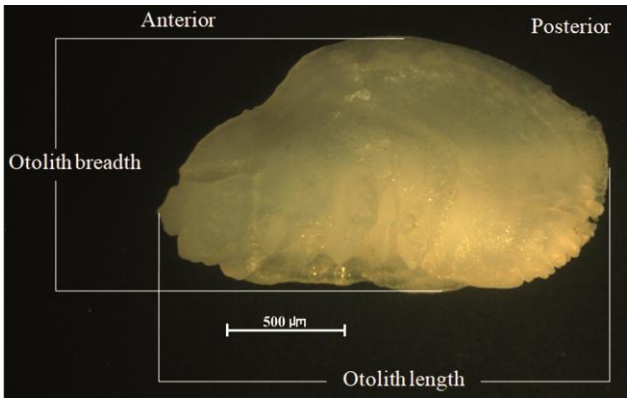

Fig. 2 — Otolith morphology of *O. pama*

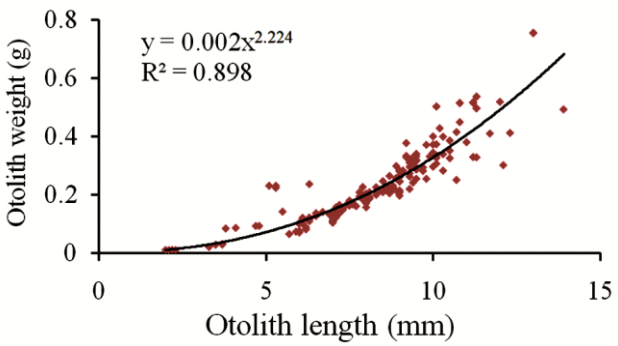

Fig. 3 — Otolith length-weight relationship of *O. pama* (pooled data)

like the sample size of each group, regression parameters of 'a', and 'b' for such relationship and coefficient of determination (R^2) were estimated. The 'b' value for male, female, and indeterminate groups was recorded as 1.558, 2.266, and 2.083, respectively. The corresponding R^2 value of length-weight was 0.669, 0.863, and 0.969 for male, female, and indeterminate groups, respectively.

The length and weight distribution frequency indicated that the fish samples (N = 184) were within the length range of 51.0 to 327.0 mm with a mean value of 184.06 ± 49.43 mm and a weight range of 1.1 to 270.0 g with a mean value of 59.64 ± 50.09 g (Table 1). The mean values of otolith length, weight, and breadth were 8.32 ± 0.213 mm, 0.243 ± 0.133 g, and 6.67 ± 1.754 mm, respectively (Table 2). The female individuals (N = 102) were relatively more in number compared to males (N = 74) in the samples and the male to female ratio was found as 0.73:1.0.

All the six relationships studied exhibited negative allometry. The relationship between TL-OL, TL-OW, TL-OB, TW-OL, TW-OW, and TW-OB were analysed and found that the exponent model had a higher coefficient of determination (R^2) compared to a linear model (Table 2). It was observed that the correlation coefficient (r) was significant ($p < 0.01$) in both the exponent and linear models. Henceforth, equation and graphical representation of the fish size and otolith morphometry relationships were drawn through the exponent models. The scatter diagram in such a model indicated that TL was positively correlated with OL (R^2 = 0.848, Fig. 4a), OW (R^2 = 0.942, Fig. 4b), and OB (R^2 = 0.782, Fig. 4c). There was also a significant positive correlation between TW-OL (R^2 = 0.847, Fig. 4d), TW-OW (R^2 = 0.933, Fig. 4e), and TW-OB (R^2 = 0.782, Fig. 4f). The correlation of fish length with otolith dimensions can be considered as a suitable means for estimation of fish length[26-27].

The otolith length (OL), otolith breadth (OB), and otolith weight (OW) between left and right otolith pairs were not significantly different. In this study, the right otolith was used for comparison of different parameters. Otoliths act as very important taxonomical and biological tools of fish populations. There are several advantages to studying the relationship between fish length and otolith size. Therefore, the studies of fish otolith size for estimating fish size are very common in fisheries science[28]. The present study is the first of its kind of work on otolith size (length, weight, and breadth) in relation to total length and the total weight of *O. pama* occurring in Hooghly-Matlah estuary or Indian waters. Hence, no comparison could be made for the values of 'b' and R^2 of the fish available in other water bodies. Few studies with other sciaenids and related species were provided to support the present research work[2,8,10].

The present study indicated a significant correlation ($p < 0.01$) of otolith length with its weight. Otolith length and weight increased along with an increase in length and age of the king soldier bream, *Argyrops spinifer*, in the Persian Gulf[29]. Kumar *et al.*[2] found that the otolith length, width, and mass have a high degree of dependence on the fish length and weight of 12 species of sciaenids occurring along the north-west coast of India, which resemble the present work.

Otoliths are mainly containing calcium carbonate ($CaCO_3$) and mostly that of aragonite. Its structure is three dimensional but not necessarily grows at the same rate equally in all dimensions. So, its size and shape vary considerably among species[30-31]. The common forms of croakers and drums of the family Sciaenidae are known to produce sound. It is being thought that sagitta exhibits both auditory and vestibular functions, and differences in its size might be due to its functions and other two adjacent otoliths[32].

Table 1 — Range and mean of TL, TW, OL, OW and OB of pooled samples of *O. pama* occurring in Hooghly-Matlah estuary

Parameters	Minimum	Maximum	Mean	SD
Total length (mm)	51.0	327.0	184.06	49.43
Total weight (g)	1.1	270	59.64	50.09
Otolith length (mm)	2.0	13.9	8.32	0.213
Otolith weight (g)	0.0085	0.756	0.243	0.133
Otolith breadth (mm)	1.6	10.2	6.67	1.754

Table 2 — Relationship between TL-OL, TL-OW, TL-OB, TW-OL, TW-OW and TW-OB of pooled samples of *O. pama* with coefficients of determination (R^2)

Types of Relationship	Model used	R^2 value
TL-OL	Linear	0.799*
	Exponent	0.848*
TL-OW	Linear	0.887*
	Exponent	0.942*
TL-OB	Linear	0.746*
	Exponent	0.782*
TW-OL	Linear	0.531*
	Exponent	0.847*
TW-OW	Linear	0.796*
	Exponent	0.933*
TW-OB	Linear	0.487*
	Exponent	0.782*

(*Significant at $p < 0.01$)

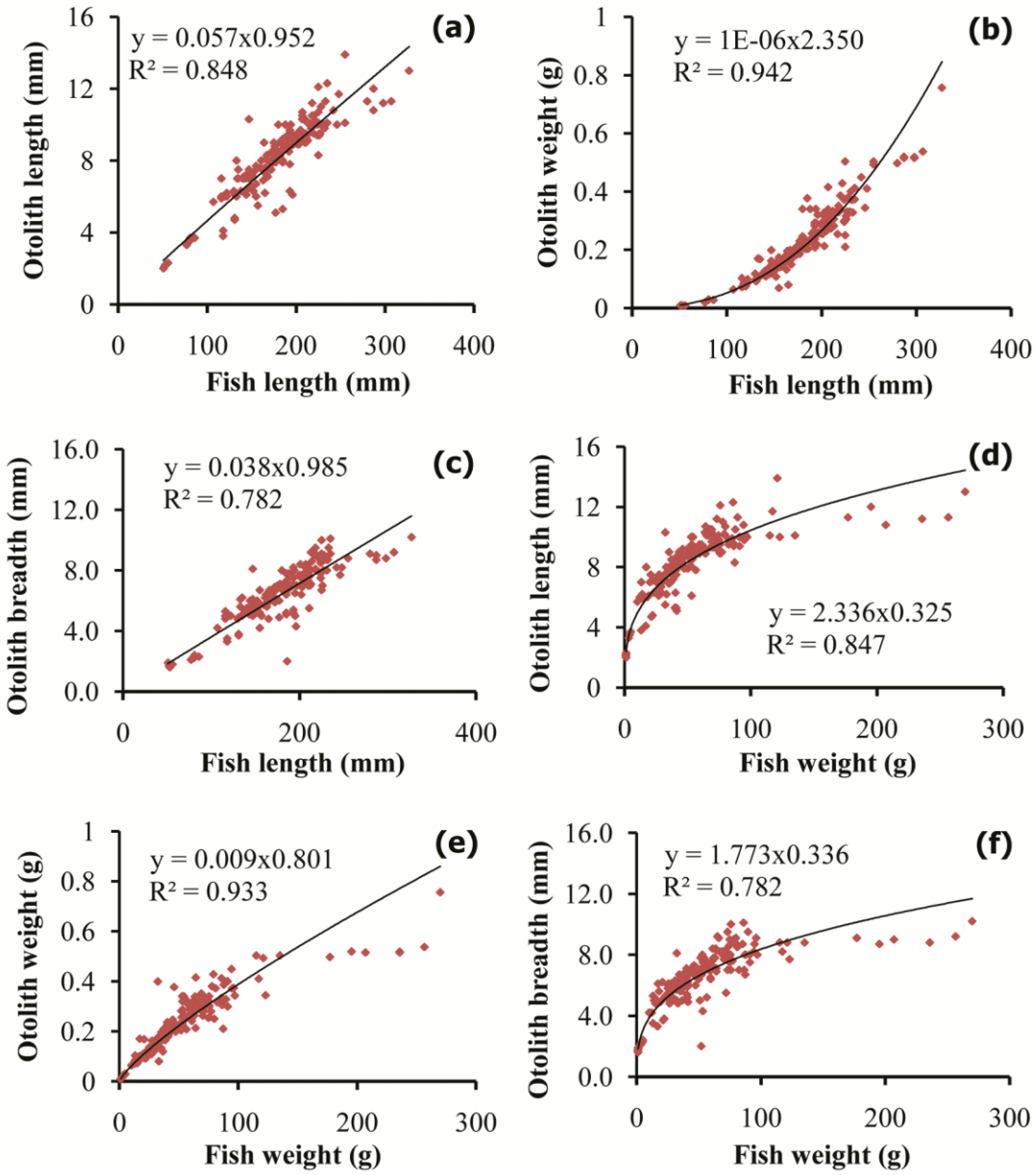

Fig. 4 — Relationship between (pooled data): a) fish length and otolith length; b) fish length and otolith weight; c) fish length and otolith breadth; d) fish weight and otolith weight; e) fish weight and otolith weight, and f) fish weight and otolith breadth

The right otolith was numerically relatively heavier than the left otolith but not different statistically. The present finding is in agreement with the study of Harvey *et al.*[33] and Waessle *et al.*[8] but differs from the study of Battaglia *et al.*[34] and Kumar *et al.*[2]. The left otoliths of *O. ruber* and *O. cuvieri* appear to be bigger than the right[2]. The left and right otolith dimensions were not significantly different as being observed for ten species of clupeids in the Persian Gulf and Oman Sea[35]. They also reported that the length and weight of otolith are considered as good indicators for estimating fish standard length and weight. The left and right otolith of *Cyprinus carpio* Linnaeus, 1758 exhibited a significant difference in the Southern Caspian Sea[36]. However, it was not significant between left and right otolith dimensions in *Nemipterus japonicus* (Bloch, 1791) in the northern Oman Sea[37].

As the size of the fish increased the weight of the respective otolith also increased due to the deposition of calcareous material at its outside, unlike other calcified parts[38]. According to Echeverria &

Volpedo[39], these variations may be due to the way calcium carbonate deposits during the sagitta development, and different morphologies of calcium carbonate crystals were also found to be induced by different biological factors. Kumar *et al.*[2] reported that otolith length, width and mass have a high degree of dependence on the fish length and weight in 12 species of sciaenids namely *J. belangerii*, *J. dussumieri*, *J. elongatus*, *J. glaucus*, *Johnieops macrorhynus*, *J. vogleri*, *J. sina*, *O. cuvieri*, *O. ruber*, *Otolithoides biauritus*, *Protonibea diacanthus* and *Pennahia macrophthalmus* collected from Mumbai, India. Ye *et al.*[40] stated that the otolith shape is correlated with fish age and that the otolith weight has the potential to predict the age of a slow-growing fish Belanger's croaker, *J. belangerii* (Cuvier, 1830) from the coastal waters of China by the alternative and objective method. Kumar *et al.*[20] reported that otolith length, width, and mass are good indicators of total length and weight in twelve species of sciaenids from Mumbai waters, India. Aguilar-Perera & Quijano-Puerto[41] found high correlations between fish length and otolith length in lionfish *Pterois volitans* and they stated that the otolith length and weight can be used to find out the length of lionfish.

David & Pancharatna[42] observed a positive correlation between OW and OD with fork length and the total weight of the Indian whiting, *Sillago indica*. Valinassab *et al.*[35] in their study mentioned that length and weight of otolith are good indicators for estimating fish standard length and total weight in clupeids (ten species studied) from the Persian Gulf and the Gulf of Oman. The length and width of otolith were considered as suitable means to find out the length of blackspot snapper *Lutjanus ehrenbergii* from Oman's Sea, at Muscat City[43].

A highly significant correlation between otolith size and fish size has been observed for many species of fishes found in other parts of the World[8]. The correlation of the size of fish and that of otolith is useful for researchers to study the food habits of piscivores and the size of fish in archaeological samples[44]. Typically otolith length exhibits a linear relationship to fish length until the fish reaches its maximum size and subsequently; the otolith increases only in thickness[45].

Conclusion

As otolith size is increasing with the increase of fish size, hence, otolith shape analysis serves as baseline information for the growth of *O. pama*. Generally, the standard length of fishes exhibits a linear correlation with otolith length. Prediction of the length and weight of fishes can be accomplished with fair reliability based on otolith size. Morphometric relationships analysis of *O. pama* indicated that otolith length, weight, and breadth can be used to estimate the fish length and weight.

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Conflict of Interest

The authors declare that there is no conflict of interest.

Author Contributions

The first author was involved in fish samples collection, otoliths extraction, data analysis, and manuscript writing, other authors helped in manuscript reviewing and editing.

References

1 Anon, *Handbook of fisheries statistics 2015-16*, (The Government of West Bengal, Department of Fisheries, Kolkata), 2016, pp. 182.

2 Kumar P, Chakraborty S K & Jaiswar A K, Comparative otolith morphology of sciaenids occurring along the north-west coast of India, *Indian J Fish*, 59 (4) (2012) 19-27.

3 Bhakta D, Das S K, Manna R K, Roshith C M & Sudhesan D, Fishery of *Otolithoides pama* (Hamilton, 1822) in Narmada estuary, *J Inland Fish Soc India*, 47 (2) (2015) 78-80.

4 Assis C A, The utricular otoliths, lapilli, of teleosts: Their morphology and relevance for species identification and systematics studies, *Sci Mar*, 69 (2005) 259-273.

5 Chilton D E & Beamish R J, Age determination methods for fishes studied by the groundfish program at the Pacific biological station, *Can Spec Publ Fish Aquat Sci*, 60 (1982) 102 p.

6 Hunt J J, Back-calculation of length at age from otoliths for silver hake of the Scotian Shelf, *ICNAF Sel Papers*, 5 (1979) 11-17.

7 Pawson M G, Using otolith weight to age fish, *J Fish Biol*, 36 (4) (1990) 521–531.

8 Waessle J A, Lasta C A & Favero M, Otolith morphology and body size relationships for juvenile Sciaenidae in the Rio de la Plata estuary (35-36 °S). *Sci Mar*, 67 (2) (2003) 233-240. doi.org/10.3989/scimar.2003.67n2233.

9 Monteiro L R, Di Beneditto A P M, Guillermo L H & Rivera L A, Allometric changes and shape differentiation of

sagitta otoliths in sciaenid fishes, *Fish Res*, 74 (1-3) (2005) 288–299. doi.org/10.1016/j.fishres.2005.03.002.

10 Kumar P, Chakraborty S K, Jaiswar A K & Ali S, Length weight relationship and otolith morphometry of twelve species of sciaenids (Family: Sciaenidae) from Mumbai waters, India, *Indian J Fish*, 62 (2) (2015) 104-109.

11 Sen D, Aydin R & Çatla M, Relationships between fish length and otolith length in the population of *Capoeta capoeta umbla* (Heckel, 1843) inhabiting Hazar Lake, Elazığ, Turkey, *Arch Pol Fish*, 9 (2001) 267-272.

12 Yilmaz S, Yazicioglu O, Saygin S A & Polat N, Relationships of Otolith Dimensions with Body Length of European Perch, *Perca fluviatilis* L., 1758 From Lake Ladik, Turkey, *Pak J Zool*, 46 (5) (2014) 1231-1238.

13 Zengin M, Saygin S & Polat N, Otolith shape analyses and dimensions of the anchovy *Engraulis encrasicolus* L. in the Black and Marmara Seas, *Sai Mal*, 44 (2015) 657-662.

14 Ozpicak M, Saygin S & Polat N, Relationships between otolith size and total length of bluefish, *Pomatomus saltatrix* (Linnaeus, 1766), in Black Sea (Turkey), *North-West J Zool*, 13 (1) (2017) 169-171.

15 Hossucu B, Kaya M & Taşkavak E, An investigation of growth parameters and otolith-total length relationship of *Solea solea* (L., 1758) (Pisces: Soleidae) in İzmir Bay, *Isr J Zool*, 45 (2) (1999) 277-287.

16 Venugopal N, Pillai N G K & Prakashan D, Length-weight relationship of *Johnieops sina* (Cuvier, 1830) off Cochin, south-west coast of India, *Indian J Fish*, 60 (4) (2013) 127-129.

17 Bhakta D, Das S K, Das B K, Nagesh T S & Behera S, Food and feeding habits of *Otolithoides pama* (Hamilton, 1822) occurring from Hooghly-Matlah estuary of West Bengal, India, *Reg Stud Mar Sci*, 32 (2019a) 100860. https://doi.org/10.1016/j.rsma.2019.100860.

18 Bhakta D, Das S K, Das B K, Nagesh T S & Samanta R, Growth, mortality and exploitation status of *Otolithoides pama* (Hamilton, 1822) from Hooghly-Matlah estuary of West Bengal, India, *Reg Stud Mar Sci*, 39 (2020) 101451. https://doi.org/10.1016/j.rsma.2020.101451.

19 Bhakta D, Das S K, Das B K, Nagesh T S, Behera S, *et al.*, Length-weight relationship and condition factor of *Otolithoides pama* (Hamilton, 1822) from Hooghly-Matlah estuarine system of West Bengal, India, *Indian J Fish*, 66 (4), (2019b) 51-59.

20 Kumar M S, Rajeswari G & Kishore B, Food and feeding habits of *Johnius carutta* (Bloch, 1793) off Visakhapatnam, East-coast of India, *Fish Tech*, 52 (2015) 88-94.

21 Fischer W & Bianchi G, *FAO Species Identification Sheet for Fishery Purposes Western Indian Ocean Fishing Area 51*, Vols 1-5, (Rome, Italy), 1984, pp. 45-49.

22 Mohan R S L, A review of the sciaenid fishery resources of the Indian Ocean, *J Mar Biol Assoc India*, 33 (1&2) (1991) 134-145.

23 Talwar P K, *Fauna of India and the adjacent countries, Pisces Perciformes: Sciaenidae*, (Zoological Survey of India, Calcutta, India), 1995, 144 p.

24 LeCren E D, The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*), *J Anim Ecol*, 20 (2) (1951) 201-219.

25 Myers R H, Classical and modern regression application, 2nd edn, (Duxbury Press, CA), 1990, pp. 488.

26 Zorica B, Sinovcic G & Cikes K V, Preliminary data on the study of otolith morphology of five pelagic fish species from the Adriatic Sea (Croatia), *Acta Adriati*, 51 (1) (2010) 85-92.

27 Basusta A, Bal H & Aslan E, Otolith biometry-total length relationships in the population of hazar bleak, *Alburnus heckeli* (Battalgil, 1943) inhabiting Lake Hazar, Elazig, Turkey, *Pak J Zool*, 45 (2013) 1180-1182.

28 Battaglia P, Malara D, Ammendolia G, Romeo T & Andaloro F, Relationships between otolith size and fish length in some mesopelagic teleosts (Myctophidae, Paralepididae, Phosichthyidae and Stomiidae), *J Fish Biol*, 87 (2015) 774-782.

29 Ghanbarzadeh M, Soofiani N M, Keivany Y & Taghavi-Motlagh S A, Use of otolith length and weight in age estimations of the king soldier bream, *Argyrops spinifer*, in the Persian Gulf, *Iran J Ichthyol*, 1 (1) (2014) 1-6.

30 Mendoza R P R, Otoliths and their applications in fishery science, *Croat J Fish Ribarstvo*, 64 (3) (2006) 89-102.

31 Campana S E & Thorrold S R, Otoliths, increments, and elements: keys to a comprehensive understanding of fish populations, *Canad J Fish Aqua Sci*, 58 (1) (2001) 30-38.

32 Paxton J R, Fish otoliths: do sizes correlate with taxonomic group, habitat and/or luminescence? *Philos T R Soc B*, 355 (1401) (2000) 1299-1303.

33 Harvey J T, Loughlin T R, Perez M A & Oxman D S, Relationship between fish size and otolith length for 63 species of fishes from the Eastern North Pacific Ocean, *NOAA Tech Rep NMFS*, 150 (2000) 1-36.

34 Battaglia P, Malara D, Romeo T & Andaloro F, Relationship between otolith size and fish size in some mesopelagic and bathypelagic species from Mediterranean Sea (Strait of Messina), Italy, *Sci Mar*, 74 (3) (2010) 605-612.

35 Valinassab T, Seifabadi J, Homauni H & Ali Afraie Bandpei M, Relationships between fish size and otolith morphology in ten clupeids from the Persian Gulf and Gulf of Oman, *Cybium*, 36 (4) (2012) 505-509.

36 Amouei F, Valinassab T & Haitov A, Age determination and morphological study using otoliths in *Cyprinus carpio* Linnaeus, 1758 in the Southern Caspian Sea, *Iran J Fish Sci*, 12 (4) (2013) 759-769.

37 Seyfabadi J, Afshari M & Valinassab T, Otolith morphology and body size relationships of *Nemipterus japonicus* (Bloch, 1791) in the northern Oman Sea, *Indian J Fish*, 61 (2) (2014) 112-117.

38 Reznick D, Lindbeck E & Bryga H, Slower growth results in larger otoliths: an experimental test with guppies (*Poecilia reticulata*), *Canad J Fish Aqua Sci*, 46 (1) (1989) 108-112.

39 Echeverria D D & Volpedo A, Morfologia de los otolitos "sagittae" de juveniles y adultos de *Micropogonias furnieri* (Demarest, 1823) (Sciaenidae), *Thalassas*, 15 (1) (1999) 19-24.

40 Ye Z J, Zhang C, Panhwar S K, Li Z G & Wan R, Ageing Belanger's croaker, *Johnius belangerii* (Cuvier, 1830), based on otolith shape analysis, *J Appl Ichthyol*, 31 (1) (2014) 27-31.

41 Aguilar-Perera A & Quijano-Puerto L, Relations between fish length to weight, and otolith length and weight, of the lionfish *Pterois volitans* in the Parque Nacional Arrecife

Alacranes, southern Gulf of Mexico, *Rev Biol Mar Oceanogr*, 51 (2) (2016) 469-474.

42 David A & Pancharatna K, Age determination of the Indian whiting, *Sillago indica* using otolith ring count, *Indian J Fish*, 50 (2) (2003) 215-222.

43 Al-Busaidi H K, Jawad L A & Al-Balushi A H, Relationships between fish and otolith size of the blackspot snapper *Lutjanus ehrenbergii* (Peters, 1869) collected from the coast of Muscat City, Sea of Oman, *Int J Mar Sci*, 7 (40) (2017) 386-393.

44 Alwany M A & Abdelhak E M, Otolith Morphology and Body Size Relationships for Selected Fishes in Suez Canal and Gulf of Suez, *Catrina*, 3 (3) (2008) 55-63.

45 Blacker R W, Recent advances in otolith studies, In: Sea fisheries research, edited by F R Harden Jones, (John Wiley and Sons, N.Y.), 1974, 67-90.