REVIEW ARTICLE
Journal of Biometry Studies (2021) 1(1): 26-34 www.biometrystudies.com
DOI: 10.29329/JofBS.2021.348.06

Journal of Biometry Studies

A review on the relationship between the fish length and otolith biometry

Yiğit TAŞTAN[1,*], Adem Yavuz SÖNMEZ[2]

[1]Kastamonu University, Faculty of Fisheries, Department of Aquaculture, Kastamonu/TURKEY
[2]Kastamonu University, Faculty of Fisheries, Department of Basic Sciences, Kastamonu/TURKEY

[*]Corresponding author: ytastan@kastamonu.edu.tr
Received: 14/06/2021, Accepted: 26/06/2021

Abstract

In teleosts, biometric parameters of certain bony structures are used for the age and/or size determination of the fish. Otolith is perhaps the most widely used of these bony structures. There are numerous studies which have shown that otolith biometry is positively and strongly correlated with fish size. In this paper, some recent studies that investigate the relationship between otolith biometry and fish length are summarized. It is possible to estimate fish size and/or age by knowing this relationship. This information can be useful, especially when it is not possible to sample a certain portion of a fish population. Besides, otoliths found in archaeological excavation sites or in the stomachs of predators can provide information about the fish they belong to. These data are useful to taxonomists, paleobiologists, and researchers studying the nutritional biology of predators.

Keywords: Back-calculation, Biometry, Fish size, Otolith, Relationship

Please cite this article as follows:
Taştan, Y., & Sönmez, A. Y. (2021). A Review on the Relationship between the Fish Length and Otolith Biometry. *Journal of Biometry Studies*, *1*(1), 26-34. https://doi.org/10.29329/JofBS.2021.348.06

1. Introduction

There are many studies on age determination and growth estimation in fish (Şen & Aydın, 2001; Aydın et al., 2004; Eroğlu & Şen, 2009; Acarli et al., 2014; Altin et al., 2015; Özdemir et al., 2019; Kara et al., 2018, 2020; Reis, 2020; Alagöz Ergüden et al., 2020; Şenbahar et al., 2020; Bal, 2021; Onay, 2021; Onay & Dalgıç, 2021; Aydın & Bodur, 2021; Alagöz Ergüden, 2021). In fish biology studies, it is important to have samples of all sizes, as well as a sufficient number of samples, for accurate estimation of age and growth. However, sometimes it is not possible to catch smaller fish depending on the fishing method applied, and sometimes due to the different habitat preferences of small fish. Also, in order to protect the stock, fishing legislation prohibits the catching of small fish. These conditions make it difficult to obtain information about the growth of fish at younger ages. In scientific studies, the growth of unsampled young fish is estimated by back-calculating using some bony structures (Starostka & Nelson, 1974; Miller & Nelson, 1974; Nelson, 1974; Tanyolaç, 1979; Duncan, 1980; Bartlett et al., 1984).

It is possible to estimate information such as the length, age, and weight of smaller individuals of the same species by back-calculating using some measurements of large-sized fish caught in bony fish. For this purpose, scales and otoliths are the most used bony structures. It is important to know that which bony structure will give a better result depending on the fish species. Therefore, when using the back-calculation method, the selection of the most suitable bony structure for a fish species is just as important as the precision in the measurements of the age determination and length estimation (Teksar, 2018).

2. Otolith in Fish

Otoliths are calcareous structures located in the head of fish and are involved in both hearing and balance functions (Quist & Isermann, 2017). In bony fish, there are three pairs of otoliths (Figure 1) called sagittae, lapilli, and asterisci (Secor et al., 1992). The sizes of otoliths vary within and between the species (Wright et al., 2002).

Generally, the largest otolith in most bony fish species is the sagittae. On the other hand, in Ostariophysean fish (Cypriniformes and Siluriformes members), asterisci and/or lapilli are larger than sagittal otolith (Schulz-Mirbach & Plath, 2012).

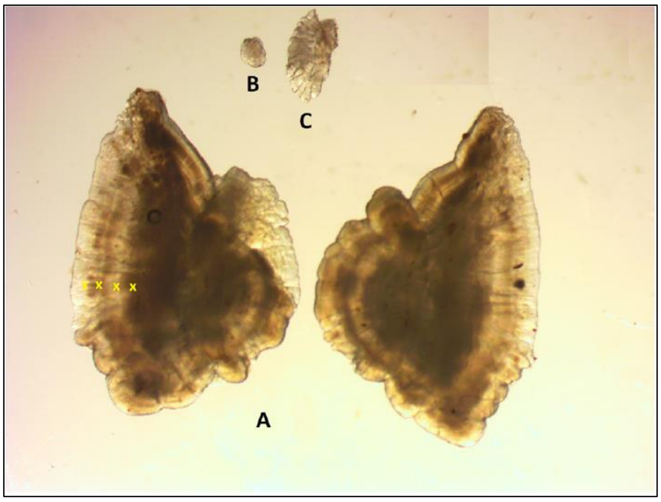

Figure 1. Otolith morphology in *Salvelinus fontinalis* (photographed by Więcaszek et al. 2019). *A*: Sagittae, *B*: Lapilli, *C*: Asterisci.

Teleost fish have 6 otoliths, three on each side. However, the sagittae formed in the sacculus of the inner ear is used to determine the age (Ekingen, 1983). Of the other two pairs, only the asterisci in the lagena is used for age determination in some mesopelagic fish, whereas the lapilli in the utriculus, the 3rd pair, is not used at all. The biggest reason for this is that the last two types of otoliths are generally very small in all bony fish (Avşar, 2005).

Since the otolith morphology is species-specific (Campana & Casselman, 1993), otolith measurements are particularly significant for the studies in the identification of the fish species and populations (Bani et al., 2013; Bostancı et al., 2015; Santos et al., 2017; Avigliano et al., 2018; Bostancı & Yedier, 2018; Özpiçak et al., 2018; Deepa et al., 2019; Song et al., 2019), trophic ecology (Yazıcıoğlu et al., 2016, 2018), taxonomy (Campana, 2004; Tuset et al., 2008; Yılmaz et al., 2015), and paleontology (Campana et al., 1995; Schulz-Mirbach & Reichenbacher, 2006).

3. Relationship between Otoliths and Fish Size

The bony structures of fish and fish size growth are related to each other. Although it varies according to the bony structure, taking various structural dimension measurements such as width, length, weight, and associating them with fish length and determining the growth rate according to this relationship are among the studies that have been carried out recently (Samsun & Samsun, 2006).

Many studies have focused on the detailed examination of marine and freshwater fish otoliths and introducing otolith morphology by preparing otolith atlases. Anatomy of fish species, identification of new fish species, taxonomic revisions of fish taxa, determination of phylogenetic relationships, ecomorphology studies, determination of relationships between fish growth and otolith growth, determination of similarities between the growth of fossil fish and fish living today are some of them (Bostancı et al., 2012).

From this point of view, estimation of fish size from otolith biometry and accordingly stock management studies are very important. Studies on the relationship between fish size and otolith biometry are quite abundant in the fields of population dynamics and stock management (Table 1).

Some studies pointed out that there is a positive and strong linear relationship between the size of some bony structures and fish length. These bony structures are otoliths, scales, anal and dorsal fin rays, cleitra, opercula, dentary and pharyngeal bones (Copp & Kovac, 2003; Aydın et al., 2004; Britton & Shepherd, 2005; Bobori et al., 2006; Tarkan et al., 2007; Bostancı et al., 2007). Computed biometric parameters in some research have shown that some bony structures are more suitable than others. Moreover, otolith and other bony structure biometry of the same fish species in different habitats may differ depending on the location and the water quality. For example, it has been shown that the otolith characteristics of *Carassius gibelio* vary between specimens collected from two different lakes (Bostancı, 2005). Furthermore, Balon (1981) stated that the skeleton formation during larval development is also species-specific and is strongly influenced by environmental factors (i.e., dissolved oxygen and temperature). Hence, these factors should also be taken into account in the otolith measurement studies to determine the biometric parameters with high precision (Munk & Smikrud, 2002).

4. Conclusion

Knowing the relationship between otolith biometry and fish length is useful for two reasons: (i) it is possible to estimate fish size from the length of otoliths found in archaeological sites and predator stomachs, (ii) if the age was determined using otoliths, it is possible to verify the age by checking the fish length when a value out of the expected is found (Echeverria, 1987). In addition, it has been reported that otolith weight can be used to determine the age of fish in some species (Pawson, 1990; Cardinale et al., 2000). Data on the biometry of the species are thought to be useful for fish taxonomists, researchers investigating the nutritional biology of fish predators, and paleobiologists dealing with the otoliths of fossil fish.

Table 1. Total length and otolith biometry parameters of some fish species reported in recent studies

Fish species	N	Total length (cm)		Otolith length (mm)		Otolith weight (g)		Otolith width (mm)		Reference
		Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Terapon jarbua	132	12.5-32.5		4.2-10.7		0.010–0.157		2.43-5.95		Chanthran et al. (2021)
Otolithoides pama	184	5.1-32.7	18.4±4.9	2.0-13.9	8.3±0.2	0.009-0.756	0.243±0.133	1.60-10.20	6.67±1.75	Bhakta et al. (2020)
Solea solea	110	20.8-28.5	24.4±1.7	3.5-5.4	4.2±0.4	0.012–0.035	0.019±0.005	2.87-4.29	3.41±0.30	Başusta et al. (2020)
Solea solea	25	10.2-38.0		2.3-6.0		0.004-0.041		1.96-4.74		Daban et al. (2020)
Lepidorhombus boscii	17	17.8-29.4		4.5-7.1		0.017-0.036		3.10-4.44		
Gaidropsarus biscayensis	50	8.7-14.5		2.3-3.4		0.001-0.026		0.89-1.20		
Lophius budegassa	15	11.9-37.4		2.5-8.6		0.001-0.047		1.10-4.78		
Uranoscopus scaber	13	9.2-20.6		3.3-9.3		0.007-0.117		1.90-5.06		
Arnoglossus kessleri	164	6.8-11.6		1.6-3.5		0.001-0.010		1.15-2.26		
Lesueurigobius friesii	213	4.9-9.3		2.4-4.2		0.005-0.027		1.93-3.43		
Capoeta angorae	178	7.5-37.8	18.1±4.1	1.4-4.2	2.6±0.4	0.001-0.009	0.002±0.001	1.25-3.57	2.18±0.33	Emre (2019)
Capoeta antalyensis	112	7.1-34.0	12.6±3.5	1.3-3.9	2.0±0.7	0.000-0.004	0.001±0.001	0.99-3.57	1.66±0.64	
Capoeta caelestis	159	4.4-28.3	14.8±6.3	0.9-3.6	1.8±0.9	0.000-0.006	0.003±0.001	0.80-2.79	1.53±0.68	
Capoeta erhani	135	15.0-47.0	23.2±5.7	2.3-4.6	3.6±0.5	0.001-0.009	0.002±0.001	1.90-3.59	2.76±0.34	
Capoeta pestai	154	6.2-26.8	15.1±4.4	1.3-3.9	2.6±0.7	0.000-0.010	0.002±0.002	1.07-2.99	2.09±0.48	
Pseudophoxinus antalyae	344	2.8-16.8	7.7±3.2	0.6-2.8	1.9±0.5	0.000-0.005	0.002±0.001	0.49-2.30	1.56±0.40	
Pseudophoxinus fahrettini	151	5.3-19.6	12.2±2.5	0.9-3.1	2.0±0.4	0.000-0.006	0.002±0.001	0.78-2.95	1.98±0.37	
Pellona harroweri	9	13.8-14.6		1.3-4.5		0.007-0.010		0.79-2.71		Oliveira et al. (2019)
Notarius grandicassis	10	17.5-46.5		1.1-2.3		0.124-1.264		0.88-1.93		
Trichiurus lepturus	10	47.7-72.1		3.7-5.4		0.004-0.010		1.56-2.04		
Haemulon plumierii	14	17.5-20.9		1.0-1.7		0.062-0.172		0.80-1.25		
Haemulon steindachneri	13	19.3-22.1		1.4-2.0		0.104-0.122		0.95-1.20		
Bairdiella ronchus	8	23.4-37.6		1.5-2.5		0.012-2.620		0.95-2.10		
Ctenosciaena gracilicirrhus	26	8.9-16.4		4.5-7.4		0.024-0.109		3.80-5.82		
Cynoscion jamaicensis	20	16.3-23.0		8.8-12.2		0.061-0.220		4.46-6.13		
Cynoscion microlepidotus	13	17.0-38.5		1.4-2.6		0.075-0.309		0.74-1.40		
Macrodon ancylodon	31	18.2-30.9		9.4-13.4		0.062-0.198		4.31-7.09		
Menticirrhus americanus	16	12.0-17.0		0.9-1.2		0.047-0.108		0.75-0.92		
Micropogonias furnieri	14	17.8-33.9		1.5-2.5		0.052-0.753		0.60-1.87		
Paralonchurus brasiliensis	10	15.6-22.0		1.4-1.9		0.059-0.091		0.67-0.93		
Stellifer naso	15	9.4-11.2		3.9-4.3		0.012-0.013		2.43-2.96		
Polydactylus virginicus	11	17.0-25.3		4.2-5.7		0.005-0.013		2.26-2.87		
Puntius sophore	41	66.0-109.0	83.9±1.6	0.5-1.1	0.7±0.1			0.61-0.98	0.91±0.02	Rani et al. (2019)*
Perca fluviatilis	195	4.6-24.0	8.9±4.2	1.4-6.0	2.7±1.0	0.001-0.031	0.005±0.005	0.81-3.23	1.42±0.51	Şimşek et al. (2019)
Pomatomus saltatrix	398	43.6-67.0	51.8±5.3	9.7-15.3	12.6±0.9	0.030-0.110	0.050±0.010	3.65-5.45	4.29±0.31	Souza et al. (2019)
	346	12.3-37.0	19.1±0.9	3.8-12.6	6.7±0.6			1.59-4.34	2.60±0.24	Bal et al. (2018)
Anguilla Anguilla	60	11.2-79.5	42.9±14.0	1.2-4.8	2.7±0.7	0.001-0.016	0.005±0.003	0.88-2.58	1.79±0.38	Kanjuh et al. (2018)
Capoeta trutta	115	11.8-38.1	25.4±6.4	1.5-3.7	2.9±0.5	0.001-0.014	0.008±0.003	1.05-2.59	1.96±0.35	Düşükcan (2018)
	106	23.7-43.4	30.6±3.0	2.0-3.9	3.1±0.3	0.004-0.013	0.007±0.002	1.75-3.07	2.27±0.27	Doğan and Şen (2017)
Centropomus parallelus	50	8.6-55.2	23.7±10.7	3.9-22.3	10.4±4.1			2.10-11.00	5.80±2.00	Assis et al. (2018)
Centropomus undecimalis	50	9.8-104.0	40.0±20.6	4.5-29.9	13.8±5.8			2.40-14.10	7.00±2.70	
Lutjanus analis	50	8.8-52.0	18.55±7.4	4.2-16.7	7.7±2.3			2.60-10.00	4.80±1.40	
Lutjanus jocu	50	17.8-53.0	25.36±5.4	6.6-14.2	8.4±1.2			3.70-7.80	4.90±0.60	
Lutjanus synagris	50	7.1-44.6	19.7±10.2	4.0-19.7	9.3±4.2			2.30-10.90	5.50±2.30	
Chaetodipterus faber	50	12.2-37.4	22.8±5.0	3.6-8.7	6.2±1.0			2.20-4.70	3.30±0.50	
Mugil curema	50	16.9-41.5	29.3±4.3	5.7-10.6	8.0±0.9			2.80-4.80	3.70±0.40	
Foetorepus calauropomus	55	10.2-28.0		2.6-5.1		0.001-0.007		1.20-2.18		Park et al. (2018)
Trachurus declivis	108	12.1-29.2		3.9-7.9		0.006-0.029		2.07-4.17		
Parequula melbournensis	145	11.0-19.4		5.1-7.8		0.013-0.049		4.06-6.17		
Neosebastes scorpaenoides	51	24.2-37.8		7.9-12.7		0.032-0.144		3.22-6.71		
Platycephalus aurimaculatus	60	18.4-52.6		6.5-15.6		0.012-0.160		2.35-5.49		
Platycephalus bassensis	62	25.0-45.9		8.7-15.4		0.028-0.173		2.86-4.95		
Platycephalus conatus	67	21.5-47.6		9.4-18.9		0.046-0.282		3.41-6.58		
Lepidotrigla mulhalli	182	10.6-21.8		2.6-5.6		0.002-0.030		2.04-4.29		
Lepidotrigla vanessa	254	11.9-32.3		2.3-5.8		0.002-0.037		1.93-4.61		

*Studies with an asterisk presented the average values as mean±standard error.

Table 1. (*Continued*)

Fish species	N	Total length (cm)		Otolith length (mm)		Otolith weight (g)		Otolith width (mm)		Reference
		Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	
Belone belone	51	11.8-32.5	22.5±4.4	1.0-3.0	2.2±0.5			0.53-1.67	1.24±0.27	Altin and Ayyildiz (2017)
Trachinotus ovatus	62	3.0-15.2	4.7±1.9	0.5-2.5	1.1±0.4			0.46-1.30	0.74±0.22	
Spicara smaris	1520	1.0-13.7	3.1±1.8	0.6-5.4	1.7±1.0			0.37-3.53	1.07±0.56	
Sprattus sprattus	42	4.3-7.4	6.5±0.7	0.8-1.5	1.2±0.1			0.53-0.87	0.69±0.06	
Pomatoschistus marmoratus	1150	1.2-13.5	3.4±1.0	0.7-2.1	1.3±0.4			0.63-1.78	1.13±0.28	
Symphodus ocellatus	1189	1.4-17.3	5.6±1.8	0.7-3.4	1.4±0.4			0.41-2.00	0.91±0.24	
Chelon labrosus	306	1.9-19.1	7.0±4.0	0.7-4.7	1.9±0.9			0.50-2.49	1.21±0.47	
Mullus surmuletus	976	4.0-14.8	5.8±1.1	1.0-2.9	1.5±0.3			0.57-2.22	1.13±0.24	
Chromis chromis	153	1.9-12.5	7.3±2.2	1.1-5.8	3.2±1.1			0.64-3.21	1.91±0.55	
Scorpaena porcus	82	3.0-31.3	12.2±5.1	1.7-8.1	5.2±1.4			0.99-3.36	2.26±0.57	
Trachinus draco	106	2.4-29.3	10.0±5.6	1.3-7.8	3.7±1.5			0.20-5.16	1.88±0.89	
Lithognathus mormyrus	2638	1.4-16.5	3.4±1.1	1.3-4.3	2.2±0.4			0.98-2.41	1.38±0.21	
Serranus scriba	638	1.5-21.4	9.6±3.3	0.5-6.9	3.5±1.2			0.08-2.83	1.58±0.50	
Serranus scriba	763	6.8-24.1	13.7±3.6	2.7-8.4	4.9±1.6	0.002-0.031	0.009±0.006	1.30-3.20	2.12±0.40	Bilge and Filiz (2018)
Bathyclupea hoskynii	15	12.7-16.7				0.024-0.043		5.24-7.01		Aneesh Kumar et al. (2017)
Chlorophthalmus nigromarginatus	28	17.2-22.0				0.009-0.025		5.59-7.74		
Neoscopelus microchir	20	15.5-22.0				0.024-0.054		6.12-8.33		
Ostracoberyx dorygenis	17	9.1-11.8				0.008-0.033		3.89-5.43		
Synagrops japonicus	16	9.1-10.2				0.007-0.013		4.36-5.17		
Cubiceps baxteri	27	12.7-20.0				0.008-0.018		5.56-7.21		
Neoepinnula orientalis	38	16.4-27.6				0.004-0.110		5.27-7.65		
Polymixia fusca	43	8.4-22.4				0.017-0.177		5.3-10.63		
Bembrops caudimacula	20	15.5-24				0.012-0.040		4.59-6.39		
Atherina boyeri	174	5.9-9.5		2.1-3.7	2.8±0.02	0.001-0.004	0.003±0.001	0.99-2.10	1.79±0.01	Bostancı et al. (2017)*
Pterois volitans	472	9.8-35.8	22.8±6.6	1.9-7.4	4.5±1.0	0.001-0.110	0.007±0.005			Aguilar-Perera and Quijano-Puerto (2016)
Micromesistius poutassou	88	6.5-39.0		3.2-19.0						Viva et al. (2015)
Phycis blennoides	76	4.5-54.0		2.9-18.2						
Mullus barbatus	149	6.5-21.5		1.8-4.0						
Trisopterus minutus	68	5.5-25.0		3.5-12.0						
Trachurus mediterraneus	163	5.0-42.0		1.8-11.4						
Trachurus trachurus	170	6.0-41.5		2.2-13.4						
Trachurus trachurus	509	11.5-21.7	16.8±0.1	1.4-6.9	4.2±0.1	0.010-0.021	0.016±0.001	2.00-3.48	3.04±0.01	Ergüden and Alagöz Ergüden (2013)*
Cynoglossus lighti	256	4.5-31.2	14.5±4.0	0.9-6.0	2.1±0.5			0.74-5.37	1.61±0.35	Zan et al. (2015)
Barbus grypus	90	37.7-69.9	59.2±5.4	2.6-3.8	3.2±0.2	0.005-0.013	0.009±0.001	1.66-2.56	2.16±0.18	Düşükcan et al. (2015)
Argentina sphyraena	401	7.0-18.1	12.3±1.8	2.6-5.4	4.0±0.5	0.003-0.006	0.007±0.003	1.70-3.70	2.70±0.33	Bilge and Gülşahin (2014)
Glossanodon leioglossus	225	6.1-13.0	9.6±1.1	2.3-4.6	3.5±0.3	0.003-0.009	0.004±0.001	1.60-3.10	2.36±0.24	
Argyrops spinifer	54	15.1-64.2	33.8±13.4	5.8-18.2	10.7±2.8	0.050-0.510	0.170±0.100			Ghanbarzadeh et al. (2014)
Alburnus heckeli	110	8.8-11.0		1.5-2.9		0.001-0.002		1.02-2.43		Basusta et al. (2013a)
Salmo trutta macrostigma	153	18.2-38.2	23.8±0.3	2.1-3.8	2.7±0.02	0.000-0.001		1.17-2.12		Başusta et al. (2013b)*
Lepidotrigla dieuzeidei	443	7.2-14.7	10.8±0.1	3.4-7.4	5.1±0.04	0.001-0.013	0.004±0.001	2.45-5.30	3.58±0.029	Başusta et al. (2013c)
Macrodon ancylodon	22	19.5-40.0	30.3	9.9-16.6	13.3	0.060-0.360	0.170	3.81-7.66	5.82	Cardoso et al. (2012)
Macrodon atricauda	22	18.2-41.0	30.1	9.1-14.7	12.2	0.040-0.190	0.110	3.94-7.15	5.63	
Mastacembelus mastacembelus	187	23.7-80.6	53.4±15.1	1.4-3.8	2.4±0.4	0.001-0.004	0.002±0.001	0.80-1.71	1.28±0.20	Eroğlu and Şen (2009)
Chondrostoma regium	506	20.1-33.3	26.6±2.6	2.2-3.6	2.9±0.3					Aydın et al. (2004)
Capoeta capoeta umbla	251	19.4-46.0	28.2±5.3	1.7-4.6	2.3±0.5					Sen et al. (2001)

*Studies with an asterisk presented the average values as mean±standard error.

Conflict of interest

The authors declare that there is no conflict of interest.

References

Acarli, D., Kara, A., & Bayhan, B. (2014). Length-Weight Relations for 29 Fish Species from Homa Lagoon, Aegean Sea, Turkey. *Acta Ichthyologica et Piscatoria*, *44*(3), 249–257. https://doi.org/10.3750/AIP2014.44.3.09

Aguilar-Perera, A., & Quijano-Puerto, L. (2016). Relations between Fish Length to Weight, and Otolith Length and Weight, of the Lionfish *Pterois volitans* in the Parque Nacional Arrecife Alacranes, Southern Gulf of Mexico. *Revista de Biología Marina y Oceanografía*, *51*(2), 469–474. https://doi.org/10.4067/s0718-19572016000200025

Alagöz Ergüden, S. (2021). Length-Weight Relationship and Condition Factor of Freshwater Blenny *Salaria fluviatilis* (Asso, 1801) in Asi River (Hatay, Turkey). *Marine Science and Technology Bulletin*, *10*(1), 54-61. https://doi.org/10.33714/masteb.782384

Alagöz Ergüden, S., Ayas, D., & Ergüden, D. (2020). The Length-Weight Relationship and Condition Factor of Yellowspotted Puffer *Torquigener flavimaculosus* Hardy & Randall, 1983 in the Eastern Mediterranean (Yumurtalık Bight, Turkey). *Marine Science and Technology Bulletin*, *9*(2), 87-91. https://doi.org/10.33714/masteb.700374

Altin, A., & Ayyildiz, H. (2017). Relationships between Total Length and Otolith Measurements for 36 Fish Species from Gökçeada Island, Turkey. *Journal of Applied Ichthyology*, *34*(1), 136–141. https://doi.org/10.1111/jai.13509

Altin, A., Ayyildiz, H., Kale, S., & Alver, C. (2015). Length-Weight Relationships of Forty-nine Fish Species from Shallow Waters of Gökçeada Island, Northern Aegean Sea Turkey. *Turkish Journal of Zoology*, *39*(5), 971-975. https://doi.org/10.3906/zoo-1412-15

Aneesh Kumar, K. V., Nikki, R., Oxona, K., Hashim, M., & Sudhakar, M. (2017). Relationships between Fish and Otolith Size of Nine Deep-sea Fishes from the Andaman and Nicobar Waters, North Indian Ocean. *Journal of Applied Ichthyology*, *33*(6), 1187-1195. https://doi.org/10.1111/jai.13467

Assis, D. A. S., Santos, J. D. A., de Moraes, L. E., & Santos, A. C. D. A. (2018). Biometric Relation between Body Size and Otolith Size of Seven Commercial Fish Species of the South-western Atlantic. *Journal of Applied Ichthyology*, *34*(5), 1176-1179. https://doi.org/10.1111/jai.13744

Avigliano, E., Rolón, M. E., Rosso, J. J., Mabragaña, E. & Volpedo, A. (2018). Using Otolith Morphometry for the Identification of Three Sympatric and Morphologically Similar Species of Astyanax from the Atlantic Rain Forest (Argentina). *Environmental Biology of Fishes*, *101*, 1319-1328. https://doi.org/10.1007/s10641-018-0779-2

Avşar, D. (2005). *Balıkçılık biyolojisi ve populasyon dinamiği*. Nobel Kitapevi. (in Turkish)

Aydın, M., & Bodur, B. (2021). Morphologic Characteristics and Length-Weight Relationships of *Sciaena umbra* (Linnaeus, 1758) in the Black Sea Coast. *Marine Science and Technology Bulletin*, *10*(1), 8-15. https://doi.org/10.33714/masteb.738661

Aydın, R., M. Calta, D. Sen, & M.Z. Coban. (2004). Relationships between Fish Lengths and Otolith Length in the Population of *Chondrostoma regium* (Heckel, 1843) Inhabiting Keban Dam Lake. *Pakistan Journal of Biological Sciences*, *7*(9), 1550-1553. https://doi.org/10.3923/pjbs.2004.1550.1553

Bal, H. (2021). Length-Weight Relationship, Sex Ratio and Condition Factor of *Merlangius merlangus* (Linnaeus, 1758) from the Sea of Marmara, Turkey. *Marine Science and Technology Bulletin*, *10*(1), 99-105. https://doi.org/10.33714/masteb.832250

Bal, H., Yanık, T., & Türker, D. (2018). Relationships between Total Length and Otolith Size of Bluefish *Pomatomus saltatrix* (Linnaeus, 1766) in the Marmara Sea of Turkey. *Natural and Engineering Sciences*, *3*(1), 38-44. https://doi.org/10.28978/nesciences.379319

Balon, E. K. (1981). Saltatory Processes and Altricial to Precocial Forms in the Ontogeny of Fishes. *American Zoologist*, *21*, 573-596. https://doi.org/10.1093/icb/21.2.573

Bani, A., Poursaeid, S. & Tuset, V. M. (2013). Comparative Morphology of the Sagittal Otolith in Three Species of South Caspian Gobies. *Journal of Fish Biology*, *82*(4), 1321-1332. https://doi.org/10.1111/jfb.12073

Bartlett, J. R., Randerson, P. F., Williams R., Ellis, D. M. (1984). The Use of Analysis of Covariance in the Back-calculation of Growth in Fish. *Journal of Fish Biology*, *24*, 201-213. https://doi.org/10.1111/j.1095-8649.1984.tb04791.x

Basusta, A., Bal, H., & Aslan, E. (2013a). Otolith Biometry-Total Length Relationships in the Population of Hazar Bleak, *Alburnus heckeli* (Battalgil, 1943) Inhabiting Lake Hazar, Elazig, Turkey. *Pakistan Journal of Zoology*, *45*(4), 1180-1182.

Başusta, A., Çetinkaya, B., & Başusta, N. (2020). The Relationships between Fish Size and Otolith Dimensions in the Common Sole (*Solea solea* (Linnaeus, 1758)) Captured in the Northeastern

Mediterranean. *Journal of Applied Ichthyology*, *36*(6), 888-892. https://doi.org/10.1111/jai.14137

Başusta, A., Özer, E. İ., & Girgin, H. (2013b). Munzur Nehri'ndeki Kırmızı Benekli Alabalığın (*Salmo trutta macrostigma* (Dummeril, 1858)) Otolit Boyutları-Balık Boyu Arasındaki İlişki. *Journal of FisheriesSciences.com*, *7*(1), 22-29. (in Turkish) https://doi.org/10.3153/jfscom.2013003

Başusta, A., Özer, E. İ., & Girgin, H. (2013c). Akdeniz'deki *Lepidotrigla dieuzeidei* (Blanc & Hureau, 1973) Populasyonunda Otolit Biyometrisi-Balık Uzunluğu Arasındaki İlişki. *Yunus Araştırma Bülteni*, *3,* 3-9. (in Turkish) https://doi.org/10.17693/yunusae.v2013i21904.235412

Bhakta, D., Das, S. K., Das, B. K., Behera, S., & Nagesh, T. S. (2020). Relationship between Otolith Morphometry and Fish Size of *Otolithoides pama* (Hamilton, 1822) from Hooghly-Matlah Estuary, India. *Indian Journal of Geo Marine Sciences*, *49*(10), 1636-1642. https://doi.org/10.32387/IJGMS.2020.34.3-4.10

Bilge, G., & Filiz, H. (2018). Otolith Biometry of *Serranus scriba* (Linnaeus, 1758) from the Southern Aegean Sea. *Natural and Engineering Sciences*, *3*(3), 259-264. https://doi.org/10.28978/nesciences.468665

Bilge, G., & Gülşahin, A. (2014). Relationship between Sagittal Otolith Size and Fish Size in *Argentina sphyraena* and *Glossanodon leioglossus* (Osteichthyes: Argentinidae) in the Southern Aegean Sea, Turkey. *Zoology in the Middle East*, *60*(1), 24-28. https://doi.org/10.1080/09397140.2014.892327

Bobori, D.C., Tsikliras, A.C., & Economidis, N. I. (2006). Some Morphological and Biological Characteristics of Fishes from Tavropos Reservoir (Western Greece). *Folia Zoologica*, *55*(2), 199-210.

Bostancı, D. & Yedier, S. (2018). Discrimination of Invasive Fish *Atherina boyeri* (Pisces: Atherinidae) Populations by Evaluating the Performance of Otolith Morphometrics in Several Lentic Habitats. *Fresenius Environmental Bulletin*, *27*(6), 4493-4501.

Bostancı, D. (2005). *Bafra Balık Gölü ve Eğirdir Gölü'nde yaşayan balık populasyonlarında opak birikim analizi ile yaş doğrulaması* [PhD dissertation, Ondokuz Mayıs University]. (in Turkish)

Bostancı, D., İlhan D. U., & Akalın S., (2012). Küçük Pisi Balığı, *Arnoglossus laterna* (Walbaum, 1792)'nın Otolit Özellikleri. *Karadeniz Fen Bilimleri Dergisi*, *6*, 1-10. (in Turkish)

Bostancı, D., Polat, N., Kurucu, G., Yedier, S., Kontaş, S. & Darçin, M. (2015). Using Otolith Shape and Morphometry to Identify Four Alburnus Species (*A. chalcoides*, *A. escherichii*, *A. mossulensis* and *A. tarichi*) in Turkish Inland Waters. *Journal of Applied Ichtyyology*, *31*, 1013-1022. https://doi.org/10.1111/jai.12860

Bostancı, D., Yedier, S., Kontaş, S., Kurucu, G., & Polat, N. (2017). Regional Variation of Relationship between Total Length and Otolith Sizes in the Three *Atherina boyeri* Risso, 1810 Populations, Turkey. *Su Ürünleri Dergisi*, *34*(1), 11-16. https://doi.org/10.12714/egejfas.2017.34.1.02

Bostancı, D., Yılmaz, S., & Polat, N. (2007). Gölhisar Gölü (Burdur)'ndeki Kızılkanat (*Scardinius erythrophthalmus* Linnaeus, 1758) Populasyonunda Yaş Belirleme, Boy-Ağırlık İlişkisi ve Kondüsyon Faktörü Üzerine Bir Araştırma. *Türk Sucul Yaşam Dergisi*, *5*(8), 99-107. (in Turkish)

Britton, J. R., & Shepherd, J. S. (2005). Biometric Data to Facilitate the Diet Reconstruction of Piscivorous Fauna. *Folia Zoologica*, *54*(1-2), 193-200.

Campana, S. E. (2004). Photographic Atlas of Fish Otoliths of the Nortwest Atlantic Ocean. *Canadian Special Publication of Fisheries and Aquatic Sciences*, *133*. https://doi.org/10.1139/9780660191089

Campana, S. E., & Casselman, J. M. (1993). Stock Discrimination Using Otolith Shape Analysis. *Canadian Journal of Fisheries and Aquatic Sciences*, *50*(5), 1062- 1083. https://doi.org/10.1139/f93-123

Campana, S. E., Secor, D. H., & Dean, J. M. (1995). *Recent developments in fish otolith research*. University of South Carolina Press.

Cardinale, M., Arrhenius, F. & Johnsson, B. (2000). Potential Use of Otolith Weight for the Determination of Age-Structure of Baltic Cod (*Gadus morhua*) and Plaice (*Pleuronectes platessa*). *Fisheries Research*, *45*, 239-252. https://doi.org/10.1016/S0165-7836(99)00122-8

Cardoso, L. G., Santos, S., & Haimovici, M. (2012). Differences in the Otoliths Support the Distinction of the Genus *Macrodon* into Two Species in the South-western Atlantic Ocean. *Marine Biodiversity Records*, 5. https://doi.org/10.1017/S1755267212000802

Chanthran, S. S. D., Lim, P. E., Poong, S. W., Du, J., & Loh, K. H. (2021). Relationships between Sagittal Otolith Size and Body Size of *Terapon jarbua* (Teleostei, Terapontidae) in Malaysian Waters. *Journal of Oceanology and Limnology*, *39*(1), 372-381. https://doi.org/10.1007/s00343-019-9193-7

Copp, G. H., & Kovac, V. (2003). Biometric Relationships between Body Size and Bone Lengths in Fish Prey of the Eurasian Otter *Lutra lutra*: Chub *Leuciscus cephalus* and Perch *Perca fluviatilis*. *Folia Zoologica*, *52*(1), 109-112.

Daban, İ. B., İhsanoğlu, M. A., & İşmen, A. (2020). Relationships between Body Size-Otolith Size for

Seven Demersal Fish Species from the Marmara Sea, Turkey. *Su Ürünleri Dergisi*, *37*(3), 1-1. https://doi.org/10.12714/egejfas.37.3.09

Deepa, K. P., Kumar, K. A., Kottnis, O., Nikki, R., Bineesh, K. K., Hashim, M., Saravanane, N. & Sudhakar, M. (2019). Population Variations of Opal Fish, *Bembrops caudimacula* Steindachner, 1876 from Arabian Sea and Andaman Sea: Evidence from Otolith Morphometry. *Regional Studies in Marine Science*, *25*, 100466. https://doi.org/10.1016/j.rsma.2018.100466

Doğan, Y., & Şen, D. (2017). Keban Baraj Gölü'nde Yaşayan *Capoeta trutta* (Heckel, 1843)'da Otolit Biyometrisi-Balık Boyu Ilişkisi. *Fırat Üniversitesi Fen Bilimleri Dergisi*, *29*(2), 33-38. (in Turkish)

Duncan, K.W. (1980). On the Back-calculation of Fish Lengths; Modifications and Extensions to the Frasier-Lee Equation. *Journal of Fish Biology*, *16*, 725-730. https://doi.org/10.1111/j.1095-8649.1980.tb03751.x

Düşükcan, M. (2018). Özlüce Baraj Gölü'ndeki *Capoeta trutta* (Heckel, 1843) Populasyonunda Balık Boyu-Otolit Biyometrisi İlişkisi. *Türk Tarım-Gıda Bilim ve Teknoloji Dergisi*, *6*(6), 764-769. (in Turkish) https://doi.org/10.24925/turjaf.v6i6.764-769.1911

Düşükcan, M., Çalta, M., & Eroğlu, M. (2015). Keban Baraj Gölü'nde Yaşayan *Barbus grypus* Heckel, 1843'de Otolit Biyometrisi-Balık Boyu Ilişkisi (Elazığ, Türkiye). *Yunus Araştırma Bülteni*, *15*(3). (in Turkish) https://doi.org/10.17693/yunusae.v15i21957.235772

Echeverria, T. W. (1987). Relationship of Otolith Length to Total Length in Rockfishes from Northern and Central California. *Fishery Bultein*, *85*(2), 383-386.

Ekingen, G. (1983). *Su ürünleri ve balıkçılık*. Fırat Üniversitesi Veteriner Fakültesi Yayınları. (in Turkish)

Emre, N. (2019). Biometric Relation between Asteriscus Otolith Size and Fish Total Length of Seven Cyprinid Fish Species from Inland Waters of Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*, *20*(3), 171-175. https://doi.org/10.4194/1303-2712-v20_3_01

Ergüden, D., & Alagöz Ergüden, S. (2013). İskenderun Körfezi'ndeki Karagöz İstavrit *Trachurus trachurus* (Linnaeus, 1758)'in Otolit Özellikleri ve Boy-Ağırlık İlişkileri. *Su ürünleri Dergisi*, *28*(2), 133-148. (in Turkish)

Eroğlu, M., & Şen, D. (2009). Otolith Size-Total Length Relationship in Spiny Eel, *Mastacembelus mastacembalus* (Banks & Solander, 1794) Inhabiting in Karakaya Dam Lake. *Journal of FisheriesSciences.com*, *3*(4), 342-351. https://doi.org/10.3153/jfscom.2009039

Ghanbarzadeh, M., Soofiani, N. M., Keivany, Y., & Taghavi-Motlagh, S. A. (2014). Use of Otolith Length and Weight in Age Estimations of the Kingsoldier Bream, *Argyrops spinifer*, in the Persian Gulf. *Iranian Journal of Ichthyology*, *1*(1), 1-6.

Kanjuh, T., Mrdak, D., Piria, M., Tomljanović, T., Joksimović, A., Talevski, T., & Milošević, D. (2018). Relationships of Otolith Dimension with Body Length of European Eel *Anguilla anguilla* (Linnaeus, 1758) from Adriatic Catchment of Montenegro. *Acta Adriatica: International Journal of Marine Sciences*, *59*(1), 91-96. https://doi.org/10.32582/aa.59.1.7

Kara, A., Acarli, D., İlkyaz, A. T., & Babaoğlu, A. Ö. (2020). Length-Weight and Length-Length Relations for 21 Fish Species Caught in Izmir Bay. *Acta Adriatica: International Journal of Marine Sciences*, *61*(2), 197-204. https://doi.org/10.32582/aa.61.2.8

Kara, A., Saglam, C., Acarli, D., & Cengiz, Ö. (2018). Length-Weight Relationships for 48 Fish Species of the Gediz Estuary, in Izmir Bay (Central Aegean Sea, Turkey). *Journal of the Marine Biological Association of the United Kingdom*, *98*(4), 879.-884. https://doi.org/10.1017/S0025315416001879

Miller, G.L., & Nelson, R. (1974). *Goldeye, Hiodon alosoides, in Lake Oahe: Abundance, age, growth, maturity, food and the fishery, 1963-69*. Technical Papers of the U. S. Fish and Wildlife Service. United States Department of the Interior Fish of Fish and Wildlife Service.

Munk, K. M., & Smikrud, K. (2002). Relationships of otolith size to fish size and otolith ages for yelloweye *Sebastes ruberrimus* and quillback *S. maliger* rockfishes. Alaska department of fish and game division of commercial fisheries mark, tag, and age lab.

Nelson, W. R. (1974). *Age, growth, and maturity of thirteen species of fish from Lake Oahe during the early years of impoundment, 1963-68*. Technical Papers of the U. S. Fish and Wildlife Service.

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., ... & Saint-Paul, U. (2019). Biometric Relationships between Body Size and Otolith Size in 15 Demersal Marine Fish Species from the Northern Brazilian Coast. *Acta Amazonica*, *49*(4), 299-306. https://doi.org/10.1590/1809-4392201900571

Onay, H. (2021). Length-Weight Relationships of Four *Symphodus* Species (Actinopterygii: Perciformes: Labridae) from Eastern Black Sea (Turkey). *Marine Science and Technology Bulletin*, *10*(3), 228-233. https://doi.org/10.33714/masteb.824561

Onay, H., & Dalgıç, G. (2021). Length-Weight Relationships for Fourteen Fish Species Collected by Bottom Trawl from the Eastern Black Sea Coast, Turkey. *Marine Science and Technology Bulletin*, (In press). https://doi.org/10.33714/masteb.881256

Özdemir, S., Özsandıkçı, U., & Büyükdeveci, F. (2019). A New Maximum Length with Length–Weight Relationship of Tub Gurnard (*Chelidonichthys lucerna* Linnaeus, 1758) from Central Black Sea Coasts of Turkey. *Marine Science and Technology Bulletin*, *8*(2), 85-91. https://doi.org/10.33714/masteb.641702

Özpiçak, M., Saygın, S., Aydın, A., Hançer, E., Yılmaz, S., & Polat, N. (2018). Otolith Shape Analyses of *Squalius cephalus* (Linnaeus, 1758) (Actinopterygii: Cyprinidae) Inhabiting Four Inland Water Bodies of the Middle Black Sea Region, Turkey. *Iranian Journal of Ichthyology*, *5*(4), 293-302. https://doi.org/10.22034/iji.v5i4.311

Park, J. M., Gaston, T. F., Riedel, R., & Williamson, J. E. (2018). Biometric Relationships between Body and Otolith Measurements in Nine Demersal Fishes from North-eastern Tasmanian Waters, Australia. *Journal of Applied Ichthyology*, *34*(4), 801-805. https://doi.org/10.1111/jai.13612

Pawson, M. G. (1990). Using Otolith Weight to Age Fish. *Journal of Fish Biology*, *36*, 521-531. https://doi.org/10.1111/j.1095-8649.1990.tb03554.x

Quist, M. C., & Isermann, D. A. (2017). *Age and growth of fishes: principles and techniques.* American Fisheries Society.

Rani, A., Rai, D., & Tyor, A. K. (2019). Morphometrics Analysis of Sagitta Otolith in Pool Barb, *Puntius sophore* (Hamilton, 1822). *Journal of Morphological Sciences*, *36*(2), 85-90. https://doi.org/10.1055/s-0039-1683911

Reis, İ. (2020). Length-Weight Relationships of 12 Fish Species from the Köyceğiz Lagoon, Turkey. *Marine Science and Technology Bulletin*, *9*(2), 136-144. https://doi.org/10.33714/masteb.722480

Samsun, N. & Samsun, S. (2006). Kalkan (*Scophthalmus maeoticus* Pallas, 1811) Balığının Otolit Yapısı, Yaş ve Balık Uzunluğu-Otolit Uzunluğu Ilişkilerinin Belirlenmesi. *Fırat Üniversitesi Fen ve Mühendislik Bilimleri Dergisi*, *18*(2), 181- 187. (in Turkish)

Santos, R. S., Costa, M. R., & Araújo, F. G. (2017). Age and Growth of the White Croaker *Micropogonias furnieri* (Perciformes: Sciaenidae) in a Coastal Area of Southeastern Brazilian Bight. *Neotropical Ichthyology*, *15*(1), e160131. https://doi:10.1590/1982-0224-20160131

Schulz-Mirbach, T., & Plath, M. (2012). All Good Things Come in Threes–species Delimitation through Shape Analysis of Saccular, Lagenar and Utricular Otoliths. *Marine and Freshwater Research*, *63*(10), 934-940. https://doi.org/10.1071/MF12132

Schulz-Mirbach, T., & Reichenbacher, B. (2006). Reconstruction of Oligocene and Neogene Freshwater Fish Faunas-An Actualistic Study on Cypriniform Otoliths. *Acta Palaeontologica Polonica*, *51*(2), 283-304.

Secor D. H., Dean, J. M., & Laban, E. H. (1992). *Otolith microstructure examination and analysis*. Canadian Special Publication of Fisheries and Aquatic Sciences 117, Canada.

Şen, D., & Aydın, R. (2001). Keban Baraj Gölü'nde Yaşayan *Acanthobrama marmid* Heckel, 1843'ün Geri Hesaplama Metodu İle Uzunluklarının Belirlenmesi. *G.Ü. Gazi Eğitim Fakültesi Dergisi*, *21*(1), 47-51. (in Turkish)

Sen, D., Aydin, R., & Calta, M. (2001). Relationships between Fish Length and Otolith Length in the Population of *Capoeta capoeta umbla* (Heckel, 1843) Inhabiting Hazar Lake, Elazig, Turkey. *Fisheries & Aquatic Life*, *9*(2), 267-272.

Şenbahar, A. M., Güleç, Ö., Tosunoğlu, Z., & Özaydın, O. (2020). Length-Weight Relationship of the Most Landed Pelagic Fish Species European Pilchard (*Sardina pilchardus* Walbaum, 1792) and European Anchovy (*Engraulis encrasicolus* Linnaeus, 1758) in the Izmir Bay (Aegean Sea, Turkey) Purse Seine Fishery. *Marine Science and Technology Bulletin*, *9*(1), 32-37. https://doi.org/10.33714/masteb.673318

Şimşek, C., Polat, N., Özpiçak, M., Saygın, S., & Yılmaz, S. (2019). The Relationships Between Otolith Dimensions-Total Length and Otolith Features of European Perch (*Perca fluviatilis* L., 1758) Sampled from Yedikır Dam Lake (Turkey). *Journal of Anatolian Environmental and Animal Sciences*, *4*(3), 348-353. https://doi.org/10.35229/jaes.594985

Song, J., Zhao, B., Liu, J., Cao, L., & Dou, S. (2019). Comparative Study of Otolith and Sulcus Morphology for Stock Discrimination of Yellow Drum along the Chinese Coast. *Journal of Oceanology and Limnology*, *37*, 1430-1439. https://doi.org/10.1007/s00343-019-8056-6

Souza, G. M. D., Tubino, R. D. A., Monteiro-Neto, C., & Costa, M. R. D. (2019). Relationships between Fish and Otolith Dimensions of *Pomatomus saltatrix* (Linnaeus, 1766) (Perciformes: Pomatomidae) in Southeastern Brazil. *Neotropical Ichthyology*, *17*(1), e180032. https://doi.org/10.1590/1982-0224-20180032

Starostka, V.J., & Nelson, W.R. (1974). *Age, growth, sexual maturity, and food of channel catfish in Central Lake Oahe, 1968-69*. Technical Papers of the U. S. Fish and Wildlife Service. United States Department of The Interior Fish and wildlife Service, Washington, USA.

Tanyolaç, J. (1979). Age and Growth of Carp, *Cyprinus carpio* L. in Lake Eymir, Ankara. *Communications de la Faculte des Sciences de I' Universite d'Ankara Serie C3: Zoologie*, 1-12.

Tarkan, A. S., Gaygusuz, C. G., Gaygusuz, 0., & Aclpmar, H. (2007). Use of Bone and Otolith Measures for Size-Estimation of Fish in Predator-Prey Studies. *Folia Zoologica*, *56*(3), 328-336.

Teksar, C. K. (2018). *Keban Baraj Gölü'nde yaşayan bazı sazan türlerinde geri hesaplama yöntemiyle balık boyunun tahmini* [Master's thesis, Fırat University]. (in Turkish)

Tuset, V. M., Lombarte, A., & Assis, A. A. (2008). Otolith Atlas for the Western Mediterranean, North and Central Eastern Atlantic. *Scientia Marina*, *72*(1), 7198. https://doi:10.3989/scimar.2008.72s17

Viva, C., Sartor, P., Bertolini, D., De Ranieri, S., & Ligas, A. (2015). Relationship of Otolith Length to Fish Total Length in Six Demersal Species from the NW Mediterranean Sea. *Journal of Applied Ichthyology*, *31*(5), 973-974. https://doi.org/10.1111/jai.12838

Więcaszek, B., Sobecka, E., Keszka, S., Panicz, R., Górecka, K., Linowska, A., & Król, S. (2019). Three New Records of Fishes and Their Parasite Fauna from Pomeranian Bay, Baltic Sea. *Acta Ichthyologica et Piscatoria*, *49*(1), 65-73. https://doi.org/10.3750/AIEP/02392

Wright, P. J., Panfili, J., Morales-Nin, B., & Geffen, A. J. (2002). Types of calcified structures. A. Otoliths. In J. Panfili, H. Pontual, H. Troadec, & P. J., Wright (Eds.), *Manual of Fish Sclerochronology* (pp. 31–57). Ifremer.

Yazicioglu, O., Polat, N., & Yilmaz, S. (2018). Feeding Biology of Pike, *Esox lucius* L., 1758 Inhabiting Lake Ladik, Turkey. *Turkish Journal of Fisheries and Aquatic Sciences*, *18*(10), 1215-1226. https://doi.org/10.4194/1303-2712-v18_10_08

Yazıcıoğlu, O., Yılmaz, S., Yazıcı, R., Erbaşaran, M., & Polat, N. (2016). Feeding Ecology and Prey Selection of European Perch, *Perca fluviatilis* Inhabiting a Eutrophic Lake in Northern Turkey. *Journal of Freshwater Ecology*, *31*(4), 641-651. https://doi.org/10.1080/02705060.2016.1220432

Yılmaz, S., Yazıcıoğlu, O., Yazıcı, R., & Polat, N. (2015). Relationships Between Fish Length and Otolith Size for Five Cyprinid Species from Lake Ladik, Samsun, Turkey. *Turkish Journal of Zoology*, *39*(3), 438-446. https://doi.org/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, China. *Journal of Applied Ichthyology*, *31*(3), 544-548. https://doi.org/10.1111/jai.12751