Thalassia Salentina
Thalassia Sal. 42 (2020), 117-124
ISSN 0563-3745, e-ISSN 1591-0725

DOI 10.1285/i15910725v42p117

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OTOLITH MASS ASYMMETRY IN *OTOLITHES RUBER* (BLOCH & SCHNEIDER, 1801) (ACTINOPTERYGII: PERCIFORMES) COLLECTED FROM THE IRAQ MARINE WATERS

SUMMARY

Water pollution is mainly an anthropogenic event affecting water resources of all types. With such a happening, fish are harmfully disturbed. Otolith mass asymmetry can reveal some growing disarrays of fish due to environmental impact. Particularly, high level of otolith mass asymmetry can negatively disturb fish life, consequently the assessment of the asymmetry is imperative for each fish species. In the present work, the otolith mass asymmetry was computed as the difference between the mass of the right and left paired otoliths divided by average otolith mass in *Otolithes ruber*. According to the previous cases obtained on other symmetrical fish species, the absolute value of x in *O. ruber* does not depend on fish length and otolith growth rate, while the absolute value of otolith mass difference is boosted with the fish length. The value of x was between -0.2 and +0.2.

INTRODUCTION

In fishes, the growth of otoliths is continuous during their life (Campana and Thorrold, 2001; Campana, 2004). These structures play a vital function in balance, hearing, gravity sensation and linear acceleration in the species; consequently, they are essential for the existence of the fish (Nolf, 1985; Poper and Lue, 2000). In spite of having 3-D structure, it not necessarily for them to grow equally in all extents (Campana, 1999; Campana and Thorrold, 2001). Otoliths are supposed to have a bilateral symmetry, but a mass difference between the left and right can be perceived in certain cases, and this is called otolith mass asymmetry.

With otolith mass asymmetry, fish have an unusual behaviour when they are introduced to weightlessness of space flight (Egorov and Samarin, 1970; Hoffman, 1977; Von Baungarten, *et al*., 1982; De Jong *et al*., 1996; Hilbig *et al*., 2002; Rehman and Ankan, 2002; Takabayashi and Ohmura-Iwasaki, 2003; Lychakov and Rebane, 2004). The asymmetry in the weight of the otolith of fish can affect the acoustic functionality owing to incompatibility and incongruity of the right and left otolith movement (Lychakov and Rebane, 2005; Lychakov, 2006).

The structure of the otoliths enables using them as a biological model for assessing quantitatively the physiological role of otolith mass asymmetry. In order to investigate the direct acoustic and space studies on fishes, it is suggested by Lychakov *et al*. (2006) to measure the natural patterns of otolith mass asymmetry beforehand. The preceding investigations on otolith mass asymmetry revealed that the bulk of the fish species examined have this asymmetry within the range of $-0.2< x < +0.2$ or < 20% (Lychakov, 1992; Lychakov *et al*., 1988; Lychakov and Rebane, 2004, 2005; Jawad *et al*, 2011; Jawad and Sadighzadeh, 2013; Jawad, 2013; Jawad *et al*, 2017; Al Balushi *et al*., 2017). Moreover, the earlier authors suggested that there is no connection between the value of otolith mass asymmetry and length or mass of the fish. Results like these could be accredited to the otolith mass fluctuation (Lychakov and Rebane, 2004, 2005). Furthermore, results of studies on the otolith mass asymmetry in various symmetric fish species have revealed that it is well below critical standards, so they do not experienced functional damage (Lychakov and Rebane, 2005).

In this study the value the otolith mass asymmetry was quantified for *O. ruber* (Bloch and Schneider, 1801) collected from the marine waters of Iraq and its range was compared. Also, the variability of this asymmetry was assessed during fish growth.

MATERIAL AND METHODS

Description of sampling area

The marine fishing areas in Iraq are the estuary of the Shatt Al Arab River at the city of Fao, Khor Abdulla, Khor al Zubair and Um Qasar regions. The Shatt al-Arab delta is an input of the Karun River and the two major Mesopotamian Rivers (Purser *et al*., 1982; Baltzer and Purser, 1990). The western area of the Iraq coast was converted into a navigation area, with a length of 40 km, a width of 600-800 m, and a depth of up to 22 m. This district contains a number of important Iraq ports.

Fish sample collection

Fish samples (33) of *O. ruber* were collected from the commercial catch using small trawler (21 m length x 3.5 m width) furnished with net of mesh size 2.5 cm functioning at from Khor Abdullah at the south extent of the marine waters of Iraq. Fishes were collected in the period January 2017 to March 2018 at depth of 10-25 m. The procedure of Lychakov *et al.* (2006) was implemented in measuring the standard length of fishes before the extraction of their otoliths. The otoliths were detached from each side, washed in distilled water, air-dried at room temperature for few days, and then weighed on a Sartorius TE 313S analytical balance to an accuracy 0.0001g. The otolith mass asymmetry *(x)* was computed from:

$$x = (MR - ML)\ M\text{-}1$$

where MR and ML are the masses of the right and left otoliths and M is the mean mass of the right and left paired otoliths. Theoretically, *x* value can range between -2 and 2, and *x* = 0 signifies the absence of mass asymmetry, whereas *x* = -2 or *x* = 2 represent the maximal asymmetry (absence of otolith from one of the two sides). The positive value of *x* means that the right otolith mass is larger than the left one and a negative sign denotes the opposite. The association between species absolute value of *x* and the species otolith growth rate was tested. The absolute value of the species otolith mass asymmetry is calculated as the average individual value. To assess otolith development rate the association between otolith mass and fish length, $m = a \times l + b$, was calculated where, *l* is the length of the fish, *"a"* is the coefficient representing the growth rate of the otolith, and *"b"* is a constant for the species in question.

RESULTS

The mean value of *x* is 0.0061 + 0.0228, *n* = 33 (Fig. 1) and the absolute value of *x* IXI?? *What is this*? is 0.0174 + 0.0132, *n* = 33 (Fig. 2). According to the regression analysis there was no relationship between fish length and both IXI (y = 0.0002x - 0.0289) (P > 0.05, *R2* = 0.115) and *x* (y = 3E-05x - 0.0001) (P > 0.05, *R2* = 0.001). The relation between otolith mass difference (MR – ML), and fish length was more complex than the relation between *x* and fish length (*n* = 33, standard length = 215-232 mm, *P* > 0.05, y = 0.0005x - 0.0065, *R2* = 0.0164) (Fig. 3). The saccular otolith mass difference increases with fish length.

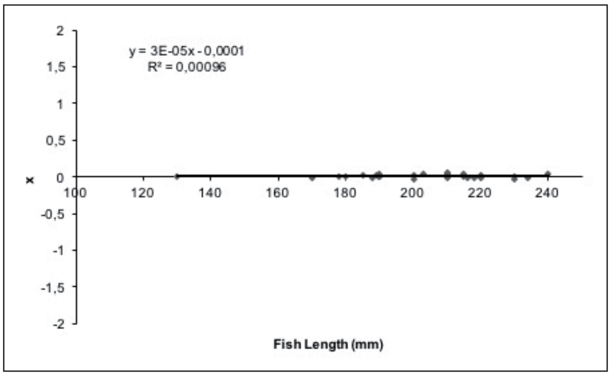

Fig. 1. Saccular otolith mass asymmetry x in *Otolithes ruber* compared with fish length.

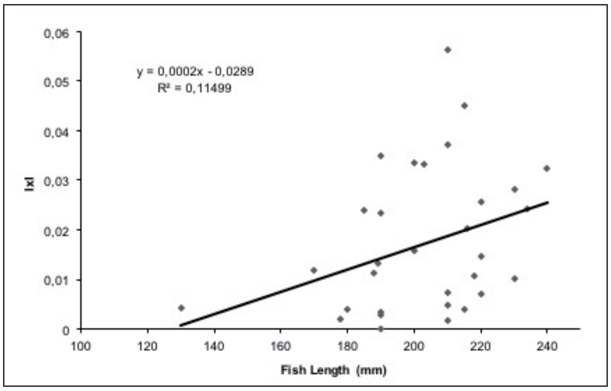

Fig. 2. Absolute otolith mass asymmetry in *Otolithes ruber* compared with length.

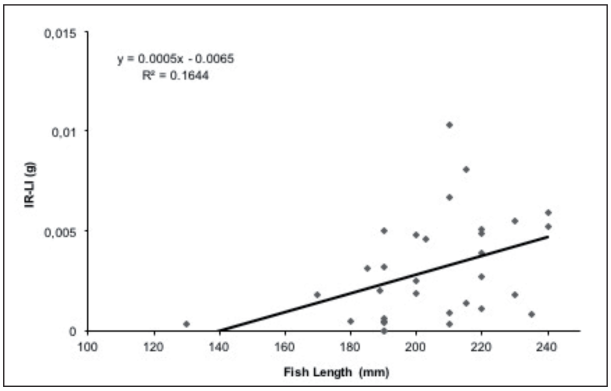

Fig. 3. Saccular otolith mass difference in *Otolithes ruber* compared with length.

DISCUSSION

In fish biology, there are many studies on otolith mass asymmetry, and the otolith mass asymmetry values range -0.2 < *x* < +0.2 for several marine and freshwater species (Lychakov, *et al* 1988; Lychakov, 1992; Takabayashi and Ohmura-Iwasaki, 2003; Lychakov and Rebane, 2004; 2005; Jawad *et al*, 2011; 2017; Jawad and Sadighzadeh, 2013; Jawad, 2013; AL Balushi *et al*., 2017). Additionally, the saccular otolith mass asymmetry was less than 0.06; a value that concurred with the value of mass asymmetry gained for large number of marine species (Lychakov *et al*., 2006) and did not be determined by on otolith growth rate. The saccular otolith mass difference rises with the fish length and this is a distinctive of the littoral and bottom fishes but not the pelagic ones (Lychakov and Rebane, 2004). Lychakov and Rebane (2004; 2005) have revealed through the mathematical modelling that acoustic and vestibular performance of a fish ear can be reduced due to otolith mass asymmetry. Though, in many fishes studied (Lychakov *et al*., 2006), including the species in question, saccular otolith mass asymmetry is very low (IXI < 0.6), regardless of fish length. This low level of otolith asymmetry is characteristic for utricular and lagenar otolith organs also in symmetric teleost fishes. Moreover, Lychakov and Rebane (2005) have displayed that only fishes that comprise the largest otoliths and the absolute value of *x* > 0.2 could, in theory, have problems with sound processing due to unsuitability and absurdity of the movement of the two otoliths on both sides of the head of the fish. Consequently, most fish species can escape functional incapacity as they have otolith mass asymmetry below critical value.

The present results on saccular otolith mass asymmetry it does not depend on fish size. This in agreement with the results obtained by another authors on a few marine and freshwater fish species (Lychakov and Rebane, 2004; 2005; Lychakov *et al*., 2006). Nevertheless, the relationship between otolith mass difference and fish length is more composite. The present work showed no relationship between fish length and otolith mass difference *asymmetry*. This agrees with the findings of Lychakov and Rebane (2004; 2005) on several fish species.

Pollution in Iraq in addition to all over the world arises due to the start of the most imperative environmental impacts. Pollution of different types can upsetting the life of the creatures in way or another. Albeit deliberating the significance of water in the life of living organisms, the effects of water pollution represents the most important problem. In both terrestrial and aquatic life, the only aim of exploring pollution is to examine the direct or indirect effects on organisms and to take needed actions conferring to the results gained. These impacts are also known to regulate the physiology, histology and anatomy, behavioral patterns and nutritional habits of living things (Yedier *et al*., 2018).

Marine areas of Iraq in general, where the fish samples in the present study were collected, are known for their high pollution level. Pollution mainly hydrocarbon was reported over years in the marine waters of Iraq (Al-Jaberi *et al*., 2014; Abdulnabi, 2016; Al-Khion *et al*. 2016) and in the Kuwaiti marine environment (Saeed *et al*., 1999; Beg and Al-Ghadban, 2003; Al-Yamani, 2008). Such source of pollution is originated from the process of exporting oil using the huge oil tankers visiting Iraq ports for loading. Such pollution leads to a degradation of the quality of water resources and the constant change of the aquatic ecosystem (Turgut and Özgül, 2009). Pollution might also cause stress in the aquatic animals, which in turn can affect the developmental stabilities in fish. Preceding studies in this area have shown a direct connection between environmental stress and asymmetry resulting from pollutions (Jawad *et al*. 2012a; b).

Additional investigations with large number of specimens and wide range of body size are required to test the connection between the otolith mass difference and the fish length.

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