

ANNALES

Anali za istrske in mediteranske študije
Annali di Studi istriani e mediterraneei
Annals for Istrian and Mediterranean Studies
Series Historia Naturalis, 32, 2022, 1





ANNALES

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

Series Historia Naturalis, 32, 2022, 1

ISSN 1408-533X
e-ISSN 2591-1783

UDK 5

Letnik 32, leto 2022, številka 1

**UREDNIŠKI ODBOR/
COMITATO DI REDAZIONE/
BOARD OF EDITORS:**

Alessandro Acquavita (IT), Nicola Bettoso (IT), Christian Capapé (FR), Darko Darovec, Dušan Devetak, Jakov Dulčić (HR), Serena Fonda Umani (IT), Andrej Gogala, Daniel Golani (IL), Danijel Ivajnsič, Mitja Kaligarič, Marcelo Kovačič (HR), Andrej Kranjc, Lovrenc Lipej, Vesna Mačič (ME), Alenka Malej, Patricija Mozetič, Martina Orlando-Bonaca, Michael Stachowitsch (AT), Tom Turk, Al Vrezec

**Glavni urednik/Redattore capo/
Editor in chief:**

Darko Darovec

**Odgovorni urednik naravoslovja/
Redattore responsabile per le scienze
naturali/Natural Science Editor:**

Lovrenc Lipej

Urednica/Redattrice/Editor:

Martina Orlando-Bonaca

Prevajalci/Traduttori/Translators:

Martina Orlando-Bonaca (sl./it.)

**Oblikovalec/Progetto grafico/
Graphic design:**

Dušan Podgornik, Lovrenc Lipej

Tisk/Stampa/Print:

Založništvo PADRE d.o.o.

Izdajatelj/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/
Address of Editorial Board:**Nacionalni inštitut za biologijo, Morska biološka postaja Piran / *Istituto nazionale di biologia, Stazione di biologia marina di Pirano / National Institute of Biology, Marine Biology Station Piran*
SI-6330 Piran / *Pirano*, Fornace/Fornace 41, tel.: +386 5 671 2900, fax +386 5 671 2901;
e-mail: annales@mbss.org, **internet:** www.zdjp.si

Redakcija te številke je bila zaključena 30. 06. 2022.

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

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

Annales - Series Historia Naturalis izhaja dvakrat letno.**Naklada/Tiratura/Circulation:** 300 izvodov/copie/copiesRevija *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).To delo je objavljeno pod licenco / *Quest'opera è distribuita con Licenza / This work is licensed under a Creative Commons BY-NC 4.0.*Navodila avtorjem in vse znanstvene revije in članki so brezplačno dostopni na spletni strani <https://zdjp.si/en/p/annalesshn/>
The submission guidelines and all scientific journals and articles are available free of charge on the website https://zdjp.si/en/p/annalesshn/
Le norme redazionali e tutti le riviste scientifiche e gli articoli sono disponibili gratuitamente sul sito https://zdjp.si/en/p/annalesshn/

VSEBINA / INDICE GENERALE / CONTENTS 2022(1)

SREDOZEMSKI MORSKI PSI
SQUALI MEDITERRANEI
MEDITERRANEAN SHARKS

Farid HEMIDA, Christian REYNAUD & Christian CAPAPÉ

Observations on Thresher Shark, *Alopias vulpinus* (Chondrichthyes: Alopiidae) from the Coast of Algeria (Southwestern Mediterranean Sea) 1
Opazovanja morskih lisic, Alopias vulpinus (Chondrichthyes: Alopiidae) ob alžirski obali (jugozahodno Sredozemsko morje)

Elif ÖZGÜR ÖZBEK & Hakan KABASAKAL

Notes on Smoothback Angel Shark, *Squatina oculata* (Squatiniiformes: Squatinidae) caught in the Gulf of Antalya 9
Zapis o pegastih sklatih, Squatina oculata (Squatiniiformes: Squatinidae), ujetih v Antalijskem zalivu

Alessandro PAGANO & Alessandro DE MADDALENA

Underwater Observations of the Rare Angular Roughshark *Oxynotus centrina* (Chondrichthyes: Squalidae) in the Waters of Santa Tecla (Sicily, Italy) 17
Podvodna opazovanja redkega morskega prašiča, Oxynotus centrina (Chondrichthyes: Squalidae) v vodah Sante Tecele (Sicilija, Italija)

Deniz ERGÜDEN, Deniz AYAS & Hakan KABASAKAL

Morphometric Measurements of Three Young Carcharhinid Species from Northeastern Levant (Mediterranean Sea) 25
Morfometrične meritve mladičev treh vrst morskih psov iz družine Carcharhinidae iz severnovzhodnega Levanta (Sredozemsko morje)

Hakan KABASAKAL

Projections on the Future of Deep-Sea Sharks in the Sea of Marmara, Where Deep Zones Are Threatened by Deoxygenation: a Review 35
Napovedi o prihodnosti globomorskih morskih psov v Marmarskem morju, ogroženem zaradi pomanjkanja kisika: pregled

BIOINVAZIJA
BIOINVASIONE
BIOINVASION

Alan DEIDUN, Bruno ZAVA & Maria CORSINI-FOKA

Distribution Extension of *Lutjanus argentimaculatus* (Lutjanidae) and *Psenes pellucidus* (Nomeidae) to the Waters of Malta, Central Mediterranean Sea 49
Širjenje areala vrst Lutjanus argentimaculatus (Lutjanidae) in Psenes pellucidus (Nomeidae) v malteške vode (osrednje Sredozemsko morje)

Sami M. IBRAHIM, Abdulrazziq A. ABDULRAZIQ, Abdulghani ABDULGHANI, Sara A.A. AL MABRUK, David SALVATORI, Bruno ZAVA, Maria CORSINI-FOKA & Alan DEIDUN

First Record of *Enchelycore anatina* (Muraenidae) from Libyan Waters and an Additional Record from Southern Italy (Western Ionian Sea) 59
Prvi zapis o pojavljanju kavljazobe murene Enchelycore anatina (Muraenidae) iz libijskih voda in dodatni zapis za južno Italijo (zahodno Jonsko morje)

Rasha Ali HENEISH & Samir Ibrahim RIZKALLA

Morphometric and Meristic Characteristics of a New Record of Bluespot Mullet *Crenimugil seheli* (Pisces: Mugilidae) in Egyptian Mediterranean waters 67
Novi zapis o pojavljanju vrste Crenimugil seheli (Pisces: Mugilidae) v egiptovskih sredozemskih vodah in njene morfometrične in meristične značilnosti

Yana SOLIMAN, Adib SAAD, Vienna HAMMOUD & Christian CAPAPÉ

Heavy Metal Concentrations in Tissues of *Siganus rivulatus* (Siganidae) from the Syrian Coast (Eastern Mediterranean Sea) 75
Vsebnost težkih kovin v tkivih marmoriranega morskega kunca Siganus rivulatus (Siganidae) iz sirske obale (vzhodno Sredozemsko morje)

IHTIOLOGIJA
 ITTIOLOGIA
 ICHTHYOLOGY

Jihade ALAHYENE, Brahim CHIAHOU, Hammou EL HABOUZ & Abdelbasset BEN-BANI

Length Based Growth Estimation of the Blue Shark *Prionace glauca* from the Moroccan Central Atlantic Coast 85
Dolžinsko-masni odnos in ocena rasti pri sinjem morskem psu (Prionace glauca) iz osrednje atlantske obale Maroka

Okan AKYOL, Altan LÖK & Funda ERDEM

Occurrence of *Cubiceps gracilis* (Nomeidae) in the Eastern Mediterranean Sea 101
Pojavljanje klateža, Cubiceps gracilis (Nomeidae), v vzhodnem Sredozemskem morju

Farid HEMIDA, Boualem BRAHMI, Christian REYNAUD & Christian CAPAPÉ

Occurrence of the Rare Driftfish *Cubiceps gracilis* (Nomeidae) from the Algerian Coast (Southwestern Mediterranean Sea) 107
Pojavljanje redkega klazeža Cubiceps gracilis (Nomeidae) z alžirske obale (jugozahodno Sredozemsko morje)

Deniz ERGÜDEN & Cemal TURAN

A Rare Occurrence of *Carapus acus* (Carapidae) in the Eastern Mediterranean, Turkey 113
Redko pojavljanje strmorinca Carapus acus (Carapidae) v vzhodnem Sredozemskem morju (Turčija)

Laith JAWAD, Murat ŞIRIN, Miloslav PETRTÝL, Ahmet ÖKTENER, Murat ÇELİK & Audai QASIM

Skeletal Abnormalities in Four Fish Species Collected from the Sea of Marmara, Turkey 119
Skeletne anomalije pri štirih vrstah rib iz Marmarskega morja (Turčija)

RAZMNOŽEVALNA EKOLOGIJA
 ECOLOGIA RIPRODUTTIVA
 REPRODUCTIVE ECOLOGY

Amaria Latefa BOUZIANI, Khaled RAHMANI, Samira AIT DARNA, Alae Eddine BELMAHI, Sihem ABID KACHOUR & Mohamed BOUDERBALA

Gonadal Histology in *Diplodus vulgaris* from the West Algerian Coast 137
Histologija gonad pri navadnem šparu (Diplodus vulgaris) iz zahodne alžirske obale

Cheikhna Yero GANDEGA, Nassima EL OMRANI, Rezan O. RASHEED, Mohammed RAMDANI & Roger FLOWER

The Growth and Reproduction of Two Sparidae, *Pagrus caeruleostictus* and *Pagellus bellottii* in Northern Mauritanian Waters (Eastern Tropical Atlantic) 143
Rast in razmnoževanje dveh vrst pagrov, Pagrus caeruleostictus in Pagellus bellottii v severnih mavretanskih vodah (vzhodni tropski Atlantik)

Nassima EL OMRANI, Hammou EL HABOUZ, Abdellah BOUHAIMI, Jaouad ABOU OUALID, Abdellatif MOUKRIM, Jamila GOUZOULI, Mohammed RAMDANI, Roger FLOWER & Abdelbasset BEN-BANI

The Reproductive Biology of the Pouting *Trisopterus luscus* from the Atlantic Coast of Morocco 155
Reproduktivna biologija francoskega moliča (Trisopterus luscus) iz atlantske obale Maroka

Mourad CHÉRIF, Rimel BENMESSAOUD & Christian CAPAPÉ

Growth Patterns and Age Structure of *Mullus surmuletus* (Mullidae) from the Northern Coast of Tunisia (Central Mediterranean Sea) 173
Rastni parametri in starostna struktura progastih bradačev Mullus surmuletus (Mullidae) iz severne tunizijske obale (osrednje Sredozemsko morje)

FLORA
 FLORA
 FLORA

Martina ORLANDO-BONACA, Erik LIPEJ, Romina BONACA & Leon Lojze ZAMUDA

Improvement of the Ecological Status of the *Cymodocea nodosa* Meadow near the Port of Koper 185
Izboljšanje ekološkega stanja morskega travnika kolenčaste cimodoceje (Cymodocea nodosa) v bližini kopskega pristanišča

FAVNA
 FAVNA
 FAVNA

Manja ROGELJA, Martin VODOPIVEC & Alenka MALEJ

Cestum veneris Lesueur, 1813 (Ctenophora) – a Rare Guest in the Northern Adriatic Sea 197
Cestum veneris Lesueur, 1813 (Ctenophora) – redek gost v severnem Jadranu

Adla KAHRIĆ, Dalila DELIĆ & Dejan KULIJER

Notospermus annulatus (Nemertea: Lineidae), a New Record for Bosnia and Herzegovina 205
Notospermus annulatus (Nemertea: Lineidae), prvi zapis o pojavljanju za Bosno in Hercegovino

Andrea LOMBARDO & Giuliana MARLETTA

Report of an Interesting *Trapania* (Gastropoda: Nudibranchia: Goniodorididae) Specimen from Central Eastern Sicily 211
Zapis o zanimivem primerku iz rodu Trapania (Gastropoda: Nudibranchia: Goniodorididae) iz osrednje vzhodne Sicilije

Abdelkarim DERBALI & Othman JARBOUI

Stock Assessment, Cartography and Sexuality of the Wedge Clam *Donax trunculus* in the Gulf of Gabes (Tunisia) 217
Ocena staleža, kartografija in spolnost klinaste školjke Donax trunculus v gabeškem zalivu (Tunizija)

Abdelkarim DERBALI, Aymen HADJ TAIEB & Othman JARBOUI

Length-Weight Relationships and Density of Bivalve Species in the Shellfish Production Area of Zarzis (Tunisia, Central Mediterranean Sea) 229
Dolžinsko-masni odnos in gostota školjk na gojišču školjk v predelu Zarsisa (Tunizija, osrednje Sredozemsko morje)

Toni KOREN

The Diversity of Moths (Lepidoptera: Heterocera) of Significant Landscape Donji Kamenjak and Medulin Archipelago, Istria, Croatia 237
Raznolikost nočnih metuljev (Lepidoptera: Heterocera) Pomembne pokrajine Donji Kamenjak in Medulinski arhipelag, Istra, Hrvaška

OCENE IN POROČILA

RECENSIONI E RELAZIONI

REVIEWS AND REPORTS

Ines Mandić Mulec & Nives Ogrinc

Recenzija knjige: Mikrobna biogeokemija vod 263

Kazalo k slikam na ovitku 265

Index to images on the cover 265

GROWTH PATTERNS AND AGE STRUCTURE OF *MULLUS SURMULETUS* (MULLIDAE) FROM THE NORTHERN COAST OF TUNISIA (CENTRAL MEDITERRANEAN SEA)

Mourad CHÉRIF

Institut National des Sciences et Technologies de la Mer, port de pêche, 2025 La Goulette, Tunisia

Rimel BENMESSAOUD

Institut National Agronomique de Tunis, 43, Avenue Charles Nicolle 1082 -Tunis- Mahrajène, Tunisia

Christian CAPAPÉ

Laboratoire d'Ichtyologie, Université de Montpellier, 34095 Montpellier cedex 5, France
e-mail: christian.capape@umontpellier.fr

ABSTRACT

Age and growth of striped red mullet, *Mullus surmuletus* Linnaeus, 1758 were estimated using sagittal otoliths from specimens collected off the northern coast of Tunisia between January 2005 and December 2007. In the studied sample, the males outnumbered the females ($\text{♀}/\text{♂} = 0.56$). The age composition ranged from one to five years, and most specimens belonged to the one-year age group. The length-weight relationship displayed positive allometry for both sexes. The fit of the von Bertalanffy growth curve was significantly different between sexes ($p < 0.05$): $TL_{\infty} = 267.8$ mm, $k = 0.242$ year⁻¹, $t_0 = -1.343$ years for males and $TL_{\infty} = 284.1$ mm, $k = 0.293$ year⁻¹, $t_0 = -0.872$ years for females.

Key words: *Mullus surmuletus*, sex ratio, growth parameters, length–weight relationship, Tunisia

MODELLI DI CRESCITA E STRUTTURA D'ETÀ DI *MULLUS SURMULETUS* (MULLIDAE) DELLA COSTA SETTENTRIONALE DELLA TUNISIA (MEDITERRANEO CENTRALE)

SINTESI

L'età e la crescita della triglia di scoglio, *Mullus surmuletus* Linnaeus, 1758 sono state stimate utilizzando gli otoliti sagittali di esemplari raccolti al largo della costa settentrionale della Tunisia tra gennaio 2005 e dicembre 2007. Nel campione studiato, i maschi hanno superato le femmine ($\text{♀}/\text{♂} = 0,56$). La composizione per età variava da uno a cinque anni, e la maggior parte degli esemplari apparteneva al gruppo di età di un anno. La relazione lunghezza-peso ha mostrato un'allometria positiva per entrambi i sessi. L'adattamento della curva di crescita di von Bertalanffy era significativamente diverso tra i sessi ($p < 0,05$): $TL_{\infty} = 267,8$ mm, $k = 0,242$ anno⁻¹, $t_0 = -1,343$ anni per i maschi, e $TL_{\infty} = 284,1$ mm, $k = 0,293$ anno⁻¹, $t_0 = -0,872$ anni per le femmine.

Parole chiave: *Mullus surmuletus*, rapporto fra sessi, parametri di crescita, rapporto lunghezza-peso, Tunisia

INTRODUCTION

The striped red mullet *Mullus surmuletus* Linnaeus, 1758 is one of the main target species of demersal fisheries in Tunisia constituting about 3% of total catch of demersal fishes (anonymous, 2018). This species is mainly exploited by trawl fishery in southern areas and small-scale fleets in northern areas (Chérif, 2013). Several aspects of *M. surmuletus* biology have been studied, including feeding and reproduction (Chérif *et al.*, 2007a, 2008a, 2013). Only a preliminary study on the age and growth patterns of the striped red mullet in northern Tunisian areas was conducted based on a scales analysis (Gharbi, 1980). Similarly, several studies reported that otoliths are the most widely used because they have proven to be a reliable and valid method for age determination in mullid species (Mahé *et al.*, 2016; ICES, 2017. Carbonara *et al.*, 2018).

The purpose of this paper is to determine age from otolith readings and estimate the growth parameters from length-age values. Additionally, length-weight relationships of *Mullus surmuletus* are calculated for specimens from the northern coast of Tunisia. The results of the study could complement previous studies and help improve strategies and policies for a sustainable production in the area.

MATERIAL AND METHODS

The otoliths of *M. surmuletus* were monthly collected from specimens caught off the northern Tunisian coast (Fig. 1) between January 2005 and December 2007. The specimens were captured by commercial trawlers using a Tunisian shrimp trawl with a stretched-mesh size of 52 mm in the wing and 40 mm in the cod end (Chérif *et al.*, 2007b). After landing, the specimens were sorted by sex, their total length (TL) was measured to the nearest millimetre and total weight (TW) recorded to the nearest gram.

A total of 410 otoliths were used for ageing. Sagittal otoliths were removed, cleaned, and put in labelled envelopes with full information for further readings. All otoliths were placed in a concave black dish and examined using the reflected light of a binocular microscope at 10x magnification.

The length-weight relationship was described by the formula proposed by Ricker (1973): $W = aTL^b$, where (W) is the weight in grams, (TL) the total length in mm, (b) the growth exponent, and (a) is a constant. The hypothesis of isometric growth was tested using a t-test (Zar, 1999).

Growth was expressed in terms of the von Bertalanffy equation: $L_t = L_\infty (1 - e^{-K(t-t_0)})$, where (L_∞) is the asymptotic total length, (L_t) the total length at

age (t), (K) the growth curvature parameter, and (t_0) the theoretical age of fish at zero total length. For weight growth, the same function was used: $W_t = W_\infty (1 - e^{-k(t-t_0)})^b$, where (W_t) is the total weight, (W_∞) is the asymptotic weight, and (b) is the power constant of the length-weight relationship. The Fishpam software including the non-linear estimation method was used to estimate the growth parameters (Saila *et al.*, 1988).

RESULTS

Sample characteristics, sex ratio, and length-weight relationship (LWR)

Of the 818 examined specimens, 426 were females, 328 males, and 64 were unidentified. In the present sample females significantly outnumbered males (m/f= 0.56) 1:1 ($\chi^2=13.57$; df = 1; $P < 0.05$). The TL of the striped red mullet ranged from 66 mm to 262 mm and the weight from 4.56 g to 244.73 g. The TL of females ranged from 111

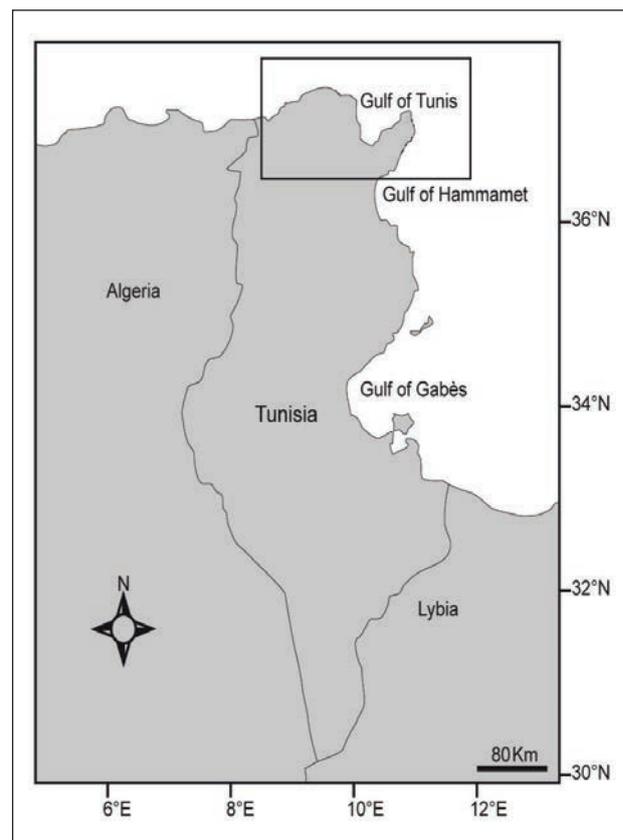


Fig. 1: Map of the Tunisian coast with a rectangle indicating the sampling area of *Mullus surmuletus*.

Sl. 1: Zemljevid tunizijske obale s pravokotnikom, ki označuje območje vzorčenja progastega bradača.

Tab. 1: Sample characteristics of *Mullus surmuletus* from the northern coast of Tunisia.

Tab. 1: Značilnosti vzorcev progastih bradačev s severne obale Tunizije.

Sex	Length (mm)			Weight (g)		
	Min	Max	Mean	Min	Max	Mean
Male	105	212	145.2	9.85	123.73	34.74
Female	111	262	160.6	9.41	244.73	49.01
Unsexed	66	175	120.1	4.56	57.97	20.58

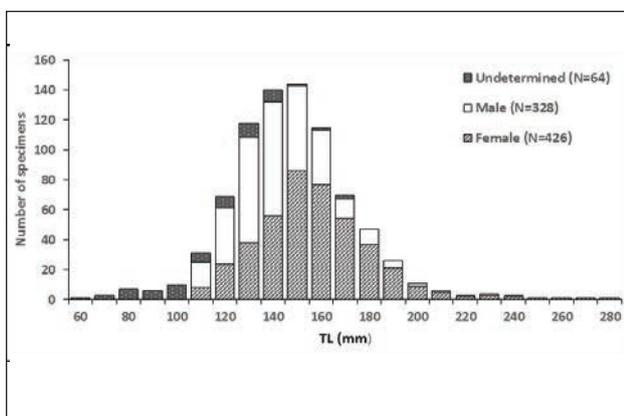


Fig. 2: Length-frequency distribution by sex of *Mullus surmuletus*.

Sl. 2: Dolžinsko-frekvenčna porazdelitev glede na spol progastih bradačev.

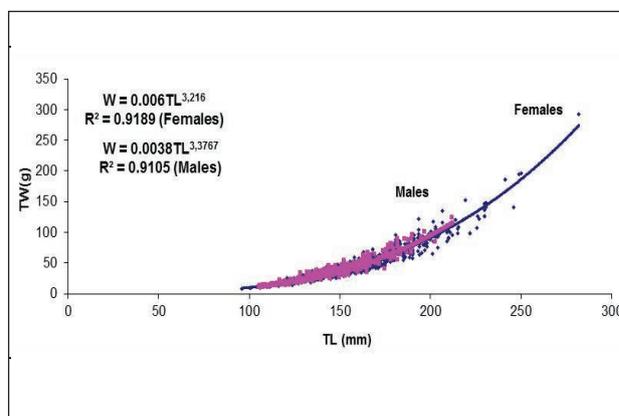


Fig. 3: Length-weight relationship of *Mullus surmuletus* (females and males).

Sl. 3: Razmerje med dolžino in težo progastih bradačev (samice in samci).

mm to 262 mm and the TL of males from 105 mm to 212 mm. The TW of females ranged from 9.41 g to 244.73 g and the TW of males from 9.85 g to 123.73 g (Tab. 1). The dominant length group was 130–160 mm, which represented 63.2% of all examined specimens (Fig. 2). Females prevailed in size classes larger than 150 mm, whereas males significantly outnumbered females in smaller size classes ($c_2 = 9.81$; $df = 1$; $P < 0.05$).

The length-weight relationship of *Mullus surmuletus*, as presented in Table 2 and Figure 3, indicated a positive allometry for males, females, and all specimens. The (b) coefficient was significantly different from 3 (t-test, $P < 0.05$). In addition, the (R^2) values for relationships among males, females, and all fish indicated a strong correlation between length and weight.

Age and growth

The age sample consisted of sagittal otoliths from 218 females, 104 males, and 88 fish of unidentified sex. Age estimates ranged from 1 to 5 years for males, females, and all specimens. Most of the fish, i.e., 90% of the total sample, were between 1 and 3 years old (Fig. 4). Specimens older than 4 years old were poorly represented in the sample.

The von Bertalanffy relationships between age and length, derived from the assumed annual periodicity of the growth increments, were described by the growth parameters (Tab. 3; Fig 4):

$TL_{\infty} = 267.8$ mm, $k = 0.242$ year⁻¹, $t_0 = -1.343$ years for males;

Tab. 2: Length-weight relationship parameters of *Mullus surmuletus*.**Tab. 2: Dolžinsko-masni parametri progastih bradačev.**

Equations	Sex	a	b	R ²	t-test	Allometry
$W = aTL^b$	♀	0.0061	3.216	0.9189	7.51	+
	♂	0.0038	3.3767	0.9105	9.13	+
	combined sexes	0.0036	3.3279	0.8922	11.09	+

Tab. 3: Age and growth parameters of *Mullus surmuletus* in the northern coast of Tunisia.**Tab. 3: Starostni in rastni parametri progastih bradačev na severni obali Tunizije.**

	Males (N = 104)	Females (N = 218)	All individuals (N = 410)
Age (years)	TL (mm) (Average + SD)	TL (mm) (Average + SD)	TL (mm) (Average + SD)
I	115.2±1.4	120.3±0.9	117.8±0.7
II	159.4±0.3	161.4±1.1	156.7±0.6
III	182.8±0.7	192.9±1.3	182.1±0.9
IV	199.3±0.2	216.8±1.5	206.1±1.9
V	210.6±0.9	233±0.8	221.8±1.4
Growth parameters (L_{∞}, W_{∞}, K and t_0)			
L_{∞} (mm)	267.8	284.1	274.6
K	0.242	0.293	0.271
t_0	-1.343	-0.872	-1.071
W_{∞} (gr)	251.8	283.5	269.96

$TL_{\infty}=284.1$ mm, $k=0.293$ year⁻¹, $t_0= -0.872$ years for females;

$TL_{\infty}=274.6$ mm, $k=0.271$ year⁻¹, $t_0= -1.071$ years for all individuals.

Females tend to grow slightly faster in length than males. The growth patterns by sex were similar up to the age of 1 year (group I), after that age, the females grew faster and attained a greater maximum length

than males (Fig. 6). Significant differences were found between the growth of males and females (t-test, $P < 0.05$).

DISCUSSION

The present sample, with the females significantly outnumbering males, is in total accordance

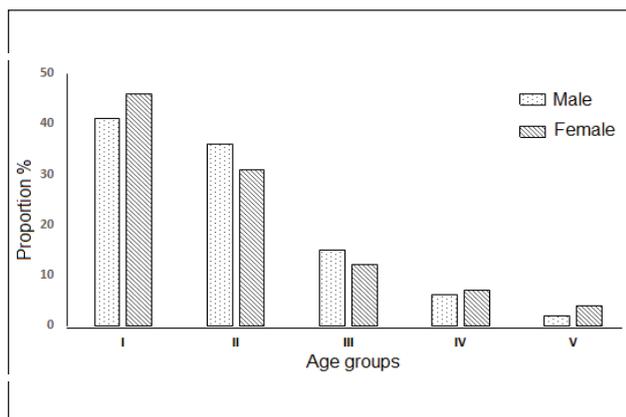


Fig. 4: Age group proportions for females and males of *Mullus surmuletus*.

Sl. 4: Razmerja starostnih skupin za samice in samce progastih bradačev.

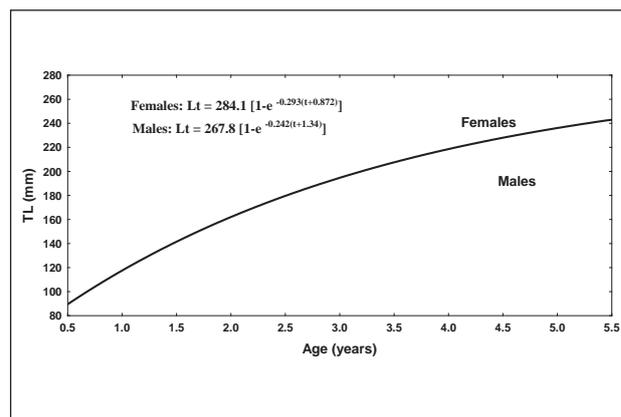


Fig. 5: The von Bertalanffy growth curve for females and males of *Mullus surmuletus*.

Sl. 5: Von Bertalanffyjeva krivulja rasti za samice in samce progastih bradačev.

with previous reports (Hashem, 1973; Gharbi & Ktari, 1981b; Pajuelo *et al.*, 1997; Amin *et al.*, 2016). Such pattern could be due to differences in the spatial distribution of males and females in the water column, as suggested by Lozano-Cabo (1983) and Caminias *et al.* (1990). It also appears that females are captured more frequently than males during fishing efforts because of the body shape dimorphism: females are heavier and fatter than males (N'Da *et al.*, 1993; Jabeur, 1999; Chérif *et al.*, 2007b).

The length-weight relationship of *M. surmuletus* in the northern area of Tunisia displays a positive allometric growth, showing that the species finds favourable conditions to develop and reproduce in the wild. The analyses of the LWR provided by several authors show, however, some differences in *b* values (Tab. 4). This variability in *b* values could be explained by many factors, such as food availability, environmental conditions, sampling methods, and the stage of maturity (Shepherd & Grimes 1983; Pauly, 1984; Chérif *et al.*, 2008b).

Males and females of *M. surmuletus* grew similarly in weight during the first year of life, after that age, the females grew faster and attained a greater maximum weight than males. This differential growth between sexes is attributed to differences in reproductive physiology and feeding behaviour (Ricker, 1975; Morey *et al.*, 2003; Chérif *et al.*, 2021). Mahé *et al.*, 2013 reported that the growth was important during the first year and slowed down thereafter. This reduction in the growth rate coincided with the age at first maturity, reflecting that the energy used for reproduction is no longer available for somatic growth (Pauly, 2010; Grabowska *et al.* 2011).

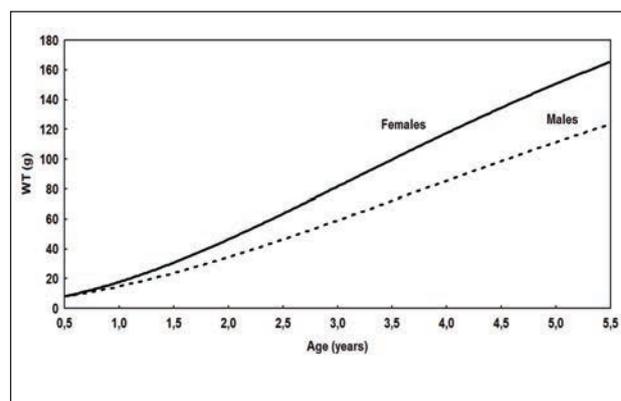


Fig. 6: Growth patterns for females and males of *Mullus surmuletus*.

Sl. 6: Rastni parametri za samice in samce progastih bradačev.

The use of whole sagittal otoliths for age determination concerning mullid species was considered to be the most suitable method and displaying the best results because the alternative pattern of translucent and opaque zones was easily distinguishable (Pajuelo *et al.*, 1997; Mahé *et al.*, 2012, 2013). Thus it was determined that the individuals sampled from the northern area of Tunisia belonged to age groups I–V. The specimens were mostly between 1 and 3 years old.

The growth rate of *M. surmuletus* recorded in this study is very similar to that reported for the same species in other areas (Tab. 4), except in the Catalonia region, where Andaloro (1981, 1982) and Sanchez *et al.* (1983) found that red

Tab. 4: Growth parameters (L_{∞} , t_0 and k) and the length-weight relationship (a and b) for *Mullus surmuletus* from different localities.**Tab. 4: Rastni parametri (L_{∞} , t_0 in k) in razmerje med dolžino in težo (a in b) za progaste bradače iz različnih lokalitet.**

Area	L_{∞} (mm)	t_0	K	a	b	Reference
Marmara Sea	328.3 TL	-2.13	0.23	0.0089	3.12	Moldur (1999)
Aegean Sea	278.2 TL	-2.16	0.2	0.0084	3.12	Mukadder & Ismen (2013)
Egyptian coast	317.4 TL	-0.30	0.47	0.0104	3.0617	Mehanna (2009)
Izmir Bay	278.5 TL	-1.58	0.19	0.0083	3.127	İlhan <i>et al.</i> (2009)
Edremit Bay	250.9 TL	-2.48	0.14	0.0044	3.35	Üstün (2010)
Mediterranean Sea	276 TL	0.39	0.27	-	2.925	Andalora (1981)
Catalan Sea	309.4 TL	3.85	0.11	-	-	Morales-Nin (1986)
Majorca	297.6 TL	-2.06	0.24	0.016	2.91	Morales-Nin (1991)
Majorca	312.8 TL	-2.35	0.21	0.009	3.12	Reñones <i>et al.</i> (1995)
Gulf of Gabés	212 TL (♀)	-0.65	0.43	710-6	3.12	Jabeur <i>et al.</i> (2000)
	226 TL (♂)	-1.07	0.27			
Gulf of Biscay	427 TL (♀)	0.641	0.28	-	-	N'Da <i>et al.</i> (2006)
	359 TL (♂)	0.74	0.30			
Gulf of Tunis	218.2 SL (♀)	-0.112	0.51	0.1403	3.351	Gharbi & Ktari (1981a)
	198.7 SL (♂)	-0.025	0.49	0.1443	3.28	
Catalonia	355.2 TL	-3.65	0.11	0.0073	3.1	Sanchez <i>et al.</i> (1983)
Canaries	357.1 TL	-1.84	0.22	0.0074	3.1826	Pajuelo <i>et al.</i> (1997)
English Channel	511.7 TL (♀)	-2.9	0.2	3,2810-6	3.24	Mahé <i>et al.</i> (2013)
	360.4 TL (♂)	-3.23	0.22			
Moroccan coast	392 TL	-3.21	0.3	0.0071	3.17	Bakali <i>et al.</i> (2016)
Northern Tunisian coasts	267.8 TL (♂)	-1.343	0.242	0.0061	3.216	Present study
	284.1 TL (♀)	-0.872	0.293	0.0038	3.376	
	274.6 TL (♂+♀)	-1.071	0.271	0.0036	3.327	

mullet can reach the age of 7. In that region, Andaloro and Giarritta (1985) and Reñones *et al.* (1995) recorded fish up to 6 years old, while Bougis (1952), Hashem (1973), and Morales Nin (1991) recorded them up to 3, 5, and 4 years old, respectively. According to Pajuelo *et al.* (1997), these age differences are attributable to

differences in the lengths of the largest fish sampled in the various studies and the selectivity of fishing gears. Finally, the results obtained from the current study provide much information that may be useful for stock assessment and optimal management in the study area and other regions of the Mediterranean Sea.

RASTNI PARAMETRI IN STAROSTNA STRUKTURA PROGASTIH BRADAČEV *MULLUS SURMULETUS* (MULLIDAE) IZ SEVERNE TUNIZIJSKE OBALE
(OSREDNJE SREDOZEMSKO MORJE)

Mourad CHÉRIF

Institut National des Sciences et Technologies de la Mer, port de pêche, 2025 La Goulette, Tunisia

Rimel BENMESSAOUD

Institut National Agronomique de Tunis, 43, Avenue Charles Nicolle 1082 -Tunis- Mahrajène, Tunisia

Christian CAPAPÉ

Laboratoire d'Ichtyologie, Université de Montpellier, 34095 Montpellier cedex 5, France
e-mail: christian.capape@umontpellier.fr

POVZETEK

Avtorji so ocenjevali starost in rast progastih bradačev, *Mullus surmuletus* Linnaeus, 1758, ujetih blizu severne tunizijske obale med januarjem 2005 in decembrom 2007 na podlagi sagitalnih otolitov. Samcev je bilo več kot samic ($\frac{\text{♀}}{\text{♂}} = 0,56$). Starostna struktura je bila od 1 do 5 let, pri čemer je glavnina primerkov pripadala starostni skupini v prvem letu. Dolžinsko-masni odnos je pokazal pozitivno alometrijo za oba spola. Prileganje von Bertalanffyjeve rastne krivulje se je med spoloma bistveno razlikovalo ($p < 0,05$): telesna dolžina $\infty = 267,8$ mm, $k = 0,242$ leto⁻¹, $t_0 = -1,343$ leta za samce in telesna dolžina $TL_{\infty} = 284,1$ mm, $k = 0,293$ leto⁻¹, $t_0 = -0,872$ leta za samice.

Ključne besede: *Mullus surmuletus*, razmerje med spoloma, rastni parametri, dolžinsko-masni odnos, Tunizija

REFERENCES

- Amin, A.M., F.F. Madkour, M.A. Abu-El-Regal & A.A. Moustafa (2016):** Reproductive biology of *Mullus surmuletus* (Linnaeus, 1758) from the Egyptian Mediterranean Sea (Port Said). *Int. J. Environ. Sci. Engin.*, 7, 1-10.
- Andaloro, F. (1981):** Contribution on the knowledge of the age and growth of the Mediterranean red mullet, *Mullus surmuletus* (L. 1758). *Rapp. Comm. int. mer Médit.*, 27(5), 111-113.
- Andaloro, F. (1982):** Résumé des paramètres biologiques sur *Mullus surmuletus* de la mer tyrrhénienne méridionale et de la mer ionienne septentrionale. *F.A.O. Fish. Rep.*, 266, 87-88.
- Andaloro F. & S. Prestipino Giarritta (1985):** Contribution to the knowledge of the age and growth of the striped mullet, *Mullus barbatus* (L., 1758) and red mullet, *Mullus surmuletus* (L., 1758) in the Sicilian Channel. *FAO Fisheries Report*, 336, 89-92.
- Anonymous (2018):** Annuaire des statistiques des produits de la pêche en Tunisie. Direction Générale de la Pêche et à l'Aquaculture (DGPA), 128 pp.
- Bakali, M.E.L., M. Talbaoui & A. Bendriss (2016):** Age structure and growth by otolith interpretation of *Mullus surmuletus* L. from the North-west Moroccan Mediterranean coast. *J. Biodiv. Environ. Sci.*, 9(3), 143-157.
- Bougis, P. (1952):** Recherches biométriques sur les Rougets (*Mullus barbatus* et *M. surmuletus* L.). *Archs Zool. expo gen.*, 89(2), 57-174.
- Caminas, J.A., J. Baro, J.C. Nunez & F. Ramos (1990):** Local Fishery Study of the Spanish South Mediterranean Region (between Punta Europa and Cabo de Gata). Third year. *Rep. IEOLEEC Collaboration Project XIV-B-111989/90*, 189 pp.
- Carbonara, P., S. Intini, J. Jerina, J. Kolutari, A. Joksimović, N. Milone, G. Lembo, L. Casciaro, L. Bitetto, W. Zupa, M. T. Spedicato, & L. Sion (2018):** A holistic approach to the age validation of *Mullus barbatus* L., 1758 in the Southern Adriatic Sea (Central Mediterranean). *Sci. Rep.* 8, Article number, 13219, 1-19
- Chérif, M., H. Gharbi, O. Jarboui, R. M'Rabet & H. Missaoui (2007a):** Le rouget de roche (*Mullus surmuletus* L. 1758) des côtes nord tunisiennes : reproduction, sexualité et croissance. *Bull. Inst. natn Sci. Technol. Mer, Salammbô*, 34, 9-19.
- Chérif, M., R. Zarrad, H. Gharbi, H. Missaoui, & O. Jarboui (2007b):** Some biological parameters of the red mullet, *Mullus barbatus* (L., 1758) from the Gulf of Tunis. *Acta Adriatica*, 48(2), 131-144.
- Chérif, M., S. Selmi, H. Gharbi, O. Jarboui & Missaoui (2008a):** Régime alimentaire du rouget de roche (*Mullus surmuletus* L., 1758) des côtes nord tunisiennes. *Bull. Inst. natn Sci. Technol. Mer, Salammbô*, 35, 39-47.
- Chérif M., R. Zarrad, H. Gharbi, H. Missaoui & O. Jarboui (2008b):** Length-weight relationships for 11 fish species from the Gulf of Tunis (SW Mediterranean Sea, Tunisia). *Pan-Amer. J. Aquat. Sci.*, 3(1), 1-5.
- Chérif, M., R. Benmassaoud, H. Missaoui & C. Capapé (2013):** The mullid species from Tunisian waters (Central Mediterranean Sea). *Inter. J. Eng. Appl. Sci.*, 4(2), 62-65.
- Chérif, M., R. Benmassaoud & C. Capapé (2021):** Age and growth parameters of the red mullet *Mullus barbatus* (Mullidae) from northern Tunisia. *Annales, Ser. Hist. nat.*, 31(2), 235-242.
- Gharbi, H. (1980):** Contribution à l'étude biologique et dynamique des rougets (*Mullus barbatus* Linnaeus, 1758 et *Mullus surmuletus* Linnaeus, 1758) des côtes tunisiennes. PhD Thesis, University of Tunis, Tunisia, 100 pp.
- Gharbi, H. & M.H. Ktari (1981a):** Croissance des rougets en Tunisie. *Bull. Inst. natn Sci. Tech. Océanogr. Pêche, Salammbô*, 8, 5-40.
- Gharbi, H. & M.H. Ktari (1981b):** Biologie de *Mullus barbatus* Linnaeus, 1758 et *Mullus surmuletus* Linnaeus, 1758 (poissons, téléostéens, mullidés) des côtes tunisiennes, taille et âge de première maturité sexuelle, cycle sexuel et coefficient de condition. *Bull. Inst. natn Sci. Tech. Océanogr. Pêche, Salammbô*, 8, 41-51.
- Grabowska, J., D. Pietraszewski, M. Przybylski, A.S. Tarkan, L. Marszał & M. Lampart-Kałużniacka (2011):** Life-history traits of Amur sleeper, *Perccottus glenii*, in the invaded Vistula River: early investment in reproduction but reduced growth rate. *Hydrobiologia*, 661, 197-210.
- Hashem, M.T. (1973):** Some biological studies on the goat fish (*M. surmuletus* L.) in the Egyptian Mediterranean waters. *Bull. Inst. Oceanogr. Fish.*, 13, 1-78.
- ICES. (2017):** Workshop on Ageing Validation methodology of *Mullus* species (WKVALMU), 15-19 May 2017, Conversano, Italy. *ICES CM 2017/ SS-GIEOM*, 31, 74 pp.
- İlhan, D.U., S. Akalin, O. Özeydin, Z. Tosunoğlu & R. Gurbet (2009):** Growth and reproduction of *Mullus surmuletus* L., 1758 in Aegean Sea. *Ege J. Fish. Aquatic Sci.*, 26(1), 1-5.
- Jabeur, C. (1999):** La pêche dans le golfe de Gabès : interaction techniques entre les métiers et exploitation partagée du rouget (*Mullus surmuletus* L., 1758). PhD Thesis, Université de Bretagne Occidentale Brest, France, 161 pp.
- Jabeur, C., H. Missaoui, H. Gharbi & A. El Abed (2000):** La croissance du rouget rouge (*Mullus surmuletus* L. 1758) dans le golfe de Gabès. *Bull. Inst. natn Sci. Technol. Mer, Salammbô*, 27, 35-43.
- Lozano-Cabo, F (1983):** Oceanografía, Biología Marina y Pesca. Madrid; Paraninfo, 391 pp.

- Mahé, K., R. Elleboode, C. Charilaou, A. Ligas, P. Carbonara & S. Intini (2012):** Striped red mullet (*Mullus surmuletus*) and red mullet (*M. barbatus*) otolith and scale exchange 2011. Ifremer, 30 pp.
- Mahé, K., F. Coppin, S. Vaz & A. Carpentier (2013):** Striped red mullet (*Mullus surmuletus*, Linnaeus, 1758) in the eastern English Channel and southern North Sea: growth and reproductive biology. J. Appl. Ichthyol., 29(5), 1067-1072.
- Mahé, K., A. Anastasopoulou, P. Bekas, P. Carbonara, L. Casciaro, C. Charilaou, R. Elleboode, N. Gonzalez, B. Guijarro, A. Indennitate, V. Kousteni, A. Massaro, Ch. Mytilineou, F. Ordines, M. Palmisano, M. Panfili & P. Pesci (2016):** Report of the striped red mullet (*Mullus surmuletus*) and red mullet (*Mullus barbatus*) Exchange 2016. Ifremer, 21 pp.
- Mehanna, S.F. (2009):** Growth, mortality and spawning stock biomass of the striped red mullet *Mullus surmuletus*, in the Egyptian Mediterranean waters. Medit. Mar. Sci., 10(2), 5-17.
- Moldur, S.E. (1999):** The Biology of Red Mullet (*Mullus surmuletus*, Linnaeus, 1758) Living in Northern Part of The Marmara Sea. Ph.D. Thesis, Firat University Graduate School of Natural and Applied Basic Sciences, 66 pp.
- Morales-Nin, B. (1986):** Age and growth of *Mullus barbatus* and *Mullus surmuletus* from the Catalan Sea. Rapp. proc. verb. com. int. Explor. sci. mer Médit., 30(2), 232.
- Morales-Nin, B. (1991):** Parametros biológicos del salmonete de roca *Mullus surmuletus* (L. 1758), en Mallorca. Bol. Inst. Espa. Oceanogr., 7(2), 139-147.
- Morey, G., J. Moranto, E. Massuti, A. Grau, F. Riera & B. Morales-Nin (2003):** Weight-length relationships of littoral to lower slope fishes from the western Mediterranean. Fish. Res., 62, 89-96.
- Mukadder, A & A. Ismen (2013):** Age, growth and reproduction of *Mullus surmuletus* (Linnaeus, 1758) in Saros Bay (Northern Aegean Sea) J. Black Sea/Medit. Environ., 19(2), 217-233.
- N'Da, K. & C. Deniel (1993):** Sexual cycle and seasonal changes in the ovary of the red mullet, *Mullus surmuletus*, from the southern coast of Brittany. J. Fish Biol., 43(2), 229-244.
- N'Da, K., C. Déniel C. & K. Yao (2006):** Croissance du rouget de roche *Mullus surmuletus* dans le nord du golfe de Gascogne. Cybium, 30, 57-63.
- Pajuelo, J.G., J.M. Lorenzo, A.G. Ramos & M. Mendez-Villamil (1997):** Biology of red mullet *Mullus surmuletus* (Mullidae) off the Canary Islands, central east Atlantic. South Afr. J. Mar. Sci., 18, 265-272.
- Pauly, D. (1984):** Length-converted catch curves: a powerful tool for fisheries research in the tropics (Part 2). Fishbyte, 2(1), 17-19.
- Pauly, D. (2010):** Gasping fish and panting squids: oxygen, temperature and the growth of water-breathing animals. Kinne, O., (Eds). Excellence in ecology. Book 22. International Ecology Institute, Oldendorf/Luhe, 216 pp.
- Reñones, O., E. Messuti, & B. Morales-Nin (1995):** Life history of the red mullet *Mullus surmuletus* from the bottom-trawl fishery off the Island of Majorca (north-west Mediterranean). Mar. Biol., 123(3), 411-419.
- Ricker, W.E. (1973):** Linear regressions in fishery research. J. Fish. Res. Board Canada, 30, 409-434.
- Ricker, W.E. (1975):** Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Bd Can., 191, 1-382.
- Saila, S.B., C.W. Recksiek & M.H. Prager (1988):** Basic Fishery Science Programs. A Compendium of Microcomputer Programs and Manual of Operation. Amsterdam; Elsevier, 230 pp.
- Sanchez, P., B. Morales-Nin & P. Martin (1983):** The mullets (*Mullus surmuletus* L. 1758, *Mullus barbatus* L. 1758) of the Catalan coast: biological and fishing aspects. ICES Doc. C.M. 1983/G, 27, 19 pp.
- Shepherd, G.R., & C.B. Grimes (1983):** Geographic and historic variations in growth of weakfish, *Cynoscion regalis*, in the Middle Atlantic Bight. Fish. Bull., 81, 803-813.
- Üstün, F. (2010):** An investigation on the biological aspects of striped red mullet (*Mullus surmuletus* L., 1758) in the Edremit Bay (North Aegean Sea), Turkey. PhD Thesis. Balıkesir University, 59 pp.
- Zar, J.H. (1999):** Biostatistical Analysis, 4th edn. Prentice-Hall, Newark, NJ. p + App. 663 pp.