



## Investigation of otolith in some species of ariidae in persian gulf and Oman Sea

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### Abstract

This study aimed to investigation of otolith in some species of Ariidae family in Persian Gulf and Oman Sea. Sampling lasted from September 2011 to December 2012. During this period two species (*Arius dussumieri* and *Arius thalassinus*) were cut and studied. Trawling time was 2-2½ hours and trawling depth was considered as 10-100 m daily. Catching and sampling operations was done within 24 hours. Sampling and catching was done in Khuzestan and Bushehr waters in fall and winter of 2011 and since the third week of September 2012 sampling was done in Hormozgan and Sistan and Baloochestan waters. All the fish were identified and their otolith was extracted to verify them. Investigation of otolith morphometric characteristics (length, breadth, weight, perimeter and area) was conducted.

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## Introduction

Inner ear of bony fish is made up of bony and vestibular labyrinth. Vestibular labyrinth distinctively consists of three more or less separated chambers (called utricle, saccule, and lagina) and three semicircular canals or ducts. Utricle and ducts form the upper extremities and saccule and lagina form the lower ones. Saccule is connected to utricle from ventral surface and lagena which is attached to the posterior part of succule is well recognized, but in some species it is not possible to identify it. In all three sectors mentioned above, there are beds of neuromast cells that otoliths are placed on them. Otoliths which are available in utricle, saccule, and lagina chambers are called Lapillus, Sagitta, and Asteriscus respectively (Sattari, 2002). Otoliths are small calcified structures found in the heads of fish, which assist in detecting sound and are used for balance and orientation. All bony fish have three pairs of otoliths (Campana and Neilson, 1985) Among the bony fish with three pairs of otoliths, Sagitta is the biggest one in most species and has the most morphological changes among the species which is basically used in determining age and size, classification, migration, and paleontology studies (Harvey *et al.*, 2000; Kinacigi *et al.*, 2000). Morphological characteristics of Sagitta are species specific and most species can be identified by certain sagitta morphology (Harvey *et al.*, 2000; Hunt, 1992). Thus, the otoliths found by paleontologists from past geological periods suggest that they are the best documents for doing systematic research on teleost fish (Harvey *et al.*, 2000; Kinacigi *et al.*, 2000). Moreover, the growth pattern of sagitta otoliths is used for species identification and recognition of different populations of a species because their growth is influenced not only by genetic factors but also by environmental factors such as seasonal changes, temperature, habitat, and food habits and thus investigating the effect of environmental factors on similar species by means of otolith is highly important in eco-morphological studies (Bermejo, 2007). To the fisheries biologist, the otolith is one of the most important tools for understanding the life of

fish and fish populations. Today, different methods are used in identification and classification. For example, in identifying the family, genus, species, and subspecies, the size and shape of otoliths are used as one of the safest classification methods. Considering the fact that no measures are taken in this regard so far by academic and scientific research centers, this research aimed to study otolith differences in some species of Ariidae.

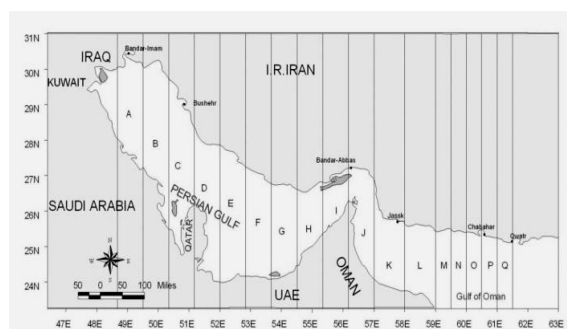
## Materials and methods

### Sampling

In present study, 124 samples out of 2 species were provided since September 2011 until December 2012. The samples were caught by Kavian Trawler owned by Kavian South Fishing Company. Trawling time was 2-2½ hours and trawling depth was considered as 10-100 m daily. Catching and sampling operations was done within 24 hours.

### Site Selection

The studied area included Khuzestan to Sistan and Baloochestan provinces. The total of area was classified into five stratum respectively from west to east (A, B, C, D, E). In each stratum, four deep layers as 10-20, 20-30, 30-50, and 50-100 m were respectively identified and isolated (Fig. 1).



**Fig. 1.** Study area in the Persian Gulf and Oman Sea.

### Biometry

Biometry was done after choosing the species and each specimen was measured for total length (m), fork length (m), body weight (g), otolith length (mm) and otolith weight (g) and classified by the taxonomic classification according to Nelson (2006).

*Otoliths extraction*

Sagittal otoliths were removed from the skulls by the vertical cut method, cutting the back of the heads. Sagittal otoliths of these fish species are large so that they can be removed in a short time with a sharp fish knife. The thumb and forefinger were used to force the head of fish in the eye sockets. The knife blade forced down the skull directly over the operculum, the plane of cutting was a curved line ¾ of the way back on the gill flap. The blade was pushed down from the top through the skull. The left and right thumbs were used to separate the anterior part and posterior part of head, the skull and optic capsules were broken open and separated. The large pairs otolith (sagittal otoliths) then lay exposed inside the otic capsules. This area is well supplied with blood vessels so that they were removed with absorbent paper before extracting the sagittal otolith. The forceps were used to remove the largest pairs from the otic capsules, below the rear of the brain.

*Otoliths preparation*

After that, the sagittal otoliths were washed in clean water to remove the otic fluid, gelatin, tissue and blood. They were allowed to air dry for 12-24 hours (Jitpukdee, 2009). Then, the turbid otoliths were washed by sodium 1% for two minutes and in order to prevent oxidation, the otoliths, based on their size, were placed in the small frames of solid paraffin which had earlier been thawed by heat until they got cold and solid.

*Otoliths classification*

Finally, the otoliths were classified based on their shapes and their photographs were taken.

**Results**

In this research, in order to identify the fish species of Ariidae in Persian Gulf and Oman Sea with otoliths, 124 samples out of 2 species were caught and studied as the following:

Ariidae: Mainly marine (to 100 m depth), many fresh or brackish water; worldwide, tropical to warm temperate. Caudal fin deeply forked; adipose fin present; usually three pairs of barbels, rarely two (no nasal barbels); some bony plates on head and near dorsal fin origin; pectoral and dorsal fins with a spine; anal fin with 14–40 soft rays; in most, if not all species, the male carries the relatively large eggs in its mouth until hatching. Many species of the sea catfishes enter freshwater and some only occur in freshwater. 21 genera with about 150 species (Nelson, 2006).

Class: Actinopterygii  
 Subclass: Neopterygii  
 Division: Teleostei  
 Order: Siluriformes  
 Family: Ariidae  
 Genus: *Arius*  
 Species: *A. dussumieri*

48 samples of *A. dussumieri* were studied; fig.s 2 and 3 illustrate each sample and its otolith. The samples characteristics such as the relationship between otolith length and weight, the relationship between fork length and otolith length, the relationship between fish length and weight and also the length range of the caught fish (cm) were shown in table (1).

**Table 1.** relationship between biometric characteristics of *A. dussumieri* and its otolith.

Relationship between otolith length and weight	$OW=257*10^{-8}OL^{0.125}$ ( $R^2=0.9329$ )
Relationship between fork length and otolith length	$FL= 43084x - 842888$ ( $R^2=0.9471$ )
Relationship between fish length and weight	$W= 0.0203 L^{2.8811}$ ( $R^2=0.8296$ )
length range of the caught fish (cm)	12-61



Fig. 2. *Arius dussumieri*.

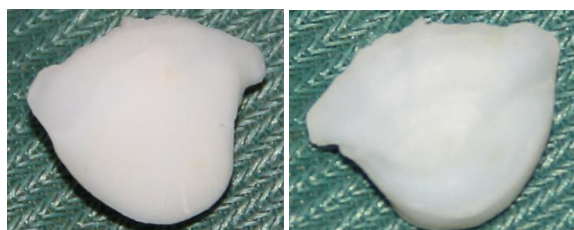


Fig. 3. Proximal and distal surface of otoliths in *Arius dussumieri*.

Morphometric characteristics of *A. dussumieri* and otolith's parameters (such as: TL: Total Length, SL: Standard Length, FL: Fork Length, TW: Total Weight, ROL: Right Otolith Length, ROB: Right Otolith Breadth, ROD: Right Otolith Depth, ROW: Right Otolith Weight, LOL: Left Otolith Length, LOB: Left

Otolith Breadth, LOD: Left Otolith Depth, LOW: Left Otolith Weight, OP: Perimeter and OS: Area) were shown in table (2).

Class: Actinopterygii  
 Subclass: Neopterygii  
 Division: Teleostei  
 Order: Siluriformes  
 Family: Ariidae  
 Genus: *Arius*  
 Species: *A. thalassinus*

76 samples of *A. thalassinus* were studied; fig.s 4 and 5 illustrate each sample and its otolith. The samples characteristics such as the relationship between otolith length and weight, the relationship between fork length and otolith length, the relationship between fish length and weight and also the length range of the caught fish (cm) were shown in table (3).

Morphometric characteristics of *A. thalassinus* and otolith's parameters were shown in table (4).

Table 2. Morphometric characteristics of *A. dussumieri* and its otolith.

Parameter	TL cm	SL cm	FL cm	TW gr	ROL mm	ROB mm	ROD mm	ROW gr	LOL mm	LOB mm	LOD mm	LOW gr	OP	OS
Max	61	51	56	1150	13.56	10.59	4.3	0.5638	13.5	11.01	4.1	0.5645	242.5858	2.542795
Min	12	7	9	85	5.1	3.82	2.11	0.0945	5.24	3.86	2.18	0.0946	9.718561	0.041804
Mean	45	32	38	690	8.43	6.3	3.1	0.2568	8.51	6.72	3.23	0.3516	44.62234	0.41667
S.D.	3.2	4.6	3.8	85.6	1.8	1.02	0.98	0.0845	1.05	1.24	0.95	0.08576		

S.D.: Standard deviation, Min: minimum, Max: maximum

Table 3. relationship between biometric characteristics of *A. thalassinus* and its otolith.

Relationship between otolith length and weight	$OW=8454*10^{-4}OL^{0.1254}$ ( $R^2=0.9593$ )
Relationship between fork length and otolith length	$FL= 51355x - 935296$ ( $R^2=0.9817$ )
Relationship between fish length and weight	$W= 0.0549 L^{2.5558}$ ( $R^2=0.9829$ )
length range of the caught fish (cm)	10-52

Table 4. Morphometric characteristics of *A. thalassinus* and its otolith.

Parameter	TL cm	SL cm	FL cm	TW gr	ROL mm	ROB mm	ROD mm	ROW gr	LOL mm	LOB mm	LOD mm	LOW gr	OP	OS
Max	52	43	48	1024	14.6	13.5	3.8	0.4764	13.8	13.1	3.56	0.4456	166.5407	1.726071
Min	10	5	7	76	2.8	2.59	0.73	0.09161	2.4	2.45	0.71	0.0886	9.450203	0.038922
Mean	36	29	32	610	8.9	7.2	2.98	0.3214	8.8	7.21	2.43	0.2956	70.82801	0.698118
S.D.	3.6	4.2	5	46	1.25	1.6	0.21	0.041	1.62	1.01	0.08	0.0578		

S.D.: Standard deviation, Min: minimum, Max: maximum



**Fig. 4.** *Arius thalassinus*.



**Fig. 5.** Proximal and distal surface of otoliths in *Arius thalassinus*.

### Discussion

Otoliths in fish have the same function as the inner ear in human beings. They contribute to both hearing and balance; therefore, aquatic animals that are skilful swimmers or those that are floating in the water and are swimming very slowly or those that are creeping on the sea floor are expected to have different forms of otolith. For example, otoliths in pelagic bony fish such as Scombridae, Carangidae, and Istiophoridae which are fast swimmers are small while they are bigger in the fish which swim slowly or which are benthic like Sciaenidae, Serranidae, etc. (Parafkande Haghghi, 2008). As mentioned before, otolith in the fish is like otoconia in other vertebrates. Otoliths are bigger than otoconias and are very complicated and different in various species of fish in terms of form and size. Like otoliths, otoconias function to keep the balance. Usually, three pairs of otoliths are all different in the fish in place, size, shape, and structure. Otolith size is slightly bigger in the species whose body structure is round such as Cod or Haddock. Flying fish also have big otoliths which are probably associated with their adaptation to maintain their balance when they come out of water. Pleuronechiformes have thinner otoliths. Generally, bigger sagittas in species and populations which have low somatic growth are called uncoupling. In this case, sagitta otolith's growth is independent of body's somatic growth. It should be noted that in some

researches, the results were different from what was mentioned, that is individuals have been seen who grow more slowly but their Sagitta otolith is bigger than those who grow more quickly (Parafkande Haghghi, 2008). Of course, there are some reports about the impressive effect of growth rate on the shape of sagitta (Wilson, 1985). Most of the reports even those about some deep species indicate that faster growth could somewhat affect the otolith shape (Blitha, 1971; Lombarte and Leonart, 1993; Lombarte, 1992). *A. dussumieri* and *A. thalassinus* are demersal fish and in both of them, the size of otolith was big, otolith's longitude was wide and otolith's thickness was thick. The results of this study show that otoliths of different species from a family can have similarities in appearance but have enough differences to be distinguished from each other. However, in this study the results showed that Variation in otoliths shape and size indicates their species features, fish which are slower moving or benthic have larger otoliths, as mention in Campana and Neilson (1985) Large sagittae occur in non-ostariophysian fishes which have well developed hearing or which communication is important such as Gadidae, Batrachoidida and Sciaenidae. Although speculative, the large size of sagittae in deep sea fishes (e.g., Macrouridae and Ophidiidae) might be important in hearing. Since otoliths function in equilibrium and acceleration, it might be expected that different otolith morphologies should be expected for fish which drift, crawl and swim with varying speeds. Fast swimming pelagic fish (e.g., Istiophoridae, Scombridae, Carangidae) have otoliths greatly reduced in dimension and fish which are slower moving or benthic have larger otoliths (e.g., Megalopsidae, Serranidae, Sciaenidae, Gadidae, Centrarchidae). Otolith shape and dimension can also be related to geographic location, ocean depth and chemical and physical qualities of the environment (Campana and Neilson, 1985).

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### References

- Bermejo S.** 2007. Fish age classification based on length, weight, sex and otolith morphological features. *Fisheries Research* **84**, 270-274
- Botha L.** 1971. Growth and otolith morphology of the Cape Hakes *Merluccius capensis* Cast and *M. paradoxus* Franca. Investigation report division of sea fisheries of South Africa No. 97. Capetown. 32 pp.
- Campana SE, Neilson JD.** 1985. Micro structure of fish otoliths. *Canadian Journal of fisheries and aquatic science.* **42**,1014-1032.
- Harvey TJ, Loughlin RT, Perez AM, Oxman SD.** 2000. Relationship between fish size and otolith length for 63 species of fishes from the Eastern North Pacific Ocean. NOAA Technical Report NMFS 150.
- Hunt JJ.** 1992. Morphological characteristics of otoliths for selected fish in the Northwest Atlantic. *Journal of Northwest Atlantic Fisheries Sciences.* **13**, 63-75.
- Jitpukdee S.** 2009. Crystalline Structure of Sagittal Otoliths from 8 Fish Species in Different Habitats. *Journal of Microscopy Society of Thailand* 2009. **23(1)**, 57-61.
- Kinacigil HT, Akyol O, Metun G, Saygl H.** 2000. A systematic study on the otolith characters of Sparidae (Pisces) in the Bay of Izmir (Aegean Sea). *Turkish Journal Zoology.* **24**, 357-364.
- Lombarte A.** 1992. Changes in otolith area: sensory area ratio with body size and depth. *Environmental biology of fishes.* **33**, 405-410.
- Lombarte A, Leonart J.** 1993. Otolith size changes related with body growth, habitat depth and body temperature. *Environmental biology of fishes.* **37**, 297-306.
- Nelson J S.** 2006. *Fishes of the World*, 4th edn. John Wiley & Sons, Inc., Hoboken, NJ, 601p.
- Parafkandeh Haghighi F.** 2008. Age determination in aquatic animals. Fisheries Research Organization Publications, Tehran.
- Sattari M.** 2002. *Fish biology, anatomy, and physiology.* Naghshe Mehr Publications, Tehran.
- Wilson RRJr.** 1985. Depth related changes in sagitta morphology in sex macrourid fishes of the Pacific and Atlantic Oceans. *Copeia* 1985 (**4**), 1011-1017.
- Yasami M.** 2008. *Ichthyology emphasis on Iranian fishes.* College of applied science and agriculture, Tehran. P.205.