AJMAS

Original article

Morphometric Traits of the Sagittae of Big Scaled Silverside (*Atherina boyeri* (Risso, 1810)) Captured from the East Coast of Libya

Eman Alfergani[1]*, Mohammad El-Mabrok[1] , Rasha Ahmed[2], Sokaina Mostafa[2]

[1]*Department of Marine Science, Faculty of Science, Omar Al-Mukhtar University, El-beida, Libya*
[2]*Department of Zoology, Faculty of Science, Omar Al-Mukhtar University, El-beida, Libya*

ARTICLE INFO

Corresponding Email. *eman.salem@omu.edu.ly*

Received*: 27-01-2023*
Accepted*: 16-02-2023*
Published*: 22-02-2023*

Keywords*. Morphometric, Benghazi, Libya, Atherina Boyeri, Fish, Sagittae.*

ABSTRACT

Aims*. This study was aimed to establish traits of morphometric parameters of Atherina boyeri sagittae and to determine the relationship of these parameters to fish size.* ***Methods.*** *A total of 80 fish were collected from the coast of Benghazi in eastern Libya, during April 2021 were used in the study.* ***Results.*** *The relationship between total length and weight (b = 2.636, R^2 = 0.768) indicates that the growth of measurements is slightly negative, the condition Falton It was (2.1925 ± .07381). Sagittae weight (SWt), length (SL), height (SH), area (SA), aspect ratio, ellipticity, rectangularity, and roundness were measured. There were no significant differences between the left and right sides. Sulcus length (SAL), ostium length (OSL) and cauda length (CL) were 2.199, 0.767 mm, and 1.417 mm, respectively.* ***Conclusion****. This study provides information on growth by examining the length-weight relationship and condition factor, as well as the morphological characteristics of sagittae, which can be used to identify species and sizes.*

Cite this article. *Alfergani E, El-Mabrok M, Ahmed A, Mostafa S. Morphometric Traits of the Sagittae of Big Scaled Silverside (Atherina boyeri (Risso, 1810)) Captured from the East Coast of Libya. Alq J Med App Sci. 2023;6(1):59-64. https://doi.org/10.5281/zenodo.7662278*

INTRODUCTION

Atherina boyeri (Risso, 1810), a sand smelt fish from the family of Atherindae, is found in the surface waters of the coast, including lagoons and lakes where it feeds on zooplankton [1]. By serving as a link between various trophic levels, *A. boyeri* has been found in several earlier studies to play a significant ecological role in the structure of food webs [2,3]. Sand smelt fisheries, together with Gilt-head sea bream and Mugilidae species, are among the most important on the Spanish Mediterranean coast and represent one of the principal fishing resources in the Mar Menor coastal lagoon [4,5]. In some inland waters of Greece and Turkey, sand smelt has become the most important commercial species [6,7].
Otoliths are calcium carbonate formations found in the inner ear of teleost fishes. The sagittae, asteriscus, and lapillus are three pairs of Otoliths found in all bony fish. Relationships between otolith size and fish length are useful for determining fish length from Otoliths in predators' stomachs, and it is cornerstone in studies of prey-predator relations, population management, and archaeological research [8,9].
A. boyeri is a prey for many fish such as *Lobotes surinamensis* [10], and the pike-perch, *Sander lucioperca* [11]. Quantitative aspects of fishing biology, such as the length-weight relationship, condition factor, growth, and mortality of fish, are useful tools for researchers [12].
In Libya, there is no information about the biological characteristics of this fish, and therefore, this study aims to provide basic information on the relationship between length and weight, condition coefficient, morphological characteristics of the Sagittae and its relationship with fish body size.

METHODS

Eighty *Atherina boyeri* collected by fishermen from the port city of Benghazi. Eastern Libya during April 2021 were

used in the study. The total length (TL) of the fish was measured to the nearest 0.1 cm and the total weight (TW) to the nearest 0.01 gm. The length-weight relationship (LWR) was estimated according to Ricker [13]: $W = aL^b$, where L is the total length of the fish in cm and W is its total weight in gm, a is the intercept of the regression line on the y axis, and b is the slope of the line. Fulton (1904)'s condition factor (K) was calculated as: $K = 100\ TW/TL^3$[14]. Then, the head region of each fish was dissected, right and left sagittae were removed from their capsules, cleaned, dried and weighed to the nearest 0.0001g (sagittae weight: SW). Sagittae length (SL), height (SH) and area (SA in mm^2), sulcus length (SAL), ostium length (OSL), and cauda length (CL) were measured to the nearest 0.1mm using image processing (Digimizer software, version 4) (Figure. 1). Percentage of sagittae length from total fish length (SL/TL%), and percentages of cauda length and ostium length from sulcus length (CL/SAL% and OSL/SAL%) were calculated.
Four indicators for shape indices were used (Aspect ratio, Ellipticity, Rectangularity, and Roundness). Sagittae relative size (SR) was calculated according to Lombarte & Cruz [15]: SR = 1000 × SA × TL^−2.
Differences between the mean length, weight, height of left and right side sagittae were tested for significance by an independent t-test. The power equation ($y=ax^b$) was used to describe the relationship between fish size and sagittae dimension, and the relationship between sagittae length and the other sagittae parameters. All calculations and statistics were performed with Excel and SPSS (Version 21.0).

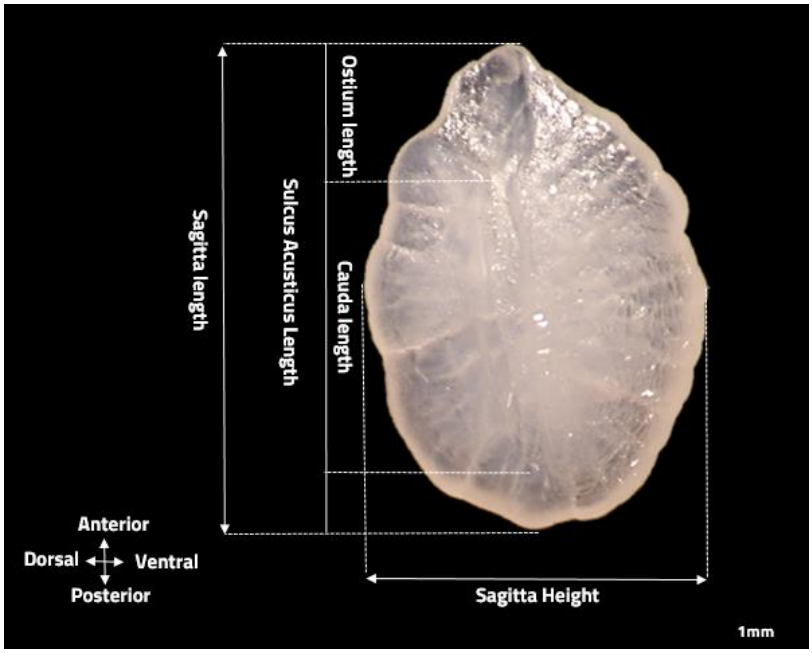

Figure 1. The morphometric parameters measured on the sagittae

RESULTS AND DISCUSSION

The present work is the first study on *Atherina boyeri* length-weight relationship, condition factor, and Sagittae morphology in Libya. *Aherina boyeri* total length and total weight ranged between 5.90 and 8.90 cm with a mean of 7.0183±0.08618 cm, and 1.30 and 4.68 gm with a mean of 2.3879±.09628 gm.
Fulton's condition factor (K), which ranged between 1.23 and 4.38 with a mean of 2.192 (Table 1) indicated that the fish was in good health [16]. The length-weight relationship was established as $TW= 0.0134*TL^{*2.636}$, $R^2= 0.76$, N=80 (Figure.2). The value of "b" of 2.636 indicated negative allometric growth, meaning that the weight increased less rapidly than the length (less than 3, the theoretical value for isometry).
Negative allometric growth was also observed in Lake Trichonis (Western Greece), where" b" was highest in the winter season (b=2.585) and the lowest in summer (b=1.974) [17]. However, in Lake Lisina (Adriatic Sea, Italy) and the Mellah Lagoon (eastern Algeria), the growth of the fish is positive allometric b= 3.10 and b=3.077 for males and 3.176 for females, respectively [18,19]. The differences in the "b" value between this study and other studies are possibly due to factors such as collection time, sample size, sex, gonadal maturity, stomach fullness and other factors [20,21].

Table 1. Descriptive statistics of the morphometric measurements of Atherina boyeri

Morphometric measurements	Min	Max	Mean	SE	SD
Total weight, TW	1.30	4.68	2.3879	0.09628	0.74582
Total length, TL	5.90	8.90	7.0183	0.08618	0.66753
Condition factor (Fulton's)	1.23	4.38	2.1925	0.07381	0.66013

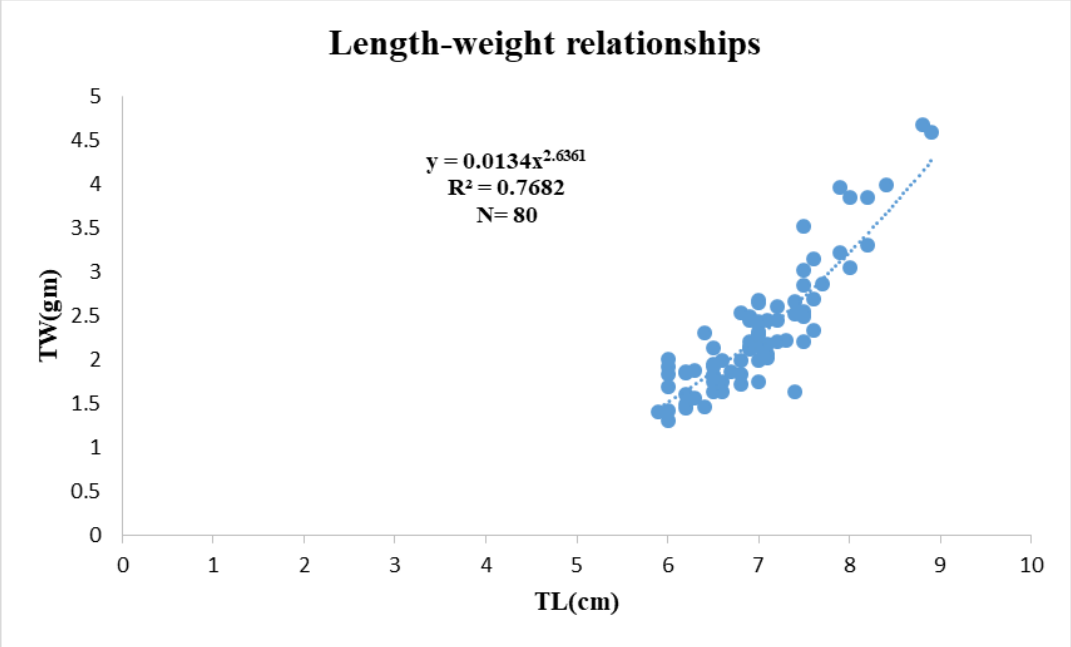

Figure 2. The power length-weight relationship of Atherina boyeri in the present study.

The descriptive statistics of the left and right sides sagittae are shown in Table 2: the average length was 2.5715mm (2.6091mm), height 1.8168mm (1.8014mm), weight 0.0036gm (0.0035gm), and area 3.4984mm^2(3.5784mm^2). Since differences between left and right sides means were not significant ($p > 0.05$) only left side sagittae parameters were used in further analysis.

Atherina boyeri sagittae is elliptic and thin, sulcus with well-defined ostium and cauda, but of quite diverse shape and size. Its length was 2.1992±.04785mm (mean± SE), the ostium was funnel-shaped and was 0.7679±.02319mm long, the cauda was1.4178±.03801mm long straight tube-shaped. Mean morphometric parameters of sagittae collected from the eastern Adriatic Sea were less than those of the present study (S_L; 1.63±0.15, OS_L; 0.71±0.14, C_L; 0.90±0.06) [22].

Table 2. Descriptive statistics of right and left sagittae.

Parameter	side	Mean	SD	SE	*P* value
SL(mm)	L	2.5715	.41677	.05293	.632
	R	2.6091	.45325	.05756	
SH(mm)	L	1.8168	.32584	.04138	.786
	R	1.8014	.30435	.03865	
SW(gm)	L	.0036	.00130	.00025	.956
	R	.0035	.00118	.00023	
SA(mm^2)	L	3.4984	1.40367	.17827	.769
	R	3.5784	1.61242	.20478	

In the present study, the ratios of sulcus length to sagittae length (SAL/ SL %), ostium length to length of the sulcus (OSL/SAL %), cauda length to length of the sulcus (CL/SAL %), and Sagittae length to length of the fish (SL/TL %) were 82.034±0.776%, 34.902±0.451%, 64.497±0.498% and 3.668±0.079% respectively (Table 3).

Table 3. Descriptive statistics of morphological indices of Atherina boyeri sagittae.

Shape indices	Mean	SD	SE
SAL/SL, %	82.034	3.7248	0.776
OSL/SAL,%	34.902	2.1659	0.451
CL/SAL,%	64.497	2.3906	0.498
SL/TL,%	3.668	0.6117	0.079
Aspect ratio	69.175	3.2685	0.415
Ellipticity	0.1728	0.0522	0.006
Rectangularity	0.7309	0.1633	0.020
Roundness	0.6583	0.1945	0.024
sagittae Relative Size, O_R	0.7106	0.2997	0.039

The average values of the aspect ratio, ellipticity, rectangularity, and roundness were 69.1759±0.41510, 0.1728±0.00664, 0.7309±0.02075 and 0.6583±0.02471, respectively. (Table 3). The highest value recorded was for the aspect ratio, while the lowest value was for the ellipticity. This is in agreement with Bostanci *et al.* [23]. The aspect ratio of the *A. boyeri* in the coastal eastern Adriatic ranged from 59.7 to 74.6, while that of the *A. hepsetus* ranged from 60.6 to 70.9 [22]. According to Lombarte & Cruz [15], who classified the relative size into four groups (very small, small, medium, and large), the average relative size in this study was greater than 0.65, and therefore this fish has a large sagittae.

The relationship of sagittal dimension and fish size has been investigated by several researchers [23-25]. The relationship between the morphometric parameters of the sagittae (length and height) and the length and weight of the fish was described using power regressions (Table 4). The value of the coefficient of determination ranged from R^2=0.75 (SH - FL) to R^2=0.50 (SH - FW).

Bostanci *et al*. [23] used logarithmic and linear regressions to establish these relationships. The value of the coefficient of determination for TL-OL was higher in Hirfanli Dam (R^2=0.91) and Iznik Lake (R^2=0.88) and lower in Lake Egirdir (R^2=0.65). These values were lower than the ones obtained in the present study, these differences can be attributed to differences in environmental characteristics of the ecosystem. The coefficient of determination was more than 0.70 for fish length and Sagittae dimension so there is a good possibility of determining the length of the fish through the length and height of the sagittae.

In a study on the ecology, age and growth of *A. boyeri* and *A. presbyter* in the Ria de Aveiro, Portugal, conducted by Pombo *et al*., [26], it was shown that the otolith length corresponds to the fish length in the same proportions for both species. Our study showed a strong relationship between the length SL and the height SH of the Sagittae; the value of the coefficient of determination was R^2 = 0.79. The best regressions between Sagittae length and sulcus dimensions (sulcus length, ostium length, and cauda length) were: SAL-SL, R^2=0.88; CL-SL, R^2=0.80; and OSL-SL, R^2=0.75.

Table 4. Regressions of Atherina boyeri length, weight, and sagittae length, with different sagittae parameters.

Power Equation	a	b	R^2
SL-FL	0.1348	1.514	0.71
SH-FL	0.0021	3.431	0.75
SL-FW	1.472	0.661	0.54
SH-FW	0.513	1.397	0.50
SH-SL	0.257	1.974	0.79
SAL-SL	0.8104	1.011	0.88
OSL-SL	0.2701	1.056	0.75
CL-SL	0.5424	0.972	0.80

CONCLUSION

This study provides information on growth by providing information on the length-weight relationship and condition factor, in addition to examining the morphological characteristics of the sagittae such as shape index, morphological percentages, and a relationship between body size and sagittae measurements, which are good tools in identifying species and their sizes.

Disclaimer

The article has not been previously presented or published.

Conflict of Interest

There are no financial, personal, or professional conflicts of interest to declare.

REFERENCES

1. Golani D, Ozturk B, Basusta N. Fishes of the eastern Mediterranean. Turkish Marine Research Foundation. Istanbul. Turkey. 2006; 115.
2. Vizzini S, Mazzola A. Feeding ecology of the sand smelt Atherina boyeri (Risso 1810) (Osteichthyes, Atherinidae) in the western Mediterranean: evidence for spatial variability based on stable carbon and nitrogen isotopes. Env. Biol. Fish. 2005; 72: 259–266.
3. Chrisafi E, Kaspiris P, Katselis G. Feeding habits of sand smelt (Atherina boyeri, Risso 1810) in Trichonis Lake (Western Greece). J. Appl. Ichthol. 2007; 23: 209–214.
4. Guevara J, Sautier-Casaseca G. 1977. Data on the environmental conditions and ichthyological fauna of the Mar Menor. CRIS.1977; 155: 18–20.
5. Cabo F. L Ichthyology of the Mar Menor (Murcia). The Physostomes. Publications Service of the University of Murcia, Murcia.. 1979; 229 pp.
6. Koutrakis E. Fishery management in the lagoons of North Greece. Problems and proposals. Proc. 9th Panhellenic Congress of Ichthyologists, Mesolongi, 2000; 133–136.
7. Ozeren S. Age, growth and reproductive biology of the sand smelt Atherina boyeri, Risso 1810 (Pisces: Atherinidae) in Lake Iznik, Turkey. J. Fish. Int. 2009; 4:34–39.
8. Harvey J, Loughlin T, Perez M, Oxman D. Relationship between fish size and otolith length for 63 species of fishes from the eastern North Pacific Ocean. NOAA Technical Report NMFS, 2000; 150: 35.
9. Tuset V, Lombarte A, Assis C. Otolith atlas for the western Mediterranean north and central eastern Atlantic. Scientia Marina, 2008; 72 (S1): 7-198. https://doi: 10.3989/scimar.2008.72s17
10. Daban İ, Cabbar K. New Occurrence of Atlantic Tripletail, Lobotes surinamensis (Bloch, 1790) from the Turkish part of the Aegean Sea, with biological notes. Acta Aquatica Turcica, 2021;17(3):327-333. https://doi.org/10.22392/actaquatr.814774
11. Yağcı M, Alp A, Yağcı A, Uysal R. Diet and Prey Selection of Pikeperch (Sander lucioperca Linnaeus, 1758) Population in Lake Eğirdir (Turkey). Archives of Biological Science Belgrade. 2014; 66(4):1515-1527. doi: 10.2298/ABS1404515Y
12. Lizama M, los A, Ambrósio A. Condition factor in nine species of fish of the characidae family in the upper paraná river floodplain, brazil. Braz J Biol.2002; 62(1): 113-124.
13. Ricker W. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada. 1975; 191:1-382.
14. Fulton T. The rate of growth of fishes. Twenty second Annual Report, Part III. Fisheries Board of Scotland, Edinburgh. 1904; 141-241.
15. Lombarte A, Cruz A. Otolith size trends in marine Fish communities from different depth strate. Journal of Fish Biology. 2007;71 :53-76.
16. Datta S, Kaur V, Dhawan A, Jassal G. Estimation of length-weight relationship and condition factor of spotted snakehead Channa punctata (Bloch) under different feeding regimes. Springer Plus. 2013;2:436. https://doi.org/10.1186/2193-1801-2-436
17. Douligeri A, Tsionki I, Petriki O, Moutopoulos D, Stoumboudi M. Length-weight relationships and condition factors of the sand smelt Atherina boyeri (Risso, 1810) estimated from commercial and experimental catches in Lake Trichonis (Western Greece). Aadray Acta Adriat. 2021;62(2):209-218.
18. Prato E, Grattagliano A, Lumare D, Lumare F, Ruscito A, Biandolino F. Growth, mortality and yield of Atherina boyeri Risso, 1810 from Lesina lagoon (Adriatic Sea, Italy). Acta Adriat. 2020;61(2):163-174.
19. Boudinar S, Chaoui L, Kara M. Age, growth and reproduction of the sand smelt Atherina boyeri Risso, 1810 in Mellah Lagoon (Eastern Algeria) J. Appl. Ichthyol. 2016; 32: 302–309. doi: 10.1111/jai.12992
20. Moutopoulos D, Stergiou K. Length-weight and length-length relationships of fish species from the Aegean Sea (Greece). Journal of Applied Ichthyology. 2002;18(3):200-203. https://doi.org/10.1046/j.1439- 0426.2002.00281.
21. Wootton R. J. Ecology of teleost fish. Chapman and Hall.1990.
22. Ferri J, Bartulin K, Škeljo F. Variability of otolith morphology and morphometry in eight juvenile fish species in the coastal eastern Adriatic. Croatian Journal of Fisheries. 2018; 76:91-98. DOI: 10.2478/cjf-2018-0012
23. Bostancı D, Yedier S, Kontaş S, Gülşah Kurucu G, Polat N. Regional variation of relationship between total length and otolith sizes in the three Atherina boyeri Risso, 1810 populations, Turkey. Ege Journal of Fisheries and Aquatic Sciences. 2017; 34(1):11-16.

24. Souza G, Tubino R, Monteiro-Neto C, da Costa M. Relationships between fish and otolith dimensions of Pomatomus saltatrix (Linnaeus, 1766) (Perciformes: Pomatomidae) in southeastern Brazi. Neotrop. Ichthyol. 2019;17(1):1-7. https://doi.org/10.1590/1982-0224-20180032.
25. Başusta A, Çetinkaya B, Başusta N. The relationships between fish size and otolith dimensions in the common sole (Solea solea (Linnaeus, 1758)) captured in the Northeastern Mediterranean. J Appl Ichthyol.2020 ;36:888–892.
26. Pombo L, Elliott M, Rebelo J. Ecology, age and growth of Atherina boyeri and Atherina presbyter in the Ria de Aveiro, Portugal Cybium. 2005;29(1):47-55.