ACTA SCIENTIARUM POLONORUM

Acta Sci. Pol. Zootechnica 20(1) 2021, 27–34

www.asp.zut.edu.pl pISSN 1644-0714 eISSN 2300-6145 DOI:10.21005/asp.2021.20.1.03

ORIGINAL PAPER

Received: 01.02.2021
Accepted: 31.03.2021

THE RELATIONSHIP BETWEEN FISH LENGTH AND OTOLITH SIZE AND WEIGHT OF *ACANTHOPAGRUS ARABICUS* IWATSUKI, 2013 (SPARIDAE) COLLECTED FROM THE IRAQI MARINE WATERS

Laith Jawad [1], Audai Qasim [2], Faleh Musa Al-Zaidy [2], Baradi Waryani [3], Jitka Rutkayová [4]

[1] School of Environmental and Animal Sciences, Unitec Institute of Technology, 139 Carrington Road, Mt Albert, Auckland 1025, New Zealand
[2] Marine Science Centre, University of Basrah, Basrah, Iraq
[3] Department of Fresh Water Biology and Fisheries, University of Sindh, Jamshoro, Sindh Pakistan
[4] University of South Bohemia, Faculty of Agriculture, Department of Animal Science, České Budějovice, Czech Republic

ABSTRACT

Fish specimens (n = 75) of *Acanthopagrus arabicus* were collected from the marine waters of Iraq at Khor al-Zubair. Collection was conducted in the period February–September 2019 at depth of 10–25 m. Relationships between fish length and otolith length, width and weight were calculated for the Arabian yellowfin seabream, *A. arabicus* using linear models. This study represents the first data available on the relationship of fish size and otolith size and weight for *A. arabicus* in the Arabian Gulf area. The various relationships between fish length otolith length, width and weight were calculated: $Y = -1E - 0.06X^2 + 0.0106X + 5.2628$, $Y = 4E - 06X^2 + 0.0077X + 2.1834$, and $Y = 9E - 07X^2 + 0.0013X - 0.191$ respectively.

Key words: Fish size, Basrah, relationship, Sparidae, otolith, Arabian yellowfin seabream

INTRODUCTION

The Arabian yellowfin seabream, *Acanthopagrus arabicus* (Iwatsuki, 2013) is a marine species inhabiting pelagic-neritic at depth ranging from the surface of the sea down to 50 meters [Randall 1995]. This species is distributed in the Western Indian Ocean region from southern coasts of Oman at the Arabian Sea and north to the Arabian Gulf at the coasts of Qatar, Kuwait and Iraq [Iwatsuki 2013, Ali and Khamees 2018]. Its distribution continues eastward to include Trivandrum, southwestern India. The maximum total length reported for this species is 345 mm, with common total length of 300 mm [Iwatsuki 2013]. Individuals of this species feeds mainly on echinoderms, worms, crustaceans and mollusks. Mainly exploited by artisanal fisheries [Bauchot and Smith 1984].

Relationships between fish size and otolith size was used in predation investigations, and have broader purposes to conclude changes in growth of fishes [Templeman and Squires 1956]. The size of a fish can be inferred from otolith measurements since somatic growth has a noteworthy impact and is positively linked with otolith mass [Munk 2012]. In the event that the prey items in the fish diets are complete to identify adequately to the genus or species level, rebuilding prey size and biomass from otoliths gained from stomach contents of fish is conceivable if correlations between detailed morphological features of the prey (e.g. otolith length and weight) and actual prey size, and weight-length relationships (WLRs) of prey species are known [Battaglia et al. 2010, Granadeiro and Silva 2000, Jawad and Al-Mamry 2012, Jawad et al. 2011, 2011a, 2011b]. In addition, otolith length and width parameters, and their as-

✉ laith_jawad@hotmail.com

sociations are generally used in keys and identification guides on fish otolith morphology therefore presenting them consistent taxonomic tools [Lombarte et al. 2006].

Relationships between fish size and otolith size have been done in several fish species globally [e.g. Battaglia et al. 2010, Jawad et al. 2011, 2011a, 2011b, Jawad and Al-Mamry 2012, Jawad et al. 2017, Oliveira et al. 2019]. In Iraqi marine waters, however, this information has not been well investigated [Qasim et al. 2019]. Based on these considerations, this paper aims at giving data on morphometric parameters by means of analysing body size and otolith size and weight data relationships in *A. arabicus*, a marine pelagic-neritic species in the north-western part of the Arabian Gulf. Such information could be valuable for future researchers investigating archaeology and food behaviours of piscivores to conclude the size of fishes from the length of regained otoliths. Several piscivorous fish species were reported in the marine waters of Iraq [Al-Faisal and Mutlak 2018] that can prey on *A. arabicus* such as the eel *Muraenesox cinereus* (Forsskål, 1775), the catfish *Plicofollis dussumieri* (Valenciennes, 1840), the scombrid *Rastrelliger kanagurta* (Cuvier, 1816), the barracuda *Sphyraena obtusata* Cuvier, 1829 and many others [Ali et al. 1993, Coad 2015]. Correspondingly, the first-hand data accumulated by the present study will present original ideas on the population dynamics of the sparid species inspected and signify the first step in congregating information and parameters helpful for the scheme and application of assessment means for the valuation of the standing of those stocks.

MATERIAL 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 (Fig. 1). Iraqi marine biodiversity has been changed by the region's geological history, position in the northwest 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 of 3 m above sea level [Kukal and Saadallah 1973, Jobling and Breiby 1986]. Until 1983, when the Shatt al-Basra canal was opened and linked the greater marsh areas in southern Mesopotamia, the fluctuating course

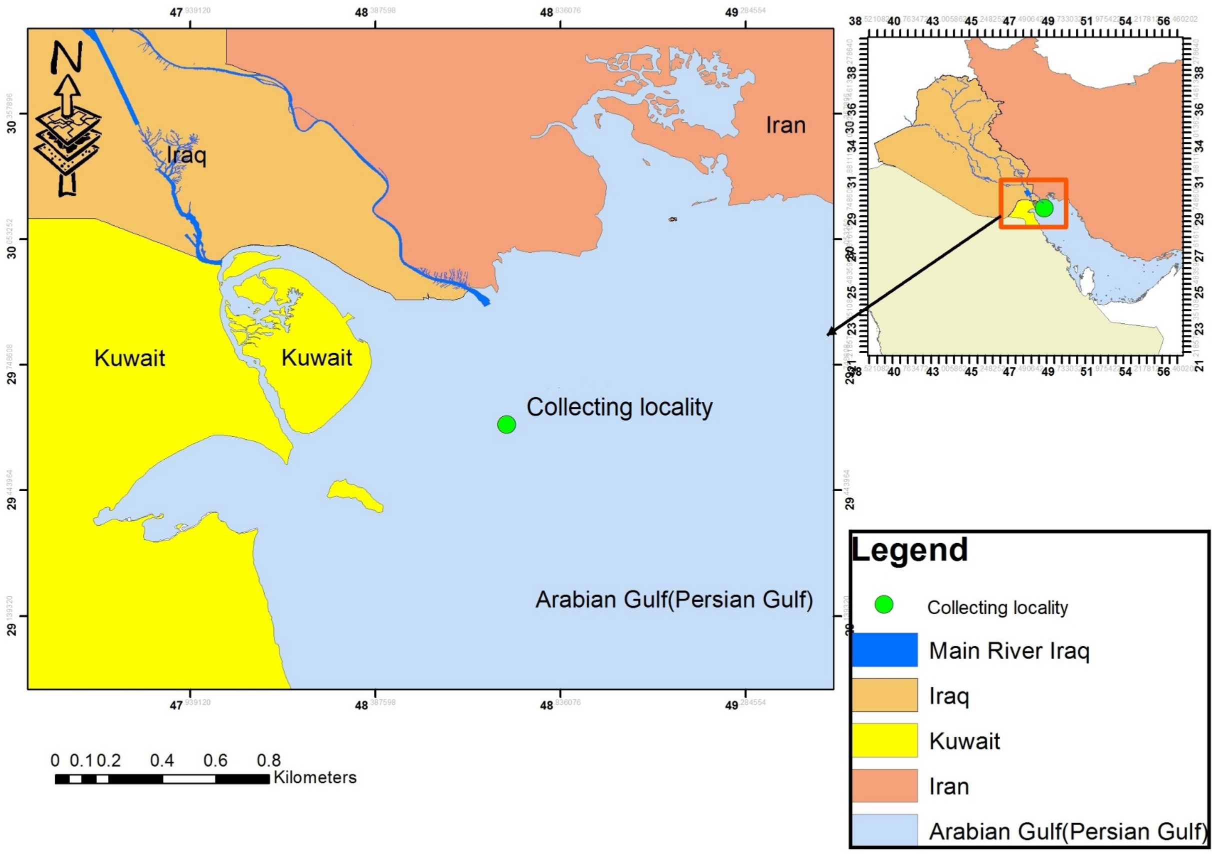

Fig 1. Collection area of *Acanthopagrus arabicus* from the marine waters of Iraq

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 30 and 35% [Bashitialshaaer et al. 2011] and it is subjected 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 (n = 75) of *A. arabicus* were collected during the ichthyological exploration in the marine waters of Iraq by means of small trawler (21 m length × 3.5 m width) furnished with net of mesh size of 2.5 cm, functioning at Khor al-Zubair, north extent of the marine waters of Iraq. Collection was made available in the period February–September 2019 at depth of 10–25 m. Total length (TL) was measured to the nearest 1 mm from the tip of the snout to the posterior edge of the caudal fin. Otoliths (sagittae) were extracted by a cut in the cranium to uncover them and then cleaned and stored dry in glass vials. Sagittae from both sides of the fish head were removed out from the sacculus part of the fish inner ear. Sagittae were obtained from different fish length groups to guarantee that the gotten sample is more characterized and the evaluated factors are more forceful. Each otolith was positioned with the sulcus acusticus oriented through the observer and its length was measured using hand-held Vernier callipers on the axis between the rostrum and post-rostrum axis to the nearest millimetre. Otolith weight was obtained to the nearest 0.001 g. The measurements used following Jawad et al. [2017].

Statistical analysis

The relationship between otolith size (length, width) and weight, and fish size (TL) were determined using least squares linear regression for the following parameters: otolith length (OL) – fish length (TL), otolith width (OW) – fish length (TL) and otolith weight (OWE) – fish length (TL). The regression coefficients were compared and when significant differences ($P < 0.05$) were not found, the H0 hypothesis was accepted. When the equations did not differ statistically, a single linear regression was reported for each parameter (OL; OW; OWE). The data analysis was carried out using the R statistical package [R Core Team 2015].

RESULTS

The range of the total length of the specimens used in this study is 195–365 mm, with a mean of 282 mm and ±0.0543 SD. The sizes of fish specimens used in the present study are those available at the commercial landing, but the extreme small and large sizes were under sampled. The ranges and means (±standard deviation) of otolith length, width and weight were respectively: 7.30–11.60 mm and 9.46 ±2.1 mm; 4.32–6.70 mm and 5.1 ±3.3 mm; 0.034–0.160 g and 0.079 ±1.18 g.

The various relationships between fish length otolith length, width and weight were calculated: $Y = -1E - 0.06X^2 + 0.011X + 5.2628$, $Y = 4E - 06X^2 + 0.0077X + 2.1834$, and $Y = 9E - 07X^2 + 0.0013X - 0.191$ respectively (Fig. 2). Single linear regression was plotted for each parameter. Statistics fitted well to the regression model for three parameters to TL as demonstrated by the high values of the coefficient of determination. ($R^2 = 0.9901$, 0.9690 and 0.9958 for otolith length, width and weight respectively).

DISCUSSION

Otoliths are considered a detailed taxonomic resources in fish species identification due to their inter-specific discrepancy [Battaglia et al. 2010]. Therefore, several investigators have examined the morphology of otoliths [Smale et al. 1995, Campana 2004, Lombarte et al. 2006, Sadigzadeh and Tuset 2012, Jawad 2018, Jawad et al. 2018]. Additional to taxonomic objectives, otolith sizes and features such as the length, width and weight are also imperative to evaluate the size and mass of the fish being preyed upon, as often in studies on feeding ecology the only item enduring in the stomach of a predator is the otolith [Jawad et al. 2011, 2011a, 2011b]. This requirement was focused in the present study and expressed the Total length – Otolith length, Total length – Otolith width and Total length – Otolith weight for otolith of *A. arabicus*. The data can be considered in the back-calculation analysis to gain fish size from regained otoliths exist in the stomachs of predator fish. Nonetheless the vital commercial part of the Arabian yellowfin seabream *A. arabicus* in the marine environment, its biology and ecology have not been well studied in the Iraqi waters [Taher 2010]. The relationship of fish size-otolith measurements of *A. arabicus* were studied for the first time in the Iraqi marine waters. This research accordingly complements information for this species and for the region, which will be valuable in gaining the marine trophodynamics in the area [Zan et al. 2015].

The absence of statistical differences between left and right sagitta indicates that otoliths on either body side are indistinguishable to be used for fish-size estimations [Battaglia et al. 2010, Yilmaz et al. 2015, Mehanna et al. 2016, Park et al. 2017]. It is more appropriate to calculate more than two equations since there is the opportunity of breaking the tip or the dorsal edge of the otolith. Harvey et al. [2000] and Waessel et al. [Waessle et al. 2003] established a remarkable difference in size of the left and right sagittae. Their results are in not in accordance to the results in the present study, which are in concurrence with those of Battaglia et al. [2010], Jawad et al. [2011, 2011a, 2011b] and Qasim et al. [2019]. Certain authors

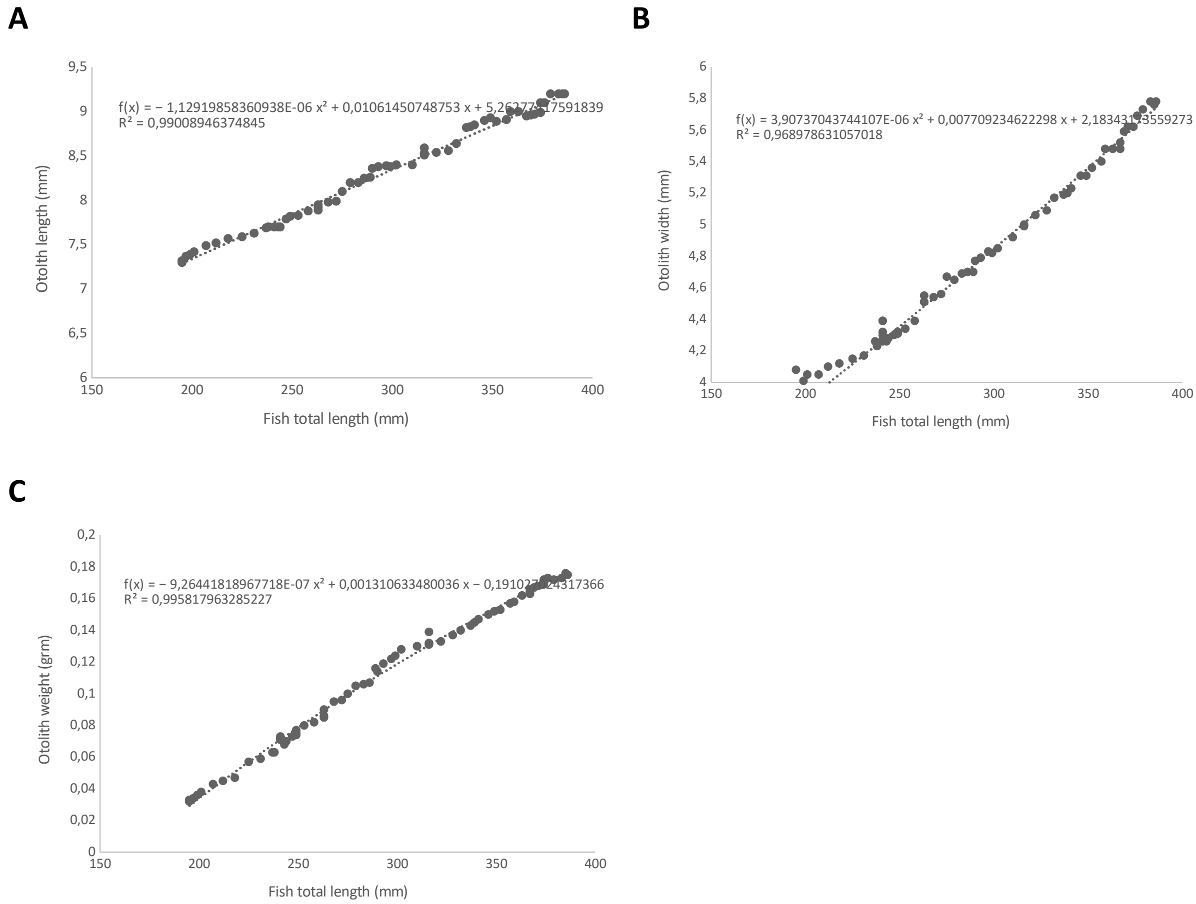

Fig 2. The relationship between fish total length and (A) otolith length, (B) otolith width and (C) otolith weight of *Acanthopagrus arabicus* from the marine waters of Iraq

have involved larvae to those of the adult fish in their investigations. Consequently, they showed two different fish size-otolith measurements, one for the small-sized fish and another for adult fish [Nishimura and Yamada 1988, Linkowski 1991]. In the present study, only adult specimens were used for the otolith analysis.

There are certain restrictions for the usage of fish weight reinstatement from otolith sizes. These limitations act from the difference in the growth of individuals belonging to the same species but of different stocks or that live in different areas [Campana and Casselman 1993, Reichenbacher et al. 2009] or variations between sexes [Echeveria 1987]. Encountering chemicals and mechanical aberrations might anguish the shape of the otolith, which markedly would reduce the usefulness for size rebuilding [Jobling and Breiby 1986, Granadeiro and Silva 2000]. Nevertheless, notwithstanding the robust biometric relationships resulting from our data, our assessed parameters should be applied with carefulness, as our small sample sizes and a discriminating effect of the mesh size used by trawlers may have produced the size distributions in our samples to be understated.

The high correlation coefficients of the mathematical relationships obtained between otolith measurements and weight on one side and fish size of *A. arabicus* on the other indicate that length of fish can be reliably estimated from otoliths found in stomach contents of predators.

Various relationship formulae could be attained for the fish size and otolith size and weight of fish specimens of *A. arabicus* collected from the neighbouring areas to the Iraqi marine waters. Such changes may disclose spatial variation owing to the influence of water physical and chemical characteristics (e.g., environmental variables, such as salinity or variation in pollutants) or food accessibility on fish growth [Mommsen 1998, Adandédjan et al. 2011, Adandédjan et al. 2012]. However, a comprehensive sampling program is required to apply for the whole months of the year in order to collect data and related biological parameters to environmental and anthropogenic factors. Certainly, seasonal variations in relative growth and condition are identified in several fish species [Safran 1992, Richter et al. 2000, Bolognini et al. 2013]. Therefore, further data and information on the structure of the populations of *A. arabicus* are required to be achieved in the Iraqi marine waters. It is maybe to be predictable that the results of the present report will offer a preliminary contribution to further population dynamics and stock assessment studies in such an impacted area with pollution as the Iraqi marine waters.

This study will aid towards future stock assessment investigations, and can be beneficial for supportable application and management of fishery and management of *A. arabicus* resources in the region.

CONCLUSIONS

Both otolith length and width showed a strong link with the fish length and can be used to retrieve the fish length. This is became clear as the coefficients of for the mathematical relationships obtained between otolith dimensions and fish size of *A. arabicus* is quite high. Further researches are required along the geographical distribution of the species in order to study firmly the stock assessment of this species and come out with more useful recommendations.

REFERENCES

Adandédjan, D., Lalèyè, P., Ouattara, A., Gourène, G. (2011). Distribution of benthic insect fauna in a West African lagoon: The Porto-Novo Lagoon in Benin. Asian Journal of Biological Sciences, 4(2), 116–127. DOI: 10.3923/ajbs.2011.116.127.

Adandédjan, D., Lalèyè, P., Gourène, G. (2012). Macroinvertebrates communities of coastal lagoon in southern Benin, West Africa. Int. J. Biol. Chem. Sci., 6(3), 1233–1252. DOI: 10.4314/ijbcs.v6i3.27.

Al-Faisal, A.J., Mutlak, F.M. (2018). Survey of the marine fishes in Iraq. Bulletin of the Iraq Natural History Museum, 15(2), 163–177. DOI: 10.26842/binhm.7.2018.15.2.0163.

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].

Ali, A.H., Khamees, N.R. (2018). Comparative Taxonomy of Two Species of *Acanthopagrus Peters*, 1855 (Pisces: Sparidae) with the First Record of A. sheim Iwatsuki, 2013 from Iraq. Basrah Journal of Agricultural Sciences, 31(2), 36–43. DOI: 10.33762/bagrs.2018.160131.

Ali, T.S., Mohamed, A.R.M., Hussain, N.A. (1993). Trophic interrelationships of the demersal fish assemblage in the Northwest Arabian Gulf, Iraq. Asian Fish. Sci., 6, 255–264.

Bashitialshaaer, R.A., Persson, K.M., Aljaradin, M. (2011). Estimated future salinity in the Arabian Gulf, the Mediterranean Sea and the Red Sea consequences of brine discharge from desalination. Int. J. Acad. Res., 3(1), 133–140.

Battaglia, P., Malara, D., Romeo, T., Andaloro, F. (2010). Relationships between otolith size and fish size in some mesopelagic and bathypelagic species from the Mediterranean Sea (Strait of Messina, Italy). Sci. Mar., 74(3), 605–612. DOI: 10.3989/scimar.2010.74n3605.

Bauchot, M.-L., Smith, M.M. (1984). Sparidae. In W. Fischer and G. Bianchi (eds.) FAO species identification sheets for fishery purposes. Western Indian Ocean (Fishing Area 51). volume 4, FAO, Rome.

Bolognini, L., Domenichetti, F., Grati, F., Polidori, P., Scarcella, G., Fabi, G. (2013). Weight-length relationships for 20 fish species in the Adriatic Sea. Turk. J. Fish. Aquatic Sci., 13, 555–560. DOI: 10.4194/1303-2712-v13_3_21.

Campana, S.E., Casselman, J.M. (1993). Stock discrimination using otolith shape analysis. Can. J. Fish. Aquatic Sci., 50(5), 1062–1083. DOI: 10.1139/f93-123.

Campana, S.E. (2004). Photographic atlas of fish otoliths of the Northwest Atlantic Ocean. NRC Research Press, Ottawa. DOI: 10.1139/9780660191089.

Coad, B.W. (2015). Review of the Spiny Eels of Iran (Family Mastacembelidae). Iran. J. Ichthyol., 2(1), 1–12.

Echeveria, T.W. (1987). Relationship of otolith length to total length in rockfishes from northern and central California. Fish. Bull., 85, 383–387.

Granadeiro, J.P., Silva, M.A. (2000). The use of otoliths and vertebrae in the identification and size estimation of fish in predator – prey studies. Cybium, 24, 383–393.

Harvey, J.T., Loughlin, T.R., Perez, M.A., Oxman, D.S. (2000). Relationship between fish size and otolith length for 63 species of fishes from the eastern North Pacific Ocean, NOAA Technical Report NMFS.

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(1), 64–95. DOI: 10.1111/jfb.12151.

Jawad, L.A., Al-Mamry, J. (2012). Relationship between fish length and otolith dimensions in the carangid fish (*Carangoides coeruleopinnatus* (Rüppell, 1830)) collected from the Sea of Oman. J. Fish. Sci., 6, 203–208. DOI: 10.3153/jfscom.2012023.

Jawad, L.A., Ambuali, A., Al-Mamry, J.M., Al-Busaidi, H.K. (2011). Relationships between fish length and otolith length, width and weight of the Indian mackerel *Rastrelliger kanagurta* (Cuvier, 1817) collected from the Sea of Oman. Ribarstvo, 69, 51–61.

Jawad, L.A., Al-Mamry, J., Al-Busaidi, H. (2011a). Relationship between fish length and otolith length and width in the lutjanid fish, *Lutjanus bengalensis* (Lutjanidae) collected from Muscat City coast on the Sea of Oman. J. Black Sea/Mediter. Env., 17(2), 116–126. DOI: 10.3153/jfscom.2012009.

Jawad, L.A., Al-Mamry, J.M., Al-Mamari, H.M., Al-Yarubi, M.M., Al-Mamary, D.S., Al-Busaidi, H.K. (2011b). Relationships between fish length and otolith length, width and weight of *Rhynchorhamphus georgi* (Valenciennes, 1846) (Family: Hemiramphidae) collected from Oman Sea. Rom. J. Biol., 56, 189–200.

Jawad, L.A., Gnohossou, P., Toussou, A.G., Ligas, A. (2017). Morphometric relationships of Coptodon guineensis and Sarotherodon melanotheron (Perciformes, Cichlidae) in two lakes of Benin (western Africa). Turk. J. Fish. Aq. Sci., 17, 217–221. DOI: 10.4194/1303-2712-v17_1_24.

Jawad, L.A. (2018). A comparative morphological investigation of otoliths of six parrotfish species (Scaridae) from the Solomon Islands. J. Fish Biol., 93(6), 1046–1058. DOI: 10.1111/jfb.13787.

Jawad, L.A., Hoedemakers, K., Ibáñez, A.L., Ahmed, Y.A., El-Regal, M.A.A., Mehanna, S.F. (2018). Morphology study of the otoliths of the parrotfish, *Chlorurus sordidus* (Forsskål, 1775) and *Hipposcarus harid* (Forsskål, 1775) from the Red Sea coast of Egypt (Family: Scaridae). J. Mar. Biol. Assoc. UK, 98, 819–828. DOI: 10.1017/S0025315416002034.

Jobling, M., Breiby, A. (1986). The use and abuse of fish otoliths in studies of feeding habits of marine piscivores. Sarsia, 71, 265–274. DOI: 10.1080/00364827.1986.10419696.

Kukal, Z., Saadallah, A. (1973). Aeolian admixtures in the sediments of the Persian Gulf. (In) The Persian Gulf, (ed.) B.H. Purser. Springer-Verlag Berlin. DOI: 10.1007/978-3-642-65545-6_7.

Linkowski, T.B. (1991). Otolith microstructure and growth patterns during the early life history of lantern fishes (Family Myctophidae). Can. J. Zool., 69, 1777–1792. DOI: 10.1139/z91-247.

Lombarte, A., Chic, Ò., Parisi-Baradad, V., Olivellal, R., Piera, J., García-Ladona, E. (2006). A web-based environment from shape analysis of fish otoliths. The AFORO database. Sci. Mar., 70, 147–152. DOI: 10.3989/scimar.2006.70n1147.

Mehanna, S.F., Jawad, L.A., Ahmed, Y.A., Abu El-Regal, M.A., Dawood, D. (2016). Relationships between fish size and otolith measurements for *Chlorurus sordidus* (Forsskål, 1775) and *Hipposcarus harid* (Forsskål, 1775) from the Red Sea coast of Egypt. J. Appl. Ichthyol., 32, 356–358. DOI: 10.1111/jai.12995.

Mommsen, T.P. (1998). Growth and metabolism. (In) The physiology of fishes, (ed.) D.H. Evans. CRC Press, New York.

Munk, M.K. (2012). Somatic-Otolith Size Correlations for 18 Marine Fish Species and Their Importance to Age Determination. Regional Information Report No. 5J12–13. Alaska Department of Fish and Game.

Nishimura, A., Yamada, J. (1988). Geographical differences in early growth of walleye Pollock *Theragra chalcogramma*, estimated by back-calculation of otolith daily growth increments. Mar. Biol., 97, 459–465. DOI: 10.1007/BF00391041.

Oliveira, R.R.D.S., Andrade, M.C., Machado, F.S., Cunha, É.J.S., Freitas, F.S.D., Klautau, A.G.C.D.M., Giarrizzo, T., Saint-Paul, U. (2019). Biometric relationships between body size and otolith size in 15 demersal marine fish species from the northern Brazilian coast. Acta Amaz., 49, 299–306. DOI: 10.1590/1809-4392201900571.

Park, J.M., Gaston, T.F., Williamson, J.E. (2017). Resource partitioning in gurnard species using trophic analyses: The importance of temporal resolution. Fish. Res., 186, 301–310. DOI: 10.1016/j.fishres.2016.10.005.

Qasim, A.M., Jawad, L.A., Abdullah, A.H.J. (2019). Fish length – Otolith size and weight relationships of the Otolithes ruber (Bloch & Schneider, 1801) collected from the marine waters of Iraq, Persian Gulf. Cah. Biol. Mar., 60, 439–443.

R Core Team (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna.

Randall, J.E. (1995). Coastal fishes of Oman. University of Hawaii Press, Honolulu, Hawaii.

Reichenbacher, B., Kamrani, E., Esmaeili, H.R., Teimori, A. (2009). The endangered cyprinodont *Aphanius ginaonis* (Holly, 1929) from southern Iran is a valid species: evidence from otolith morphology. Env. Biol. Fishes, 86, 507–521. DOI: 10.1007/s10641-009-9549-5.

Richter, H.C., Luckstadt, C., Focken, U., Becker, K. (2000). An improved procedure to assess fish condition on the basis of length-weight relationships. Arch. Fish. Mar. Res., 48, 255–264.

Sadigzadeh, Z., Tuset, V.T. (2012). Otolith atlas from the Persian Gulf and the Oman sea fishes. Lambert Academic Publishing, Saarbrücken.

Safran, P. (1992). Theoretical analysis of the weight-length relationships in the juveniles. Mar. Biol., 12, 545–551. DOI: 10.1007/BF00346171.

Smale, M.J., Watson, G., Hecht, T. (1995). Otolith atlas of Southern African marine fishes. JLB Smith Institute of Ichthyology, Grahamstown. DOI: 10.5962/bhl.title.141860.

Taher, M.M. (2010). Specialization, trophic breadth and diet overlap of thirteen small marine fish species from Shatt Al-Basrah Canal, Southern Iraq. Marsh Bull., 5, 118–130.

Templeman, W., Squires, H.J. (1956). Relationship of otolith lengths and weights in the haddock *Melanogrammus aeglefinus* (L.) to the rate of growth of the fish. J. Fish. Bd. Cand., 13, 467–487. DOI: 10.1139/f56-029.

Waessle, J.A., Lasta, C.A., Bavero, M. (2003). Otolith morphology and body size relationships for juvenile Sciaenidae in the Río de la Plata estuary (35–36°S). Sci. Mar., 67, 233–240. DOI: 10.3989/scimar.2003.67n2233.

Yilmaz, S., Yazicioğlu, O., Yazici, R., Polat, N. (2015). Relationships between fish length and otolith size for five cyprinid species from Lake Ladik, Samsun, Turkey. Turk. J. Zool., 39, 438–446. DOI: 10.3906/zoo-1403-58.

Zan, X.X., Zhang, C., Xu B.-D., Zhang, C.-L. (2015). Relationships between fish size and otolith measurements for 33 fish species caught by bottom trawl in Haizhou Bay. J. Appl. Ichthyol., 31, 544–548. DOI: 10.1111/jai.12751.

ZWIĄZEK MIĘDZY DŁUGOŚCIĄ CAŁKOWITĄ A WIELKOŚCIĄ I MASĄ OTOLITU U *ACANTHOPAGRUS ARABICUS*, IWATSUKI 2013, (SPARIDAE) ZŁOWIONEGO W IRACKICH WODACH MORSKICH

STRESZCZENIE

Ryby *Acanthopagrus arabicus* w liczbie n = 75 zostały złowione w wodach morskich Iraku, w Khor al-Zubair. Połowy prowadzono od lutego do września 2019 roku na głębokości 10–25 m. Zależności między całkowitą długością ryby a długością, szerokością i masą otolitu obliczono dla *A. arabicus* przy użyciu modeli liniowych. Niniejszy artykuł przedstawia pierwsze dostępne dane dotyczące zależności między wielkością ryby a wielkością i masą otolitu dla *A. arabicus* w rejonie Zatoki Arabskiej. Obliczono różne zależności pomiędzy długością, szerokością i masą otolitu ryb, odpowiednio: $Y = -1E - 0,06X^2 + 0,0106X + 5,2628$, $Y = 4E - 06X^2 + 0,0077X + 2,1834$, and $Y = 9E - 07X^2 + 0,0013X - 0,191$.

Słowa kluczowe: wielkość ciała ryby, Basra, zależność, Sparidae, otolit, *Acanthopagrus arabicus*

Laith Jawad https://orcid.org/0000-0002-8294-2944
Audai Qasim https://orcid.org/0000-0001-5883-8736
Faleh Musa Al-Zaidy https://orcid.org/0000-0002-2246-5234
Jitka Rutkayová https://orcid.org/0000-0002-4997-7643