

Research article

The length-weight (LWR) and length-length (LLR) relationships of *Nemipterus randalli* (Russel, 1986), an invasive species in Iskenderun BayRamazan YAZICI^{1,*}, Okan YAZICIOĞLU², Mahmut YILMAZ³Tamer AKKAN⁵, Cengiz MUTLU⁶, Nazmi POLAT⁶¹Laboratory and Veterinary Health Program, Veterinary Department, Çiçekdağı Technical Vocational Schools of Higher Education, Kırşehir Ahi Evran University, Kırşehir, Türkiye²Department of Agricultural Biotechnology, Faculty of Agriculture, Kırşehir Ahi Evran University, Kırşehir, Türkiye³Organic Farming Program, Plant and Animal Production Department, Technical Vocational Schools of Higher Education, Kırşehir Ahi Evran University, Kırşehir, Türkiye⁴Department of Biology, Faculty of Arts and Science, Giresun University, Giresun, Türkiye⁵Department of Environmental Engineering, Faculty of Engineering, Giresun University, Giresun, Türkiye⁶Biology Department, Faculty of Sciences, Ondokuz Mayıs University, Atakum, Samsun, Türkiye

*Corresponding author e-mail: rmznyzci@gmail.com

Abstract: This study was carried out to determine the length-weight and length-length relationships of the Randall's threadfin bream (*Nemipterus randalli* Russel, 1986) living in the İskenderun Bay. In November 2018, a total of 187 Randall's threadfin bream were obtained. The total length, fork length and standard lengths of the samples were measured, and their weights were weighed. In the study, length-weight and length - length relationships were established using total length. The b value of the length -weight relationship in females, males and all individuals were determined as 2.985, 2.715 and 2.830, respectively. It was determined that the calculated b values were significantly different from 3 in male individuals and in the entire sample (t-test, P<0.05). Therefore, females showed isometric growth, while males showed negative allometric growth. Within the scope of length-height relationships, high correlations were obtained between all size types of the species.

Keywords: Iskenderun Bay, Invasive Species, Length-weight Relationships, *Nemipterus randalli*

Citation: Yazıcı, R., Yazıcıoğlu, O., Yılmaz, M., Akkan, T., Mutlu, C., & Polat, N. (2024). The length-weight (LWR) and length-length (LLR) relationships of *Nemipterus randalli* (Russel, 1986), an invasive species in Iskenderun Bay. *Acta Biologica Turcica*, 37(1), J7:1-7.

Introduction

Nemipterus randalli (Russell, 1986) is a demersal fish species belonging to the Nemipteridae family. Typically, it inhabits sandy and muddy terrains at depths ranging from 5 to 80 meters. This carnivorous species feeds on a diet consisting of small fish, crustaceans, mollusks, polychaetes, and echinoderms (Russell, 1990; Gurlek et al., 2010). Its natural range extends from the Red Sea, western India, and the Gulf of Arabia to the coast of East Africa, including Madagascar (Russell, 1990; Bakhsh, 1994; Hanafi et al., 2010). Along the Turkish coasts,

documented sightings include İskenderun Bay (Mediterranean Sea) by Bilecenoğlu and Russell (2008), Antalya Bay (Mediterranean Sea) by Gökoğlu et al. (2009), Gökova Bay (Southern Aegean Sea) by Gülşahin and Kara (2013), and İzmir Bay (Aegean Sea) by Aydın and Akyol (2017). Notably, *N. randalli* has been flagged as a blacklisted marine invasive species (Otero et al., 2013).

Fish diversity in the Mediterranean Sea has been severely affected by the introduction of invasive fish species (Goren et al., 2016). After entering the

Mediterranean Sea, *N. randalli* is defined as an invasive fish species for the Mediterranean Sea since it uses the same habitat as the native species (Arndt et al., 2018), competes with local species in terms of reproduction strategies (Taylan & Yapıcı, 2021) and feeding habits (Gilaad et al., 2017), and quickly expands (Gurlek et al., 2010). Therefore, information about the biology of invasive fish species is very valuable.

Length-weight relationship, one of the basic biological parameters, is a widely used tool in fisheries science to estimate the weight of fish according to their length. It is important in fisheries management as it can be used to calculate the biomass of a fish population and determine the growth and condition of the fish. The length-weight relationship can be used as a basic tool in researching and managing fish stocks. It can also help in comparing morphometric parameters between various species or among the same species living in different habitats (Goncalves et al., 1997; Moutopoulos & Stergiou, 2002). Length-to-length conversions are needed to facilitate these comparisons. By calculating the transformations of different length types in fish populations, comparisons between habitats are easily made (Yazıcıoğlu & Yazıcı, 2016). Many researchers have made it easier to discuss in scientific studies by calculating length conversions. (Sinovčić et al., 2004; Hossain et al., 2009; Yılmaz et al., 2010; Siddique et al., 2021; Yazıcı & Saylar, 2022; Yazıcıoğlu et al., 2023).

Useful and practical biological data, such as the length-weight relationship, contain important information about the adaptation and development of invasive species. Therefore, in this study, we aimed to determine the length-weight and length-length relationships of *N. randalli* species, which have the potential to seriously invade the marine ecosystems of our country.

Materials and Methods

Fish samples were obtained from local fishermen in Iskenderun Bay in November 2018. A total of 187 samples, 61 female and 126 males, were obtained. The total, fork and standard lengths of the samples were

measured on a fish measuring board with ± 1 mm precision, and their weights were weighed with a scale with ± 0.01 g precision. Sex determination was determined by macroscopic examination of the gonads and considering the morphological characteristics of the samples. To determine the length-weight relationships of the examined samples.

$$W=a \times L^b$$

equation was used (Ricker, 1975). In this equality; W = body weight (g), L = total length (cm), a and b = length-weight relationship parameters.

The a and b parameters of the length-weight relationship was determined by the linear regression transformation of the relationship as $\text{Log}W = \text{Log}a + b \text{Log}L$, and whether the b value of each individual was different from isometric growth ($b = 3$) was tested using the t-test. Additionally, the 95% confidence interval of the b value was calculated (Zar, 1999).

Total length-fork length, total length-standard length and fork length-standard length relationships were put forward to compare the measured total, fork and standard length values with the length values in other studies on the species. length-length relationships were calculated using linear regression analysis and were determined separately for females, males, and all individuals (Zar, 1999).

Results

As a result of sampling, a total of 187 individuals were obtained. 67.38% (126) of the samples were male and 32.62% (61) were female.

Descriptive statistics for length and weight are given in Table 1. Total length and weight distributions across the sample were determined as 11.1-19.3 (Se= ± 0.099) cm and 17.12-77.66 (Sh= ± 0.823) g, respectively. The average total length and weight values of the sample were determined as 15.28 cm and 43.783 g. The difference between the average total length and weight values of male and female individuals was found to be statistically significant (Mann-Whitney U test, $P < 0.05$). Therefore, length-weight relationship parameters were calculated separately for males, females, and the general population.

Table 1. Descriptive statistics of length and weight values of *Nemipterus rendalli* in Iskenderun Bay (N: number of samples, Min: minimum, Max: maximum, S.E.: standard error)

Sex	Total Length					Weight				
	N	Min	Max	Mean	S.E.	N	Min	Max	Mean	S.E.
Male	126	12.000	19.300	14.989	0.114	126	22.330	77.660	41.117	0.893
Female	61	11.100	18.500	15.880	0.167	61	17.120	75.700	49.290	1.500
Combined sexes	187	11.100	19.300	15.280	0.099	187	17.120	77.660	43.783	0.823

The total length-weight relationship parameters of the *N. randalli* sample were determined separately for the sexes and the general population and are given in Table 2. The b value of the length-weight relationship in females, males and all individuals were determined as 2.985, 2.715 and 2.830, respectively. It was determined that the calculated b values were significantly different from 3 in

male individuals and in the entire sample (t-test, $P < 0.05$). On the other hand, it was determined that the b value in female individuals was not statistically different from 3 (t-test, $P > 0.05$).

The graphs of the total length-weight relationship for males, females, and the population are shown in Figure 1-3.

Table 2. Length-weight relationship parameters of *Nemipterus randalli* in Iskenderun Bay. (N: number of samples, a: intersection, b: slope, r²: correlation coefficient, P: probability value).

Sex	N	a	b	95 % CI of b	r ²	P
Male	126	0.0026	2.715	2.574-2.856	0.92	0.000
Female	61	0.0126	2.985	2.782-3.186	0.92	0.875
All Samples	187	0.0191	2.830	2.719-2.940	0.93	0.003

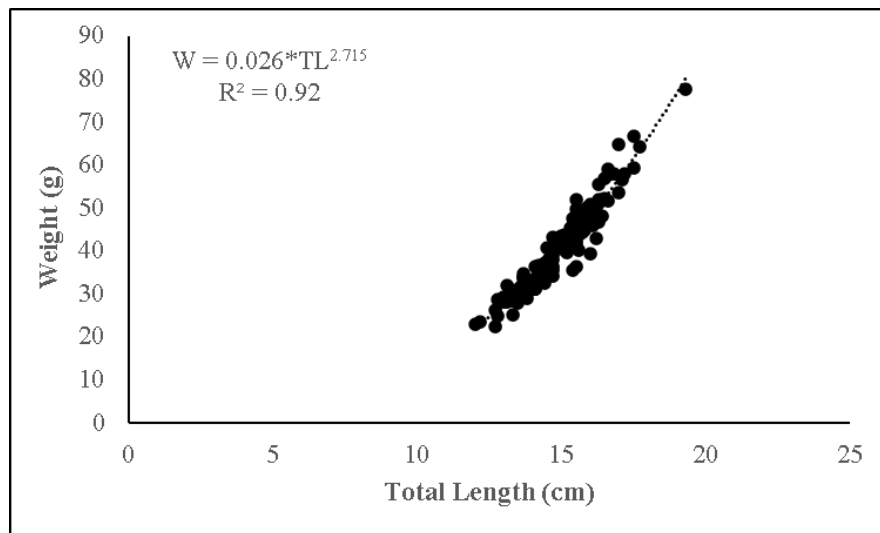


Figure 1. Length-weight relationship for male individuals of *Nemipterus randalli* in Iskenderun Bay.

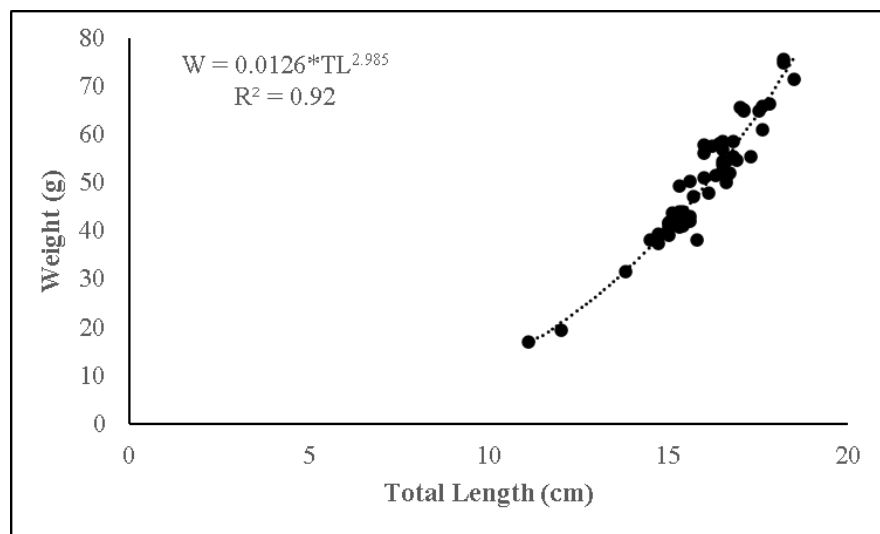


Figure 2. Length-weight relationship for female of *Nemipterus randalli* in Iskenderun Bay.

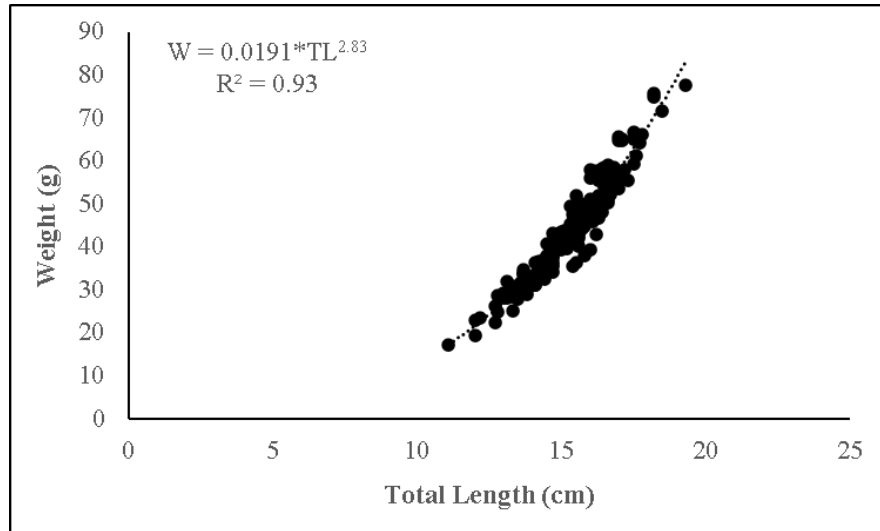


Figure 3. Length-weight relationship for combined sexes of *Nemipterus randalli* in Iskenderun Bay.

The relationships between total, fork, and standard lengths of *N. randalli* living in Iskenderun Bay are presented in Table 3. Very strong relationships have been detected between different lengths in males, females, and all individuals of the species.

Table 3. Length-length relationship parameters of *Nemipterus randalli* in Iskenderun Bay.

Sex	N	Equation	a	b	r ²
Male	126	TL= a + bFL	0.175	1.12	0.97
		TL= a + bSL	4.943	0.8486	0.56
		FL= a + bSL	4.467	0.7421	0.57
Female	61	TL= a + bFL	-0.988	1.21	0.96
		TL= a + bSL	0.334	1.29	0.94
		FL= a + bSL	1.470	1.03	0.93
All Samples	187	TL= a + bFL	-0.310	1.57	0.97
		TL= a + bSL	3.440	0.99	0.66
		FL= a + bSL	3.460	0.84	0.65

Discussion

A total of 187 individuals were used in this study. The length-weight and length-length relationships of the samples were calculated and their analysis in comparison with the literature is presented below.

The length-weight relationship is a very important tool for fisheries management (Bolger & Connolly, 1989). In addition to being used to determine the growth trajectories of fish, these relationships are also very useful for comparing fish growth and condition between sexes, seasons, and habitats (Froese, 2006). As is known, the b value in fish varies between 2-4 (Bagenal & Tesch, 1978). The calculated b parameter of the length-weight relationship for females, males and all individuals were found to be less than 3, indicating isometric growth. However, this situation was statistically different only in

men and in the general population. This result shows that males and all individuals have negative allometric growth.

The length-weight relationship parameters obtained in different studies was shown in Table 4. Although the length-weight relationship parameters obtained for the examined samples largely overlap with the results of studies in other habitats, there are also some differences. The number of samples used in the research, length-weight distributions, sampling time, type of length used, and ecological conditions of the environments may have caused these differences. The length-weight relationship in fish varies depending on condition and body shape (Schneider et al., 2000), factors such as nutritional adequacy, feeding rate, gonad development and reproductive period (Bagenal and Tesch, 1978).

The fact that the length types used in different studies are not the same creates problems in comparing the research results (Yazıcı et al., 2015). Length transformations in fish are very useful in comparing studies using different length types (Yılmaz et al., 2010; Tsagarakis et al., 2015). For this reason, the relationships between total fork and standard lengths of *N. randalli* were determined, allowing the transformation of length types into each other, and enabling studies using different length types to use these research findings. Despite the importance of length transformations, when the existing literature is examined, there are no studies reporting length - length relationships.

As a result, it was determined that females showed isometric growth, whereas males showed negative allometric growth in the Iskenderun Bay population of *N. randalli* species. These data are invaluable for understanding invasive species and implementing

effective fisheries management. Considering that more alien species will enter our country in the coming years

due to global warming, it is very important that such studies be carried out by researchers.

Table 4. Length-weight relationship parameters obtained in different studies for *Nemipterus randalli*.

a	b	r ²	Location	Reference
0.0130	2.687	0.979	İskenderun Bay	Erguden et al. (2009)
0.0011	3.061	0.982	İskenderun Bay	Erguden et al. (2010)
0.0174	2.924	0.989	Southern Aegean Sea	Bilge et al. (2014)
0.0120	2.975	0.937	Antalya Gulf	Ozvarol (2014)
0.0105	3.043	0.983	Antalya Gulf	İnnal et al. 2015
0.0201	2.980	0.980	Gökova Bay	Ateş et al. (2017)
0.0350	2.740	0.970	Pakistani waters	Kalhor et al. (2017)
0.0171	2.920	0.970	Gökova Bay	Uyan et al. (2019)
0.0106	3.090	0.970	İskenderun Bay	Demirci et al. (2020)
0.0173	2.858	-	Antalya Gulf	Özen and Çetinkaya (2020)
0.0120	2.945	0.956	Mannar Gulf	Sonwal et al. (2022)
0.0191	2.830	0.930	İskenderun Bay	This study

Acknowledgements

Thanks to the Hüseyin Oğulları-6 fishing ship for their help in providing samples.

Ethical Approval

No need for ethical approval for this study.

Funding Statement

This research was funded by Kırşehir Ahi Evran University Scientific Research Projects Coordination Unit with the project code CMY.A4.19.001.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

Arndt, E., Givan, O., Edelist, D., Sonin, O., & Belmaker, J. (2018). Shifts in eastern Mediterranean fish communities: Abundance changes, trait overlap, and possible competition between native and non-native species. *Fishes*, 3, 19.

Ateş, C., Cerim, H., & Celik, M. (2017). Length-weight relationships of commercial indigenous and Lessepsian fishes in Gökova Bay, Turkey. *Cahiers de Biologie Marine*, 58(1), 43-47.

Aydın, İ., & Akyol, O. (2016). Occurrence of *Nemipterus randalli* Russell, 1986 (Nemipteridae) of Izmir Bay, Turkey. *Egyptian Journal of Aquatic Research*, 18, 267-74.

Bagenal, T. B., & Tesch, F. W. (1978). *Age and Growth*, in: Bagenal T.B. (Edt). *Methods for Assessment of Fish Production in Freshwaters*, Oxford. Blackwell Science Publication, London.

Bakhsh, A. A. (1994). The biology of Thread Bream *Nemipterus japonicus* (Bloch) from Jizan Region of the Red Sea. *Journal of King Abdulaziz University-Marine Sciences*, 7, 179-189.

Bilecenoglu, M., & Russell, B. C. (2008). Record of *Nemipterus randalli* Russell, 1986 (Nemipteridae) from Iskenderun Bay, Turkey. *Cybiurn*, 23, 115-130.

Bilge, G., Yapıcı, S., Filiz, H., & Cerim, H. (2014). Weight-length relations for 103 fish species from the southern Aegean Sea, Turkey. *Acta ichthyologica et piscatoria*, 44(3), 263-269.

Bolger, T., & Connolly, P. L. (1989). The Selection of Suitable Indices for the Measurement and Analysis of Fish Condition. *Journal of Fish Biology*, 34(2), 171-182.

Demirci, S., Demirci, A., & Şimşek, E. (2020). The Validation of Different Growth Models of Randall's Threadfin Bream, *Nemipterus randalli* (Russell, 1986), in Northeastern Mediterranean Sea. *Pakistan Journal of Zoology*, 52(3), 1113-1119.

Erguden, D., Turan, C., & Gurlek, M. (2009). Weight-length relationships for 20 Lessepsian fish species caught by bottom trawl on the coast of Iskenderun Bay (NE Mediterranean Sea, Turkey). *Journal of Applied Ichthyology*, 25(1), 133-135.

Erguden, D., Turan, C., Gurlek, M., Yagliglu, D., & Gungor, M. (2010). Age and growth of the Randall's threadfin bream *Nemipterus randalli* (Russell, 1986), a recent Lessepsian migrant in Iskenderun Bay, northeastern Mediterranean. *Journal of Applied Ichthyology*, 26(3), 441-444.

Froese, R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of applied ichthyology*, 22(4), 241-253.

Gilaad, R. L., Galil, B. S., Diamant, A., & Goren, M. (2017). The diet of native and invasive fish species along the eastern Mediterranean coast (Osteichthyes). *Zoology in The Middle East*, 63, 325-335.

- Gökoglu, M., Güven, O., Balci, B. A., Çolak, H., & Golani, D. (2009). First records of *Nemichthys scolopaceus* and *Nemipterus randalli* and second record of *Apterichthys caecus* from Antalya Bay, Southern Turkey. *Marine Biodiversity Records*, 2, e29.
- Gonçalves, J. M. S., Bentes, L., Lino, P. G., Ribeiro, J., Canário, A. V., & Erzini, K. (1997). Weight-length relationships for selected fish species of the small-scale demersal fisheries of the south and south-west coast of Portugal. *Fisheries research*, 30(3), 253-256.
- Goren, M., Galil, B. S., Diamant, A., Stern, N., & Levitt-Barmats, Y. A. (2016). Invading up the food web? Invasive fish in the southeastern Mediterranean Sea. *Marine Biology*, 163, 1-11.
- Gülşahin, A., & Kara, A. (2013). Record of *Nemipterus randalli* Russell, 1986 from the southern Aegean Sea (Gökova Bay, Turkey). *Journal of Applied Ichthyology*, 29, 933-934.
- Gurlek, M., Erguden, S., Yaglioglu, D., Turan, F., Demirhan, S., Gurlek, M., Gungor, M., Ozbalcilar, B., & Ozcan, T. (2010). Feeding habits of Indo-Pacific Species *Nemipterus randalli* Russel, 1986 (Nemipteridae) in Iskenderun Bay, Eastern Mediterranean Sea. *Ciesm*, 39, 539.
- Hanafi, N. A., Mohamed, A. R., & Al-Dubakel, A. Y. (2010). Fishery, growth and mortality of the threadfin bream, *Nemipterus japonicus* (Bloch, 1791) (Pisces: Nemipteridae) from the southern Sudanese waters, Red Sea. *Basrah Journal of Agricultural Science*, 2, 187-199.
- Hossain, M. Y., Jasmine, S., Ibrahim, A. H. M., Ahmed, Z. F., Rahman, M. M., & Ohtomi, J. (2009). Length-weight and length-length relationships of 10 small fish species from the Ganges, Bangladesh. *Journal of Applied Ichthyology*, 25(1), 117-119.
- Innal, D., Aksu, M., Akdoganbulut, D., Kisin, B., Can, M., Unal, M. O., & Pek, E. (2015). Age and growth of *Nemipterus randalli* from Antalya Gulf-Turkey. *International Journal of Fisheries and Aquatic Studies*, 2(4), 299-303.
- Kalhor, M. A., Tang, D., Ye, H., Morozov, E., Liu, Q., Memon, K. H., & Kalhor, M. T. (2017). Population dynamics of Randall's threadfin bream *Nemipterus randalli* from Pakistani waters, Northern Arabian Sea. *Indian Journal of Geo-Marine Sciences*, 46(3), 551- 561.
- Moutopoulos, D. K., & Stergiou, K. I. (2002). Length-weight and length-length relationships of fish species from the Aegean Sea (Greece). *Journal of Applied Ichthyology*, 18(3), 200-203.
- Otero, M., Cebrian, E., Francour, P., Galil, B., & Savini, D., (2013). *Monitoring marine invasive species in Mediterranean Marine Protected Areas (MPAs): A strategy and practical guide for managers*. Malaga, Spain: IUCN.
- Özen, M.R., & Çetinkaya, O. (2020). Population composition, growth and fisheries of *Nemipterus randalli* Russell, 1986 in Antalya Gulf, Mediterranean Sea, Turkey. *Acta Aquatica Turcica*, 16(3), 330-337.
- Özvarol, Y. (2014). Length-weight relationships of 14 fish species from the Gulf of Antalya (northeastern Mediterranean Sea, Turkey). *Turkish Journal of Zoology*, 38(3), 342-346.
- Ricker, W. E. (1975). *Computation and Interpretation of Biological Statistics of Fish Populations*, Bull. Fish. Res. Board. Can., Canada.
- Russell, B. C. (1990). *Vol. 12. Nemipterid fishes of the world (threadfin breams, whiptail breams, monocle breams, dwarf monocle breams and coral breams): An annotated and illustrated catalogue of nemipterid species known to date*. Rome, IT: Food and Agriculture Organization of the United Nations.
- Siddique, M. A. M., Rahman, M., Khan, N. S., & Islam, M. M. (2021). Size frequency, length-weight, and length-length relationship of bearded worm goby *Taenioides cirratus* (Blyth, 1860) from the Noakhali Coast, Bay of Bengal. *Thalassas: An International Journal of Marine Sciences*, 37, 347-351.
- Sinovčić, G., Franičević, M., Zorica, B., & Čikeš-Keč, V. (2004). Length-weight and length-length relationships for 10 pelagic fish species from the Adriatic Sea (Croatia). *Journal of Applied Ichthyology*, 20(2), 156-158.
- Sonwal, M. C., Kingston Samuel, D., Lakshmanan, R., & Paulraj, J. (2022). Length-weight relationship of five species of Nemipteridae family along the Gulf of Mannar, Eastern Indian Ocean. *Journal of Applied Ichthyology*, 38(2), 265-267.
- Taylan, B., & Yapıcı, S. (2021). Reproductive biology of non-native *Nemipterus randalli* Russell, 1986 and native *Pagellus erythrinus* (Linnaeus, 1758) from the Aegean Sea. *North-Western Journal of Zoology*, 17, 180-186.
- Tsagarakis, K., Başusta, A., Başusta, N., Biandolino, F., Bostanci, D., Buz, K., Djodjo, Z., Dulčić, J., Gökoglu, M., Gücü, A. C., Machias, A., Maravelias, C. D., Özvarol, Y., Polat, N., Prato, E., Vasilakopoulos, P., & Yedier, S. (2015). New Fisheries-related Data from The Mediterranean Sea (October 2015). *Mediterranean Marine Science*, 16(3), 703-713.
- Uyan, U., Filiz, H., Tarkan, A. S., Çelik, M., & Top, N. (2019). Age and growth of *Nemipterus randalli* in the southern Aegean Sea, Turkey. *Journal of The Black Sea/Mediterranean Environment*, 25(2), 140-149.
- Yazıcı, R., & Saylar, Ö. (2022). Length-Weight and Length-Length Relationships and Condition Factor of An Endemic Fish Species (*Capoeta tinca* (Heckel, 1843)) Inhabiting Bayat Pond (Ankara, TÜRKİYE). *Bilge International Journal of Science and Technology Research*, 6(2), 132-137.
- Yazıcı, R., Yılmaz, S., Yazıcıoğlu, O., & Polat, N. (2015). Population structure and growth of rudd *Scardinius erythrophthalmus* (L., 1758) from a eutrophic lake in northern Anatolia. *Croatian Journal of Fisheries: Ribarstvo*, 73(3), 94-102.

- Yazıcıoğlu, O., & Yazıcı, R. (2016). The Length-Weight, Length-Length Relationship and Condition Factor of Angora Loach, *Oxynoemacheilus angorae* (Steindachner, 1897) Inhabiting Kılıçözü Stream in Kızılırmak River Basin (Central Anatolia-Turkey). *Turkish Journal of Agriculture-Food Science and Technology*, 4(12), 1165-1168.
- Yazıcıoğlu, O., & Yazıcı, R. (2023). Some Biological Features of Tench (*Tinca tinca*, L., 1758) Inhabiting Sıddıklı Dam. *Black Sea Journal of Agriculture*, 6(2), 204-209.
- Yazıcıoğlu, O., Yazıcı, R., & Akkan, T. (2023). Harşit Çayı'nda Yaşayan *Squalius orientalis* Heckel, 1847'in Kondisyon Faktörü Boy-Ağırlık ve Boy-Boy İlişkileri. *Journal of Anatolian Environmental and Animal Sciences*, 8(1), 140-145.
- Yılmaz, S., Yazıcıoğlu, O., Yılmaz, M., & Polat, N. (2010). Length-weight and length-length relationships of *Capoeta sieboldii* from Hirfanlı Dam Lake, Turkey. *Journal of Freshwater Ecology*, 25(2), 205-209.
- Zar, J. H. (1999). *Biostatistical Analysis*, 4th ed., Prentice-Hall, New Jersey.