

ANNALES



UDK 5

*Analí za istrske in mediteranske študije
Annali di Studi istriani e mediterranei
Annals for Istrian and Mediterranean Studies
Series Historia Naturalis, 31, 2021, 1*



UDK 5

ISSN 1408-533X
e-ISSN 2591-1783



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Anali za istrske in mediteranske študije
Annali di Studi istriani e mediterranei
Annals for Istrian and Mediterranean Studies

Series Historia Naturalis, 31, 2021, 1

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Izdajatelja/Editori/Published by:Zgodovinsko društvo za južno Primorsko - Koper / Società storica del Litorale - Capodistria[®]Inštitut IRRIS za raziskave, razvoj in strategije družbe, kulture in okolja / Institute IRRIS for Research, Development and Strategies of Society, Culture and Environment / Istituto IRRIS di ricerca, sviluppo e strategie della società, cultura e ambiente[®]**Sedež uredništva/Sede della redazione/
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Redakcija te številke je bila zaključena 30. 06. 2021.

**Sofinancirajo/Supporto finanziario/
Financially supported by:**

Javna agencija za raziskovalno dejavnost Republike Slovenije (ARRS), Luka Koper in Mestna občina Koper

Annales - Series Historia Naturalis izhaja dvakrat letno.

Naklada/Tiratura/Circulation: 300 izvodov/copie/copies

Revija Annales, Series Historia Naturalis je vključena v naslednje podatkovne baze / La rivista Annales, series Historia Naturalis è inserita nei seguenti data base / Articles appearing in this journal are abstracted and indexed in: BIOSIS-Zoological Record (UK); Aquatic Sciences and Fisheries Abstracts (ASFA); Elsevier B.V.: SCOPUS (NL); Directory of Open Access Journals (DOAJ).

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received: 2021-04-20

DOI 10.19233/ASHN.2021.14

**LENGTH-WEIGHT RELATIONSHIPS AND METRIC CHARACTERS
OF THE ATLANTIC HORSE MACKEREL, *TRACHURUS TRACHURUS*
(PERCIFORMES: CARANGIDAE), CAUGHT IN BÉNI-SAF BAY,
WESTERN MEDITERRANEAN (ALGERIA)**

Khaled RAHMANI & Fatiha KOUDACHE

University Djillali Liabes, Ecodeveloppement of spaces Laboratory, Sidi Bel Abbès 22000, Algeria
e-mail: khaled46310@gmail.com

Amaria Latefa BOUZIANI & Alae Eddine BELMAHI

Laboratory Network for Environmental Monitoring (LRSE), Department of Biology, Faculty of Life and Nature,
University of Ahmed Ben Bella Oran 1, BP 1524 El M'naouer, 31000 Oran, Algeria

ABSTRACT

The present study is to describe the morphometric characteristics of the Atlantic horse mackerel, Trachurus trachurus (Linnaeus, 1758), from Béni-Saf Bay (Algeria). A total of 355 specimens were investigated, sampled between November 2016 and October 2017, and consisting of 47.04% males, 44.79% females, and 8.17% undetermined individuals. The total length of the observed fish ranged from 7.4 to 35.4 cm. Seventeen measurements were carried out for each specimen. The length-weight relationship was investigated, and the results showed that the increase in size is proportional to the increase in weight (isometric allometry). The analysis of 17 metric characters allowed us to determine the type of growth allometry; all the characters presented a lowering allometry, with six characters displaying sexual dimorphism, five in favor of the males and one in favor of females.

Key words: Atlantic horse mackerel, *Trachurus trachurus*, length-weight relationship, metric characters, Béni-Saf Bay, Algeria

RELAZIONI LUNGHEZZA-PESO E CARATTERI METRICI DEL SUGARELLO, *TRACHURUS TRACHURUS* (PERCIFORMES: CARANGIDAE), CATTURATO NELLA BAIA DI BÉNI-SAF, MEDITERRANEO OCCIDENTALE (ALGERIA)

SINTESI

L'articolo riporta le caratteristiche morfometriche del sugarello, Trachurus trachurus (Linnaeus, 1758), proveniente dalla baia di Béni-Saf (Algeria). Un totale di 355 esemplari sono stati campionati tra novembre 2016 e ottobre 2017, con il 47,04 % di maschi, il 44,79 % di femmine e l'8,17 % di indeterminati. La lunghezza totale degli esemplari variava da 7,4 a 35,4 cm. Sono state eseguite 17 misure per ogni esemplare. In merito al rapporto lunghezza-peso è stato evidenziato che l'aumento della taglia è proporzionale all'aumento del peso (allometria isomerica). L'analisi di 17 caratteri metrici ha permesso di determinare il tipo di allometria di crescita. Tutti i caratteri presentano un'allometria decrescente. Sei caratteri sono legati al dimorfismo sessuale, cinque a favore dei maschi e uno a favore delle femmine.

Parole chiave: sugarello, *Trachurus trachurus*, rapporto lunghezza-peso, caratteri metrici, baia di Béni-Saf, Algeria

INTRODUCTION

The Atlantic horse mackerel, *Trachurus trachurus* (Linnaeus, 1758), is a gregarious species of the Carangidae family. It can be found in circa-littoral bottoms and even in the higher horizon of the bathyal zone (Athanasios & Konstantinos, 2015). The species is common in shallow coastal waters of the north-eastern Atlantic, from Iceland to the Islands of Cape Verde. It is also found in the Mediterranean, including the Sea of Marmara and, more rarely, in the Black Sea (Polonsky, 1969; Arneri, 1983), the Eastern Channel, and the North Sea. *T. trachurus* is a migratory species; it lives and hunts in shoals. Usually, it migrates towards the coast in summer, and returns to offshore waters in winter; it can be found close to the sea bottom, where it lives between 50 and 400 m of depth; the species also has the capacity to adapt to brackish water (Santic et al., 2003). In the Mediterranean Basin, *T. trachurus* is very common (Fezzani et al., 2002), living in open water and near sandy bottoms; it feeds primarily on fish, such as gobies, anchovy, sardine, and only on certain shellfish (Ameri, 1983; Kerstan, 1985).

Horse mackerel has been the subject of several studies on reproduction (Korichi, 1988; Tahari, 2011; Aydin & Erdo an, 2018; Gherram, 2019; Rahmani & Koudach, 2020; Rahmani et al., 2020a), growth (Karlou-Riga & Sinis, 1997; Moutopoulos et al., 2002; Abaunza et al., 2003; Jardas et al., 2004; Ikyaz et al., 2008; Ak et al., 2009; Costa, 2010; Torres et al., 2012; Kerkich et al., 2013; Erdogan et al., 2016; Bensahla et al., 2017; Azzouz et al., 2018; Gherram, 2019; Rahmani, 2020), and diet (Olaso-Toca et al., 1999; Cabral & Murta, 2002; Jardas et al., 2004; Šantić et al., 2005; Bahar & Tuncay, 2009; Bayhan et al., 2013; Shawket et al., 2015; Rahmani et al., 2020b).

This paper focuses on the growth of the Atlantic horse mackerel, *T. trachurus*, living in Béni-Saf Bay (North-West Algeria), with an emphasis on the length-weight relationship and metric characters, aiming to complete the gaps in the life cycle of this Carangidae fish species and help manage this resource better in that part of the Algerian coast.

MATERIAL AND METHODS

A total of 355 specimens of *Trachurus trachurus* were collected from Béni-Saf trawl fishery, captured by trawlers operating between 30–130 m of depth (Fig. 1), from November 2016 to October 2017. The specimens sampled were subjected to biometric analysis. For each specimen, we recorded 17 measurements (Fig. 2). The biometric data were recorded in the laboratory, the different lengths measured

using a caliper to the nearest mm, and the sex was determined macroscopically based on the morphology and the color of gonads (Rahmani et al., 2020).

Sex-ratio

The sex ratio is defined as the share of male or female individuals in the total number of individuals. It also gives an idea on the balance of the sexes within the population. It generally translates as the rate of femininity or masculinity in the population:

$$SR = F / (M+F) \times 100$$

F = number of females;

M = number of males.

The length-weight relationship (LWR)

The Length-weight relationship (LWR) was calculated from the equation:

$$Wt = a \cdot Lt^b \quad (\text{Korichi, 1988})$$

where: Wt = fish body weight in grams, Lt = fish total length in centimeters, a = intercept or constant, b = slope or length exponent, and r = correlation coefficient.

Isometric growth means that an organism's body shape does not change as it grows, and that weight increases as the third power of length, i.e., the allometric parameter (b) is 3. A $b < 3$ value indicates negative allometric growth, which means the fish becomes more slender as it grows longer. A $b > 3$ value indicates positive allometric development, which means the fish becomes stouter or deeper-bodied as it increases in weight. It should be remembered that the coefficient a is only a rough indicator of shape



Fig. 1: Geographical location of the Beni-Saf Bay (western coast of Algeria).

Sl. 1: Zemljovid obravnavanega območja zaliva Béni-Saf (zahodna obala Alžirije).

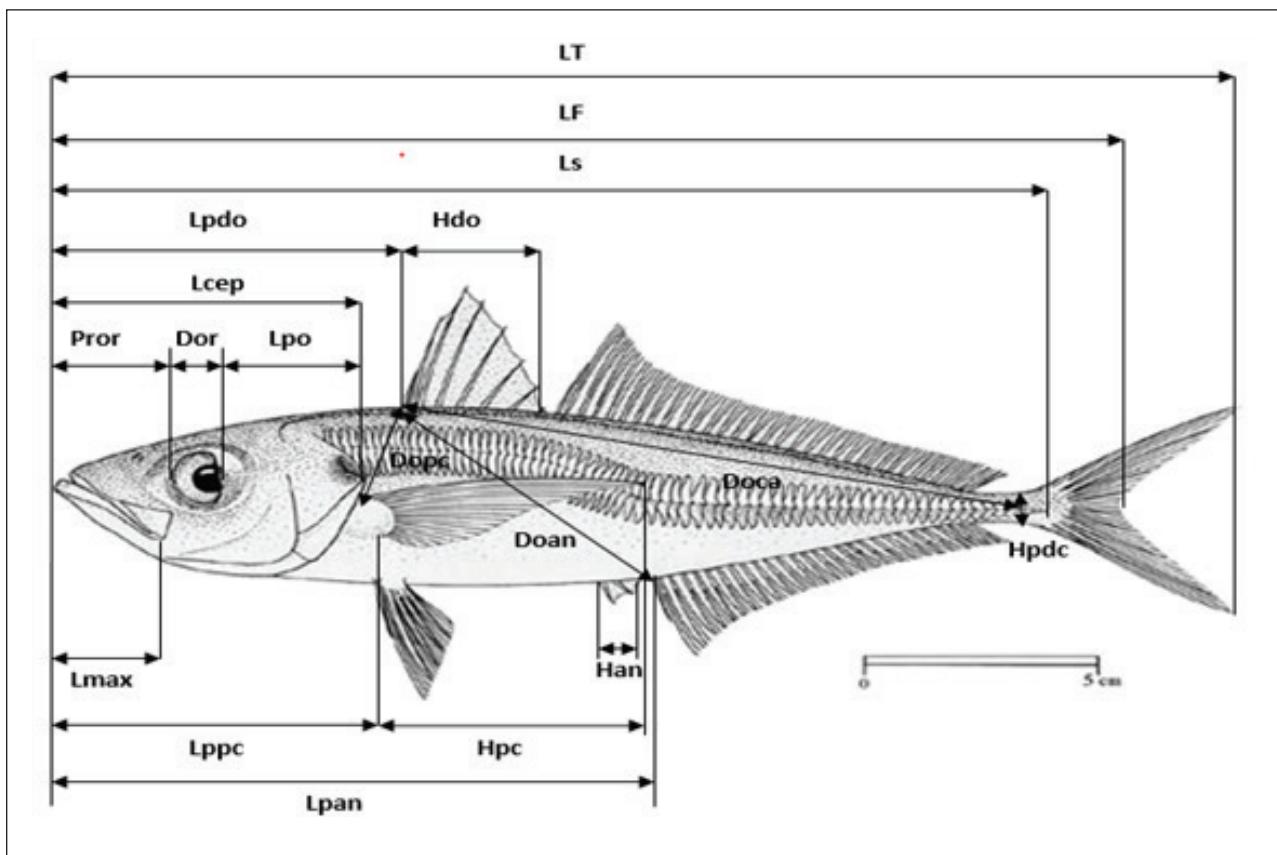


Fig. 2: Morphometric measurements taken on each fish. (**Lt:** Total length; **LF:** At fork length; **Ls:** Standard length; **Lpdo:** Length pre-dorsal; **Lpan:** Length pre-anal; **Lcep:** Cephalic length; **Lppc:** Length pre-pectoral; **Doan:** Dorsal/anal distance; **Doca:** Dorsal/caudal distance; **Lmax:** Maxillary length; **Dor:** Diameter orbital; **Pror:** Length pre-orbital; **Hpc:** Pectoral Height; **Hdo:** Dorsal Height; **Han:** Anal Height; **Hpdc:** Peduncle Height; **Dopc:** Distance dorsal/pectoral).
Sl. 2: Morfometrične meritve na vsakem primerku rib. (**Lt:** Skupna dolžina; **LF:** dolžina do vilice; **Ls:** standardna dolžina; **Lpdo:** dolžina do hrbtne plavuti; **Lpan:** dolžina do zadnjične plavuti; **Lcep:** cefalična dolžina; **Lppc:** dolžina do prsne plavuti; **Doan:** hrbtina / analna razdalja; **Doca:** dorzalna / kavdalna razdalja; **Lmax:** maksilarna dolžina; **Dor:** premer očesa; **Pror:** predorbitalna dolžina; **Hpc:** dolžina prsne plavuti; **Hdo:** dolžina baze hrbtne plavuti; **Han:** dolžina baze analne plavuti; **Hpdc:** višina pedunkla; **Dopc:** oddaljenost med hrbitno in prsno plavutjo).

when growth is not isometric, or of shape variation when two species or sexes have different allometric parameters. The degree to which one species or sex is considered slender or stouter than another would change with length in the latter case. The a value is directly interpretable as the weight of a fish in grams when it is one centimeter in length, as measured here (Riedel et al., 2007).

Metric characters

To characterize the morphology of *T. trachurus*, the various parameters measured are expressed as a function of the total length by the following regression formula:

$$Y = a \cdot Lt^b$$

Polynomial regression was applied to the examination of morphometric relations compared to increase in total length (Kováč et al., 1999).

RESULTS

Sex Ratio

In total, 355 specimens of *Trachurus trachurus* were collected, 167 males (47.04%), 159 females (44.79%), and 29 unsexed (8.17%). The length frequency distribution of the entire population is shown in Fig. 3. Male length range was 9.3 to 33.5 cm; female length range 8.8 to 35.4 cm. Male weight ranged from 5.55 to 292.83 g, female weight from 5.24 to 312.78 g (Fig. 3). The variations of sex ratio according to size, verified by the χ^2 test, revealed significant differences

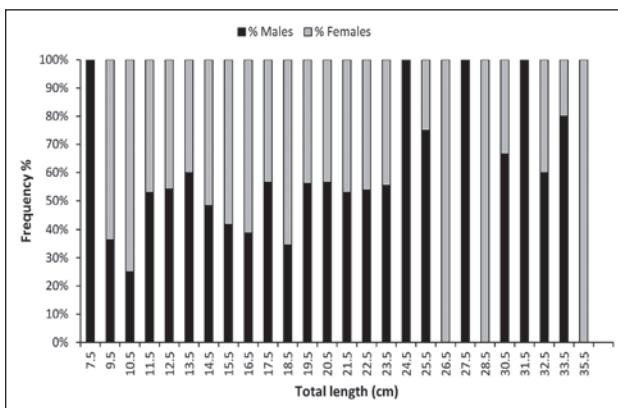


Fig. 3: Length frequency distribution of *Trachurus trachurus* caught in Béni-Saf Bay.

Sl. 3: Dolžinska razporeditev primerkov šnjura (*Trachurus trachurus*) ujetih v zalivu Béni-Saf.

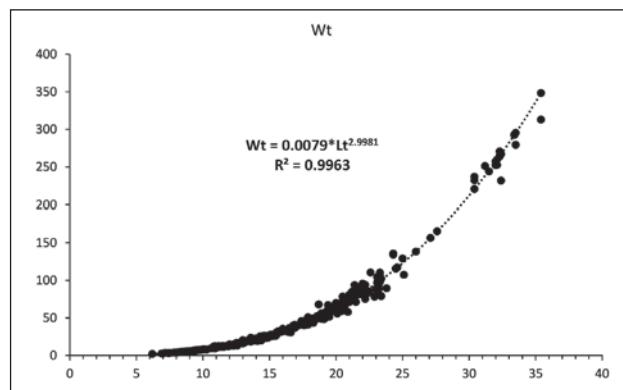


Fig. 6: Weight-length relationships for *Trachurus trachurus* (total population).

Sl. 6: Odnos med maso in dolžino telesa pri šnjuru (*Trachurus trachurus*) (celotna populacija).

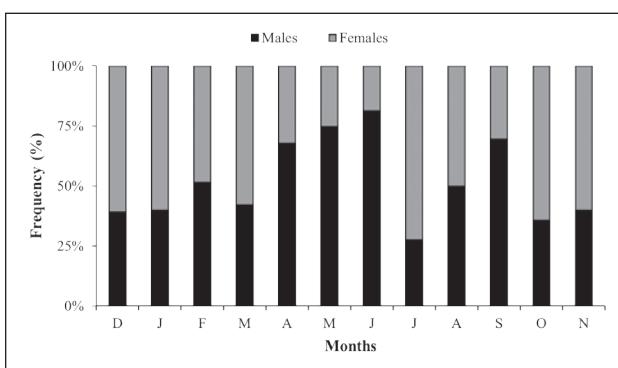


Fig. 4: Monthly evolution of Sex ratio of *Trachurus trachurus* caught in Béni-Saf Bay.

Sl. 4: Mesečna dinamika spolnega deleža primerkov šnjura (*Trachurus trachurus*), ujetih v zalivu Béni-Saf.

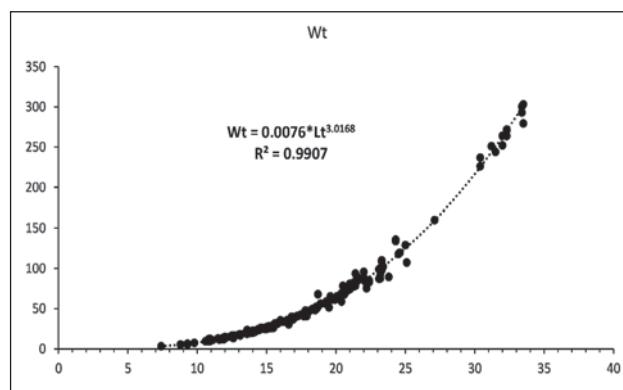


Fig. 7: Weight-length relationships for *Trachurus trachurus* (Males).

Sl. 7: Odnos med maso in dolžino telesa pri samcih šnjura (*Trachurus trachurus*).

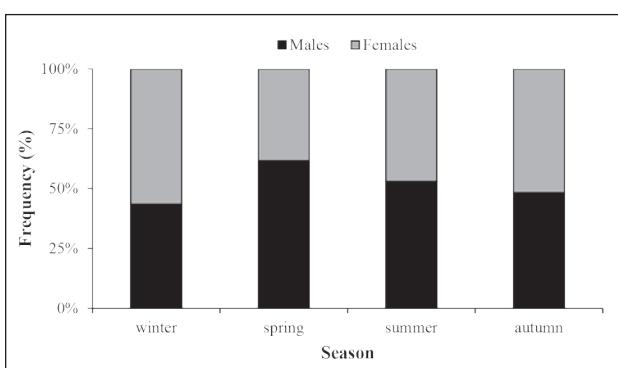


Fig. 5: Evolution of Sex ratio by seasons of *Trachurus trachurus* caught in Béni-Saf Bay.

Sl. 5: Sezonska dinamika spolnega deleža primerkov šnjura (*Trachurus trachurus*), ujetih v zalivu Béni-Saf.

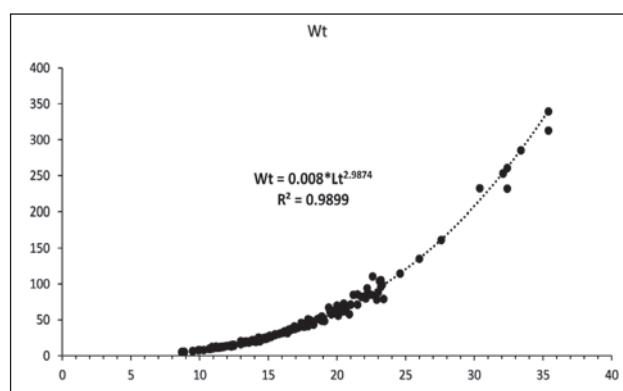


Fig. 8: Weight-length relationships for *Trachurus trachurus* (Females).

Sl. 8: Odnos med maso in dolžino telesa pri samicah šnjura (*Trachurus trachurus*).

Tab. 1: Estimated parameters of the weight-length relationship for *Trachurus trachurus* - males, females and the two sexes combined.**Tab. 1: Ocenjeni parametri odnosa med maso in dolžino telesa za samce in samice šnjurov (*Trachurus trachurus*) ter ne glede na spol.**

<i>T. trachurus</i>	n	Lt (min-max)	Wt (min-max)	a	b	R ²	Growth
total	355	7.4-35.4	3.11-312.78	0.0079	2.9981	0.9963	isometric
males	167	12-33.5	5.55-292.83	0.0076	3.0168	0.9907	isometric
females	158	8.7-35.4	5.24-312.78	0.0085	2.9874	0.9899	isometric

in favor of females for length classes between 9.5 and 11 cm of TL ($\chi^2=11 > \chi^2_{t,0.05}=3.84$); beyond the 16.5 cm of total length, males have the advantage, but without significance (khi2). Beyond the 34.5 cm of TL females are dominant.

Monthly variations of sex ratio (Fig. 4) reveal that females dominate during the months of November, October, December, January, March, and July. Males outnumbered females during April, May, June and September, with numerical equality in August and February.

Evolution of sex ratio related to seasons (Fig. 5) showed that females outnumbered males during the autumn-winter period, while males outnumbered females during the spring-summer period ($\chi^2=5.54 > \chi^2_{t,0.05}=3.84$) corresponding to the spawning period of *T. trachurus* in Béni-Saf Bay.

The length-weight relationship (LWR)

Model parameters for the Wt =f(Lt) relations of *T. trachurus* are given in Table 1 and Figures 6, 7, and 8.

Tab. 2: Correlation coefficients and regression equations of the various parameters measured as a function of total length in *Trachurus trachurus* (female sex, n = 158).**Tab. 2: Koeficienti korelacije in regresijske enačbe raznih parametrov, povezanih s celotno dolžino pri šnjuru (*Trachurus trachurus*) (število samic, n = 158).**

Y=f(Lt)	Equation	R ²	Growth Type	Range
<i>Ls=f(Lt)</i>	$Ls = 0.8457Lt^{0.9871}$	0.9946	Allometric (-)	$7 \leq Ls \leq 28.6$
<i>Lpdo=f(Lt)</i>	$Lpdo = 0.4268Lt^{0.906}$	0.9038	Allometric (-)	$2.8 \leq Lpdo \leq 10.8$
<i>Lpan=f(Lt)</i>	$Lpan = 0.5349Lt^{0.9702}$	0.9923	Allometric (-)	$4.2 \leq Lpan \leq 17$
<i>Lcep=f(Lt)</i>	$Lcep = 0.2684Lt^{0.9659}$	0.9836	Allometric (-)	$2.1 \leq Lcep \leq 8.3$
<i>Lppc=f(Lt)</i>	$Lppc = 0.3371Lt^{0.9037}$	0.987	Allometric (-)	$2.3 \leq Lppc \leq 8.5$
<i>Doan=f(Lt)</i>	$Doan = 0.2489Lt^{1.0564}$	0.9941	Allometric (-)	$2.4 \leq Doan \leq 10.8$
<i>Doca=f(Lt)</i>	$Doca = 0.4713Lt^{1.0293}$	0.9979	Allometric (-)	$4.4 \leq Doca \leq 18.5$
<i>Lmax=f(Lt)</i>	$Lmax = 0.1409Lt^{0.8626}$	0.9105	Allometric (-)	$0.9 \leq Lmax \leq 3.1$
<i>Dor=f(Lt)</i>	$Dor = 0.0914Lt^{0.8864}$	0.9543	Allometric (-)	$0.6 \leq Dor \leq 2.2$
<i>LF=f(Lt)</i>	$LF = 0.9841Lt^{0.9682}$	0.9949	Allometric (-)	$8 \leq LF \leq 31.1$
<i>Pror=f(Lt)</i>	$Pror = 0.0946Lt^{0.9802}$	0.9879	Allometric (-)	$0.8 \leq Pror \leq 3.1$
<i>Hpc=f(Lt)</i>	$Hpc = 0.1258Lt^{1.1604}$	0.9736	Allometric (-)	$1.5 \leq Hpc \leq 8.2$
<i>Hdo=f(Lt)</i>	$Hdo = 0.1113Lt^{1.0639}$	0.9606	Allometric (-)	$1.1 \leq Hdo \leq 4.8$
<i>Han=f(Lt)</i>	$Han = 0.1004Lt^{0.9856}$	0.9376	Allometric (-)	$0.8 \leq Han \leq 3.6$
<i>Hpdc=f(Lt)</i>	$Hpdc = 0.0301Lt^{1.022}$	0.8548	Allometric (-)	$0.3 \leq Hpdc \leq 1.2$
<i>Dopc=f(Lt)</i>	$Dopc = 0.1085Lt^{1.0766}$	0.9802	Allometric (-)	$1.1 \leq Dopc \leq 5$

Tab. 3: Correlation coefficients and regression equations of the various parameters measured as a function of total length in *Trachurus trachurus* (male sex, n = 167).**Tab. 3: Koeficienti korelacije in regresijske enačbe raznih parametrov, povezanih s celotno dolžino pri šnjuru (*Trachurus trachurus*) (število samcev, n = 167).**

$Y=f(Lt)$	Equation	R^2	Growth Type	Range
$Ls=f(Lt)$	$Ls = 0.9048Lt^{0.9612}$	0.9971	Allometric (-)	$6.2 \leq Ls \leq 27.1$
$Lpdo=f(Lt)$	$Lpdo = 0.4737Lt^{0.8658}$	0.9058	Allometric (-)	$2.7 \leq Lpdo \leq 9.9$
$Lpan=f(Lt)$	$Lpan = 0.5631Lt^{0.9524}$	0.9892	Allometric (-)	$3.8 \leq Lpan \leq 16.1$
$Lcep=f(Lt)$	$Lcep = 0.2819Lt^{0.9485}$	0.9806	Allometric (-)	$1.9 \leq Lcep \leq 7.9$
$Lppc=f(Lt)$	$Lppc = 0.3382Lt^{0.9052}$	0.9827	Allometric (-)	$2.1 \leq Lppc \leq 8.1$
$Doan=f(Lt)$	$Doan = 0.2922Lt^{1.0003}$	0.9903	Allometric (-)	$2.2 \leq Doan \leq 10.1$
$Doca=f(Lt)$	$Doca = 0.496Lt^{1.0111}$	0.9964	Allometric (-)	$3.8 \leq Doc a \leq 17.9$
$Lmax=f(Lt)$	$Lmax = 0.0954Lt^{0.9909}$	0.9575	Allometric (-)	$0.7 \leq Lmax \leq 3.1$
$Dor=f(Lt)$	$Dor = 0.1121Lt^{0.8183}$	0.9211	Allometric (-)	$0.6 \leq Dor \leq 2$
$LF=f(Lt)$	$LF = 0.9844Lt^{0.9772}$	0.9868	Allometric (-)	$7.1 \leq LF \leq 31.9$
$Pror=f(Lt)$	$Pror = 0.1065Lt^{0.9286}$	0.9644	Allometric (-)	$0.7 \leq Pror \leq 2.8$
$Hpc=f(Lt)$	$Hpc = 0.1034Lt^{1.2343}$	0.9887	Allometric (-)	$1.2 \leq Hpc \leq 8.1$
$Hdo=f(Lt)$	$Hdo = 0.0702Lt^{1.2147}$	0.9771	Allometric (-)	$0.8 \leq Hdo \leq 5$
$Han=f(Lt)$	$Han = 0.0721Lt^{1.0912}$	0.9541	Allometric (-)	$0.6 \leq Han \leq 3.3$
$Hpdc=f(Lt)$	$Hpdc = 0.0218Lt^{1.138}$	0.9145	Allometric (-)	$0.2 \leq Hpdc \leq 1.3$
$Dopc=f(Lt)$	$Dopc = 0.099Lt^{1.1093}$	0.9841	Allometric (-)	$0.9 \leq Dopc \leq 5.1$

The best fit was for male *Trachurus* ($R^2=0.9907$) and the poorest for female *Trachurus* ($R^2=0.9899$). *T. trachurus* presented an isometric allometry ($b\approx 3$), the weight increasing slightly less rapidly than the length.

Metric characters

The regression equations of observed values of all measurements are represented in Tables 2 and 3, and plotted in Figures 9, 10, 11, and 12. The proximity of observed values indicates that the regression equations obtained for each of the different morphometric measurements have a good fit.

Whatever the sex, all parameters show a lower growth allometry (negative allometry). The high values of correlation coefficient of all measurements with total length confirm the close coincidence between them.

DISCUSSION

The sex ratio is slightly in favor of the males, the evolution of this index does not have phrenological regularity and is close to 1 for the March-June

period, whereas females dominate in July. The Atlantic mackerel is a pelagic fish living in dense fish benches. It is possible that certain fish populations display a predominance of males or females. According to Carbonara et al. (2012) and Wahbi et al. (2015), fluctuations of the sex ratio are due to ethological phenomena (stray species, demographic segregations) responsible for over-dispersion and segregated distribution of the sexes. Due to several factors, such as behavior of the species, spawning period, mortality, sampling procedure, and aggregation of same sex individuals, the changes of this ratio are not readily understood.

The present study shows that the values of parameter b remain close to 3 regardless of the sex, the small differences indicating that the weight increases slightly faster than the height. The size-weight relationship of *T. trachurus* shows isometric type allometric growth for females, males, and for the total population. The values of the coefficient of determination (R^2) is close to 1, which confirms a strong correlation between the two variables (Lt, Wt).

We find that our results are relatively close to those published in literature (Tab. 4): Anadon (1960)

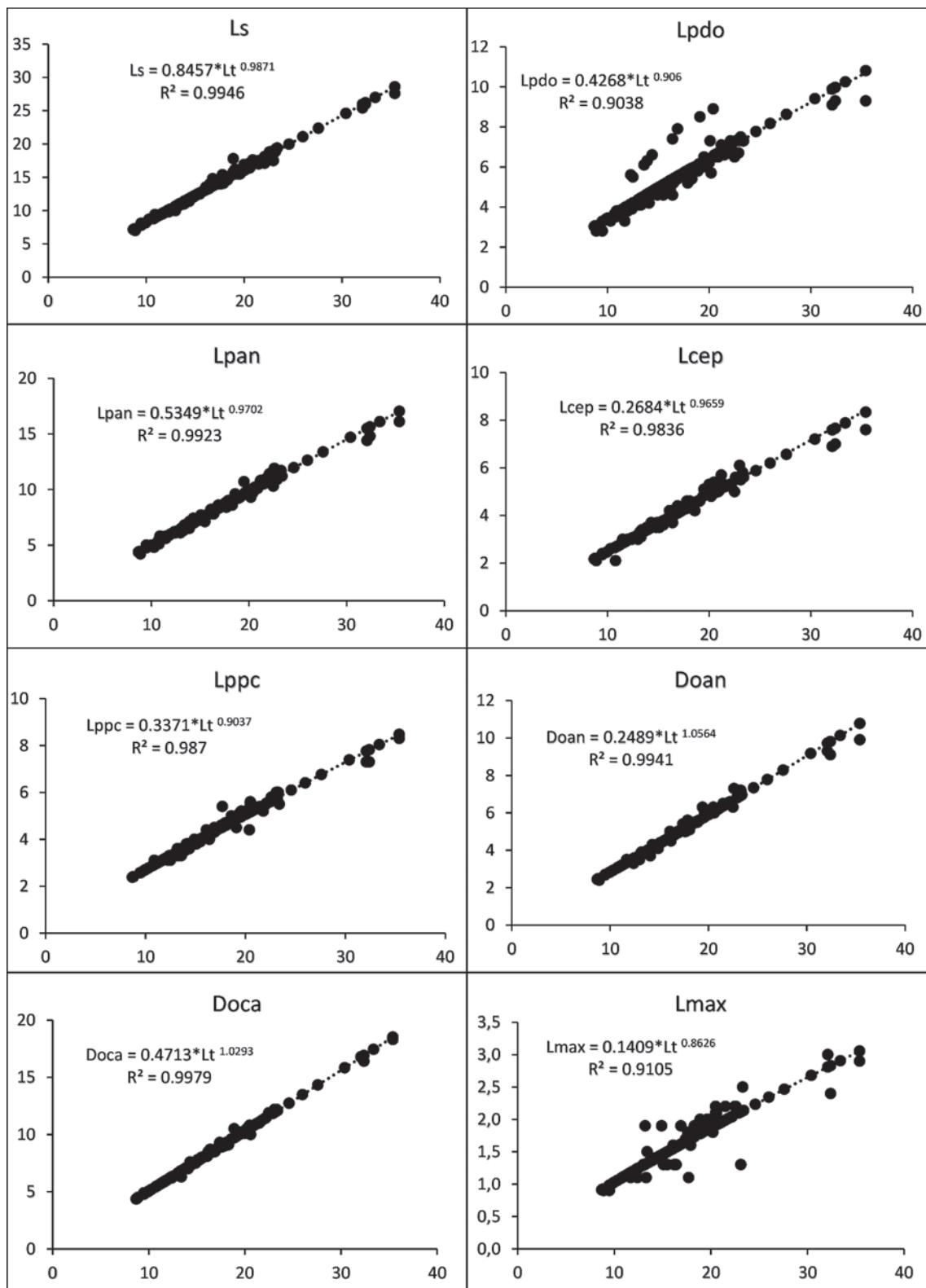


Fig. 9: Relationship of total length and different morphometric indices for females *Trachurus trachurus* (*Ls*, *Lpdo*, *Lpan*, *Lcep*, *Lppc*, *Doan*, *Doca*, *Lmax*).

Sl. 9: Odnos med celotno dolžino in različnimi morfometričnimi indeksi za samice šnjura (*Trachurus trachurus*) (*Ls*, *Lpdo*, *Lpan*, *Lcep*, *Lppc*, *Doan*, *Doca*, *Lmax*).

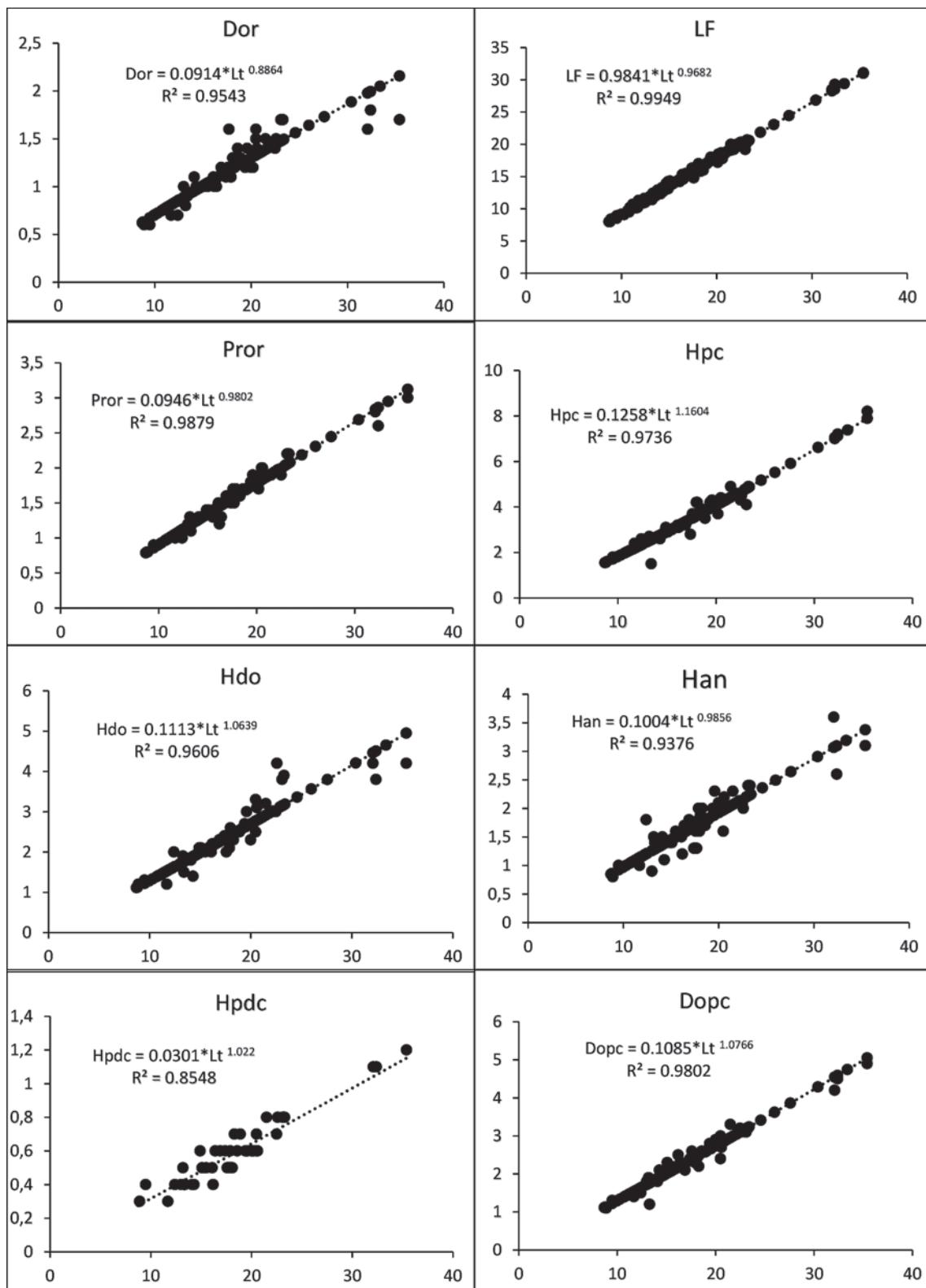


Fig. 10: Relationship of total length and different morphometric indices for females *Trachurus trachurus* (Dor, LF, Pror, Hpc, Hdo, Han, Hpdc, Dopc).

Sl. 10: Odnos med celotno dolžino in različnimi morfometričnimi indeksi za samice šnjura (*Trachurus trachurus*) (Dor, LF, Pror, Hpc, Hdo, Han, Hpdc, Dopc).

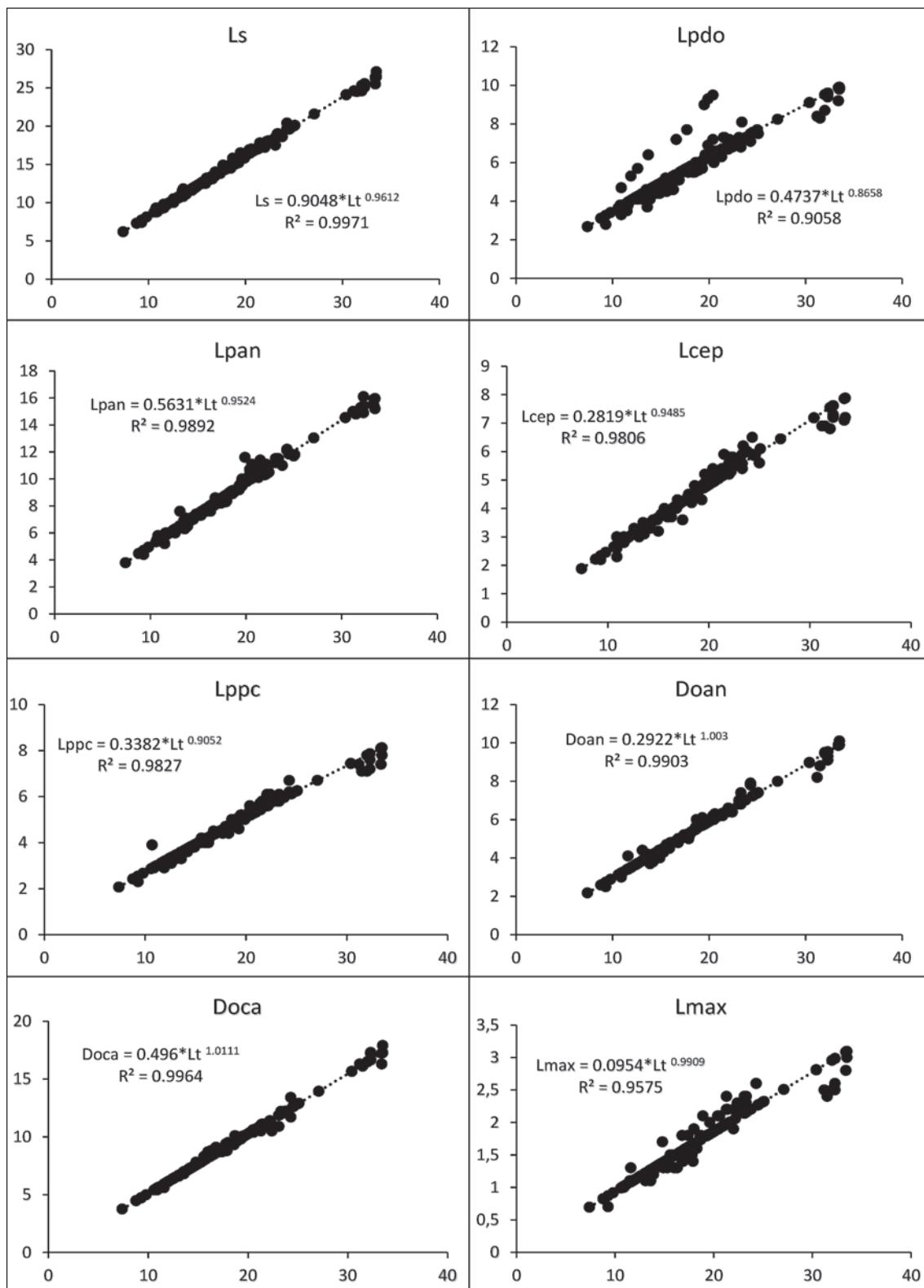


Fig. 11: Relationship between total length and different morphometric indices in males *Trachurus trachurus* (*Ls*, *Lpdo*, *Lpan*, *Lcep*, *Lppc*, *Doan*, *Doca*, *Lmax*).

Sl. 11: Odnos med celotno dolžino in različnimi morfometričnimi indeksi za samce šnjura (*Trachurus trachurus*) (*Ls*, *Lpdo*, *Lpan*, *Lcep*, *Lppc*, *Doan*, *Doca*, *Lmax*).

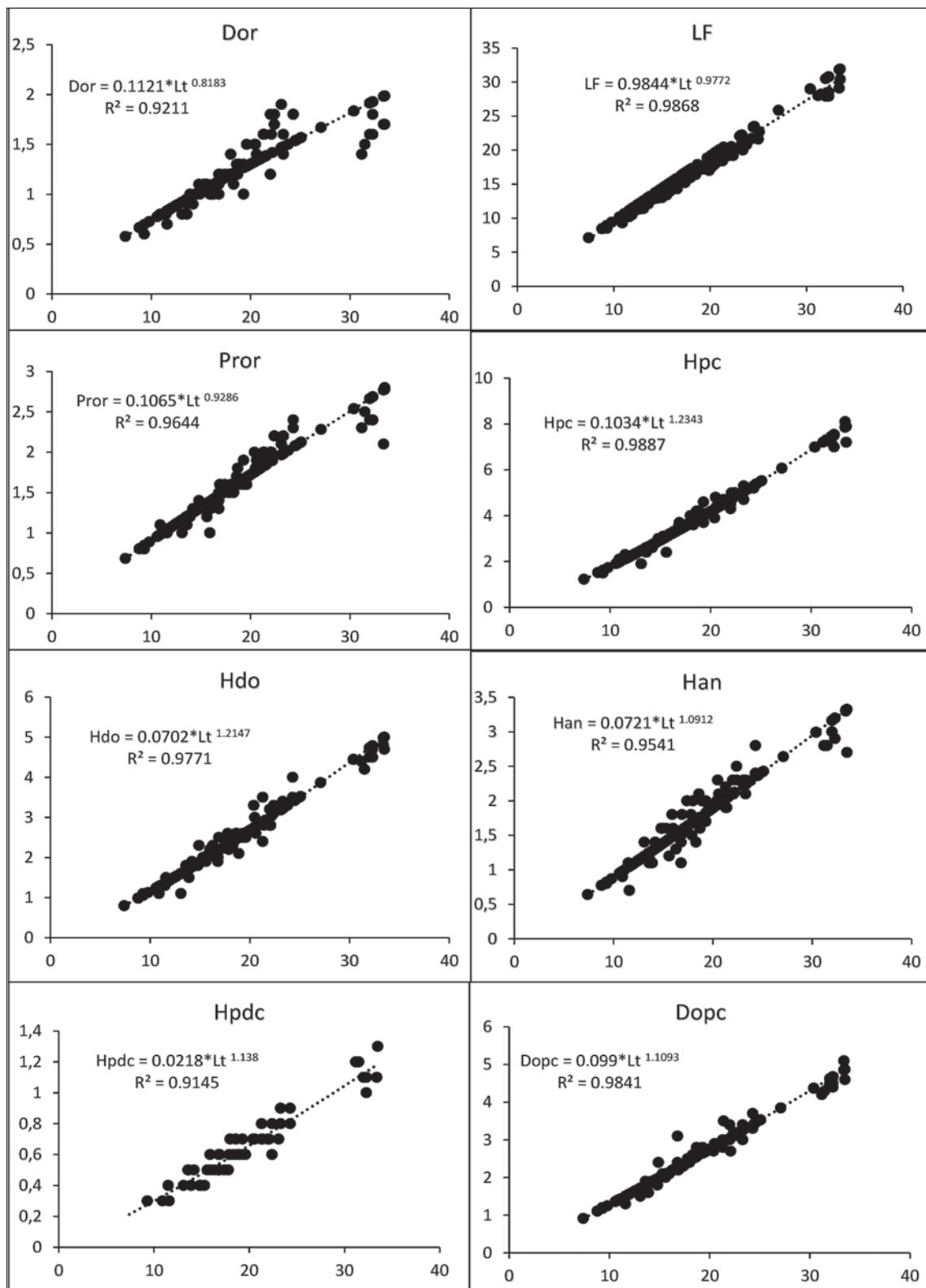


Fig. 12: Relationship between total length and different morphometric indices in males *Trachurus trachurus* (*Dor*, *LF*, *Pror*, *Hpc*, *Hdo*, *Han*, *Hpdc*, *Dopc*).

Sl. 12: Odnos med celotno dolžino in različnimi morfometričnimi indeksi za samce šnjura (*Trachurus trachurus*) (*Dor*, *LF*, *Pror*, *Hpc*, *Hdo*, *Han*, *Hpdc*, *Dopc*).

Tab. 4: Parameters of the height-weight relationship and weight in *Trachurus trachurus* obtained by various authors.**Tab. 4: Parametri odnosa med masno-višinskim odnosom in maso pri šnjuru (*Trachurus trachurus*) na podlagi objavljenih zapisov.**

Author (year)	Region	a	b	Growth
Anadon (1960)	Espagne	0.00816	3.023	0 allometric
Wengryn (1975)	NW Afrique	0.0049	3.14	+ allometric
Trouverey (1977)	Golf de Gascogne	0.158	1.83	- allometric
Borges et al. (1977)1976	Côtes Portugaise Central Port. Côtes Portugaise		2.931 2.936 2.962	0 allometric 0 allometric 0 allometric
Carrillo (1978)	NW Méditerranée	0.0102	2.945	- allometric
Nazarov (1978)	Gascogne	0.00585	3.087	0 allometric
Farina-Pérez (1983)	NW Espagne	0.01291	2.8545	- allometric
Arruda (1983)a	Portugal (Matosinhos)	0.0199	2.885	- allometric
Arruda (1983)b	Portugal (Peniche)	0.0173	2.927	0 allometric
Arruda (1983)c	Portugal (Portimão- Sagres)	0.0135	3.005	0 allometric
Kerstan (1985)	Irland et Royaume unit (Atlantique est)	0.00431	3.1251	+ allometric
Korichi (1988)	Baie Bou-Ismail	0.0125	2.979	0 allometric
Lucio & Martin (1989)	Baie de Biscaye	---	3.061	0 allometric
Borges & Gordo (1991)	Portugal	0.009224	2.957	0 allometric
Maxim (1995)	NW Afrique	0.0139	2.961	0 allometric
Šantić (2002)	Adriatique	0.008	3.019	0 allometric
Charef-Belifa (2009)	Oran	0.00373	3.13	+ allometric
Šantić (2011)	Adriatique	0.008	3.001	0 allometric
Itchir & Merine (2018)	Bassin algérien	0.011	2.906	- allometric
Gharram (2019)	Baie d'Oran	(♂+♀) 0.0143 (♂) 0.0140 (♀) 0.0143	3.347 3.322 3.409	+ allometric + allometric + allometric
Present study	Béni-Saf Bay	(♂+♀) 0.0079 (♂) 0.0076 (♀) 0.0085	2.9981 3.0168 2.9874	0 allometric 0 allometric 0 allometric

for Spain, Borges and Gordo (1991), Santic (2002 and 2011) for the Adriatic. While our findings were very close to those recorded by Wengryn (1975) in Northwest Africa, Borges et al. (1977) in the coasts of Portugal, Kerstan (1985) in Ireland and the United Kingdom, Korichi (1988) in the Bay of Bou-Ismail, Lucio and Martin (1989) in the Bay of Biscay, Maxim (1995) in Northwest Africa, and Charef-belifa (2009) in the Bay of Oran, they do not agree with those cited

by Trouverey (1977) for the Bay of Biscay, Fariña Perez (1983) for NW Spain, Arruda (reference within Gherram, 2019) for Portugal (Matosinhos), Itchir and Merine (2018) for the Algerian Basin, and Gherram (2019) for the Bay of Oran.

The length-weight relationship parameters can vary between stocks and even between areas as mentioned by Andrade and Campos, 2002. These differences in b values can be attributed to the combination of one

or more of the following factors: a) differences in the number of specimens examined, b) area/season effect, and c) differences in the observed length ranges of the specimens caught. Dulčić and Kraljević (1998) stated that temperature, food quantity, size, sex, and stage of maturity are responsible for the differences in parameters of relationship. In addition, Froese (2006) stated that small specimens have a different WLR relationship than larger ones.

All the metric characters studied (17 parameters) evolve in a minor way compared to the total length, i.e., less rapidly than the total length of the fish. Only a few of the 17 measurements allow us to suggest a slightly more or less marked sexual dimorphism, which is in agreement with Geldenhuys, 1973; Macer, 1977; and Borges et al., 1977; 1991. Certain metric parameters do not develop in the same way in the two sexes. On the other hand, six (6) characters present sexual dimorphism, five (5) in favor of males (Lmax, Hpc, Hdo, Hpdc and Dopc), and one (1) in favor of females (Doan).

CONCLUSIONS

The results of our study on the length-weight relationships and morphometry of *Trachurus trachurus* of Béni-Saf Bay supplements the work already conducted on this species in the Mediterranean, and allows for a better management of the exploitable resource. Our findings can be a useful tool for scientists, administrators, and professionals in the fisheries sector, aiding the regulation of the fishing effort and the update of minimum landing sizes for this species. There are still many points to be elucidated in relation to the fishery of this species in the Mediterranean Basin, and Algerian waters especially, and these will be subject of future research.

ACKNOWLEDGMENTS

The authors are grateful to coast guards of Béni-Saf for their precious help and also grateful to the reviewers who improved the manuscript with their helpful advices and directives.

ODNOS MED DOLŽINO IN MASO IN METRIČNI ZNAKI NAVADNIH ŠNJUROV,
TRACHURUS TRACHURUS (PERCIFORMES: CARANGIDAE), UJETIH V
ZALIVU BÉNI-SAF, ZAHODNO SREDOZEMSKO MORJE (ALŽIRIJA)

Khaled RAHMANI & Fatiha KOUDACHE

University Djillali Liabes, Ecodeveloppement of spaces Laboratory, Sidi Bel Abbès 22000, Algeria
e-mail: khaled46310@gmail.com

Amaria Latefa BOUZIANI & Alae Eddine BELMAHI

Laboratory Network for Environmental Monitoring (LRSE), Department of Biology, Faculty of Life and Nature,
University of Ahmed Ben Bella Oran 1, BP 1524 El M'naouer, 31000 Oran, Algeria

POVZETEK

V pričujočem delu avtorji opisujejo morfometrične značilnosti navadnega šnjura, *Trachurus trachurus* (*Linnaeus*, 1758), iz zaliva Béni-Saf Bay (Alžirija). Analizirali so 355 primerkov, vzorčenih med novembrom 2018 in oktobrom 2017, od katerih je bilo 47,04% samcev in 44,79% samic, 8,17% pa ni bilo določenih do spola. Celotna dolžina preiskanih rib je bila od 7,4 do 35,4 cm. Na vsakem primerku je bilo opravljenih sedemnajst meritev. Raziskali so odnos med dolžino in maso, ki je pokazal, da je porast v velikosti proporcionalen porastu v masi (izomerična alometrija). Analiza sedemnajstih metričnih znakov je omogočila ugotavljanje tipa rastne alometrije. Vsi znaki so pokazali upadajočo alometrijo, šest znakov pa je kazalo na spolno dvoličnost, od katerih se je 5 nanašalo na samce in eden na samico.

Ključne besede: navadni šnjur, *Trachurus trachurus*, odnos med dolžino in maso, metrični znaki, zaliv Béni-Saf, Alžirija

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