



ON THE FECUNDITY OF THE SEABREAM, *Pagellus acarne* (RISSO, 1827) OF THE WESTERN MEDITERRANEAN SEA, ALGERIAN COASTS

BENSAHLA TALET LOTFI^{(1)*}, MOUFFOK SALIM^(1,2), BENSAHLA TALET AHMED^(1,3) & BOUTIBA ZITOUNI⁽¹⁾

(1) Laboratoire réseau de surveillance environnementale (LRSE).

Université d'Oran .31000-Algérie.

*Corresponding author e-mail : btlotfi77@hotmail.fr

(2) E-mail:halieutesalim@yahoo.fr

(3) E-mail :ahmedbensahla@yahoo.fr

ABSTRACT

The fecundity of the Seabream from the western Mediterranean (Algerian coast) was assessed by the volumetric method using 22 ovaries from females between 169 and 263 mm total length (206.62 ± 19.93). Estimates of total potential annual fecundity varied between 19875 and 49125 oocytes per female (29448.86 ± 8198.12). Relationships between total potential fecundity (F) and total length (Lt), total weight (Wt), gonad weight (Wg) were established using the multiplicative regression model and a significant correlation was found (ANOVA: $P < 0.01$).

Key words: Marine fisheries; Sparidae; Fecundity; Oran bay.

RESUMEN

Se evaluó la fecundidad de la dorada del Mediterráneo occidental (costa argelina) mediante el método volumétrico utilizando 22 ovarios de hembras entre 169 y 263 mm de longitud total ($206,62 \pm 19,93$). Las estimaciones del total de fecundidad potencial anual varían entre 19.875 y 49.125 ovocitos por hembra ($29448,86 \pm 8198,12$). Las relaciones entre la fecundidad potencial total (F) y la longitud total (Lt), peso total (WT) y peso de las gónadas (Wg) se establecieron mediante el modelo de regresión multiplicativo obteniendo correlación estadísticamente significativa (ANOVA: $P < 0,01$).

Palabras clave: pesca marítima; Sparidae; fecundidad; Bahía de Orán.



Reproductive biology of *Pagellus acarne* (Risso, 1927) (Teleostei: Sparidae) off western Algerian waters (Western Mediterranean)

Lotfi BENSAHLA TALET¹, Malika GHERRAM², Fatiha DALOUCHE², Ahmed BENSAHLA TALET²
and Zitouni BOUTIBA¹

(¹) *Laboratoire Réseau de Surveillance Environnementale (LRSE). University of Oran1 Ahmed Benbella.
Faculty of Natural Sciences and Life. Department of Biology. Oran, Algeria
E-mail: bensahla.lotfi@univ-oran.dz, btlotfi1977@gmail.com*

(²) *Laboratoire Aquaculture et Bioremediation (AQUABIOR). University of Oran1 Ahmed Benbella.
Faculty of Natural Sciences and Life. Department of Biology. Oran, Algeria*

Abstract: The reproduction of *Pagellus acarne* caught in Oran Bay was studied. The samples used were sorted monthly from commercial catches of coastal trawlers operating in this area from April 2008 to July 2009. The overall sex ratio was in favor of females 1:1.27 and length frequency distribution according to sex revealed that the females were highly representative beyond 20.5 cm of total length presuming a sexual inversion already described for this sparidae. The estimated lengths at maturity (L_m) were 12.8 cm for females and 16.0 cm for males. Two spawning periods were made out by the follow-up of the gonado and hepato somatic indexes: a spring period from April to June with a peak in May and an autumnal period, between November and January with a peak in December. The closed season in Oran Bay extends from 1st May to 31th August, which is to our opinion insufficient to safeguard the renewal of the resource and its spawning stock.

Résumé : *Biologie de la reproduction chez Pagellus acarne (Risso, 1927) (Teleostei : Sparidae) au large des côtes algériennes occidentales (Méditerranée occidentale).* L'étude a cerné le cycle reproducteur du pageot argenté *Pagellus acarne* pêché dans la baie d'Oran. Les spécimens provenaient mensuellement de la pêche chalutière commerciale entre avril 2008 et Juillet 2009. Le sex ratio était en faveur des femelles 1:1,27 et la distribution des fréquences de taille par rapport aux tailles des individus a révélé que les femelles étaient majoritaires au-delà de 20,5 cm de longueur totale reflétant sans doute le phénomène d'inversion sexuelle déjà décrit pour ce sparidé. La taille de première maturité sexuelle a été estimée à 12,8 cm pour les femelles et 16,0 cm pour males. Le suivi mensuel des indices gonado- et hépato-somatiques nous a permis de mettre en évidence deux périodes de ponte : l'une printanière d'avril à mai et la deuxième automnale entre novembre et décembre. La fermeture de la pêche au chalut s'étale du 1^{er} Mai au 31 Août, ce qui est de notre point de vue insuffisant pour préserver le renouvellement du stock reproducteur ainsi que celui de la ressource.

Keywords: *Pagellus acarne* • Oran Bay • Reproductive cycle • Sex-ratio • Spawning season • Size at first maturity.



Reproductive Biology of the Common Pandora *Pagellus erythrinus* (Linnaeus, 1758) of Oran Bay (Algerian west coasts)

Hadjer Mahdi^{1,*}, Lotfi Bensahla Talet¹, Zitouni Boutiba¹

¹ University of Oran, Ahmed Benbella, Laboratoire Réseau de Surveillance Environnementale (LRSE), Oran 31000, Algeria.

* Corresponding Author: Tel.: +213670317225 ; Fax: ;
E-mail: mahdihadjer@hotmail.fr

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Abstract

A reproductive study was conducted on 320 individuals of common Pandora *Pagellus erythrinus*, from Oran Bay providing information for a more understanding of the reproductive cycle. These specimens were sampled monthly during the landing of coastal fisheries among the whole samples, 86 (29.86%), were males and 202 (70.14%) were females. The monthly sex ratio showed significant differences between males and females. Females outnumbered males at size 16.5cm and 28.5cm. high gonad index values associated with advanced stages of maturity were observed in *P.erythrinus* females between April and July, less important values were recorded in October while size at first maturity L_{50} for females occurred at 12.5cm.

Keywords: Sparidae, Common Pandora, *Pagellus erythrinus*, Reproduction, Oran Bay.

Introduction

The common pandora, *Pagellus erythrinus* (Linnaeus, 1758), which belongs to the family of Sparidae, is a valuable species for aquaculture and fisheries (Metin, İlkyaz, Soykan, & Kinacigil, 2011). It is a gregarious demersal species living on rocky and muddy-sandy bottoms, between 20 and 300 m depth (Whitehead, Bauchot & Hureau 1986; Mytélino, 1989; Santos, Monteiro, & Erzini, 1995). It has been reported in the Black Sea, the Mediterranean Sea and the eastern Atlantic from Norway to Angola (Bonnet, 1969; Whitehead et al, 1986; Fischer et al, 1987; Fredj & Maurin, 1987; Froese & Pauly, 2014).

Investigations carried out in different Mediterranean areas showed that common pandora, preferably, inhabits on the continental shelf (Spedicato, Greco, Sophronidis, Lembo, Giordano, & Argyri, 2002). Depending on size, common pandora is widely distributed from shallow coastal waters to 300 m depth. (Orsi Relini & Romeo, 1985; Somarakis & Machias, 2002; Spedicato et al, 2002).

P. erythrinus is among the most captured species for the small-scale fishing fleet in many Mediterranean countries, playing an important role in the local micro economy by the volume of catches and by its high price (Ghorbel, 1996; Pajuelo, J.G., Lorenzo, J.M., Méndez-Villamil Nespereira, & Mata, M. 1996., Hoşsucu & Çakır, 2003). On the other

hand, this Sparidae is well known and appreciated also in the Japanese market which has been importing large quantities of Mediterranean pandora for many years (Tomiya, 1974). The result is that this Sparidae is currently severely overfished in several Mediterranean countries (Hadjistephanou, 1992; Ghorbel, 1996; Pajuelo et al, 1996).

Signs of overexploitation of the species standing stock have been reported in diverse Mediterranean geographical sub-areas (GSAs) (Vassilopoulou, & Papaconstantinou, 1986; Jarboui et al, 1998; Abella, Colloca, Sartor, & Mannini, et al, 2010; Mehanna 2011; Gurbet et al, 2012) and also in Sicilian waters (Fiorentino, Knittweis, Gancitano, Mifsud, Gravino, & Gristina, 2012). The current conservation legislation on fisheries sets the minimum size limit for this species at 150 mm TL (EU Regulation 1967/2006). Also in Algerian waters this length is the same (J.O.R.A.D.P, 2004).

Valdés, García-Alcázar, Abdel, Arizcun, Suárez, & Abellán (2004), reported that the common pandora is a suitable species for aquaculture in the Mediterranean and that the correct determination of the species spawning period is also very important. Spawning period, sex-ratio, GSI, length at first maturity and length weight relationship were studied in different regions such as, Aegean sea (Hossucu & Çakır, 2003 ; Metin, İlkyaz, Soykan, & Kinacigil, 2011), southern Portugal (Coelho, Bentes, Correia,

Weight-Length Relationships of Seven Fish Species (Teleostei: Sparidae, Mullidae, Carangidae) of Western Mediterranean Sea (Oran Bay, Algeria)

Lotfi Bensahla Talet^{1*}, Malika Gherram² and Ahmed Bensahla Talet²

¹University of Oran1 Ahmed BENBELLA Laboratoire Réseau de Surveillance Environnementale (L.R.S.E), Faculty of Natural Sciences and Life. Department of Biology. Es-sénia 31000 Oran Algeria

² University of Oran1 Ahmed BENBELLA. Laboratoire d'Aquaculture et de Bio remédiation (Aquabior), Faculty of Natural Sciences and Life, Department of Biology. Es-sénia, 31000 Oran. Algeria

*btlotfi77@hotmail.fr

Abstract - No information currently exists on the weight-length relationships of Sparidae: Axillary seabream *Pagellus acarne* (Risso, 1827), bogue *Boops boops* (Linnaeus, 1758); Mullidae: Red mullet *Mullus barbatus* (Linnaeus, 1758), surmulet *Mullus surmuletus* (Linnaeus, 1758) and Carangidae: Atlantic horse mackerel *Trachurus trachurus* (Linnaeus, 1758), Mediterranean horse mackerel *Trachurus mediterraneus* (Steindachner 1863), Blue jack mackerel *Trachurus picturatus* (Bowdich 1825), seven commercial fish species of Oran Bay in Western Mediterranean Sea. Data are presented for the first time for that region of the Mediterranean Sea to contribute and help comparative growth studies. Samples were collected from commercial catches at Oran Bay fisheries in Algeria. The values of the slope b in the length-weight relationship, $W=aL^b$ ranged from 2.841 to 3.296. The coefficients of correlation r^2 were comprised between 0.85 and 0.97. "a" and "b" parameters were compared with other fishing sites for the same fish species with Froese plot [$\log a=f(b)$].

Keywords: Weight-Length relationship; *Pagellus acarne*; *Boops boops*; *Mullus barbatus*; *Mullus surmuletus*; *Trachurus trachurus*; *Trachurus mediterraneus*; *Trachurus picturatus*; Oran Bay, Algeria.

1. Introduction

Oran Bay provides a significant proportion of the overall marine fish production in Algeria and is considered as one of the most important fishery grounds in Algerian coasts (Bensahla Talet and Boutiba, 2000). Sparidae, Mullidae and Carangidae are three fish families widely consumed by local people. In this study, we targeted seven species from those families: *Pagellus acarne*, *Boops boops*, *Mullus*

barbatus, *Mullus surmuletus*, *Trachurus trachurus*, *Trachurus mediterraneus* and *Trachurus picturatus* because they represent the most dominant species caught from Oran Bay.

Many studies have been already done concerning the weight-length relationships: 40 fish species from Greek waters (Moutopoulos and Stergiou, 2002); 39 species from Turkish waters (Sangun *et al.*, 2007). For Algerian

First record of invasive green algae *Caulerpa racemosa* var. *cylindracea* in Oran Bay (Western Alegria)

Hussein Kais Boumediene¹ & Bensahla Talet Lotfi^{2*}

¹University Oran1-Ahmed BENBELLA. Department of Biology. Faculty of Natural Sciences and Life. Oran 31000 - Algeria

²Laboratoire d'Aquaculture et Bioremédiation (AQUABIOR). University Oran1-Ahmed BENBELLA. Department of Biology. Faculty of Natural Sciences and Life. Oran 31000 - Algeria

*[E-mail: btlotfi77@hotmail.fr]

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Caulerpa racemosa var. *cylindracea* (hereafter *Caulerpa cylindracea*) was first reported in the Mediterranean Sea in 1926¹ in Tunisian waters and then in Tripoli harbor in Libya, in 1990. In late 90s it invaded the southern shore of Europe. In Algeria, this invasive species was reported for the first time in 2007², five years after it appeared about 450 km from the first site in the eastern part of the Oranian littoral. This situation required widespread monitoring of this invasive species all along 124 km of the coastline. More than 10 stations were patrolled and monitored since then, studied by scuba diving between the surface and 30 m depth.

The observations devoted to the distribution of *Caulerpa cylindracea* in Oran showed that specimens presented the same appearance with irregularly entangled branched stolons attached to the substrate by colorless rhizoids from which the name of the variety *cylindracea* was derived. Chronologically, the invasion direction seems to move from the bottom to the surface with an orientation from east to west, in the Oranian coastline. *In situ* observations confirmed high propagation speed of *Caulerpa* in the Oranian coastline where invasions were signaled in several stations. The seaweed was observed for the first time in late 2011 and early 2012 (*pers.obs*) in Arzew Gulf (Cap Carbon) at the extreme east of the littoral, where the first fronds were noticed. Then it extended geographically to the center of the coastline, in Kristel, early 2013. In 2014, it was observed in Ain Turc and Cap Falcon. In 2015, it was observed in the western shoreline near Bousfer beach and in 2016 it reached the "Plane" island (Paloma).

This alien species was encountered at depths ranging from a few centimeters in microcuvettes up to 37 m, on various substrates (hard, sandy, muddy) between marine phanerogams rhizomes and, also between the lower mid-littoral and infra-littorals superior algae, with *Posidonia oceanica* herbarium. The study suggested a strong need for scientific monitoring and management program, using optimized methods like biological control or manual eradication for controlling the invasion.

[Keywords: Invasive algae, *Caulerpa cylindracea*, Oran coastline, Algeria]

Introduction

Caulerpa racemosa var. *Cylindracea* hereafter referred to as *C. Cylindracea* is an exotic species (sometimes also referred to as an alien, introduced, non-indigenous or non-native species), gets introduced intentionally or unintentionally after having established a population and spreading wild in the new host region³. This species, native of south-western Australia, was described for the first time in Tunisian waters¹ and then in Libyan waters⁴. But the invasion danger represented by *Caulerpa racemosa* was pointed in early 90s^{5,6,7}.

In its original habitat, this species lives in balance with its natural environment and its population is controlled by several ecosystem interactions, such as predation, parasitism, and diseases. However, this species can immediately settle in a new environment

and become invasive, causing biological disturbance in the marine coastal ecosystems^{8,9,10}.

In Algeria, since 2007, *Caulerpa cylindracea* has been mainly located in the central region of the Algerian coast, where it covers a wide variety of substrates ranging from mud to rocky bottoms². It was reported at different depths during phytosociological follow-up of macrophyte populations in different coastal zones of Algiers area and became widely spread in Algiers Bay in a very short time^{2,11,12}.

C. cylindracea was first identified in Bou-Ismaïl in 2006², Bordj El Kiffan in the East of Algiers¹¹, and in different areas of Algiers coast¹². On the Algerian west coast, this algae was reported in Mostaganem^{13,14} by the presence of several stands in the Gulf of Arzew, Stidia, and near the port of Salamandre at the West of Mostaganem.

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SPAWNING PERIOD, SIZE AT FIRST SEXUAL MATURITY AND SEX RATIO OF THE ATLANTIC HORSE MACKEREL *TRACHURUS TRACHURUS* FROM BÉNI-SAF BAY (WESTERN COAST OF ALGERIA, SOUTHWESTERN MEDITERRANEAN SEA)

Khaled RAHMANI & Fatiha KOUDACHE

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

Nasr Eddine Riad MOUEDDEN

University center Belhadj Bouchaib of Ain Temouchent, 46300, Algeria

Lotfi BENSABLA TALET

University Oran 1 Ahmed Benbella, Faculty of Natural Sciences and Life, 31000 Oran, Algeria

Roger FLOWER

Department of Geography, University College London, Pearson Building, Gower Street, London WC1E 6BT, UK

ABSTRACT

Reproduction characteristics of the Atlantic horse mackerel, Trachurus trachurus (Linnaeus, 1758), from Béni-Saf Bay were investigated. A total of 355 specimens were sampled between November 2015 and October 2017, comprising 47.04 % males, 44.79 % females and 8.17 % undetermined. The length of individuals ranged between 7.2 and 35.4 cm, and the weight from 5.28 to 312.7g. The length at first sexual maturity was evaluated at 15.6 cm for males and 14.9 cm for females. Variations in gonado-somatic index (GSI) showed that gonads of both sexes started to develop in late February and reached sexual maturity in May-June, which marks the spawning period of the species. T. trachurus from Béni-Saf Bay uses nutritional reserves mainly accumulated in spring to develop their sexual products for spawning in early summer.

Key words: Atlantic horse mackerel, *Trachurus trachurus*, reproduction, Béni-Saf Bay, Algeria

PERIODO DI RIPRODUZIONE, DIMENSIONE ALLA PRIMA MATURITÀ SESSUALE E RAPPORTO TRA SESSI NEL SUGARELLO *TRACHURUS TRACHURUS* NELLA BAIA DI BÉNI-SAF (COSTA OCCIDENTALE ALGERINA, MEDITERRANEO SUD-OCCIDENTALE)

SINTESI

Gli autori hanno studiato le caratteristiche della riproduzione del sugarello, Trachurus trachurus (Linnaeus, 1758), proveniente dalla baia di Béni-Saf. Un totale di 355 individui sono stati campionati tra novembre 2015 e ottobre 2017, con il 47,04 % di maschi, il 44,79 % di femmine e l'8,17 % di indeterminati. La lunghezza degli individui variava da 7,2 a 35,4 cm, e il peso da 5,28 a 312,7 g. La lunghezza alla prima maturità sessuale è stata valutata a 15,6 cm per i maschi e 14,9 cm per le femmine. Le variazioni dell'indice gonado-somatico (GSI) hanno mostrato che le gonadi di entrambi i sessi hanno iniziato a svilupparsi a fine febbraio e hanno raggiunto la maturità sessuale a maggio-giugno, il che evidenzia il periodo di riproduzione della specie. I sugarelli della baia di Béni-Saf utilizzano le riserve nutrizionali accumulate principalmente in primavera per sviluppare i loro organi sessuali per la deposizione delle uova all'inizio dell'estate.

Parole chiave: sugarello, *Trachurus trachurus*, riproduzione, baia di Béni-Saf, Algeria

On a New Occurrence of the Invasive Grapsid Crab, *Percnon gibbesi* (H. Milne Edwards, 1853) (Crustacea: Decapoda: Percnidae) in Oran Bay (Northwestern Algeria)

Kais Boumediene HUSSEIN¹, Lotfi BENSATLA-TALET^{2*}, Ahmed BENSATLA-TALET²

¹ University Oran1. Ahmed BENBELLA, Faculty of Natural Sciences and Life, Department of Biology. Laboratory Réseau de Surveillance Environnementale (LRSE). 31000 Oran, Algeria.

² University Oran1. Ahmed BENBELLA, Faculty of Natural Sciences and Life, Department of Biology. Laboratory of Aquaculture and Bioremediation (AQUABIOR). 31000 Oran, Algeria.

*Corresponding author: bensatlatalet.lotfi@univ-oran1.dz / btlotfi1977@gmail.com

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Abstract

Percnon gibbesi is an invasive crab reported for the first time from Linosa Island and the Balearic Islands. This grapsid crab is the most invasive decapod species to enter the Mediterranean Sea. It was first recorded in 1999 and has since spread from Spain to Turkey. In this paper, we report the first record in Oran coasts, where it probably established in « la Madrague beach » in winter of 2017 after its establishment in eastern and central Algerian waters since 2008.

Keywords: Occurrence, *Percnon gibbesi*, alien species, Oran Bay, Algeria

İstilacı Grapsid Yengeci *Percnon gibbesi* (H. Milne Edwards, 1853) (Crustacea: Decapoda: Percnidae)'nin Oran Körfezi'ndeki (Kuzeybatı Cezayir) ilk gözlem kaydı

Özet

Percnon gibbesi, ilk kez Linoz Adası ve Balear Adaları'nda görülmüş olan istilacı bir yengeçtir. Bu grapsid yengeç, Akdeniz'de yayılım gösteren en istilacı Decapoda türüdür. İlk kez 1999 yılında kaydı verilen bu tür o zamandan günümüze kadar İspanya'dan Türkiye'ye kadar yayılım göstermiştir. 2008 yılında Doğu ve Orta Cezayir sularında (muhtemelen 2017 kışında) görülen bu türün, Oran « la Madrague Beach » kıyılarındaki ilk kaydı bu makalede rapor edilmiştir.

Anahtar kelimeler: İlk kayıt, *Percnon gibbesi*, istilacı tür, Oran Körfezi, Cezayir

INTRODUCTION

Percnon gibbesi is native to the Pacific (California to Chile) and Atlantic (Florida to Brazil) coasts of the Americas, and the Atlantic coast of Africa (Madeira, the Azores, the Cape Verde Islands and the coast of Africa from Morocco to Ghana and offshore islands in the Gulf of Guinea) (Manning & Holthuis, 1981). Reconstituting *P. gibbesi* invasion Katsanevakis et al., 2011 stated that it was first recorded in the Mediterranean Sea in 1999 in Linosa Island (Sicily Strait), southeastern Sicily, and the Balearic Islands (Relini et al., 2000; Garcia and Reviriego, 2000; Müller, 2001; Mori and Vacchi, 2002). Since then, its population in the Mediterranean Sea has expanded rapidly.

In Algeria, it was first reported in Collo (Skikda district) in 2010 (Katsanevakis et al., 2011) also in Algiers, in the localities of Rais Hamidou and Sidi Fredj by Lamouti (2010) in central Algerian waters and then in Eastern Algerian waters Bada and Derbal (2018), Menail et al. (2019) add to this our first record for northwestern Algerian waters.

The first sighting of *P. gibbesi* in Algerian shallow waters dates back to 2008 in the region of Jijel (Noël and Prouzet, 2017). This crab frequented the Oranian coasts probably the winter of 2017. Herbivorous more or less strict, this stealth crab is active during the day. It frequents rocky shores, ports, and marinas where it hides in cracks or under stones up to -30 m deep. Generally, its shell is slightly longer than wide, and the maximum length observed in la Madrague was a specimen of 16 cm.

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GONADAL DEVELOPMENT OF BOGUES, *BOOPS BOOPS* (LINNAEUS, 1758), FROM ORAN BAY (TELEOSTEI, SPARIDAE)

Fatiha DALOUCHE, Lotfi BENSABLAH-TALET, Sidi Mohamed El Amine ABI AYAD & Ahmed BENSABLAH-TALET
Laboratoire Aquaculture et Bioremediation (*AquaBior*). University Oran1 Ahmed Benbella. Faculty of Natural Sciences and Life.
Department of Biology. Oran-Algeria
e-mail: btlotfi1977@gmail.com

ABSTRACT

Our study aims to investigate the reproductive cycle of Boops boops caught in Oran Bay. The samples were received monthly from commercial catches of coastal trawlers operating in this area from January 2016 to December 2017. The overall sex ratio was in favor of females and the length frequency distribution according to sex revealed that females were predominant beyond 14 cm of total length, presuming the beginning of the sexual inversion already described for this Sparidae species. The spawning period was established based on the follow-up of the gonado-somatic index, and appeared to last from February to late June with a peak in the March-April period. Our findings can contribute to a better understanding of the reproductive cycle of this species and help adopt measures toward a more adequate stock management of the most abundant sparid that is landed daily in many Mediterranean and Algerian fisheries.

Key words: *Boops boops*, reproductive cycle, spawning season, size at first maturity, Oran, Algeria

SVILUPPO GONADALE DELLA BOGA, *BOOPS BOOPS* (LINNAEUS, 1758) NELLA BAIA DI ORANO (TELEOSTEI, SPARIDAE)

SINTESI

Lo studio si propone di indagare il ciclo riproduttivo degli esemplari di Boops boops catturati nella baia di Orano. I campioni mensili provenivano dalle catture commerciali dei pescherecci costieri operanti in quest'area, da gennaio 2016 a dicembre 2017. Il rapporto tra i sessi è risultato a favore delle femmine e la distribuzione della frequenza della lunghezza in base al sesso ha rivelato che le femmine erano predominanti oltre i 14 cm di lunghezza totale, presumendo l'inizio dell'inversione sessuale già descritta per questa specie di sparidi. Il periodo di riproduzione è stato stabilito sulla base del follow-up dell'indice gonado-somatico e sembra durare da febbraio a fine giugno, con un picco nel periodo marzo-aprile. Tali risultati possono contribuire a una migliore comprensione del ciclo riproduttivo di questa specie e aiutare ad adottare misure per una gestione più adeguata dello stock dello sparide più abbondante, che viene sbarcato quotidianamente in molte zone di pesca del Mediterraneo e dell'Algeria.

Parole chiave: *Boops boops*, ciclo riproduttivo, stagione di deposizione delle uova, taglia alla prima maturità, Orano, Algeria

A new maximum length of the spotted weever, *Trachinus araneus* Cuvier, 1829 (Perciformes: Trachinidae) from Western Mediterranean (Oran Bay)

Lotfi BENSANHLA-TALET and Ahmed BENSANHLA-TALET

University Oran1. Ahmed BENBELLA, Faculty of Natural Science and Life,
Department of Biology, 31000-Oran, Algeria

***Corresponding author: bensahlatalet.lotfi@univ-oran1.dz**

On the 29th of October 2018, one specimen of the spotted weever, *Trachinus araneus* measuring 47.3 cm in total length and weighting 968 g was captured by trammel net operating in Oran Bay (Kristel fishery) Western Algerian coast at 100 m depth. Up to date, this length is a new record of maximum length reached for this trachinid in the Mediterranean basin.

Key words: The spotted weever, *Trachinus araneus*, maximum size, Oran Bay, Mediterranean Sea

INTRODUCTION

The maximum observed length of individuals of certain fish species is a useful information for a rapid evaluation of growth rates in the absence of basic data (LEGENDRE & ALBARET, 1991; FROESE and BINOHLAN, 2000; AKYOL *et al.*, 2007). Maximum length and maximum weight are important theoretical parameters in fisheries science. Directly or indirectly, these measurements enter in most of the models used in stock assessments. In this sense, updating the maximum size of a species that might be commercially exploited in the future, gains importance (BORGES, 2001).

The spotted weever *Trachinus araneus* is a member of Trachinidae family found in the eastern Atlantic, from Morocco to southern Angola. Its range extends north into the Mediterranean, and along the Atlantic coast of Europe

to southern Portugal (CARPENTER *et al.*, 2015). It is particularly abundant in the eastern Mediterranean. It lives in the shallow waters on sandy and sandy-muddy detrital bottoms, up to about 100 m deep, burrowing into the substrate. It feeds on small fish and crustaceans (FROESE & PAULY, 2018).

It is a venomous species that commonly reaches between 10 and 30 cm in total length, with a maximum of 45 cm in the Mediterranean and between 15 to 20 cm with a maximum of 36 cm in the Black Sea (BAUCHOT and HUREAU, 1986).

It appears to be both common and abundant, particularly in the eastern Mediterranean. This species is taken as bycatch in demersal trawl fisheries and is sometimes marketed. This species is likely found in marine protected areas throughout its range. Therefore, *T. araneus* is assessed as Least Concern (CARPENTER *et al.*, 2015).

A PRELIMINARY STUDY ON MACRO-LITTER POLLUTION ON BEACHES ALONG AÏN EL TURK BAY (WESTERN MEDITERRANEAN)

NOUREDDINE BENAÏSSA¹, FATMA ZOHRA HADDAD¹, AHLEM AMINA TALEB BENDIAB¹, LOTFI BENSATLA-TALET^{2*}, AHMED HAMOU³, ALEXANDRU DIMACHE⁴

¹ University Oran1 Ahmed BENBELLA, Faculty of Natural Sciences and Life, Department of Biology, Environmental Monitoring Network Laboratory (LRSE), 31000 Oran-Algeria

² University Oran1 Ahmed BENBELLA, Faculty of Natural Sciences and Life, Department of Biology, Laboratory of Aquaculture and Bioremediation (AQUABIOR), 31000 Oran-Algeria

³ University Oran1 Ahmed BENBELLA, Faculty of Exact and Applied Sciences, Laboratory for Study of Environmental Sciences and Materials (LESEM), 31000 Oran-Algeria

⁴ Technical University of Civil Engineering of Bucharest, Faculty of Hydrotechnics, Bucharest-Romania
corresponding author*:btlotfi1977@gmail.com

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Abstract. Marine anthropogenic litter is one of the most important environmental problems that affect directly and indirectly all marine ecosystems. A lot of efforts are made to reduce the litter pollution in oceans, and, in this way, to reduce their negative effects on the marine biota. This study provides information about the quantities of marine litter found on 10 beaches situated along the occidental coast of Algeria. A total of 14537 items were collected throughout Ain El Turk beaches. From this litter, 93% were plastics and the remaining 7% were represented by rubber, glass and metal. The results highlight a heterogeneous distribution along the coastal beaches, with higher concentrations at some beaches rather than others, as well as the west coast, which seems more affected compared to the east coast. We notify that the litter has the tendency to accumulate in the upper levels of the beach, which confirms that these beaches are exposed to litter from land-based sources rather than from maritime activities.

Key words: Pollution, Macro-litter, Coastline, Beaches, Oran Bay

1. INTRODUCTION

Marine litter is a human-created waste, transported by wind and rivers into the sea and on beaches. It is defined as "any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment" (UNEP/PAM/MEDPOL, 2009). The problem of plastic waste first appeared in the 1950s, when massive production of plastic began, and then it became one of the most significant global environmental problems. Plastics are a major component of this waste dumped in the environment; it becomes the dominant category of litter present especially in the marine environment. Plastic debris has been detected in all major marine environments

worldwide, from shorelines and surface water to the deepest parts of the ocean, even at the bottom of the Mariana Trench (WWF, 2018). The UNEP/WHO/IAEA (1988) report estimates that only 15% of the waste is floating on the surface of the sea, 15% is hovering in the water column, and 70% is on the sea bottom. Since 2000, the world has produced as much plastic as all the preceding years combined (WWF, 2019). Beaches are subject to several threats both from land and from the sea, the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP, 2019) estimating that land sources account for up to 80% of world sea pollution, of which 60% to 95% is plastic waste (Kurtela & Antolović, 2019). Fishing activities (Tschernij & Larsson, 2003),