Morphometric Relationships of *Nemipterus randalli* (Russell, 1986) from İskenderun Bay

Ramazan YAZICI[1*]   **Okan YAZICIOĞLU**[2]   **Tamer AKKAN**[3]

[1*]*Laborant and Veterinary Health Program, Veterinary Department, Çiçekdağı Vocational School, Kırşehir Ahi Evran University, Kırşehir, Turkey*
[2]*Department of Plant and Animal Production, Vocational School of Technical Sciences, Kırşehir Ahi Evran University, Kırşehir, Turkey*
[3]*Giresun University, Science and Art Faculty, Biology Department, Giresun, Turkey*

[ID]: https://orcid.org/0000-0003-2274-0707
[ID]: https://orcid.org/0000-0003-4302-2181
[ID]: https://orcid.org/0000-0002-9866-4475

*Corresponding author's:
Ramazan YAZICI
Laborant and Veterinary Health Program, Veterinary Department, Çiçekdağı Vocational School, Kırşehir Ahi Evran University, Kırşehir, Turkey.
✉ rmznyzci@gmail.com
Mobile telephone: +90 (541) 717 75 73
Telephone   **:** +90 (386) 280 55 10
Fax   **:** +90 (386) 280 40 40

Abstract: In this study was aimed to describe the relationships between morphometric characters and total length of *Nemipterus randalli*. A total of 107 samples were collected from Iskenderun Bay in November 2018. The results show that estimates of total length of this species through morphometric character are reliable. Linear regressions showed the best accuracy for all relationships between morphometric characters and total length. Among obtained relationships, the best fit was recorded between total length and head length, while the lowest value of coefficient of determination was also determined between total length and horizontal mouth gape. Establishing morphometric relationships can provide an alternative to back-calculation of fish length and can provide information that aids in understanding complex relationships between predator and prey size. The equations generated to obtain the total length of the fish using morphometric character data can be used in dietary studies of top predators and paleontological studies.

Keywords: İskenderun Bay, Linear Relationships, Morphometry, *Nemipterus randalli*.

İskenderun Körfezi'ndeki *Nemipterus randalli* (Russell, 1986)'nin Morfometrik İlişkileri

*Sorumlu yazarın:
Ramazan YAZICI
Laborant ve Veteriner Sağlık Programı, Veterinerlik Bölümü, Çiçekdağı Meslek Yüksekokulu, Kırşehir Ahi Evran Üniversitesi, Kırşehir, Türkiye.
✉ rmznyzci@gmail.com
Cep telefonu : +90 (541) 717 75 73
Telefon   **:** +90 (386) 280 55 10
Faks   **:** +90 (386) 280 40 40

Öz: Bu çalışmada, *Nemipterus randalli*'nin morfometrik karakterler ile toplam uzunluğu arasındaki ilişkileri tanımlamak amaçlanmıştır. Kasım 2018 tarihinde toplam 107 örnek İskenderun Körfezi'nden elde edilmiştir. Sonuçlar, morfometrik karakter üzerinden bu türün toplam uzunluğunun tahminlerinin güvenilir olduğunu göstermektedir. Doğrusal regresyonlar, morfometrik karakterler ve toplam uzunluk arasındaki tüm ilişkiler için en iyi doğruluğu göstermiştir. Elde edilen ilişkiler arasında en iyi uyum toplam uzunluk ve baş uzunluğu arasında kaydedilmiş iken, en düşük korelasyon katsayısı değeri ise toplam uzunluk ile yatay ağız açıklığı arasında belirlenmiştir. Morfometrik ilişkilerin kurulması, balık uzunluğunun geriye doğru hesaplanmasına bir alternatif sağlayabilir ve avcı ile av boyutu arasındaki karmaşık ilişkilerin anlaşılmasına yardımcı olan bilgiler sağlayabilir. Morfometrik karakter verilerini kullanarak balıkların toplam uzunluğunu elde etmek için oluşturulan denklemler, predator balıkların beslenme çalışmalarında ve paleontolojik çalışmalarda kullanılabilir.

Anahtar kelimeler: İskenderun Körfezi, Linear ilişkiler, Morfometri, *Nemipterus randalli*.

INTRODUCTION

Nemipterus randalli Russell, 1986, Randall's threadfin bream, has a common distribution western Indian Ocean including the east and west coasts of India, Pakistan, the Persian (Arabian) Gulf, Red Sea, including the Gulf of Aqaba, the Gulf of Aden, and the eastern African coast: the Seychelles and Madagascar (Russell, 1990). Randall's threadfin bream being benthic species, lives on sand or mud bottoms in depths of 22 to 225 m (Russell, 1990).

The morphometric characters of fishes are a good tool for estimating about feeding style, the life history, and

swimming abilities of fish (Kováč et al., 1999). The calculated analyses from morphometric character help to understand the relationships between the body parts. Morphometric characters can identify aspects of body shape in fishes. These characters can commonly use in fisheries biology to measure discreteness between different fish stocks (Qadri et al., 2017) and relationships among various taxonomic categories (Turan, 1999).

There are researches on feeding habits (Gurlek et al., 2010), age and growth (Erguden et al., 2010; Innal et al., 2015; Demirci et al., 2020), length-weight relationships (Erguden et al., 2009), fish length and otolith size relationships (Uyan et al., 2019) and reproductive feature (Demirci et al., 2018) of Randall's threadfin bream. The available data on the morphometric characteristics of Randall's threadfin bream are very rare. Only Innal et al. (2015) published some comparable morphometric data on this species from Antalya Gulf. Moreover, the study about morphometric relations was not found for İskenderun Bay populations. The aim of paper is to determine relationships between morphometric characters and total length.

MATERIAL AND METHOD

Samples were collected from İskenderun Bay in November 2018. Sampling operations were carried out with a medium water trawl net made of polyethylene (PE) material (∅0.40 * 10) with a mouth opening of 1.5-2m, 22 mm mesh width, 35m length and 7 m width, of Iskenderun Bay Denizciler area. A total of 107 specimens were analyzed to determine relationships between the morphometric characters and total length. A total of eight morphometric character measurements were made on left side of the body of each fish specimen. The total length (TL) of the fish were measured to the nearest 0.1 cm using fish measuring board. The measurements of the others morphometric characters were done by using a digital caliper. The sex of samples was detected by the examination of gonads macroscopically. The morphometric features studied included total length (TL), pectoral fin ray length (PFRL), dorsal fin length (DFL), head height (HH), head length (HL), body height (BH), vertical mouth gape (VMG) and horizontal mouth gape (HMG) of the specimens. The morphometric character was measured as given in Table 1.

Linear (y = ax + b) and non-linear (y = ax^b, power model) regression models were calculated to determine what equations best described the relationships between morphometric character and total length. Where Y is the

variable (morphometric character), 'x' is the independent character (total length) and 'a' and 'b' are constants. The model with the highest coefficient of determination (r^2) was chosen to describe these relationships.

Table 1. Measured morphometric character of *Nemipterus randalli*

orphometric character	Abbreviation	Description of measured parameters
Total length	TL	Measurement of body length from tip of largest jaw to the largest part of caudal fin
Pectoral Fin Ray Length	PFRL	The length of the longest find ray of pectoral fin.
Dorsal Fin Length	DFL	Distance from the start of the fin to the end by the dorsal side.
Head Height	HH	Distance between the upper and lower edges of the head in ventral position.
Head Length	HL	Distance between the anterior head extremity and the end of operculum
Body Height	BH	Maximum vertical length of body
Vertical Mouth Gape	VMG	Greater distance between the measured lips with mouth open
Horizontal Mouth Gape	HMG	Internal distance from the mouth when fully open

The t-test was used to compare the outcomes of morphometric measurements between sexes. Paired t-test was used to determine the difference in measurements of left and right pectoral fin rays length. The differences in the slope of regressions equations between males and females were tested by analysis of covariance (ANCOVA). Statistical analyses were performed with Minitab 17.0 software package and a level of significance of α=0.05 was accepted.

RESULTS

A total of 107 specimens were examined for determining the relationships between morphometric characters and total length. Of the total fish examined, 36 were females and 71 were males. The total lengths of all samples ranged from 11.1 cm to 19.3 cm, with a mean value of 15.3 ± 1.518 cm (sd). The descriptive statistics of morphometric characters are given in Table 2. The mean values of TL, PFRL, DFL HH, HL, and BH of females were higher than mean values of male (Table 2). The mean values of mouth morphometric characters (VMG and HMG) were detected the highest in males (Table 2).

There was significant difference in the measurements of all morphometric character (TL, PFRL, DFL, HH, HL, BH, VMG, and HMG) between females and males (t-test, p< 0.0.5). For this reason, the relationships between total length and morphometric characters were generated separately according to female, male, and entire sample. The differences in morphometric measurements of both left and right pectoral fin ray length in female and male are not statistically significant (paired t-test, p>0.05). Therefore, the left pectoral fin ray length was used to determine regression model.

Table 2. The descriptive statistics of morphometric characters of female, male, and entire sample in *Nemipterus randalli*.

Morp. Characters	Sex	n	Min-Max	Mean	SD	t-test
TL	Female	36	11.1 - 18.5	15.9	1.497	
	Male	71	12.0 - 19.3	15.0	1.455	P<0.05
	Entire	107	11.1 - 19.3	15.3	1.518	
PFRL	Female	36	2.9000 - 4.8000	4.2083	0.4735	
	Male	71	2.6000 - 4.6000	3.5803	0.3698	P<0.05
	Entire	107	2.6000 - 4.8000	3.7916	0.5032	
DFL	Female	36	4.400 - 7.300	6.208	0.643	
	Male	71	4.4000 - 7.7000	5.8718	0.5844	P<0.05
	Entire	107	4.4000 - 7.7000	5.9850	0.6227	
HH	Female	36	2.1000 - 4.4000	3.4028	0.4672	
	Male	71	2.3000 - 4.2000	3.0085	0.4006	P<0.05
	Entire	107	2.1000 - 4.4000	3.1411	0.4672	
HL	Female	36	2.9000 - 5.0000	4.1389	0.4416	
	Male	71	2.8000 - 5.0000	3.9113	0.4393	P<0.05
	Entire	107	2.8000 - 5.0000	3.9879	0.4511	
BH	Female	36	2.9000 - 5.4000	4.3278	0.5262	
	Male	71	2.6000 - 5.1000	3.9178	0.4876	P<0.05
	Entire	107	2.6000 - 5.4000	3.9178	0.5784	
VMG	Female	36	1.0000 - 2.9000	1.6667	0.3825	
	Male	71	1.5000 - 3.4000	1.9099	0.2742	P<0.05
	Entire	107	1.0000 - 3.4000	1.8280	0.3336	
HMG	Female	36	0.9000 - 2.8000	1.5306	0.3311	
	Male	71	1.4000 - 3.2000	1.8845	0.2901	P<0.05
	Entire	107	0.9000 - 3.2000	1.7654	0.3464	

Both linear and non-linear regression model were calculated to determine the relationships between morphometric characters. The linear regression model was showed the best fitted compared to the non-linear regression for expressing these relationships. All morphometric measurements were positively related to fish total length, with r^2 values ranging between 0.22 and 0.87. No significant difference was observed in slopes (b) of relationships between morphometric characters of females and males (ANCOVA, p>0.05). However, slopes (b) of TL-VMG and TL-HMG relationships were statistically different between female and male (ANCOVA, p<0.05).

The all morphometric characters were showed well correlated with the total length, except the mouth morphometric characters. Among calculated these relationships, the highest value of the coefficient of regression (r^2) was obtained for total length (TL) and head length (HL) in entire sample, while the lowest value of coefficient of determination was detected between total length (TL) and horizontal mouth gape (HMG). The r^2 values of TL-HL, TL-HH, TL-PFRL, and TL-BH relationship were higher in male, while the r^2 values of TL-DF, TL-HMG, and TL-VMG relationship were the higher in female (Figure 1 and Figure 2).
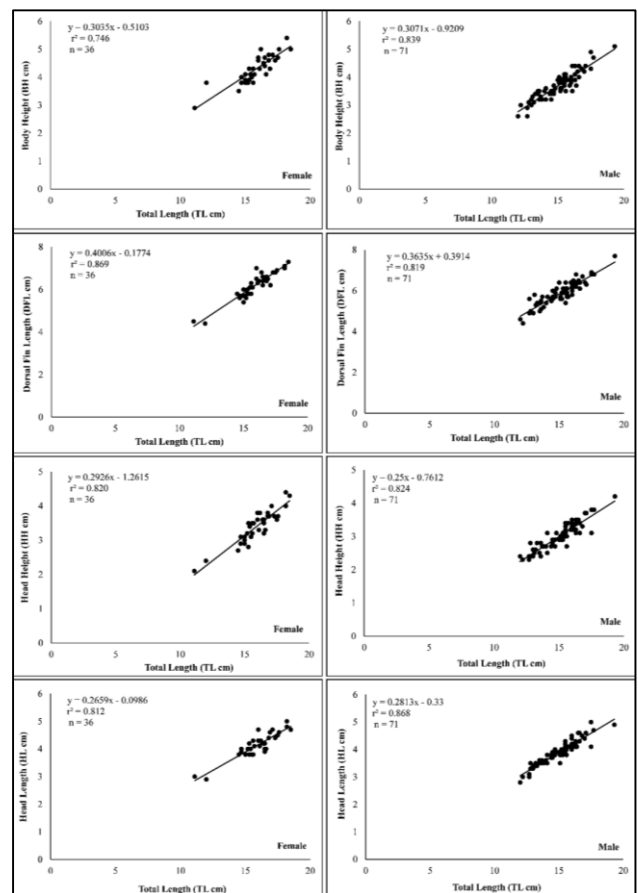

Figure 1. The relationships between BH, DFL, HH, and HL and and total length in females and males of *Nemipterus randalli*.
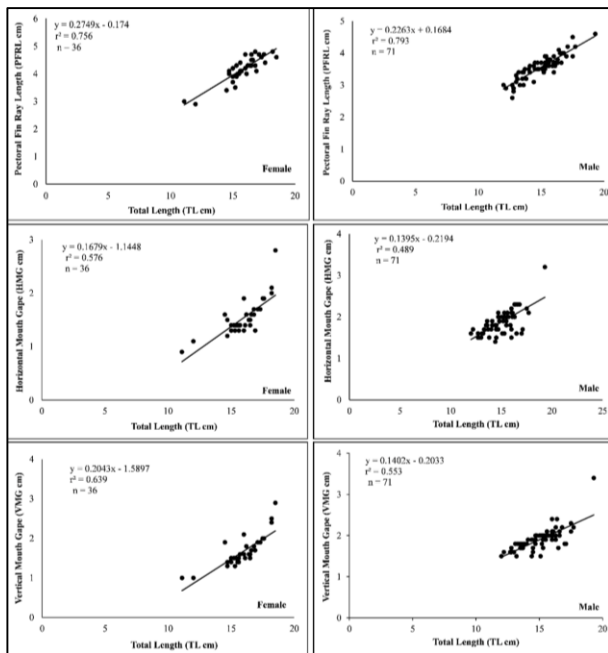
Figure 2. The relationships between PFRL, HMG, and VMG and total length in females and males of *Nemipterus randalli*.

DISCUSSION AND CONCLUSION

The biological features such as age and growth, length-weight relationships, fish length and otolith size relationship, and reproduction feature of *N.randalli* Antalya Gulf and İskenderun Bay population were determined by different researchers (Erguden et al., 2009; Erguden et al., 2010; Özvarol, 2014; Uyan et al., 2019; Demirci et al., 2020). Little information is available on the morphometric character measurements of *N. randalli* (Innal et al., 2015). Since there is no study on relationships between morphometric measures and body length for Randall's threadfin bream inhabiting İskenderun Bay, the comparisons were done the other populations of this species

The linear regression model is generally chosen to detect relationships between morphometric characters and length of the fish (Šantić et al., 2011). In this study, both linear and non-linear models were analyzed for defining the relationships between morphometric characters and total length. The simple linear regression model determined morphometric relationships, for the eight morphometric features evaluated here had higher correlation coefficients than non-linear model. Similarly, studies that being high positive correlation coefficients of morphometric relationships have been reported (Innal et al., 2015; Balai et al., 2017).

The mean values of morphometric measurements of females were higher than mean values of male in this study. These differences between morphometric characters for sexes in this study are in general agreement with other

studies reported on *Amblypharyngodon mola* (Gogoi & Goswami, 2015). However, Innal et al. (2015) stated that length and weight of males were higher than females in *N randalli*.

The morphometric characters of Randall's threadfin bream were all positively related to fish total length. The lowest determination coefficient value was found between the mouth measurements and total length in this study. The relationships between other characters and total length had high determination coefficient values.

In conclusion, the use of all measurements except mouth measurements is more reliable for assessing and calculating morphometric data. There is a significant difference in size and body depth between both the sexes.

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