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RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

STUDY ON THE OTOLITH MASS ASYMMETRY IN *Lutjanus bengalensis* (FAMILY: LUTJANIDAE) COLLECTED FROM MUSCAT CITY ON THE SEA OF OMAN

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Abstract: The sagittae mass asymmetry was studied in the teleost *Lutjanus bengalensis* and it is calculated as the difference between the mass of the right and left paired otoliths divided by average otolith mass. As in the case of other symmetrical fish species, the result of the present study showed that the absolute value of sagittae mass asymmetry (X) in *L. bengalensis* does not depend on fish length and otolith growth rate. On the other hand, the absolute value of otolith mass asymmetry is increased with the fish length. The value of sagittae mass asymmetry falls between -0.2 and +0.2.

Keywords: Otolith, Mass asymmetry, *Lutjanus bengalensis*, The Sea of Oman

Özet: **Umman Denizi, Muscat Şehrinde Lutjanus Bengalensis (Family: Lutjanidae) Otolit Kütle Asimetrisi Üzerine Bir çalışma**

Bu çalışmada; teleost Lutjanus bengalensis'in kütle asimetrisi, sağ ve sol otolit çiftlerinin kütleleri, ortalama otolit kütlesine bölümü ile hesaplanarak çalışılmıştır. Diğer simetrik balık türlerinde olduğu gibi, bu çalışmada da sagittae kütle asimetrisinin mutlak değeri (X)'nin L. Bengalensis türünde de balığın boyuna ve otolit büyüme oranına bağlı olmadığı görülmüştür. Diğer yandan mutlak otolit kütle asimetrisinin boy uzadıkça artmıştır. Sagittae kütle asimetri değeri -0.2 ile +02 arasında hesaplanmıştır.

Anahtar Kelimeler: Otolit, Kütle asimetrisi, *Lutjanus bengalensis*, Umman Denizi

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Introduction

The behaviour of fish might show significant changes when individuals experience weightlessness condition and if there are mass asymmetry in their otolith (Egorov and Samarin 1970, Hoffman 1977, Von Baungarten *et al.* 1982, De Jong *et al*. 1996, Hilbig *et al* . 2002, Rehman and Anken 2002, Takabayashi 2003, Lychakov and Rebane 2004). Among the striking changes happened to the acoustic functionality of a fish as a result of otolith mass asymmetry is the incompatibility and incongruity of the right and left otolith (Lychakov and Rebane 2005, Lychakov 2006). Additionaly, the vestibular and auditory functions get impaired, but Lychakov *et al.* (2006) stated that the definit quantitative morphological and physiological consequences of otolith asymmetry are still unclear.

In symmetrical fish species, the value of otolith mass asymmetry usually falls between -0.2<X<+0.2 or <20% (Lychakov 1992, Lychakov et al., 1988, Lychakov and Rebane 2004, 2005, Takabayashi 2003). Otolith mass fluctuation might be considered the reason behind such effects Due to the fact that those authors did not obtain a relationship between the magnitude of otolith mass asymmetry and length and weight of the fish (Lychakov and Rebane 2004, 2005). Besides, when the otolith mass asymmetry falls well below the critical values as the case in the symmetric fish species, the functional impairment will not develop (Lychakov and Rebane 2005, Lychakov *et al*. 2006). The quality of reception might be affected by the amount mass asymmetry of otolith as proposed by Egorov and Samarin (1970), Lychakov (1992), Samarin (1992), Lychakov (2002) and Scherer (2001).

Researches on the otolith mass asymmetry are a new issue in Oman icthyological studies and the only works on Omani fishes are of Jawad *et al*. (2010, 2011). Thus, the present work will add further information in this field for Omani fish fauna. The aim of this study is to quantify and to asses the variability of this asymmetry of the lutjanid fish species, *L. bengalensis*.

Materials and Methods

One hundred and fifty fish specimens of *L. bengalensis* and 300 otoliths were obtained. Fish specimens were collected from the coasts of Muscat City at the Sea of Oman over the period of January 2010- July 2010. The method of Jawad *et al*. (2010, 2011) for measuring total length was adopted in this study. The otoliths were extracted from the auditory capsules then rinsed in distilled water, air-dried at room temperature for few days and weighed on a Sartorius TE 313S analytical balance to an accuracy of 0.0001g.

In the statistical analysis, the formula $x = (MR - ML)\ M^{-1}$ is used to calculate the otolith mass asymmetry (x), where MR and ML are the otolith masses of the right and left paired otoliths and M is the mean mass of the right and left paired otoliths.

The usual variation of x value falls between -2 and 2, and when x=0 then absence of asymmetry (MR-ML) occurs and x = -2 or x = 2 represent the maximal asymmetry (absence of one otolith). Positive value of x on the right side means larger otolith and a negative sign means the opposite. The absolute value of the species otolith mass asymmetry is calculated. To evaluate otolith growth rate the linear model for the relationship between otolith mass and fish length was used.

Results and Discussion

The mean value of x is 0.0003+ 0.0209, n=150 (Figure 1) and the value of IXI is 0.0140 +0.0209, n=150 (Figure 2). According to the regression analysis there was no relationship between fish length and both IXI (y = 0.0023x -0.0355) (P>0.05, R^2=0.0167) and x (y= -0.0004x + 0.0109) (P > 0.05, R^2 = 0.0002). The relation between otolith mass difference (MR – ML), and fish length was more complex than the relation between x and fish length (n = 150, total length = 195-230 mm, P > 0.05, y = -3E-05x + 0.0009, $R2$ = 0.0003) (Figure 3).

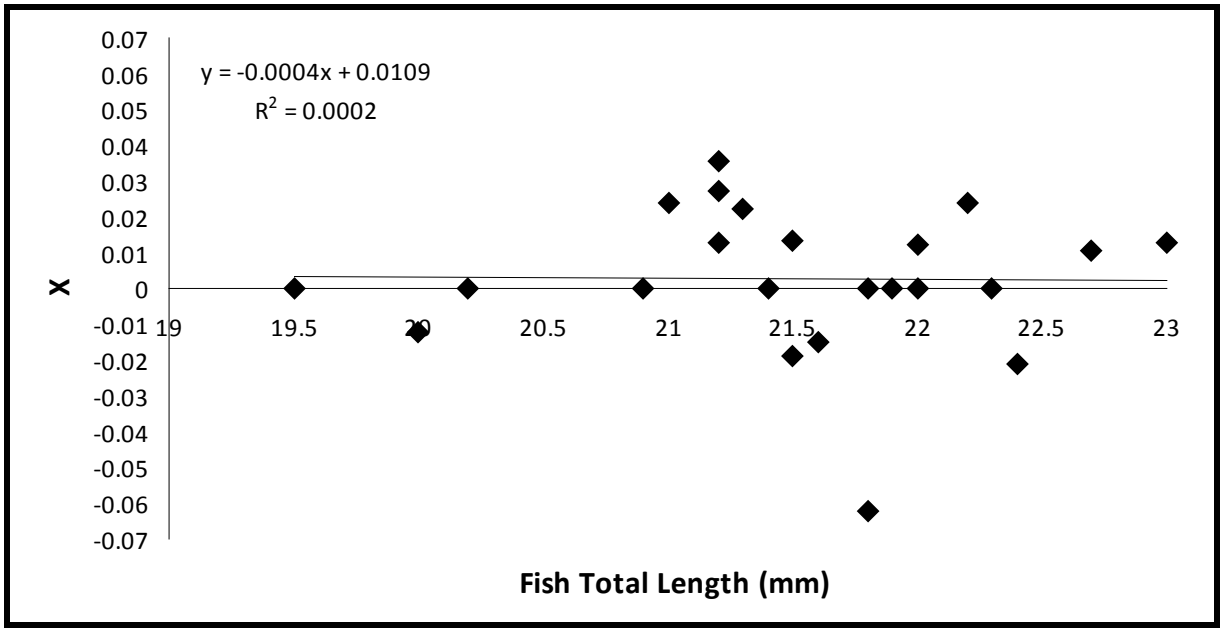

Figure 1. Saccular otolith mass asymmetry x in *Lutjanus bengalensis* as a function of fish length.

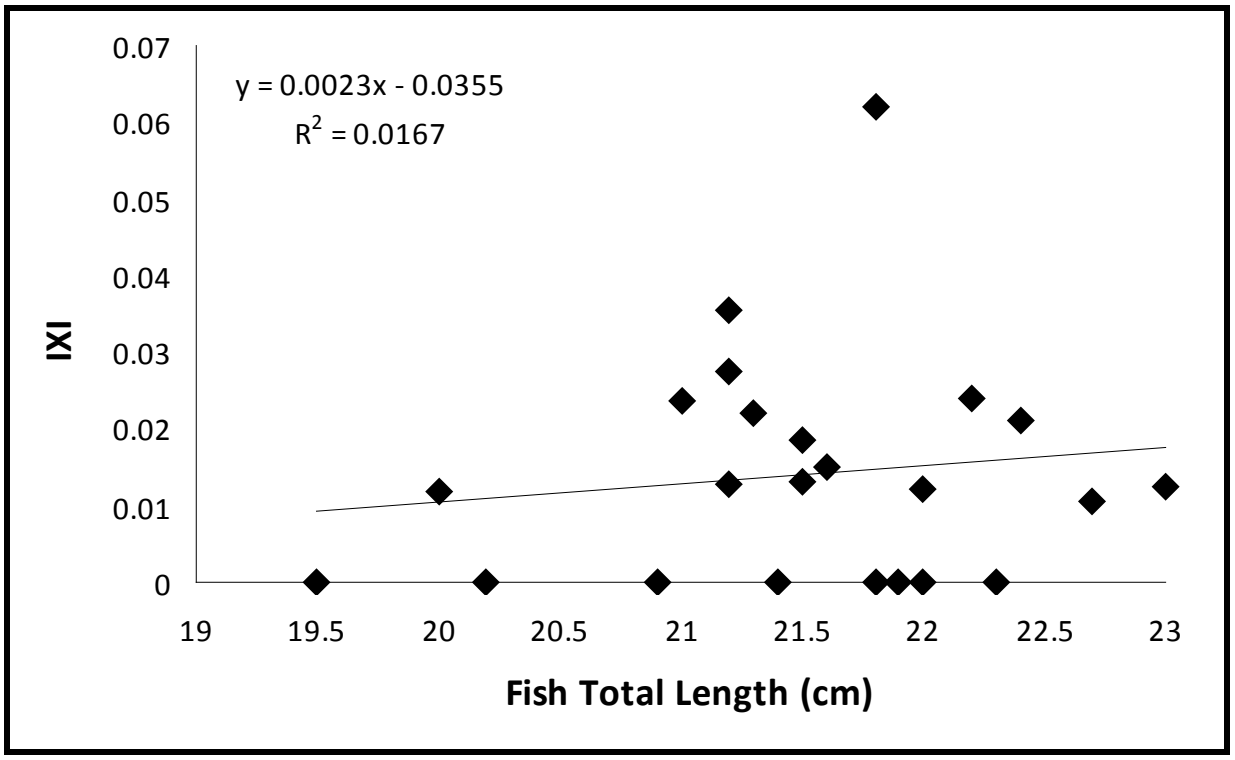

Figure 2. Absolute otolith mass asymmetry as function of fish length.

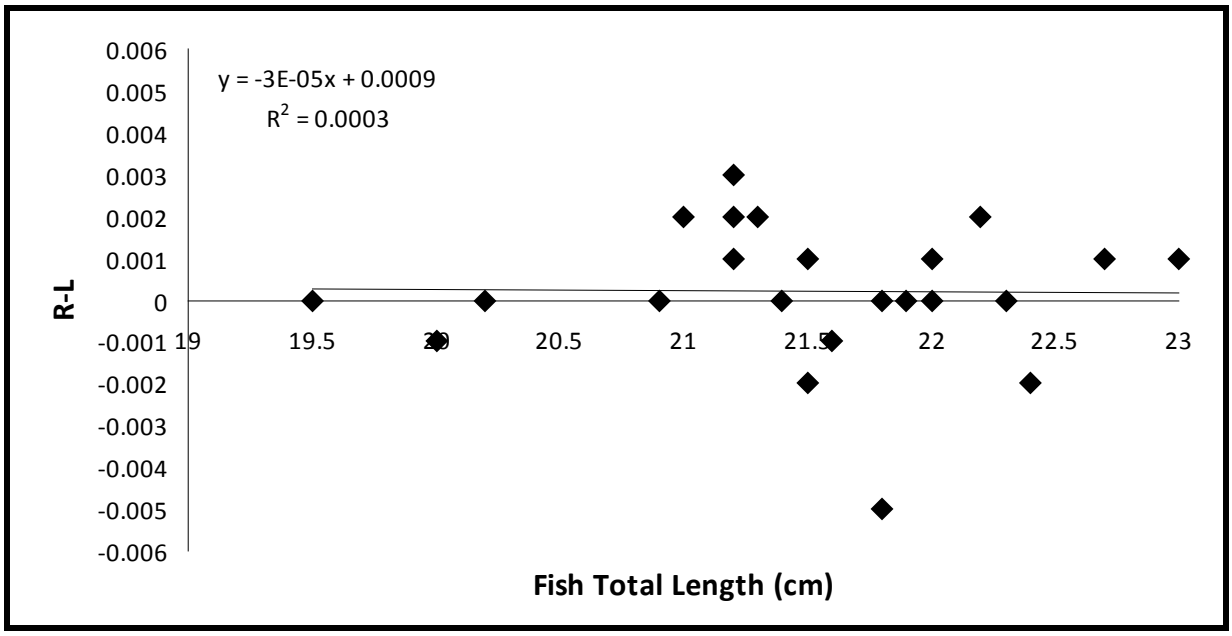

Figure 3. Saccular otolith mass difference in *Lutjanus bengalensis* as a function of fish length.

The range obtained for the value of *x* is between -0.2 and +0.2 as in other marine fish species (Lychakov *et al*. 2008). Lychakov *et al*. (2006) suggested that the value of mass asymmetry of the saccular otolith obtained for large number of marine species is usually less than 0.05. This value is in agreement with the value of mass asymmetry obtained for *L. bengalensis* in the present work. In both symmetrical roundfish and asymmetric flatfish species and whether they are benthic, littoral or pelagic fishes, there are no apparent differences in X (Lychakov *et al*. 2006).

It is well known that otolith mass asymmetry is considered among the reasons that lead to reduction in acoustic and vestibular functionality of a fish ear. This fact was determined by Lychakov and Rebane (2004, 2005) through the mathematical modeling they wrote. In the fish species in question the value of IXI is shown to be low (<0.5), irrespective of fish length. This is in agreement with the results obtained for the majority of fish studied (Lychakov *et al*. 2006). Asymmetry in the utricular and lagenar otolith organs of symmetric fish species is usually low. In theory, only fishes with largest otolith and with IXI >0.5 will experience difficulty in sound reception due incompatibility and incongruity of the movement of the two otoliths (Lychakov and Rebane (2005). Therefore, functional affliction can be avoided by most fish species when otolith mass asymmetry falls below critical value.

The results obtained in the present study about the saccular otolith mass asymmetry showed that this value does not depend on fish size. Such result is in support of the results obtained by other workers on several marine and freshwater fish species (Lychakov and Rebane 2004, 2005, Lychakov *et al*. 2006, Jawad *et al*. 2010, 2011). In spite of the mathematical model of Lychakov *et al*. (2006) that shows the stability of the value of *x* during the life of the fish, it is unknown yet how fish manage to keep the value of their otolith asymmetry at low level (Lychakov *et al*. 2006). The work of Rahmman and Anken (2002) has shown that a monitoring agent acts on the growth of the otolith via negative feedback loop between the brain and the inner ear. Luchakov (2002) suggested that the weight of the otolith on the sensory epithelium is the monitoring agent, but such suggestion faced with evidence disagrees with this hypothesis, and otolith weight seems not to be involved in the regulation of its growth (Luchakov 2002).

The relationship between fish length and otolith mass difference is always considered as a complex relationship and in the present work, no relationship between fish length and otolith mass difference is found. Such result is in agreement with the results obtained by Lychakov and Rebane (2004, 2005) and Jawad *et al*. (2010, 2011) on several fish species. For the absence of the relationship between fish length and otolith mass

difference, Lychakov *et al*. (2006) suggested three reasons; (1) small sample size plays a vital rule in this study; (2) narrow range of variation in the specimen's size studied; and (3) feasible genetic factors. These suggestions are evident in the data of the species in question as only 150 specimens ranging in total length between 202-313 mm were used in this work.

For the future studies, it is advisable to use large number of specimens and wide range of body size to further investigate the relationship between the otolith mass difference and the fish length.

Conclusion

As in the case of other symmetrical fish species, the absolute value of sagittae mass asymmetry (X) in *L. bengalensis* does not depend on fish length and otolith growth rate. The absolute value of otolith mass asymmetry is increased with the fish length and the value of sagittae mass asymmetry falls between -0.2 and +0.2.

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