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Otolith mass asymmetry in *Acanthopagrus arabicus* Iwatsuki, 2013 collected from the Iraqi marine waters

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Abstract

Otolith mass asymmetry may show some growth disorders in fish affected by environmental impacts. Mostly high-level otolith mass asymmetry can negatively upsetting fish life, consequently the assessment per species is very momentous. Saccular otolith mass asymmetry is investigated in the sparid fish species, Acanthopagrus arabicus *collected from Khor al-Zubair at the North-West region of the Arabian Gulf. This feature was calculated as the discrepancy between the weight of the right and left otoliths divided by mean otolith weight in the three sparid species examined. Conferring to the preceding instances attained on another symmetrical fish species, the absolute value of* x *in these species does not resolute by fish length and otolith growth ratio, while the absolute rate of otolith weight disparity is increased with the fish length. The estimate of* x *was between -0.2 and +0.2. Otolith mass asymmetry can show some growth anomaly of fish due to environmental impacts.*

Key words: *Otolith, Ecology, Asymmetry, Sparidae,* Acanthopagrus*, Arabian Gulf.*

Introduction

Among animals, fishes can be affected by unfavourable environmental factors more than any other groups because they are directly facing and become vulnerable to such impacts (Yedier *et al.*, 2018). In teleosts fish species, there are three sets of otolith inside their inner ear known as Asteriscus, lapillus, and Sagitta. The function of the otoliths in the fish body is imperative for the endure living of the fish and contains body balance, hearing, gravity sensation and linear acceleration in the species (Nolf, 1985; Poper and Lue, 2000). The otoliths are usually having bilateral symmetrical structure in the fish, but their weights are different between the left and right otolith, and this is what called otolith mass asymmetry.

The asymmetry in fish species is expected to express the growth disorders of fish owing to different type of impacts such as genetic or environmental stresses (Valentine *et al.*, 1973). Whatever the mass asymmetry is, increase or decrease, the result will affect negatively fish action, chiefly hearing and balance. Consequently, otolith mass asymmetry has been exploited as a bioindicator to check the health of the environment that the fish living in (Grønkjaer and Sand, 2003).

The sparid fish examined in the present study are amongst the significant commercial fish species along its geographical dispersal. It is marine species and often found in fresh and brackish waters. Individuals of the yellowfin seabream, *A. arabicus* (Houttuyn, 1782) favour demersal habitats and regularly ingoing in river mouths and estuaries (Iwatsuki, 2013). They reaching a maximum total length of 400 mm (Wang *et al.*, 2016). This species has been recorded from the Arabian Gulf area (Al-Salim and Jassim, 2013; Iwatsuki, 2013).

Notwithstanding of the increase in otolith weight asymmetry studies in the literature, information of otolith mass asymmetry on the yellowfin seabream investigated in the present study remains unknown in the Arabian Gulf area. In the current study, the value the otolith mass asymmetry was quantified for *A. arabicus* chosen for this study, which was collected from Khor al-Zubair area North-West region of the Arabian Gulf the marine waters. Also, the disproportion of this asymmetry was assessed throughout fish length.

Materials and Methods

Description of sampling area

Khor al-Zubair is one of the four marine coastal areas of Iraq, which include the estuary of the Shatt al-Arab River at the city of Fao, the Khor Abdulla, and Um Qasar regions. Iraqi marine biodiversity has been changed by the region's geological history, position in the North-West Arabian Gulf and its physiographical intricacy. The Tigris and Euphrates Rivers convene at Qurnah to form the Shatt al-Arab River, which flows southward, entering the Arabian Gulf at the city of Fao. The coastal areas in the Khor al-Zubair region spread from sea-level to an elevation 3 m above sea level (Kukal and Saadallah, 1973). Until 1983, when the Shatt al-Basra canal was opened and linked the greater marsh areas in Southern Mesopotamia, the fluctuating course of the Euphrates made Khor al-Zubair a North-West marine extension of the Arabian Gulf (Al-Mussawy, 1991). Salinity values of this lagoon range between 32 and 38 and it is subject to a semi-diurnal tidal cycle with 2-3 m spring tides, similar to the Northern part of the gulf.

Fish sample collection

Fish samples of *A. arabicus* (120) and were collected from the commercial catch using small trawler (21 m length x 3.5 m width) provided with net of mesh size 2.5 cm working at from Khor al-Zubair area at the North-West region of the Arabian Gulf. Fishes were collected in the period February-July 2020 and at depth of 10-25 m. The method of Lychakov *et al.* (2006) was adopted in measuring the standard length of fishes before the removing of their otoliths. The otoliths were isolated from each side, washed in water, left to dry at room temperature, and then weighed on a Sartorius TE 313S analytical balance to an accuracy 0.0001 g. Alterations between left and right otolith mass assessments for each species was confirmed using t- test. Similarly, discrepancy of otolith weight between males and females was corroborated using t- test. The otolith mass asymmetry *(X)* was calculated from $X = (mr - ml)\ m\text{-}1$, where mr and ml are the otolith masses of the right and left otoliths and m is the mean mass of the right and left otoliths. Notionally, the X value can vary between -2 and 2, $X = 0$ signifies the nonappearance of mass asymmetry ($mr - ml$), and $X = -2$ or $X= 2$ exemplifies the maximal asymmetry (absence of one otolith). A positive value of X represents a larger mass for the right otolith mass than the left while a negative value shows the opposite. The connection between the absolute value of X and the otolith growth rate was examined. The association between otolith mass and fish total length, $m = a\ l + b$, was work out in order to assess the otolith growth rate, where m signifies the mass of the otolith, l for the total length of the fish, *"a"* for the coefficient indicating the growth degree of the otolith, and *"b"* for a variables for the sparid species in question.

Results

The mean value of x is 0.0054 ± 0.0131, n = 120 and the value of IXI is 0.0177 ± 0.0152, n = 120. According to the regression analysis, there was no link between fish total length and both X (y = -7E-05x + 0.0206) ($P > 0.005$, $R^2 = 0.0114$) (Figure 1) and IXI (y = -7E-05x + 0.0031) ($P > 0.05$, $R^2 = 0.0252$) (Figure 2). The relation between the otolith mass difference (MR - ML), and the fish length is further complex than the relation between x and the fish length (n = 120, total length = 200-240 mm, $P > 0.05$, y = -1E-05x + 0.0032, $R^2 = 0.0090$) (Figure 3).

Discussion

In recent years, the studies that dealt with otolith mass asymmetry were numerous and in all these investigations the otolith mass asymmetry estimates were shown to be in the range of $-0.2 < x < +0.2$ for quite a few marine and freshwater species (Lychakov *et al.*, 1988; Lychakov, 1992; Takabayashi and Ohmura-Iwasaki, 2003; Lychakov and Rebane, 2004; Lychakov and Rebane, 2005; Jawad *et al.*, 2011; Jawad and Sadighzadeh, 2013; Jawad, 2013; Jawad *et al.*, 2017; Al Balushi *et al.*, 2017). Additionally, the otolith weight asymmetry was less than 0.06 a value that agreed with the value of this phenomenon developed for great number of marine species (Lychakov *et al.*, 2006) and did not be definite by on otolith growth level. The otolith weight inconsistency increases with the fish length and this is peculiarity of the littoral and bottom fishes and not the pelagic fishes (Lychakov and Rebane, 2004). Lychakov and Rebane (2004, 2005) have revealed

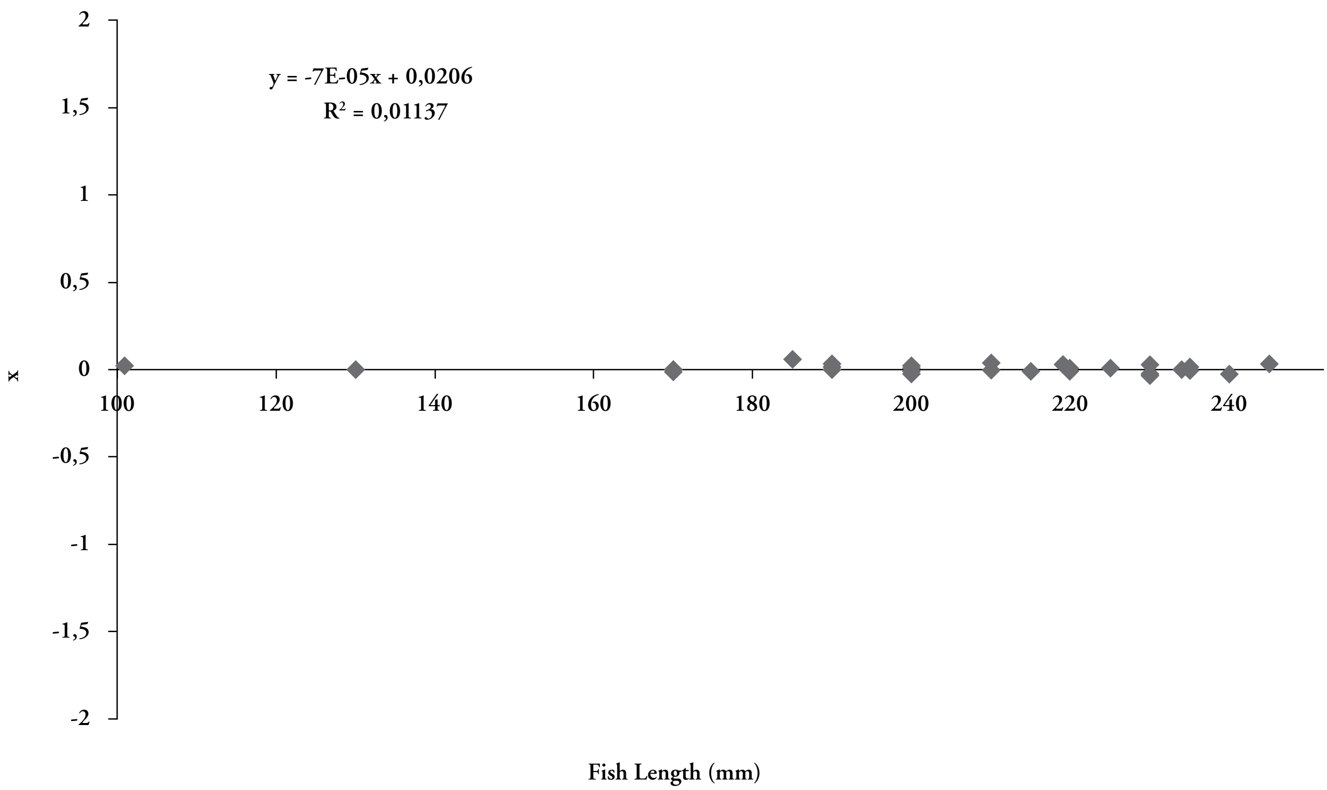

Fig. 4 – Saccular otolith mass asymmetry x in *Acanthopagrus arabicus* as a function of fish total length.

over the mathematical modelling that acoustic and vestibular operative of a fish ear can be reduced due to otolith weight inequality. However, in some fishes examined (Lychakov *et al.*, 2006), containing the species in question, otolith weight asymmetry is very low (IXI < 0.6), irrespective of fish length. This low level of otolith asymmetry is typical for utricular and lagenar otolith organs also in symmetric teleost fishes. Besides, Lychakov and Rebane (2005) have showed that only fishes that encompass the largest otoliths and IXI > 0.2 might, in theory, show difficulty with sound handling due to unsuitability and discrepancy of the movement of the two otoliths on both sides of the head of the fish. Consequently, the majority of fish species can getaway functional incapability as they have otolith mass asymmetry below serious value.

Lychakov *et al.* (2006) suggested that otolith mass asymmetry exhibits resemblances and variations between the marine roundfishes and flatfishes (Lychakov *et al.*, 2008). They concluded that the saccular otolith weight asymmetry is not subjective by the fish length or the otolith growth rate.

Similarly, further marine fish (Lychakov *et al.*, 2008), the value of *X* obtained in the present study falls in a range between -0.2 and +0.2. The otolith weight asymmetry, though, was less than 0.05, a value that concurs with that attained for a large number of marine species (Lychakov *et al.*, 2006). The otolith weight discrepancy increases with the fish length as is the case for other fish species (Lychakov and Rebane, 2004). Lychakov and Rebane (2004, 2005) suggested in their mathematical model that the acoustic and vestibular functioning of a fish ear can decrease due to otolith weight asymmetry. However, in the majority of fish species (Lychakov *et al.*, 2006), including the species studied, the otolith weight asymmetry is very little (IXI < 0.5), regardless of the fish length. This low level of otolith asymmetry is characteristic of the utricular and lagenar otoliths. Conversely, Lychakov and Rebane (2005) specified that only fish with the biggest otoliths and IXI > 0.2 could, in theory, have complications with sound management owing to the unsuitability and conflict of the mobility of the two otoliths on both sides of the head.

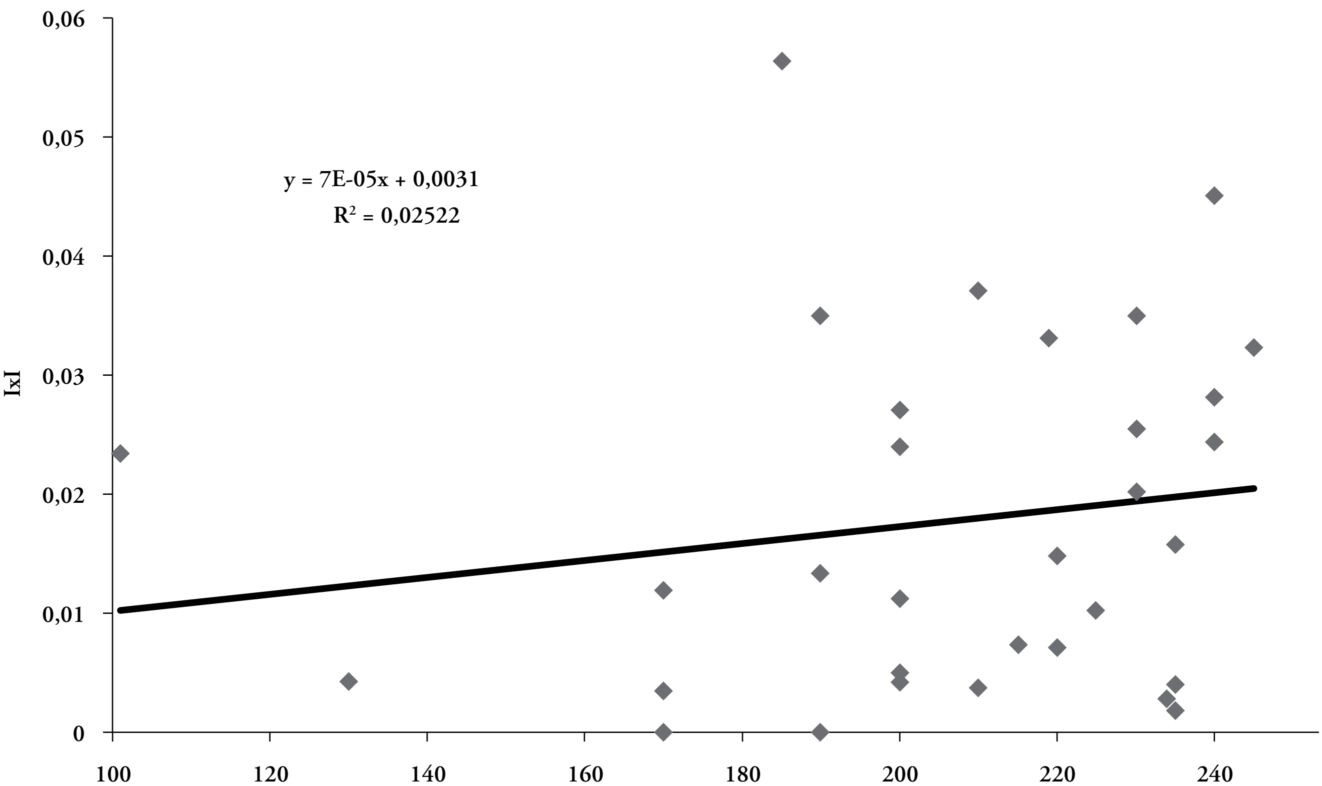

Fig. 5 – Absolute otolith mass asymmetry in *Acanthopagrus arabicus* as function of fish total length

Thus, furthermost teleost species can escape an operating ineffectiveness as they have an otolith weight asymmetry lower than the crucial value.

The impact of otolith weight asymmetry on the vestibular performance was studied and clarified by Lychakov and Rebane (2000, 2004) in their mathematical model that showed the reaction of the ellipsoid-shaped otolith to the action of the force of gravity. They calculated the change between the static displacement of the right and left ellipsoid-shaped otoliths and found that it connected to the otolith weight asymmetry. This displacement modification, they determined, could be the main source of the different release features of the paired otolithic organs and hereafter the performing of otolith asymmetry.

The results of this study on otolith weight asymmetry in *A. arabicus* show that it does not rely on the fish size. This agrees with the results acquired by other researchers on many marine and freshwater fish species (Lychakov and Rebane, 2004, 2005; Lychakov *et al.*, 2006; Jawad, 2013; Jawad and Sadighzadeh, 2013, Jawad *et al.*, 2011, 2012). However, the association between otolith weight difference and fish length is more complex. In the present study, no relationship between fish length and otolith mass has been found. Such an outcome in support of the results attained by Lychakov and Rebane (2004, 2005) on some teleost species. Lychakov *et al.* (2006) suggested that a small link might be owing to the small sample used in the study or when specimens do not visibly deviate in size. Both endorsements can be related to our dataset as only 120 specimens with total lengths between 200-240 mm were used.

Otolith mass asymmetry can have an effect on the life of a fish, so the investigation about the asymmetry of fishes is very vital. In the present study, the average otolith mass asymmetry of *A. arabicus* from Khor al-Zubair area, Iraq, North-West region of the Arabian Gulf was lower than that attained on an individual basis. These outcomes disclose that the population of the species in question is under environmental impact.

Pollution in Iraq is a problem that facing the whole world owing to the impact of on environ-

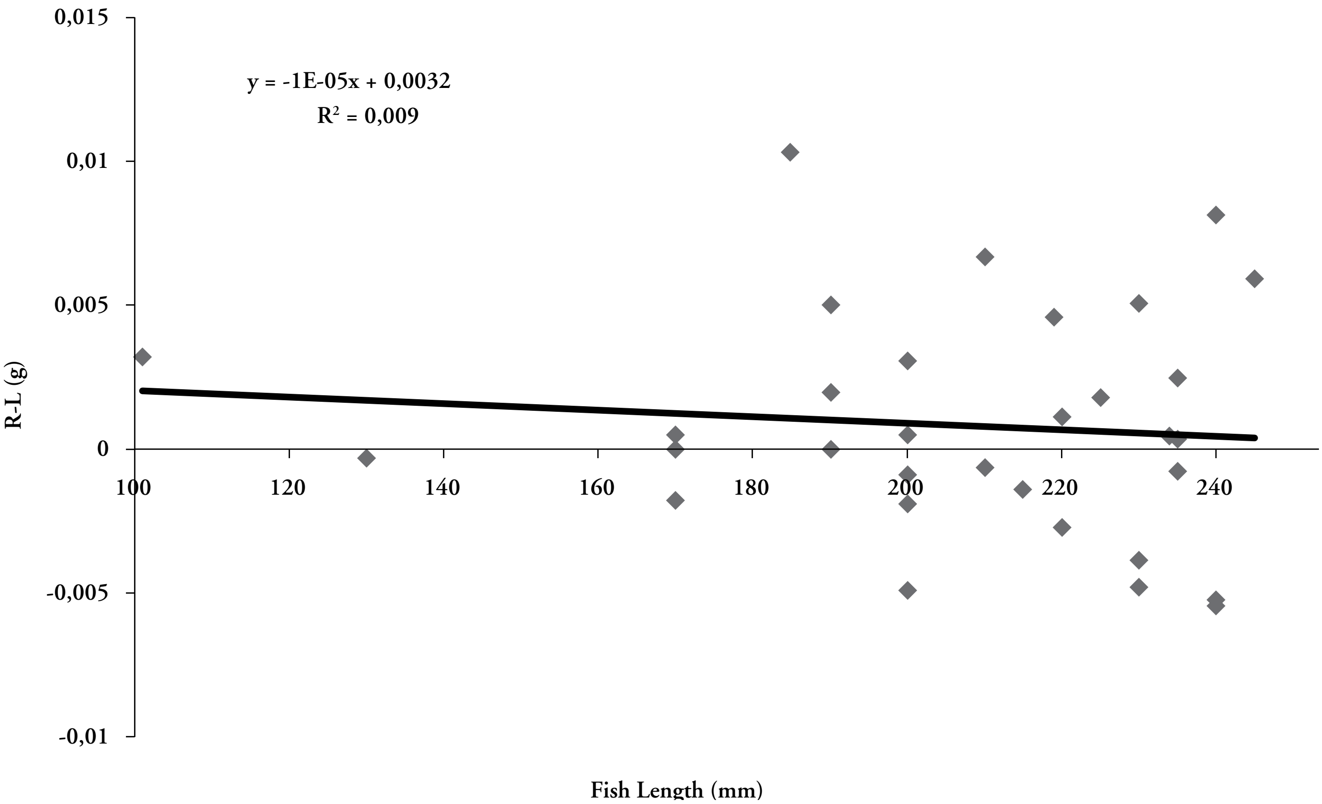

Fig. 6 – Saccular otolith mass difference in *Acanthopagrus arabicus* as a function of fish total length

ment. Pollution of different types can upsetting the life of the biota in way or another. Though bearing in mind the prominence of water in the life of living organisms, the results of water pollution forms the most chief type of pollution in this aspect. The only way to find out about the level of pollution in the aquatic environment is by studying the impact of the adverse factors on the biota. Such events can be applied in both the terrestrial and aquatic habitats. These influences are also identified in controlling the physiology, histology and anatomy, behavioral patterns and nutritional behaviors of living things (Yedier *et al.*, 2018).

Marine areas of Iraq in general, where the fish samples in the study at hand were collected are known for their high pollution level. Pollution chiefly hydrocarbon was distinguished over years in this area (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 started from the course of exporting oil using the huge oil tankers visiting Iraqi ports for loading. Such pollution can cause collapse of the quality of water resources and the constant change of the aquatic ecosystem (Turgut and Özgül, 2009). Pollution could also be a reason for pressure cause on the aquatic animals, which in turn can disturb the growth constancies in fish. Earlier studies in this area have revealed a direct connection between environmental impact and asymmetry as an outcome from pollutions (Jawad *et al.*, 2012).

Further investigations with larger numbers of specimens and a wider series of body size are imperative to find the association between the otolith weight difference and the fish length, particularly in view of the absence of studies on otolith weight asymmetry in the marine waters of Iraq. This study suggests a starting point for future investigations in marine fish species in Iraq and will allow researchers to make links between species in Iraq and species living in the neighbouring areas. A management plan is instantly needed in order to restore a healthy environment in the marine waters of Iraq.

Declarations

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Conflicts of interest/Competing interests
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Availability of data and material
No data deposited in any data base.

Code availability
No software application or custom code were used

Authors' contributions
L.A.J. put the idea of the work, designed the sampling, write the manuscript.

A.Q. collects the samples, measure the fish, extracted otolith and assist in the statistical analysis.

References

ABDULNABI Z.A., 2016. Assessment of some toxic elements levels in Iraqi marine water. Mesopotamian J Mar Sci 31: 85-94.

AL BALUSHI A. H., JAWAD L.A., AL BUSAIDI H.K., 2017. Otolith Mass Asymmetry in Lutjanus ehrenbergii (Peters, 1869) Collected from the Sea of Oman. Intern. J Mar Sci 7.

AL-JABERI M.H., AL-DABBAS M.A., 2014. Assessment of heavy metals pollution in the sediments of Iraqi coastlines. Science 3: 9.

AL-KHION D.D., AL-ALI B.S., AL-NAGAR G., AL-SAAD H.T., AL-ANBER L.J., 2016. Polycyclic aromatic hydrocarbons in some fishes from the Iraqi marine waters. Intern J Sci Res 7: 1911-1917.

AL-MUSSAWY S.N., 1991. About Khor Al-Zubair classification and the ability of determining it's approaching since its different development stages. Oceanography of Khor Al-Zubair (PhD thesis). University of Basra, Iraq (in Arabic).

AL-SALIM N.K., JASSIM A.A.R., 2013. *Acanthopagrus latus* (Houttuyn, 1782) (Perciformes: Sparidae) a new host for the trematode *Erilepturus hamati* (Yamaguti, 1934) Manter, 1947 in Iraqi marine waters. Basrah J Agri Sci 26: 172-177.

AL-YAMANI F., 2008. Importance of the freshwater influx from the Shatt Al-Arab River on the Gulf marine environment. In *Protecting the Gulf's marine ecosystems from pollution*. Birkhäuser Basel: 207-222.

BEG M.U., AL-GHADBAN A.N., 2003. Impact of draining of Iraqi marshes on sediment quality of Kuwait's Northern marine area. Bull Environ Contam Toxicol 71: 60-67.

GRØNKJÆR P., SAND M.K., 2003. Fluctuating asymmetry and nutritional condition of Baltic cod (*Gadus morhua*) larvae. Mar Biol 143: 191-197.

IWATSUKI Y., 2013. Review of the *Acanthopagrus latus* complex (Perciformes: Sparidae) with descriptions of three new species from the Indo-West Pacific Ocean. J Fish Biol 83: 64-95.

JAWAD L.A., 2013. Otolith Mass Asymmetry in *Carangoides caerulepinnatus* (Rüppell, 1830 (Family: Carangidae) Collected from the Sea of Oman. Croatian J Fish 71: 37-41.

JAWAD L.A., SADIGHZADEH Z., 2013. Otolith mass asymmetry in the mugilid fish, *Liza klunzingeri* (Day, 1888) collected from Persian Gulf near Bandar Abbas Anal Biol 35: 105-107.

JAWAD L.A., AL-MAMRY J.M., AL-MAMARI H.M., AL-YARUBI M.M., AL-BUSAIDI H.K., AL-MAMARY D.S., 2011. Otolith mass asymmetry in *Rhynchorhamphus georgi* (Valenciennes, 1846) (Family: Hemiramphidae) collected from the Sea of Oman. J Black Sea / Med Environ 17: 47-55.

JAWAD L.A., AL-MAMRY J.M., AL-MAMARI D., AL-HASANI L., 2012. Study on the otolith mass asymmetry in *Lutjanus bengalensis* (Family: Lutjanidae) collected from Muscat City on the Sea of Oman. J FisheriesSciences.com 6: 74-79.

JAWAD L.A., MEHANNA S.F., ABU EL-REGAL M.A., AHMED Y.A., 2017. Otolith mass asymmetry in two parrotfish species, *Chlorurus sordidus* (Forsskål, 1775) and *Hipposcarus harid* (Forsskål, 1775) from Hurghada, Red Sea Coast of Egypt, Intern. J Mar Sci 7: 200-204.

KUKAL Z., SAADALLAH A., 1973. Aeolian admixtures in the sediments of the Persian Gulf. In Purser B.H. (Editor), The Persian Gulf. Berlin: Springer-Verlag: 115-121.

LYCHAKOV D.V., 1992. Morphometric studies of fish otoliths in relation to vestibular function. Zhurnal Evoliutsionnoi Biokhimii I Fiziologii 28: 531-539.

LYCHAKOV D.V., REBANE Y.T., 2004. Otolith mass asymmetry in 18 species of fish and pigeon. J Grav Physiol 11: 17-34.

LYCHAKOV D.V., REBANE Y.T., 2005. Fish otolith mass asymmetry: morphometry and influence on acoustic functionality. Hearing Res 201: 55-69.

LYCHAKOV D.V., BOYADZHIEVA-MIKHAILOVA A., CHRISTOV I., PASHCHININ A.N., EVDOKIMOV I.I., MAT-

KOV A.A., 1988. Changes in the otolith apparatus of rat and fish after prolonged exposure to acceleration. Kosmicheskaya biologiya I Aviakosmicheskaya Meditsina 22: 27-33.

LYCHAKOV D.V., REBANE Y.T., LOMBATE A., FUIMAN L.A., TAKABAYASHI T., 2006. Fish Otolith asymmetry: morphometry and modelling. Hearing Res 219: 1-11.

LYCHAKOV D.V., REBANE Y.T., LOMBATE A., DEMESTRE M., FUIMAN L., 2008. Saccular otolith mass asymmetry in adult flatfishes. J Fish Biol 72: 2579-2594.

NOLF D., 1985. Otolith piscium. In: Schultze H.P. (Editor), Handbook of Paleoichthyology, Vol. 10, Stuttgart, Gustav Fisher Verlag: 1-145.

POPPER A.N., LU Z., 2000. Structure-function relationships in fish otolith organs. Fish Res 46: 15-25.

SAEED T., AL-GHADBAN A.N., AL-SHEMMARI H., AL-MUTAIRI M., AL-HASHASH H., 1999. Preliminary assessment of the impact of draining of Iraqi marshes on Kuwait's Northern marine environment. Part II. Sediment associated pollutants. Water Sci. Technol. 40: 89.

TAKABAYASHI A., OHMURA-IWASAKI T., 2003. Functional asymmetry estimated by measurements of otolith in fish. Biol Sci Space 17: 293-297.

VALENTINE D.W., SOULE M.E., SAMOLLOW P., 1973. Asymmetry in fishes: a possible statistical indicator of environmental stress. Fish Bull 71: 357-370.

WANG J.Q., HUANG L.M., LI J., ZHANG Y.Z., ZHU G.P., CHEN X.J., 2016. Length-weight relationships of 45 fish species in the Min River Estuary, East China Sea. J Appl Ichthyol 32: 131-133.

YEDIER S., BOSTANCI D., KONTAŞ S., KURUCU G., POLAT N., 2018. Comparison of Otolith Mass Asymmetry in Two Different *Solea solea* Populations in Mediterranean Sea. Ordu Üniversitesi Bilim ve Teknoloji Dergisi 8: 125-133.